Inflation in Emerging and Developing Economies
Evolution, Drivers, and Policies

Editors
Jongrim Ha, M. Ayhan Kose, and Franziska Ohnsorge

http://www.worldbank.org/inflation
Many emerging market economies experienced a remarkable decline in inflation rates over the last two decades, after years of seemingly intractable high inflation. Ha, Kose, and Ohnsorge offer the first book-length analysis of this remarkable achievement, asking how it happened, what it tells us about best policy frameworks, and whether it will endure. At a time when global financial conditions pose a challenge to emerging-market currencies and monetary policies, this book is an essential guide to the road ahead. All students of the global economy will want to read it carefully.

Maurice Obstfeld
Economic Counsellor and Director of Research
International Monetary Fund

A remarkable resource for anyone interested in inflation in the modern world, clear and easy to follow. This book is an order of magnitude more comprehensive than anything else out there, not only in its country coverage, but in its exploration of all the major issues and debates surrounding inflation. Curiously, most of the existing academic literature has focused on advanced economies—which are also thoroughly covered here—yet there is so much to be learned from the dramatic inflation decline in emerging markets and low-income economies, including for design of advanced economy institutions. Any student, academic researcher or policy economist who wants to understand the big picture on world inflation, and when and where it might surprise in the future, will find this book fascinating.

Kenneth Rogoff
Thomas D. Cabot Professor of Public Policy and Professor of Economics
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This is an important and timely contribution to our understanding of inflation and the causes of the synchronized decline in the second half of the 1990s around the world. Compared to previous research, it distinguishes specific features of the inflation process in advanced economies, emerging market and developing economies, and low-income countries. It provides many policy insights such as discussions on anchoring inflation expectations and the determinants of exchange rate pass-through, two central issues for price stability. The book reminds us that achieving low inflation does not imply that the risks of high inflation have disappeared and presents policy lessons to achieve and maintain price stability. I am certain that this would be a valuable reference for scholars and policymakers.

José De Gregorio
Dean of the School of Business and Economics, Universidad de Chile
Former Governor of the Central Bank of Chile
Advance Praise for *Inflation in Emerging and Developing Economies*

This book tackles important issues that have received far less attention than they deserve—what drives inflation in emerging and developing economies, what effects it has on the populations of these economies, and how the scourge of high inflation can be conquered. The book is rich in data, analysis, and useful policy prescriptions, all of which are woven together in a masterful and thoughtful way that makes it a very useful reference source for academics and policymakers alike.

**Eswar Prasad**
Tolani Senior Professor of Trade Policy
Cornell University

This is a truly monumental work, incorporating pathbreaking data collection, a comprehensive survey of the literature, all viewed through the lens of new empirical methods. The volume represents a much-needed compilation of the research on inflation dynamics and broader economic effects, with special reference to emerging market and low-income country experiences that have heretofore been largely neglected. This will be the reference on the phenomenon of inflation for years to come.

**Menzie Chinn**
Professor of Public Affairs and Economics
University of Wisconsin at Madison
Inflation in Emerging and Developing Economies

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Abbreviations

AE advanced economy
BCB Central Bank of Brazil
BCC Central Bank of Chile
CBI central bank independence and transparency index
CGE computable general equilibrium model
CMA commodity-importing EMDEs
CPI consumer price index
CXA commodity-exporting EMDEs
DSGE dynamic stochastic general equilibrium model
EAP East Asia and Pacific
ECA Europe and Central Asia
ECB European Central Bank
ECM error correction model
EMDE emerging market and developing economy
ERPTR exchange rate pass-through ratio
FAVAR factor-augmented vector autoregressive model
G7 Group of Seven Countries
GDP gross domestic product
GNI gross national income
GTAP Global Trade Analysis Project
GVC global value chains
IMF International Monetary Fund
IT inflation targeting
LAC Latin America and the Caribbean
LIC low-income country
MNA Middle East and North Africa
NBP National Bank of Poland
NEER nominal effective exchange rate
OECD Organisation for Economic Co-operation and Development
OLS ordinary least squares
OPEC  Organization of the Petroleum Exporting Countries
PPI    producer price index
RHS    right-hand side (in figures)
SAR    South Asia region
SSA    Sub-Saharan Africa
SVAR   structural vector autoregressive model
UNCTAD United Nations Conference on Trade and Development
VAR    vector autoregressive model
WTI    West Texas Intermediate
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In the 1970s inflation became a severe problem of global dimensions. Following remarkable stability in the 1960s, prices rose sharply in 1973 and 1974. ... The inflationary surge helped provoke the global recession of 1974-75... The developing countries did not pass through these economic disruptions unscathed. Global inflation swept them along, even regions with traditions of price stability experienced high domestic inflation rates.

Bruce K. MacLaury (1981)

There are forces in the global economy today that are conspiring to hold inflation down. Those forces might cause inflation to return more slowly to our objective. But there is no reason why they should lead to a permanently lower inflation rate.

Mario Draghi (2016)
Motivation

The global economy has witnessed a remarkable decline in inflation over the past four to five decades. Inflation has fallen around the world, with median annual national consumer price inflation down from a peak of nearly 17 percent in 1974 to about 1.7 percent in 2015—the lowest level in almost half a century (Figure 1). Among advanced economies, median inflation has similarly dropped to its lowest level—0.3 percent—from its highest—15 percent—over the same period.

Encouragingly, emerging market and developing economies (EMDEs) have also experienced an extraordinary decline in inflation over the same time frame: after peaking in 1974 at 17.3 percent, inflation in these economies has declined to 3.5 percent in 2017—only marginally up from its lowest level in the period, 2.7 percent, reached in 2015. Despite a checkered history of managing inflation among many EMDEs, disinflation occurred across all regions, including those with a history of persistently high inflation, such as Latin America and Sub-Saharan Africa. Even among low-income countries (LICs), inflation has fallen by two-thirds since the mid-1970s, to 5 percent in 2017.

Although the “near-universal” character of the decline in inflation since the mid-1970s was recognized at an early stage by Rogoff (2003), research has almost exclusively focused on low inflation in advanced economies. Numerous studies have analyzed the sources of low inflation, its highly synchronized nature, and its policy implications for these economies. To date, however, no comprehensive study has explored the evolving dynamics of inflation in EMDEs. This book fills that critical gap with the following contributions:

- **A comprehensive analysis of inflation in EMDEs and LICs.** Seven chapters analyze the recent history of inflation among EMDEs, including its evolution, its synchronization across countries, the global and domestic sources of inflation, and the roles of expectations and exchange rate pass-through. In addition, the book also presents a detailed examination of inflation and monetary policy-related challenges in LICs and assesses their implications for development outcomes.

- **A truly global dataset.** By assembling a database that includes the largest sample of countries of any major inflation study, this research is enriched by
FIGURE 1 Evolution of inflation

Global inflation declined from a peak of nearly 17 percent (annual average) in 1974 to 2.6 percent in 2017. The decline was broad-based, across country groups and inflation measures, but began somewhat earlier in advanced economies than in EMDEs and LICs. The recent low and stable global inflation environment resembles those of the Bretton Woods fixed exchange rate system in the post-war period up to the early 1970s, and the gold standard of the early 1900s.

A. Global core and headline CPI inflation

B. Global PPI, CPI, and GDP deflator inflation

C. Inflation in advanced economies and EMDEs

D. Inflation distribution in EMDEs

E. Inflation in LICs

F. Inflation and inflation volatility

A. Median headline and core year-on-year inflation for 41 economies, including 16 EMDEs (see details in Database Annex).
B. Median producer price (PPI), consumer price (CPI) and GDP deflator year-on-year inflation for 39 economies, including 22 EMDEs.
C. Median year-on-year consumer price inflation for 29 advanced economies and 123 EMDE (including 28 LICs).
D. Sample includes 27 advanced economies and 50 EMDEs. Refers to year-on-year inflation.
E. Solid line shows median year-on-year headline inflation and dotted lines refer to interquartile range, based on 28 LICs.

Click here to download data and charts.
information that is considerably more representative of “global inflation” than earlier work, which relied predominantly on advanced economy data. The database further covers multiple measures of inflation, and macroeconomic and structural country features over almost five decades.

- **Use of cutting-edge methodologies.** The study examines EMDE inflation using cutting-edge empirical methodologies that have thus far mostly been employed in studies of inflation in advanced economies. A variety of time-series and panel econometric models are complemented by event studies, case studies, and historical comparisons that shed additional light on the topics under consideration.

**Why does inflation matter?**

High inflation is often associated with lower growth and financial crises (IMF 2001; Mishkin 2008). Rising price levels are further linked to weaker investor confidence, undercut incentives to save, and erode financial and public sector balance sheets. Moreover, the damage of high inflation can fall disproportionately on the poor, since poorer households are more reliant on wage income, have less access to interest-bearing accounts, and are unlikely to have significant holdings of financial or real assets apart from cash. For these reasons, low and stable inflation has been associated with better growth and development outcomes, financial stability, and poverty reduction.¹

**Key findings and policy messages**

The book offers a range of analytical findings and policy messages. A recurring theme are the benefits of stability-oriented and resilient monetary policy frameworks, including central bank transparency and independence. Such policy frameworks need to be complemented by strong macroeconomic and institutional arrangements. For many EMDEs, measures to strengthen monetary policy frameworks, and macroeconomic policy frameworks more broadly, are particularly urgent. The book documents that inflation expectations are more weakly anchored in EMDEs than in advanced economies and that, in EMDEs that do not operate inflation targeting frameworks, exchange rate movements tend to have larger and more persistent effects on inflation.

¹ Extremely low inflation, however, such as has prevailed in many advanced economies over the past decade, can also be problematic: it may make it difficult for central banks to lower real short-term interest rates sufficiently to provide the requisite stimulus to demand, given the lower bound on nominal interest rates; and it may tip into deflation—a sustained decline in prices—which can exacerbate recessionary tendencies (Blanchard, Dell’Arriccia and Mauro 2010; Arteta et al. 2018).
Low inflation: Here to stay?

Disinflation over recent decades has been broad-based across country groups and is evident in multiple measures of inflation, including headline and core consumer prices, energy and food prices, producer prices and the GDP deflator. It began in advanced economies in the mid-1980s and in EMDEs in the mid-1990s. By 2000, global inflation had stabilized at historically low levels. Inflation in EMDEs has fallen from stubbornly persistent double-digits during the 1970s, 1980s, and most of the 1990s to 3.5 percent in 2017. By 2017, inflation was within or below central bank target ranges in three-quarters of EMDEs that had adopted inflation targeting. As the level of inflation has fallen, its volatility has also declined, most sharply in the transition economies of the former Soviet Union and in Sub-Saharan Africa.

But, is low inflation here to stay? A reason for optimism is that the confluence of structural and policy related factors that have fostered global disinflation are unlikely to be reversed. Foremost among these has been unprecedented international trade and financial market integration. In the median EMDE, as in the median advanced economy, trade has increased by half since 1970, to 75 percent of GDP in 2017, and international assets and liabilities have more than tripled (although they remain only one-quarter the level of advanced economies). Technological changes have also transformed production processes in ways that affect the formation of prices (Draghi 2016; Lowe 2017; Yellen 2017).

On the policy front, the adoption of more resilient monetary, exchange rate and fiscal policy frameworks by some EMDEs has facilitated more effective control of inflation (Hammond, Kanbur, and Prasad 2009; Taylor 2014; Fischer 2015). Twenty-four EMDEs have introduced inflation targeting monetary policy frameworks since the late 1990s. In some EMDEs, structural reforms of labor and product markets have also supported disinflation by making markets more flexible and strengthening competition.

However, there are reasons to worry that factors that have held inflation at bay over the past decades may lose momentum or be rolled back. In his seminal essay, Rogoff (2003) concludes that “the greatest threat to today’s low inflation, of course, would be a reversal of the modern trend toward enhanced central bank independence, particularly if trend economic growth were to slow, owing, say, to a retreat in globalization and economic liberalization.” The rising protectionist sentiment of recent years and reform fatigue in some economies may slow the pace of globalization and structural policy improvements.

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2 Disinflation is a decline in inflation rates, regardless of inflation being negative (deflation) or positive.
I N T R O D U C T I O N

Mounting public and private debt in many countries could weaken commitment to strong fiscal and monetary frameworks. These reversals, especially if they were to coincide with tight labor markets or commodity price volatility, could reignite inflation.

The current period of low and stable inflation resembles those of the Bretton Woods fixed exchange rate system of the post-war period up to 1971 and of the gold standard of the early 1900s. All three episodes are characterized by inflation below 5 percent for an extended period. It is notable, however, that these two earlier episodes were followed by sharply rising inflation, illustrating that maintaining low inflation can be as great a challenge as achieving low inflation.³

The achievement of low inflation over the course of the past four to five decades may be by no means permanent (Rogoff 2014; Draghi 2016; Carstens 2018). If unwanted inflation makes a comeback, many EMDEs would be particularly vulnerable to the undesirable economic outcomes associated with high inflation: their inflation expectations are less well-anchored, and the absence of strong monetary policy frameworks in many of these economies means that inflation is more sensitive to exchange rate movements. In addition, as debt loads have risen in recent years, EMDE fiscal positions have become increasingly vulnerable to shifts in market sentiment and rising borrowing costs. Central banks may struggle to contain inflationary pressures and may not receive much support from stabilizing fiscal policy.

Global inflation cycle: Learning to live with it

A critical feature of the international inflation experience of the past fifty years has been the rising importance of a “global inflation cycle” (captured in a common global factor) in explaining inflation at the country level (Carney 2015). Since 2001, this global factor has accounted for one quarter of the inflation variation in the median advanced economy, and almost one fifth in the median EMDE. The role of the global inflation cycle has been most prominent in countries that are more developed and more integrated into the global economy.

The emergence of a global inflation cycle is likely to have been driven by multiple structural and cyclical forces, including globalization, technological

³ In the 1970s, inflation became a serious global problem after a remarkable period of price stability in the 1960s. The sharp increase in oil prices in 1973-74 led to a rapid acceleration in inflation and sharp decline in growth in many countries. This major oil price shock also triggered the 1975 global recession that in turn marked the beginning of a prolonged period of stagflation (Kose and Terrones 2015). Global inflationary pressures also led to a significant increase in domestic inflation in developing economies, including those that experienced relatively low and stable inflation in the late 1960s and early 1970s (Cline 1981; Bordo and Orphanides 2013).
progress, changes in policy frameworks, and a variety of cyclical global shocks. For example, global demand shocks and oil price shocks have accounted for 40 percent each of the variation in global inflation since 1970. In the median country, three global shocks—global demand shocks, supply shocks, and oil price shocks—have accounted for about one-quarter of domestic inflation variation since 2001. Of these, the most important were global demand (especially the global recession of 2008-09) and oil price shocks (especially the plunge of 2014-16). Nonetheless, domestic shocks—especially domestic supply shocks—have remained the main source of domestic inflation variation.

A strengthening global inflation cycle raises concerns that central banks’ control over domestic inflation may have weakened. Inflation synchronization in and of itself need not warrant policy intervention (IMF 2018). However, heads of major advanced-economy central banks have already acknowledged the need to consider the global environment in setting monetary policy in light of the highly synchronized nature of global inflation (Bernanke 2007a; Draghi 2015; Carney 2015). The increased synchronicity of global inflation could increase the risk of policy errors when the appropriate response to undesirably low or high inflation differs depending on the origin (domestic versus foreign) of the underlying inflation shock (Hartmann and McAdam 2018). In addition, a weakening of monetary policy influence over domestic inflation could raise the stakes for fiscal policy to respond to excessive or insufficient domestic demand.

For policymakers, these observations suggest an increasing urgency to build resilience to global and domestic shocks and to develop a keener understanding of their underlying sources. This is particularly the case for EMDEs with deep or rapidly growing integration into the global economy or ones with weak monetary policy frameworks. Options to help insulate economies from the impact of global shocks include the active use of countercyclical policies; strengthening institutions, including through greater central bank independence; and establishing a fiscal environment resilient enough to effectively contribute to macroeconomic stabilization.

The global inflation cycle could also strengthen the case for coordinated monetary policy action to respond to undesirably low or high global inflation. Coordinated action could amplify the impact of policies implemented by individual countries.

**Anchoring inflation expectations: Better but not enough**

Long-term inflation expectations have declined and become more firmly anchored in the past two decades in both advanced economies and EMDEs. However, expectations are more weakly anchored in EMDEs in general than in
advanced economies. The introduction of inflation-targeting regimes and increased central bank transparency have been associated with the firmer mooring of long-term expectations. Among EMDEs, lower public debt ratios and greater trade openness have also been associated with stronger anchoring of expectations.

**Exchange rate pass-through: Amplification mechanism**

Exchange rate pass-through to inflation varies widely among EMDEs depending on the sources of shocks and country characteristics. Exchange rate movements that stem from domestic monetary policy shocks are often accompanied by above-average pass-throughs to inflation in EMDEs while the impact on inflation of exchange rate movements resulting from domestic demand shocks typically produce negative or insignificant pass-through ratios, reflecting the offsetting effects of growth and exchange rate channels. Global shocks account for a relatively smaller proportion of exchange rate movements and their pass-through depends on country characteristics and the source of the shock. Greater central bank independence and the adoption of credible inflation targets are associated with significantly lower average pass-throughs.

These findings underscore the importance of understanding the underlying sources of exchange rate movements in the formulation of appropriate monetary policy responses. Moreover, a credible commitment to maintaining low and stable inflation can play a key role in dampening the pass-through of even sizable currency depreciations to prices in EMDEs.

**Inflation in LICs: Challenges abound**

Global factors have been an important driver of the decline in LIC inflation since 1990. What sets LICs apart from other country groups may be not so much that they differ in terms of country characteristics but that these characteristics appear to operate differently in the LIC environment. For example, although LICs with fixed exchange rates seem to succeed in anchoring inflation expectations about as well as other EMDEs with fixed rates, LICs with floating exchange rates have had a much more difficult time in anchoring inflation expectations than other countries with floating rates. In part because of poorly anchored inflation expectations, any temporary shocks to inflation, such as those arising from food price spikes, can trigger higher inflation than LIC central banks can contain. Separately, the transmission of global food price spikes to domestic LIC inflation (combined with unintended consequences of other policies) can materially raise poverty, as observed during the global food price spikes in 2007-08 and 2010-11.
The sizable role that global factors have played in driving inflation in LICs points to the need to improve LIC central bank control over domestic inflation. For example, central banks could strengthen their efforts to convince the public of the primacy of the low-inflation objective by committing to an inflation target. However, this strategy may not yet be appropriate for LICs, many of which have weak and uncertain channels of monetary policy transmission, data deficiencies, and limited analytical capacity at central banks. Beyond monetary policy, the judicious use of budgetary levers consistent with macroeconomic stability, is critical for LICs. In addition, LICs need to undertake structural reforms that reduce their vulnerability to shocks, strengthen automatic fiscal stabilizers, improve the effectiveness of discretionary fiscal policy, and increase the flexibility of labor markets.

A nuanced policy approach is necessary to mitigate the impact of global food price shocks on poverty without adverse side-effects. The use of trade policies (such as changes to export and import restrictions) to insulate domestic markets from food price shocks may compound the volatility of international prices and may ultimately be counterproductive in protecting the most vulnerable people. Instead, storage policies and targeted safety net interventions, such as cash, food and in-kind transfers, can mitigate the negative impact of food price shocks while avoiding the economy-wide distortionary impacts of trade policies. Measures such as crop and weather insurance, warehouse receipt systems, commodity exchanges, and futures markets could also be used to manage risks.

**Synopsis**

The remainder of this introduction presents a summary of each chapter. After presenting the motivation of the chapter, each summary explains the main questions, contributions to the literature and analytical findings. After the summaries, a brief discussion of future research directions is presented.

**Part A. Global and Domestic Drivers**

Part A first analyzes the evolution of inflation and its correlates and consequences. It then turns to the extent of global inflation synchronization, and the roles of global and group-specific factors in driving inflation in EMDEs. It concludes with an analysis of the global and domestic sources of inflation in these economies.

**Chapter 1. Inflation: Concepts, Evolution, and Correlates**

In Chapter 1, Ha, Ivanova, Ohnsorge, and Unsal analyze the impact of inflation on activity, provide a comprehensive analysis of the evolution of inflation over time, and document the main factors that have contributed to disinflation in
recent decades across the world. Specifically, they address the following questions.

- How does inflation support or hinder economic activity?
- How has global inflation evolved over the past four to five decades?
- What factors have contributed to these trends in global inflation?

The chapter’s contributions to the literature are threefold. First, it documents the broad-based nature of disinflation over almost half a century using a sample of countries that is much larger than that of earlier studies, and so provides a truly global picture. Second, in contrast to earlier studies, the chapter identifies stylized facts that are robust across different measures of inflation and extend to various groups of countries. Third, it provides a systematic analysis of the structural factors that have been credited with helping to lower inflation over the past four to five decades, including increased global economic integration and strengthened macroeconomic policy frameworks.

Before delving into the evolution of inflation and its determinants, the authors review the literature on the impact of inflation on activity, poverty, and inequality. Previous studies show that low and stable inflation has often been associated with more stable output and employment and more rapid output growth and investment (Khan and Senhadji 2001; Woodford 2003; Mishkin 2008). Although the evidence regarding the effect of inflation on poverty is mixed when assessed at the economy-wide level, the negative effects of inflation are more established when examined at the household level.

The empirical exercise conducted in the chapter leads to three major findings. First, inflation has fallen around the world, reaching historically low levels by 2000 (Figure 1). The decline has been evident among both advanced economies and EMDEs, although it began earlier in advanced economies (in the mid-1980s) and started in EMDEs in the mid-1990s. Lower inflation was also accompanied by lower inflation volatility, especially in advanced economies.

Second, this global disinflation has been supported by a wide range of structural changes. The most significant of these has been globalization—increased international economic integration—and the adoption of more effective and more resilient monetary, exchange rate, and fiscal policy frameworks (Figure 2).

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4 Rogoff (2003) anticipates the discussion here, with an overview of the main factors supporting lower inflation, including globalization and broad-based changes in monetary policy regimes. Cecchetti and Krause (2002) document that lower average inflation has been associated with greater central bank credibility and, to a lesser extent, transparency in 24 advanced economies. Shambaugh (2004) examines the role of the external environment in monetary policy for different types of exchange rate regimes.
Third, although it features lower inflation volatility, the current period of low and stable inflation is similar to two historical episodes: the Bretton Woods fixed exchange rate system of the post-war period up to 1971 and the gold standard of the early 1900s. These two earlier episodes were followed by sharply rising inflation as soon as the two fixed exchange rate regimes were abandoned (Cline 1981; Bordo 1999).

After documenting inflation trends over almost half a century, Chapters 2 and 3 then turn to the global synchronization of inflation and the underlying drivers of inflation movements.

Chapter 2. Understanding Global Inflation Synchronization

In Chapter 2, Ha, Kose, Ohnsorge, and Unsal motivate their study with a well-known observation: inflation has recently appeared to move in tandem among countries around the globe. They then explore the extent to which global and group-specific factors have driven national inflation rates that led to highly synchronized movements in inflation. In this context, they ask three specific questions:

- How has inflation synchronization among countries around the world evolved over the past four to five decades?
- Which goods and price indices have been associated with greater inflation synchronization?
- What country characteristics have been associated with greater inflation synchronization?

Their chapter makes several contributions to the rapidly growing literature on global inflation. First, they employ one of the largest sample of countries of existing studies—a sample that is considerably more representative of “global inflation” than those used in most earlier studies that relied predominantly on data from advanced economies. In their global sample, the evidence of growing global inflation synchronization during the 2000s is unambiguous, whereas some earlier studies based on advanced-economy samples have found no such increase.

Second, the authors employ a dynamic factor model to examine the extent of inflation synchronization around the world. In recognition of structural differences between EMDEs and advanced economies, their model explicitly

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allows for distinct roles of an EMDE factor and an advanced economy factor whereas the focus of the literature thus far has been on global factors only. Third, the chapter systematically explores commonalities and differences in inflation synchronization among a wide range of inflation measures based on price indices that differ in their tradables content. This permits a more precise interpretation of the global factor and broadens the evidence for increased inflation synchronization. Fourth, the authors systematically study a wider range
of country characteristics conducive to high inflation synchronization than have been examined in earlier studies.

Their analysis yields the following main results.

First, inflation has become increasingly globally synchronized (Figure 3). The role of the global factor has grown and since 2001 explains about one-fifth and one-quarter of EMDE and advanced economy inflation variation, respectively. But over the past four decades, an EMDE-specific factor has also become increasingly important, and since 2001 this factor has explained nearly a tenth of EMDE inflation variation. With the rising importance of these global and group-specific factors, inflation synchronization has also become more broad-based over time.

Second, international synchronization of inflation has tended to be higher than that of output growth over the past four to five decades. Differences in the degree of synchronization in output growth and inflation may reflect differences in the nature and frequency of global shocks and structural factors, including the evolution of policy frameworks, that influence these two variables. However, the degree of synchronization of output growth has increased over time to become comparable to that of inflation.

Third, global inflation synchronization has broadened—across different types of goods and different types of countries. In 1970-85, the extent of inflation synchronization was pronounced only for inflation measures with a large portion of tradable goods; it has more recently become sizeable across all inflation measures. During 1970-2017, it was most pronounced for the inflation measures with the largest share of tradables. Since 2001, it has grown to one-third even for core CPI inflation and GDP deflators.

Fourth, countries differ widely in the degree to which global factors and, to a lesser extent, group factors, account for domestic inflation variation. The global factor has accounted for a larger share of domestic inflation variation in countries that were more open to global trade, participated more in global value chains, relied on commodity imports, and were more developed. In general, the global factor has explained a greater share of inflation variability in EMDEs that were commodity importing or open to trade. It has also been larger in countries with more resilient monetary policy frameworks. That said, over the past four to five decades, this heterogeneity has narrowed such that, since 2001, no country characteristic appears to systematically account for greater contributions of global or group factors.

The analysis in Chapter 2 identifies a global inflation cycle and documents the emergence of group-specific factors in explaining national inflation rates. However, it does not quantify the fundamental sources of global and national
Inflation has become increasingly globally synchronized. The global factor accounted for a higher share of the inflation variance in advanced economies than in EMDEs. A greater tradable goods and services content of the price basket was associated with a higher share of the global factor in inflation variance. Inflation synchronization has been stronger than the synchronization of output growth, especially in EMDEs.

A. Contributions of global and group factors to inflation variation

B. Contribution of global factor to inflation variation, by income group

C. Contribution of global factor to inflation variation, over time

D. Contribution of global and group factors to inflation variation

E. Contribution of global and group factors to inflation variation

F. Contribution of global factor to output growth and inflation variation


A.-C. The results are based on a dynamic factor model with inflation in 99 countries (25 advanced economies and 74 EMDEs). The model includes global and group inflation factors. All numbers refer to median variance shares of total inflation variance counted by the global or group factors.

D.E. The global and group inflation factors are estimated with a two-factor dynamic factor model for annual inflation in 38 countries (25 advanced economies and 13 EMDEs) for the period 1970-2016, the size of the sample being constrained by data availability.

E. Median variance share of global factor in inflation variation. The common factor from three measures for domestic inflation (import prices, producer prices, and headline consumer prices) is used as a proxy variable for the common component for tradable goods. Similarly, common factors for headline consumer prices, core consumer prices, and the GDP deflator are extracted as a proxy for the global inflation factor for non-tradable goods.

F. Median contribution of the global and group factor to the variance of real GDP growth and to inflation in 99 countries, based on a two-factor dynamic factor model.

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inflation, and, beyond providing suggestive evidence of a relationship with certain country characteristics, it does not interpret these global or group-specific factors. These issues are taken up in the next chapter.

Chapter 3. Sources of Inflation: Global and Domestic Drivers

Ha, Kose, Ohnsorge, and Yilmazkuday begin their analysis in Chapter 3 with a summary of the main movements in global inflation over almost half a century: since 1970, global inflation has undergone considerable swings around a pronounced downward trend. These swings in inflation have generally been associated with cyclical fluctuations in the global economy or with sharp movements in oil prices. They then build on the work of Chapter 2 by analyzing the underlying drivers of global and national inflation. Specifically, they address the following questions:

- What have been the main drivers of global inflation?
- What have been the main drivers of domestic inflation?
- How have the main drivers of domestic inflation differed by country characteristics?

The chapter expands the literature in several dimensions. First, it systematically examines the sources of variation in global inflation in a unified econometric model that also serves to explain domestic inflation for a more diverse sample of countries than existing studies. Unlike previous studies that have focused on subsets of the possible drivers of inflation, this chapter examines the contributions of global shocks (global demand, global supply, and global oil price shocks) to global inflation movements, and then quantifies the drivers (domestic demand, supply, monetary policy, and exchange rate shocks) of domestic inflation while controlling for the influence of global shocks.

Second, in contrast to previous studies, this chapter employs a global sample of countries, allowing an analysis of inflation dynamics in both advanced economies and EMDEs over a long period. Third, the chapter employs an event study to analyze the movements in global and domestic inflation rates during major economic events since 1970. By putting the recent low-inflation episode

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6 Charnavoki and Dolado (2014), Conti, Neri, and Nobili (2015), and Forbes, Hjoertsoe, and Nenova (2017, 2018) also analyze the role of different types of factors in explaining domestic inflation but they focus on narrower subsets of drivers of inflation in the context of mostly advanced-economy samples. Another branch of the literature relies on more traditional Phillips curve models to quantify the response of inflation to changes in domestic and global output gaps or cost factors (see Borio and Filardo (2007); Gerlach et al. (2008); Ihrig et al. (2010); Eickmeier and Pijnenburg 2013; Auer, Borio, and Filardo (2017)). However, this literature reports mixed findings about the importance of global drivers of domestic inflation.
into historical context, the chapter highlights the exceptional severity of inflation weakness over the past decade. Fourth, the chapter investigates a wide range of country characteristics to see which are associated with a particularly high contribution of global (or domestic) shocks to domestic inflation variability.

The authors report the following findings.

First, rapid changes in global inflation have generally occurred near turning points of the global business cycle or in the wake of sharp movements in global oil prices. In particular, following the global financial crisis and subsequent recession, the past decade witnessed a pronounced and broad-based disinflation that took global inflation well below its downward trend. Exceptionally large fractions of both advanced economies (more than three-quarters) and EMDEs (more than one-half) were in outright deflation at some point during 2014-17.

Second, global demand and oil price shocks have accounted for 40 percent, each, of the variation in global inflation since 1970 (Figure 4). Negative global demand shocks were associated with three global recessions and slowdowns, but large positive global demand shocks often coincided with the year before the global economy slid into a recession or slowdown. Positive oil price shocks were generally associated with oil supply disruptions, often coinciding with armed conflict or civil unrest (e.g., the Iran-Iraq War, the Iranian Revolution, and the Persian Gulf War) or militant attacks on pipelines (e.g., in Iraq and Nigeria). Negative oil price shocks were associated with major OPEC decisions to end production restraint amid discoveries of new sources of oil supply (1986, 2014-16) or price normalization after spikes. The relative importance of global demand shocks has increased since 2001 to account for 60 percent of global inflation variation. The 2014-16 oil price plunge, however, was a major source of post-crisis global disinflation.

Third, during the past four to five decades, domestic shocks accounted for about three-quarters of domestic inflation variation, the most important being domestic supply shocks. Since 2001, however, the role of domestic supply shocks has declined. During this period, in part as a result of the global financial crisis and the 2014-16 oil price plunge, the contributions to domestic inflation variation of global demand and oil price shocks have increased to 22 and 17 percent, respectively.

Finally, the contribution of global shocks to domestic inflation variation was larger in advanced economies and those countries with higher trade and financial openness, fixed exchange-rate regimes, and greater reliance on commodity imports. Domestic shocks contributed more to domestic inflation variation in countries that were less open to global trade and finance and that had inflation-targeting monetary policy regimes with flexible exchange rates.
Global recessions and oil price plunges were typically associated with slowing global inflation. Reflecting this, the estimation results indicate that since the 1970s, global demand and oil price shocks have accounted for a growing share of the variation in global inflation and domestic inflation. That said, domestic shocks have continued to account for about three quarters of domestic inflation variation, with domestic supply shocks being most important.

A. Global inflation around global recessions

B. Global inflation around oil price plunges

C. Contribution of global shocks to global inflation variation over time

D. Share of countries with statistically significant impulse responses after two years

E. Contribution of global shocks to domestic inflation variation

F. Contributions of domestic and global shocks to domestic inflation variation


A.B. Horizontal axis indicates years before and after the troughs of global recessions or local troughs of short-term oil price cycle (t=0). Global inflation is defined as median trend inflation (9-quarter moving average) across 65 countries.

A. Troughs of global recessions are identified using global per capita GDP and the algorithm in Harding and Pagan (2002) and are consistent with the results in Kose and Terrones (2015).

B. There were six oil price plunges of more than 30 percent (1986, 1990-91, 1997-98, 2001, 2008, and 2014-16; Baffes et al. 2015). The four episodes with the largest oil price plunges are presented.

C.-F. The results are based on the country-specific FAVAR estimation, as discussed in Chapter 3.

C.E.F. All numbers refer to median shares of variance.

C.E. Share of global inflation variance (C) or domestic inflation variance (E) accounted for by global shocks.

D. Based on cumulative impulse response of domestic inflation to global shocks after two years.

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PART B. Expectations and Pass-Through

Part B delves deeper into two key challenges that confront EMDE central banks. Burdened by a history of high inflation, many EMDE central banks struggle to build credibility, leaving inflation sensitive to shocks and inflation expectations unanchored. In addition, EMDE exchange rates can be subject to severe swings, amplifying the impact of exchange rate movements on inflation.

Chapter 4. Inflation Expectations: Review and Evidence

In Chapter 4, Kose, Matsuoka, Panizza, and Vorisek argue that, since EMDEs tend to experience more pronounced business and financial cycles than advanced economies, they face greater challenges in anchoring expectations. This makes understanding how inflation expectations are affected by different types of shocks especially critical for policymakers in these economies.7

Since robust measurement is key to evaluating inflation expectations, they first examine the pros and cons of survey-based and market-based measures.8 Due to the breadth of country coverage and the availability of long time series, they employ survey-based inflation expectations in their empirical work. They then present a survey of the literature on inflation expectations. Theoretical studies have examined how public and private information is used by economic agents in formulating inflation expectations.9 A large body of empirical work has tested the predictions of theoretical models and assessed how firmly inflation expectations are anchored, by measuring the sensitivity of expectations to various shocks. This literature, while extensive, has mainly focused on advanced economies.

The chapter, therefore, represents the first comprehensive analysis of the evolution and determinants of inflation expectations in EMDEs. Specifically, it addresses three key questions:

- How does the degree of anchoring of inflation expectations differ between advanced economies and EMDEs?
- How sensitive are inflation expectations to global and domestic shocks?
- What are the main determinants of the degree of anchoring of inflation expectations?

7 Bernanke (2007b) explains the importance of inflation expectations for the design of monetary policy.
8 For background on market- and survey-based measures of inflation expectations, see Coibion et al. (2018) and Grothe and Meyler (2018) for the United States and the Euro Area; and Sousa and Yetman (2016) for EMDEs.
9 Coibion, Gorodnichenko, and Kamdar (forthcoming) and Mankiw and Reis (2018) survey the literature on the formation of expectations.
The chapter studies these issues by taking novel approaches in several dimensions. First, it employs data for a large and diverse sample of countries (24 advanced economies and 23 EMDEs) for a period of close to three decades. Second, it analyzes the degree of anchoring of inflation expectations by employing two empirical strategies: a panel regression model and a time-varying coefficients model. The former approach provides an overview of how well expectations are anchored in different country groups and time periods while the latter is useful to track how country-specific and time-varying measures of the degree of anchoring have evolved. Third, the chapter examines the determinants of the degree of anchoring of expectations using a dynamic panel regression framework. Fourth, it complements these empirical exercises with case studies that examine the role of inflation targeting in stabilizing inflation expectations in three EMDEs.

This strategy yields the following major results.

First, long-term inflation expectations have declined and become more firmly anchored in the past two decades in both advanced economies and EMDEs (Figure 5). However, anchoring in EMDEs remains notably weaker than in advanced economies. This finding is consistent with the view that monetary policy remains less credible in EMDEs than in advanced economies.

Second, long-term inflation expectations in EMDEs are more sensitive to both global and domestic shocks than are expectations in advanced economies. However, the sensitivity of EMDE inflation expectations to domestic shocks gradually fell between 2005 and 2012 and has since been mostly stable while their sensitivity to global shocks has fallen slightly since 2000. This contrasts with the experience of advanced economies, where a large drop in the sensitivity of inflation expectations to global shocks in the wake of the global financial crisis followed a steady decline from the late 1990s to the late 2000s, and there was a less pronounced downward trend in sensitivity to domestic shocks.

Third, the institutional and monetary policy environment matters for the anchoring of inflation expectations, as do the general macroeconomic environment and structural characteristics of the economy. The authors report that the presence of an inflation-targeting regime and a rise in central bank transparency are associated with better anchoring of long-term inflation expectations. For EMDEs, lower public debt ratios and greater trade openness are also associated with better anchoring of expectations.

IMF (2016, 2018) and Mehrotra and Yetman (forthcoming) also study inflation expectations in advanced economies and EMDEs.
Fourth, case studies for Brazil, Chile, and Poland provide examples of how these factors have worked to anchor inflation expectations. In Brazil, for instance, accommodative fiscal policy, and a backtracking on central bank transparency for a period, may have held back progress on improving the anchoring of inflation expectations. In Chile, a highly transparent central bank, together with a credible macroeconomic framework, appear to have contributed to the central bank’s success in anchoring inflation expectations. And in Poland, the simultaneous adoption of inflation targeting and exchange-rate flexibility seems to have helped anchor expectations.

Chapter 5 focuses on the role of another channel for monetary policy transmission that is especially important for EMDEs—the pass-through of changes in the exchange rate to domestic prices. It takes the novel approach of quantifying, in a large sample, the extent to which exchange rate pass-through varies according to the different types of shocks that lead to movements in exchange rates.

Chapter 5. Inflation and Exchange Rate Pass-Through

Ha, Stocker, and Yilmazkuday motivate their study with a basic observation: monetary policy authorities in EMDEs have long been worried that significant exchange-rate fluctuations can jeopardize price stability and force disruptive policy adjustments. As a result, some EMDEs have adopted managed currency arrangements or employ aggressive policy responses to dampen undesirable currency movements—practices motivated by what has been dubbed the “fear of floating” (Calvo and Reinhart 2002). However, the resulting lack of exchange rate flexibility can amplify the impact of external shocks and make it more difficult for a central bank to credibly anchor inflation expectations.

Although large depreciations have become less frequent in EMDEs, they continue to be associated with large increases in inflation. In order to formulate the appropriate monetary policy response to exchange-rate movements, it is essential to correctly assess their impact on inflation. But pass-through ratios—the percentage increase in consumer prices associated with a 1 percent depreciation of the nominal effective exchange rate—are found to vary considerably across countries and over time. Two fundamental factors help to account for these variations: the nature of the shock triggering the currency movement and country characteristics.

To explore these issues in detail, the authors build on the econometric framework developed in Chapter 3 but focus on the relative responses of inflation and exchange rates to domestic and global shocks. In particular, they address three questions:
**FIGURE 5 Inflation expectations**

After declining in the 1990s, inflation expectations in advanced economies have remained stable at around 2 percent since the mid-2000s. Inflation expectations in EMDEs declined in the second half of the 1990s, but have risen somewhat since 2005, and remain higher than in advanced economies. The sensitivity of inflation expectations to inflation surprises has fallen in the past decade in both advanced economies and EMDEs but remains comparatively higher in EMDEs. Inflation expectations in EMDEs are better anchored in the presence of an inflation targeting regime, and when central bank transparency is high.

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**Sources:** Consensus Economics, International Monetary Fund, World Bank.

**Note:** Inflation expectations are long-term (five-year-ahead) expectations of annual inflation, measured at a biannual frequency.

A.-D. Sample includes 24 advanced economies (1990H1-2018H1 for panel A; 1995H1-2018H1 for panel C) and 23 EMDEs (1995H1-2018H1 for panel B; 2000H1-2018H1 for panel D).

C.D. Inflation shocks are defined as the difference between realized inflation and short-term inflation expectations in the previous period. Time-varying sensitivity is estimated by regressing the change in five-year-ahead inflation expectations on inflation shocks. Model is described in Chapter 4. Solid lines indicate median of estimates and the dotted lines indicate medians of 68 percent confidence intervals.

E.-F. Bars represent coefficients in panel regressions of 24 advanced economies, 23 EMDEs, and all 47 economies using annual data for 1995–2016. Model is described in Chapter 4. Vertical lines denote 90 percent confidence intervals.

[Click here to download data and charts.]
• How have exchange-rate movements impacted consumer price inflation over time?

• How does the pass-through to inflation depend on the underlying shock triggering the exchange-rate movement?

• What country characteristics are associated with lower pass-throughs?

Their analysis is novel in several dimensions. First, they draw on event studies of large currency movements and analyze shifts in the relationship between exchange rates and inflation. This leads to empirical results that shed new light on the heterogeneity of pass-through estimates across countries and over time. Second, their chapter supplements a growing empirical literature linking the exchange rate pass-through to underlying shocks, contrasting with traditional reduced-form approaches that estimate an “average” pass-through based on the assumption of an exogenously determined exchange rate. Third, compared with earlier studies that have derived state-dependent pass-through estimates, their work investigates a greater menu of shocks, uses a larger sample of countries, and employs a state-of-the-art econometric framework that combines domestic and global shocks. Finally, their chapter is able to explore the role of some EMDE-specific characteristics, including monetary policy frameworks, participation in global value chains, and foreign currency invoicing.

This approach yields estimates of exchange rate pass-through that differ widely by the source of shocks and country characteristics. Specifically, the approach produces the following results.

First, domestic shocks were the main driver of exchange rate fluctuations across most countries but resulted in significantly different pass-throughs to inflation, depending on their nature (Figure 6). The pass-through associated with domestic monetary policy shocks was generally higher, particularly in EMDEs without inflation-targeting central banks. In contrast, domestic demand shocks were typically accompanied with negative and mostly insignificant pass-throughs, reflecting the offsetting effects of growth and exchange rate channels (i.e., weakening domestic demand giving rise to both currency depreciation and declining inflation).

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11 Past empirical studies disentangling the impact of different types of shocks on estimated pass-throughs include Forbes, Hjortsoe, and Nenova (2017, 2018) and Shambaugh (2008).

12 The link between the adoption of inflation targets by central banks and declining exchange rate pass-throughs has been investigated in some other studies, including Gagnon and Ihrig (2004), Mishkin and Schmidt-Hebbel (2007), and Coulibaly and Kempf (2010).
Global shocks accounted for a smaller proportion of exchange rate movements and their pass-through ratios varied widely, depending on country characteristics and the type of shock. For instance, although global demand shocks were linked to positive pass-throughs in many EMDEs, in some cases pass-throughs were negative or insignificant. The pass-through for oil price shocks was mostly positive for energy exporters, but widely divergent for energy importers.

Second, greater central bank independence has been associated with significantly lower pass-through ratios, highlighting a self-reinforcing feedback between central bank credibility and price stability (Carriere-Swallow et al. 2016). The insulation provided by central bank independence was evident in weaker pass-throughs following domestic monetary policy, global demand, and oil price shocks.

Third, evidence of a downward trend in average exchange rate pass-through ratios over the last two decades is consistent with a broader movement towards improved central bank policies and a more solid anchoring of inflation expectations, as reported in Chapter 4. Other structural factors, including growing integration in global value chains, could have played a role as well, but are not able to account for substantial cross-country differences in pass-through ratios.\(^{13}\)

The authors argue that differences in shock-specific pass-through ratios could have important implications for monetary policy. For example, the exchange rate pass-through during an initial economic recovery phase could be low, reflecting the predominance of domestic demand shocks. However, grounding subsequent monetary policy tightening decisions on the assumption of a similarly low pass-through could be misleading, since monetary policy shocks are typically associated with much higher pass-through ratios. Failing to take these factors into account may lead central banks to overshoot their objective, creating unnecessary fluctuations in inflation and real economic activity.

**PART C. Low-Income Country Considerations**

Part C focuses on inflation and monetary policy related challenges faced by LICs. Chapter 6 delves into the problem of identifying drivers of inflation in LICs. This is followed by an analysis of vulnerability to large food price swings in LICs and their poverty implications in Chapter 7.

\(^{13}\) Some studies have found that global value chain integration can reduce the response of import and export prices to exchange-rate movements in both advanced economies and EMDEs, including Amiti Itskhoki and Konings (2014); de Soyres et al. (2018); and Georgiadis, Gräb, and Khalil (2017). However, these effects were not detectable in estimated pass-throughs to consumer price inflation across countries.
FIGURE 6 Inflation and exchange rate pass-through

The frequency and severity of EMDE currency depreciations has declined since the 1990s. Domestic shocks remain the dominant driver of exchange rate fluctuations but are associated with different pass-throughs, from significantly positive for monetary policy shocks to negative for domestic demand shocks. Global shocks accounted for a smaller proportion of exchange rate movements and were associated with considerable heterogeneity of estimated pass-through ratios. Greater central bank independence tends to be linked to lower exchange rate pass-throughs, both across countries and over time.

A. Frequency of EMDE currency depreciations

B. Variance decomposition of exchange rate movements

C. Pass-through: domestic shocks

D. Pass-through: global shocks

E. Central bank independence and pass-through from monetary policy shocks

F. Average pass-through

A. Depreciations are defined as negative quarterly changes in the nominal effective exchange rate.
B. Median share of country-specific exchange rate variance accounted for by domestic, global, and exchange rate shocks.
C.-F. Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change estimated from FAVAR models for 29 advanced economies and 26 EMDEs over 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers show the cross-country median.
E. The central bank independence index is computed by Dincer and Eichengreen (2014). Low and high central bank independence is defined as below or above the sample average.
F. Shock-specific pass-throughs are aggregated using shares of currency movements accounted for by each type of shock as weights. This summary measure reflects the average sensitivity of inflation to exchange rate movements over the entire estimation period. Full sample estimations are over the period 1971 to 2017, but can vary at the individual country level.

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Chapter 6. Inflation in Low-Income Countries

Ha, Ivanova, Montiel, and Pedroni start their study of inflation in LICs with the observation that there has been, in recent decades, a remarkable degree of convergence in academic and policy circles in views about the principles to which monetary policy should adhere in order to yield the low and stable medium-term inflation that is conducive to healthy economic growth. Nevertheless, central banks in LICs face significant challenges in achieving low and stable inflation and in anchoring inflation expectations (Mishra, Montiel, and Spilimbergo 2012). Meanwhile, globalization has proceeded apace in LICs as it has elsewhere, magnifying, through several channels, the challenges confronted by LICs in achieving these objectives.

Inflation rates in LICs over the last two decades have declined from exceptionally high levels in many cases and have converged closer to those of advanced economies and other EMDEs, despite the special challenges faced by these countries. These challenges include being susceptible to relatively large domestic as well as external shocks. At the same time, global inflation has stabilized at low rates.

These observations lead the authors to study to what extent the improvement in LIC inflation performance over the past two decades reflects improved domestic policies, as opposed to having been imported. The chapter also examines the extent to which core inflation in LICs has remained stable in the face of a variety of external shocks, including shocks to global core, energy, and food price inflation, and other shocks transmitted to domestic economies through exchange rate fluctuations. Specifically, the authors address the following questions.

- How has inflation in LICs evolved?
- How well anchored are inflation expectations in LICs?
- What country characteristics have been associated with stronger anchoring?

The chapter extends the existing literature in several ways. First, it presents the results of the first-ever investigation of the sensitivity of core inflation to various inflation shocks, both domestic and global, in a large group of countries over a long period. They estimate a novel econometric model that helps identify the global component of core inflation endogenously and produces a parsimonious representation of the common and idiosyncratic components of core inflation (Pedroni 2013). Second, the chapter is unique in its specific focus on LICs. Third, the chapter reports findings on which country characteristics help explain differences in the responses of core inflation to different types of shocks.
The authors report the following main results.

First, although LIC inflation has declined sharply from the mid-1990s, both the level and volatility of headline inflation have remained above those in advanced economies (Figure 7). Second, core inflation in LICs was more susceptible to external shocks—in particular, to global core and food prices—than in the other country groups. Around three-quarters of the variation in core inflation rates among LICs was due to global shocks, compared with one-quarter in advanced economies. Global food and energy price shocks accounted for 12 percent of core inflation variation in LICs, half more than in advanced economies and one-fifth more than in non-LIC EMDEs. Third, domestic characteristics appear to matter for determining the responsiveness of inflation to external shocks. Notably, LICs with fixed exchange rates seem to succeed in anchoring inflation expectations about other EMDEs with fixed exchange rates whereas LICs with floating exchange rates have had a much more difficult time.

This suggests that LIC central banks have not been able to secure low and stable medium-term inflation rates on their own, and their improved inflation performance may therefore have been largely imported. This means that if global inflation were to rise, LICs would face the risk of their own inflation rising in tandem, unless steps can be taken to improve their home-grown anti-inflationary credibility.

The next chapter extends the examination of the sensitivity of LIC inflation to global shocks by considering the effect of global food prices on domestic food prices and poverty.

Chapter 7. Poverty Impact of Food Price Shocks and Policies

In August 2011, international food prices hit an all-time high. This followed the 2007-08 food price spike, which pushed an estimated 105 million people into extreme poverty and prompted widespread concerns about the food security of the poorest. Although food prices have been lower in recent years, they are still significantly above their lows in 2000 (Figure 8). In Chapter 7, Laborde, Lakatos and Martin ask three specific questions:

- How do food price shocks affect EMDEs and LICs?
- How do countries intervene to reduce the impact of food price shocks?
- What was the impact of the 2010-11 food price shock on poverty?

Their study adds to the literature by quantifying the degree to which countries intervened during this episode. The chapter also estimates the impact of the
2010-11 food price spike and associated trade policy interventions on poverty using a general equilibrium model complemented with data from household surveys (Laborde, Robichaud, and Tokgoz 2013).

In some respects, the last two food price spikes (2007-08 and 2010-11) resembled earlier, similar episodes: world prices rose rapidly whereas domestic...
prices increased only gradually. In other respects, however, the 2010-11 spike was different from previous episodes. The 2007-08 increase in food prices came after a long period of stability in food prices (Ivanic and Martin 2008). In 2007-08, world prices of all staple foods increased steeply, led by a strong increase in the world price of rice. Most countries reacted strongly by introducing insulating policies.\textsuperscript{14} In contrast, the 2010-11 episode occurred when world markets and policies were still normalizing from the 2007-08 episode. Government interventions differed considerably across countries and across commodities, and insulating policies actually dampened the increase in world rice prices.\textsuperscript{15}

The analysis by Laborde, Lakatos, and Martin yields several major findings. First, food prices can affect poverty through multiple channels, and the effects depend upon country characteristics.

- At the macroeconomic level, high shares of agriculture and food in total output, consumption, employment, trade, and government revenues heighten countries’ vulnerability to volatility in international food prices. LICs are particularly susceptible, as agriculture in these countries accounts, on average, for close to one-third of value added and two-thirds of total employment, nearly three times their shares in other EMDEs. In addition, more than three-quarters of LICs are net food importers compared to only half of other EMDEs. During the 2010-11 event, the increase in food prices accounted disproportionately for the rise in inflation—about two-thirds of the change in inflation in LICs and a little more than half in other EMDEs.

- At the microeconomic level, food price spikes are felt most severely by the poor, since they are net buyers of food and a disproportionate share of their income (two-thirds in LICs) is spent on food. Through these channels, food price spikes raise poverty, reduce nutrition, and cut the provision of essential services such as education and healthcare (World Bank 2011).

Second, the authors show that governments in EMDEs tend to respond particularly strongly to sharp changes in world prices for staple foods—such as rice, wheat and maize—to smooth volatility. Domestic food prices are considerably less volatile than world food prices in the short run. However, the

\textsuperscript{14} During the 2007-08 food price spike, close to three-quarters of EMDEs took policy action to insulate their domestic markets from the sharp increase in world prices (World Bank 2009).

\textsuperscript{15} Important net rice exporters such as India, Pakistan, and Yemen implemented policy interventions that raised domestic rice prices more than the increase in world price. In India, for example, the abolition of export quotas in September 2011 (in place since 2007), coincided with the agricultural marketing season and resulted in a surge of exports and a rise in domestic prices.
FIGURE 8 The poverty impact of food price shocks

A high share of agriculture and food in total output and consumption, employment, trade, and government revenues heighten countries' vulnerability to volatility in international food prices. Insulating policies introduced during the 2010-11 food price spike accounted for 40 percent of the increase in the world price of wheat and one-quarter of the increase in the world price of maize. Combined with government policy responses, the 2010-11 food price spike increased global poverty by 1 percent or 8.3 million.

Sources: Ag-Incentives Database, World Bank.
A. Based on annual commodity price indexes. Deflated using the World Bank manufactures unit value index.
B. Based on household survey data for 2010 on the share of food in total consumption expenditure of households.
C. Average inflation based on a sample of 12 LICs.
D.-F. Based on estimates using the computable general equilibrium model MIRAGRODEP, described in detail in Chapter 7.
E.F. Assuming increases in the price of maize, rice, and wheat as represented in Panel D and based on a poverty line of $1.90/day, PPP.

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The dampening effect of policies dissipates over time, and domestic prices tend to match world prices in the long term.

Third, while individual countries can insulate their domestic markets from short-term fluctuations in global food prices, these interventions can have the perverse effect of making global food prices more volatile (Anderson, Martin, and Ivanic 2017). Indeed, these policy interventions accounted for 40 percent of the increase in the world price of wheat and one-quarter of the increase in the world price of maize during the 2010-11 food price spike. In contrast, government interventions in rice markets (in part, to reverse restrictions imposed after the 2007-08 food price shocks) damped the shock to world prices by about 50 percent.

Fourth, overall, the 2010-11 food price spike may have increased the number of poor by 1 percent, or 8.3 million, despite—and in part, because of—widespread government intervention. The increase in world food prices, combined with government intervention, was most strongly felt in countries such as India, Bangladesh, and Uganda, where the extreme poor tend to be net food-buyers whose real incomes declined. Countries like Ethiopia and Nigeria implemented insulation policies that reduced poverty.

**Future research directions**

The analysis in the book not only presents original analytical work on inflation in EMDEs, but also suggests a number of new research avenues to be explored.

**Decline in inflation.** The discussion of long-term trend disinflation over almost half a century invites future research in two directions. First, the relative contributions of long-term structural changes—including technological advances, globalization of trade and finance, and others—to global disinflation over the past four to five decades could be more formally quantified. This could be done in a general equilibrium framework, since most empirical models are not well suited to uncovering the relationship between such slow-moving variables. Second, future work could examine more formally the degree of global comovement in long-term inflation trends, as Chapters 2 and 3 currently do for comovement in short-term inflation movements. This could be set in the context of a more sophisticated measure of trend inflation by extracting cycles at different frequencies.

**Global inflation and other sources of domestic inflation.** Research on global and EMDE inflation synchronization could be taken further in three directions. First, rather than simply focusing on levels of development, the implications of more granular country characteristics for synchronization could be explored,
such as commodity exporter status, regional trade links, and the size of the tradables versus non-tradables sectors. Second, it would be useful to explore the extent to which synchronization is driven by common shocks that affect all countries, or by country-specific shocks that spill over between countries.

**Inflation expectations.** This book’s study on inflation expectations points to several avenues for future research to explore. First, research could examine the determinants of a wider range of measures of inflation expectations in EMDEs if data availability improved—for example with the development of domestic financial markets to provide market-based measures of expectations. Second, it would be useful to consider non-linearities between institutional factors and the anchoring of inflation expectations. In addition, there is a need to investigate how complementarities between institutional factors and fiscal and monetary policy frameworks help improve the anchoring of inflation expectations.

**Exchange rate pass-through.** Future work on this topic could more formally investigate the relationship between estimated exchange rate pass-through and structural factors, such as the degree of value chain participation and foreign currency invoicing practices in EMDEs. This could take the form of event studies around significant policy or other structural changes. The analysis of shock-specific pass-through rates could also be extended to different inflation measures, e.g., import prices, PPI, GDP deflator, and core CPI inflation. This could shed light on the source of incomplete pass-through to consumer price inflation and help guide monetary policy decisions that are robust to more volatile price components, including energy and food. Finally, nonlinearities in exchange rate pass-through could be further investigated, looking at both the direction and size of the various shocks under consideration.

**Inflation in LICs.** The implications for inflationary outcomes of country-specific characteristics in LICs remain to be explored. There is also need to understand which specific reforms to the operations of LIC central banks would be most effective in achieving home-grown credibility. This latter topic has been covered extensively for the advanced economies, but given the particular challenges faced by LICs, these priorities may well differ from those that have worked elsewhere.

Despite the growing body of literature on food price stabilization policies, several questions remain outstanding. Chapter 7 cautions about the unintended consequences of government policies and highlights the need for a more formal analysis of the effectiveness and development impact of targeted and untargeted policy interventions. Since trade policy interventions are likely to continue to be used, it would be useful to explore how policies—especially those coordinated at the multilateral level—could be designed to reduce their negative effects.
References


In this era of hyperglobalisation, are central banks still masters of their domestic monetary destinies? Or have they become slaves to global factors? … [t]here’s evidence of global inflationary cycles that correspond with an intensifying globalisation that propagates common shocks via commodity, trade and financial channels.

Mark Carney (2015)

Over the last decade there has been a growing interest in the concept of “global inflation”. This is the notion that, in a globalised world, inflation is becoming less responsive to domestic economic conditions, and is instead increasingly determined by global factors.

Mario Draghi (2015)
PART A

INFLATION

Global and Domestic Drivers
In the past four to five decades, inflation has fallen around the world, with median annual global consumer price inflation down from a peak of 16.6 percent in 1974 to 2.6 percent in 2017. This decline began in advanced economies in the mid-1980s and in emerging market and developing economies in the mid-1990s. By 2000, global inflation had stabilized at historically low levels. Lower inflation has been accompanied by reduced inflation volatility, especially in advanced economies. This improvement in inflation outcomes over the past four to five decades has stemmed in large part from structural economic changes, including improved monetary and fiscal policy frameworks as well as international trade and financial liberalization. Lower and more stable inflation has often been associated with better growth and development outcomes, partly by reducing uncertainty, fostering a more efficient allocation of resources, and helping preserve financial stability.

Introduction

Inflation has declined sharply around the world since the global financial crisis. Global inflation—defined as median consumer price inflation among all countries—fell from 9.2 percent (year-on-year) in the second quarter of 2008 to 2.3 percent in the second quarter of 2018 (Figure 1.1). In 80 percent of emerging market and developing economies (EMDEs), inflation in the second quarter of 2018 ranged between 0.9 and 7.5 percent (year-on-year), compared with a range of 4.8 to 25.3 percent in the second quarter of 2008. Among EMDEs, this has created room for monetary policy to support activity. In advanced economies, however, persistent below-target inflation since the crisis has increased risks of de-anchoring inflation expectations and has led central banks to resort to unconventional monetary policy instruments to support demand.

The recent easing of inflation continues a trend that spans nearly 50 years. After a rapid rise during the 1960s, global inflation peaked in 1974 at 16.6 percent (annual average), four times the global inflation in 2017. Similarly, inflation in EMDEs has declined from a peak of 17.3 percent (annual average) in 1974 to 3.5 percent in 2017. The disinflation over the past four to five decades has been the result of a confluence of factors, including the adoption of new monetary and fiscal policy frameworks, severe global shocks and structural changes in national economies and the global economy.

Notes: This chapter was prepared by Jongrim Ha, Anna Ivanova, Franziska Ohnsorge, and Filiz Unsal. Annex 1.1 was prepared by Peter Nagle.
FIGURE 1.1 Global inflation

Global inflation fell sharply between 1970 and 2000. It has been low since then, a trend shared by all measures of inflation. The post-crisis period of globally low inflation has helped bring inflation into inflation target ranges in the majority of EMDEs but has raised concerns about deflation in advanced economies.

A. Global inflation

B. Inflation in advanced economies and EMDEs

C. Share of advanced economies and EMDEs with inflation below or within target range

D. Share of advanced economies with low inflation

E. Global core and headline inflation

F. Global PPI, CPI, GDP deflator inflation

Note: All inflation rates refer to year-on-year inflation.
A. Median consumer price inflation among 152 economies.
B. Median consumer price inflation of 29 advanced economies and 123 EMDEs.
C. Share of 24 advanced economies and 11 EMDEs with consumer price inflation below-target or within target range. Horizontal line indicates 50 percent.
D. Percent of 29 advanced economies with consumer price inflation below zero and between 0-2 percent. Horizontal lines indicate 1970-2017 averages.
E. Median for 41 economies.
F. Median for 39 economies.

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Low and stable inflation has often been associated with more stable output and employment and more rapid output growth and investment. Low and stable inflation increases the transparency of relative price changes, provides confidence for long-term savers and investors, protects the purchasing power of household income and wealth, and enhances financial stability (Annex 1.1, Box 1.1). By contrast, economies that have experienced high inflation have suffered significantly lower growth (Kremer, Bick, and Nautz 2013). Extended periods of chronically high inflation, often in Latin America, have frequently ended in large output losses during stabilization programs, or even in balance of payments crises.

Extremely low inflation, however, such as has prevailed in many advanced economies over the past decade, may make it difficult for central banks to lower real short-term interest rates sufficiently to provide the requisite stimulus to demand, given the lower bound close to zero on nominal rates. It may therefore limit the room for maneuver of conventional monetary policy, and lead central banks to use unconventional measures, including large-scale purchases of longer-term financial assets, to reduce longer-term rates. Such difficulties in implementing expansionary monetary policy, in turn, increase the risk of sliding into a self-reinforcing period of deflation that raises debt burdens and depresses activity further. Extremely low inflation may also hinder the adjustment of absolute and relative real wages, because of the general downward rigidity of nominal wages.

**Focus.** This chapter focuses on the factors that have supported long-term disinflation across the world. It also discusses the benefits from such long-term disinflation. This complements the analysis of the drivers of short-term inflation movements in Chapters 2-5. Specifically, this chapter discusses the following questions.

- How does inflation support or hinder economic activity?
- How has global inflation evolved over the past four to five decades?
- What factors have contributed to these trends in global inflation?

**Contribution to the literature.** This chapter’s contributions are three-fold.

First, it documents the broad-based disinflation over the past four to five decades using a rich database of countries and inflation measures. Specifically, the analysis is based on a comprehensive dataset for a virtually global sample of countries over almost half a century (141 EMDEs and 34 advanced economies for 1970-2018). Earlier studies have documented the broad-based global disinflation, but with datasets that covered a narrower set of countries or a shorter time period. These studies have been mostly restricted to advanced
BOX 1.1 Benefits and costs of inflation: A review

Estimates of the optimal inflation rate lie in a wide range, depending on country characteristics. Either excessively high or excessively low inflation can trigger self-perpetuating output losses. Particular policy challenges arise in exiting from high inflation and in navigating very low inflation.

A large literature has documented the challenges posed by high inflation, for advanced economies and emerging market and developing economies (EMDEs). In the 1970s and 1980s in advanced economies and until the early 1990s in EMDEs, the perils of high inflation were the main macroeconomic policy concern. By the early 2000s, at least for advanced economies, the focus had shifted to the causes and consequences of very low inflation, including deflation (i.e., negative inflation). This literature enjoyed a renaissance after the global financial crisis as deflation fears mounted.

Against this backdrop, this box addresses the following questions:

- What output losses have been associated with high inflation?
- Why is high inflation associated with weak activity?
- What policy challenges does excessively low inflation pose?

What output losses have been associated with high inflation?

Adverse effects of high inflation on output have been extensively studied since the 1990s. Early studies found that inflation above 40 percent was associated with slower economic growth in large samples of countries from the 1960s to the mid-1990s (Fischer 1993, Bruno and Easterly 1998; Temple 2002). In most (31 out of 41) episodes of inflation above 40 percent, output losses were sharp (2.4 percent, on average) but they were not significant at lower inflation levels (Bruno and Easterly 1998). Lower inflation thresholds, typically below 20 percent, for a negative relationship between inflation and growth were also reported by a number of subsequent studies based on large samples of countries stretching over multiple decades.

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1 The focus here is on the challenges of persistently high inflation. Bohl and Siklos (2018) review hyperinflation episodes, when month-on-month inflation exceeded 50 percent.

2 See Espinoza, Leon and Prasad (2012) for a literature review of thresholds in the relationship between inflation and growth. Threshold effects were also estimated by Judson and Orphanides (1999); Omay and Öznur Kan (2010); Bick (2010); and Lopez-Villavalencio and Mignon (2011).
There is growing evidence that the threshold for a negative relationship between inflation and growth depends on country characteristics. Some of the earliest studies in this literature documented that the threshold tends to be lower in advanced economies—below 10 percent, and typically around 2-3 percent—than in EMDEs where inflation thresholds have been estimated at around 20 percent. The range of estimates varies widely, however. Some studies have estimated inflation thresholds at around 5-8 percent for Asian EMDEs and 7-9 percent for Sub-Saharan African EMDEs. Country features that have been associated with a more negative link between inflation and growth have included greater financial development and trade openness, larger government, weaker institutions and greater political risk.

Why is high inflation associated with weak activity?

High inflation is likely to weaken activity by obscuring and distorting relative prices, creating uncertainty that undermines long-term decision-making and discourages savings; redistributing incomes and thereby to weaken consumption; and eroding financial stability. Activity is also likely to be weakened by the policies needed to reduce inflation from high levels, including tighter monetary policies.

Transparency of relative price changes. High inflation is likely to require frequent price adjustments by firms to maintain their profitability. If price adjustments for different goods and services prices are asynchronous (“staggered price setting”), relative price distortions will result (Woodford 2003, Fischer 1993). Even if temporary, these will tend to undermine the efficient allocation of resources and productivity growth. In particular,

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3 Khan and Senhadji (2001); Drukker, Gomis-Porqueras, and Hernandez-Verme (2005); Vaona and Schiavo (2007).
4 Ndoricimpa (2017); Thanh (2015); Vinayagathasan (2013).
5 In a large sample for 1950-2009 or 1960-2009, Ibarra and Trupkin (2011, 2016) and Eggoh and Khan (2014) find that, on average, inflation above thresholds of 19 and 12 percent, respectively, are associated with lower growth. However, the negative association between inflation and growth is stronger in countries with greater financial depth, broader trade openness, higher investment, and larger government expenditures. The threshold is in single digits for EMDEs with highest-quality political institutions and the most favorable ICRG ratings of political risk.
inflation may encourage investment in property rather than more productive investments (White 2006). If high inflation obscures relative price changes, it also creates a need for costly information search (Aksoy et al. 2017).

Uncertainty. High inflation may make it difficult for households and firms to disentangle relative from absolute price changes (Lucas 1972). High inflation is also typically associated with more volatile inflation (Logue and Willet 1976; Andersen and Gruen 1995; IMF 2001). Finally, high and volatile inflation signals an inability of government policies to ensure macroeconomic stability (Fisher 1993). These factors increase uncertainty about the future value of assets and hence discourage investment that requires solid long-term returns to ensure profitability (Woodford 2003). Such investment can be an important source of productivity growth, especially when it embodies new technologies (Greenwood, Hercowitz, and Krusell 1997).

Erosion of after-tax and real incomes. High inflation may reduce saving through two channels. First, it lifts nominal income growth and, thus, accelerates tax progression when rising nominal incomes are measured against fixed nominal income tax brackets (Greville and Reddell 1990; Feldstein 1997, 1999). This squeezes post-tax incomes, which will tend to depress household saving. Second, high inflation reduces the real value of debt—which serves as an investment vehicle for household savings—and any income derived from it (Briault 1995). The erosion of both after-tax incomes and income derived from debt discourage savings and, hence, the funding envelope for productive investment.

Risks to financial sector stability. With high inflation, households will tend to shun financial instruments carrying fixed nominal returns and thus withdraw from bank-intermediated savings. Such disintermediation may force banks to rely on non-deposit liabilities which will tend to raise the (short-term) cost of financing their (long-term) investment portfolios. This will raise the maturity risks inherent in the balance sheets of financial intermediaries that hold long-term assets, often at fixed interest rates, against short-term liabilities (Schwartz 1995). Furthermore, high inflation will raise the term premia and maturity risks embodied in long-term interest rates that compensate investors for long-term inflation risks. The
BOX 1.1 Benefits and costs of inflation: A review (continued)

resulting higher borrowing costs increase rollover or default risk and the cost of financing long-term investments (Wright 2011).  

**Income redistribution that weakens consumption.** Low-income households tend to rely on wages, pensions, and social benefits as their main sources of income and to hold a larger share of their savings in cash (Erosa and Ventura 2002). Wages, pensions, and social benefits tend to respond less and with longer lags to inflation than non-wage income and the real value of cash savings, being unremunerated, is eroded by inflation (Kahn 1997). As a result, poor households’ real incomes tend to decline more than those of higher-income households in high-inflation environments (Romer and Romer 1997; Albanesi 2007). Since poor households have a higher marginal propensity to consume—as, for example, shown by Dynan, Skinner, and Zeldes (2004) for the United States—this tends to weaken consumption.

**Exiting high-inflation episodes.** The detrimental effect on growth of high inflation is now well established in the literature, although precise thresholds vary. Additional damage to output is done when the necessary measures are taken to exit high inflation. Indexation of wages and other prices can make large output losses necessary to achieve disinflation, especially when central banks lack credibility (Blanchard and Gali 1997; Annex 1.3 for U.S. experience with disinflation).

**What policy challenges does excessively low inflation pose?**

The low inflation of the early 2000s raised concerns about the ability of advanced-economy central banks to support demand when policy rates are near the zero lower bound (Reifschneider and Williams 2000; Eggertsson and Woodford 2003). An extended period of low inflation (“lowflation”) could pose challenges for financial institutions and the real economy. In particular, low inflation can reduce the real value of nominal claims such as loans, which may erode the wealth of borrowers and potentially lead to higher default rates. Additionally, low inflation can reduce the attractiveness of long-term investments, as the expected real return on these investments is lower. This can lead to a decrease in long-term investment and further negatively impact economic growth.

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7 Long-term interest rate can be decomposed into (i) expected inflation, (ii) expectations about the future path of real short-term interest rates, and (iii) a term premium that reflects changes in the perceived riskiness of longer-term securities and their liquidity. Term premiums on longer-term securities will be higher when investors are more risk-averse and/or the perceived risk of holding those securities is high. Historically, the most important risk for long-term bondholders has been the risk of unexpected inflation. Uncertainty about the near-term outlook for the economy or monetary policy also raises the riskiness of bonds.

8 In addition, poor households often lack access to financial technologies that allow hedging against inflation (Mulligan and Sala-i-Martin 2000). Conversely, those poor households that do have access to credit may benefit from inflation because it erodes the real value of nominal claims such as loans (Doepke and Schneider 2006).
can distort resource allocation, present policy challenges in responding to recessions and undermine the credibility of central banks. Deflation, once entrenched, can trigger a spiral of self-reinforcing output losses.

**Lowflation.** When inflation is extremely low—meaning significantly below the target—relative price declines may require negative inflation in categories of goods and services with excess supply. This presents a challenge when rigidities prevent nominal price cuts of goods and services (Taylor 2000). When nominal prices cannot be reduced, low inflation can lead to distorted relative prices and inefficient allocation of resources across the economy.

Low inflation also poses monetary and fiscal policy challenges. Low inflation is typically associated with low nominal monetary policy rates. In such an environment, monetary policy may be unable to respond with conventional tools to negative shocks that reduce economic activity and inflation since interest rate cuts needed to support activity would imply negative nominal monetary policy rates. Two decades ago, it was thought that monetary policy rates could not fall below zero—the so-called “zero lower bound”—because of the incentive this would create for moving out of financial instruments into cash (Svensson 2003). The resulting disintermediation could undermine monetary policy effectiveness and capital markets. Since 2010, however, the experience of Denmark, the Euro Area, Japan, Sweden, and Switzerland indicates that mildly negative interest rates can be sustained for extended periods of time without causing large-scale financial disintermediation (Arteta et al. 2016; Rogoff 2015).

However, the limited room for monetary policy action amid very low inflation and short-term interest rates implies that fiscal policy has to shoulder more of the responsibility for macroeconomic stabilization (Feldstein 2002). Such proactive fiscal policy may be difficult when government debt is high because, all else equal, the real burden of debt is likely to remain persistently higher in a lowflation environment than an inflationary environment where nominal incomes are rising (Contessi, Li, and De Pace 2014).

**Deflation.** Outright deflation, if sustained over an extended period, can reduce output by dampening investment and consumption and by

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9 Ciccarelli and Osbat (2017); Moghadam, Teja, and Berkmen (2014).
distorting resource allocation (Fisher 1933; Friedman and Schwartz 1963). Deflation increases the real burden of debt and debt service, and depresses collateral values, thus straining financial systems (“debt deflation;” Bernanke and James 1991; End et al. 2015; Baig et al. 2003). It compresses price dispersion and dulls signals of relative price changes that are critical for an efficient allocation of resources (Benabou 1992). Once deflation becomes entrenched in expectations, it may become self-reinforcing (Branch and Evans 2017, Banerjee and Mehrotra 2018). By raising real interest rates, negative inflation tightens monetary conditions and depresses activity further (Bernanke, Reinhart, and Sack 2004). While these mechanism suggest theoretically that deflation could impose heavy cost, empirical evidence suggests that these cost are modest in practice (Borio et al. 2015).

The optimal inflation rate

The jury is still out on the optimal inflation rate. Theoretical models offer a wide range of optimal inflation rates, negative and positive, depending on the assumptions. Dierck (2017) analysed 100 studies that provided quantitative estimates for optimal inflation. Of these, about 80 recommended inflation targets at or below zero. Negative inflation would ensure that real interest rates are positive even when nominal interest rates are zero such that there is no cost to holding money. However, these models typically assume perfect price flexibility. Models with sticky prices generate temporary deviations in relative prices and, hence, give rise to allocative inefficiencies and welfare cost from inflation or deflation. These models typically suggest an optimal inflation rate of zero. In models that incorporate additional constraints that arguably add realism—such as sticky wages, a zero lower bound to nominal interest rates, distortionary taxation, financial frictions, and price indexation—a low positive inflation rate becomes optimal.

The empirical literature suggests that optimal inflation rates lie in a wide range, depending on country characteristics (Anand, Prasad, and Zhang 2015; Mankiw and Reis 2002). “Too high” inflation and deflation are associated with output losses, while “too low” inflation carries the risk of slipping into deflation in the next recession. The threshold for considering inflation “too high” varies widely with country characteristics, while the threshold for “too low” depends on the size and frequency of adverse
shocks, fiscal policy flexibility, and the effectiveness of monetary policy transmission.

Given these tradeoffs and risks, some studies (Blanchard, Dell’Arricia, and Mauro 2010; Ball 2014; Krugman 2014; Kiley and Roberts 2017; Andrade et al. 2018) recommend raising central banks’ inflation targets to 4 percent, double the median inflation target of advanced economy inflation-targeting central banks (2 percent). However, other authors (Coibon and Gorodnichenko 2012; Coibon, Gorodnichenko, and Wieland 2012; Mishkin 2018; Dorich et al. 2018; Schmitt-Grohe and Uribe 2010) caution that raising the inflation target is too blunt a solution for addressing risks around the zero lower bound: a higher inflation target imposes higher economic cost most of the time, but lowers the cost of hitting the zero lower bound only in rare circumstances.

economies and have not taken account of either the oil price drop of 2014 or the period of unusually depressed post-crisis inflation.

Second, in contrast to earlier studies, this chapter identifies a rich set of stylized facts that are robust across different measures of inflation. Trend disinflation over the past four to five decades manifested itself in all measures of inflation (headline and core consumer prices, producer prices, import prices and GDP deflator).

Third, the chapter provides a uniquely comprehensive and systematic analysis of the structural factors that have been credited with lowering inflation over the past four to five decades. The literature has identified many structural changes that have supported the long-term trend toward lower and more stable inflation. These include increased global economic integration and strengthened macroeconomic policy frameworks. However, there has been no study to date presenting a systematic analysis of the role of these factors. This chapter provides such an analysis as well as a preliminary quantification of their associations with the trend decline in inflation.

Findings. The chapter documents the following findings.

- Inflation has fallen around the world. Median consumer price inflation has declined from a peak of 16.6 percent (annual average) in 1974 to 2.6 percent in 2017. Similarly, median inflation in EMDEs has declined from a peak of 17.3 percent (annual average) in 1974 to 3.5 percent in 2017 and, in low-income countries (LICs), it has declined from a peak of 24.9 percent (annual average) in 1994 to 5.0 percent in 2017. The decline began in
advanced economies in the mid-1980s and in EMDEs in the mid-1990s. By 2000, global inflation had stabilized at historically low levels. Lower inflation was accompanied by lower inflation volatility, especially in advanced economies.

- Global disinflation has been supported by structural economic changes. Among the most significant drivers of global disinflation have been globalization—increased international economic integration—and a shift towards more effective and more resilient monetary and fiscal policy frameworks and exchange rate regimes. On average, inflation has declined faster in countries with greater trade and capital account openness, more transparent central banks and a switch to inflation targeting regimes.

- The current low and stable inflation environment resembles those of the Bretton Woods fixed exchange rate system of post-war period to 1971 and of the gold standard of the early 1900s. All three episodes are characterized by inflation of below 5 percent for an extended period of time (7-19 years) but the current environment differs from the two earlier episodes in its lower inflation volatility.

- The gains of the past fifty years in terms of inflation are by no means guaranteed. Inflation can easily make a comeback if the fundamental structural and policy changes that have compressed inflation over the past four to five decades lose momentum or even reverse. However, as long as strong monetary policy frameworks are supported by sound fiscal policies and institutional structures, it would be possible to keep in check the inflationary implications of fluctuations in business and financial cycles, and movements in commodity prices.

**Conceptual considerations**

Before exploring the longer-term drivers of inflation, several conceptual issues require clarification. These include the relationship between inflation and relative price changes, the interpretation of different measures of inflation, the appropriate rate of inflation as a policy objective, and the implications of inflation volatility and persistence.

**Inflation versus relative price changes.** *Inflation* refers to a sustained and broad-based increase in the overall price level.¹ This is distinct from changes in *relative prices*, which measure the price of one good or service relative to the price of another (or a weighted average of all other goods and services) and which signal

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¹ When the word “inflation” was first used in economic contexts in the early- to mid-19th century, it referred to growth in money supply. In the 1930s, it began to be associated with rising prices, which were attributed to growing money supply (Bryan 1997, 2002).
information about relative surpluses or shortages in different product markets. A rising relative price of a certain good or services indicates that the demand for it outstrips supply and encourages production while discouraging consumption. Hence, in contrast to inflation, relative price movements are critical for the efficient allocation of resources. If goods, services, and factor markets were fully flexible, inflation (which in principle involves no change in relative prices) would not affect the allocation of resources and relative price changes would occur without inflation. If, however, nominal rigidities limit the scope for downward price adjustments, then broad-based inflation can facilitate relative price adjustments by allowing above-average price increases for goods, services or factors of production that are in high demand (Taylor 2000). This is particularly relevant to the market for labor because of the general downward rigidity of nominal wages.

Disinflation versus deflation. Deflation refers to negative inflation—i.e., a decline in price levels—whereas disinflation refers to a decline in inflation rates that are still positive (Federal Reserve Bank San Francisco 1999). Disinflation has been widespread since the mid-1970s, whereas outright deflation has been rare.

Headline versus core inflation. Headline inflation usually refers to changes in the prices of all goods and services in a basket of goods and services that is representative of consumer expenditures. Core inflation measures are intended to capture the underlying, common trend in all prices, regardless of relative price changes. In practice, core inflation is often measured by excluding from the calculation movements in those prices of goods and services that are most volatile, in particular food and energy. For example, swings in food and energy prices tend to be changes in relative prices that shift consumption and production patterns. Alternatively, core inflation is sometimes calculated as the common component of price movements of all goods and services (Stock and Watson 2007, 2010; Schembri 2017).

Consumer prices, producer prices, and GDP deflators. The most common measure of inflation is the percent change in the headline consumer price index (CPI) that captures the cost of living of the average consumer. The CPI includes both domestically produced and imported consumer goods. The producer price index (PPI), in contrast, reflects the price charged by domestic producers of goods and services. Domestically produced goods and services can be for several

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2 The Wholesale Price Index (WPI) is closely related to the PPI but, in principle, refers to sales in the wholesale market whereas the PPI refers to all sales. In the United States, for example, the Wholesale Price Index was renamed Producer Price Index in 1978 (Bureau of Labor Statistics 2018). In contrast, the Personal Consumption Expenditure Index (PCE) is a closely related to the CPI but, in contrast to the CPI, includes services not directly paid for by consumers such as employer-paid services such as medical insurance.
purposes, including domestic consumption, domestic investment, and exports. When the composition of consumption and production differs, e.g., because of large consumer goods imports or because of extensive production of investment goods, CPI and PPI inflation can diverge materially. Finally, the GDP deflator measures the average price of the economy’s output, broadly defined. It differs from the CPI by excluding import prices but including prices of exports, investment, and government consumption. It differs from the PPI by including taxes net of subsidies. The emphasis in this chapter is on the CPI because it offers the largest possible cross-country sample, especially at monthly and quarterly data frequencies, and it is the measure targeted by the largest number of central banks.

Contemporaneous quarterly movements in quarter-on-quarter CPI and PPI inflation tend to be correlated (about 70 percent), while the correlations for both the CPI and the PPI with the GDP deflator are considerably lower (below 50 percent). In more closed EMDEs, the correlation between the CPI and PPI is almost complete (95 percent). In contrast, in more open economies, exports and imports drive a wedge between consumption and production such that CPI and PPI correlate only 62 percent. Similarly, in advanced economies more than in EMDEs, taxes and subsidies drive a wedge between the PPI and GDP deflator; as a result, the correlation between the PPI and GDP deflator in advanced economies is two-thirds that in EMDEs (Figure 1.2).

**Inflation rates and volatility.** In the absence of large commodity price or exchange rate shocks, high and accelerating inflation rates signal an economy in which aggregate demand outpaces aggregate supply. High inflation volatility is often associated with macroeconomic instability and uncertainty about the future path of prices. High inflation persistence near target levels—a tendency of inflation to stay near its recent values, absent economic forces that move it away from the current level—indicates that monetary policy has helped anchor inflation expectations and reflects structural features of the economy such as wage or price indexation (Fuhrer 2009).

**Inflation and economic activity**

Historically, low and stable inflation, combined with well-anchored inflation expectations, has been associated with greater short-term stability of output and employment and higher long-term growth.

Lower inflation has tended to be accompanied by lower inflation volatility and higher output growth. Lower inflation volatility, in turn, has typically been accompanied by lower output growth volatility, higher investment, and savings (Figure 1.3). Several channels account for the beneficial effects of low and stable
inflation on economic activity. These include greater predictability for investors and households, greater transparency of relative price changes, and greater financial stability. The large literature documenting these channels is summarized in Box 1.1. The following provides a short summary.

- **First**, low inflation reduces uncertainty. By inspiring confidence in the future real value of nominal assets and reducing the uncertainty surrounding future returns on productive investment, low and stable inflation fosters long-term investment. Such investment can be an important source of productivity and income growth, especially when new technologies are embodied in investment.

- **Second**, low and stable—but positive—inflation makes relative price changes more transparent. This reduces the need for costly search for information that would be required when high inflation obscures relative price changes.

- **Third**, low and stable inflation helps preserve the real value of after-tax incomes, especially when tax brackets are fixed in nominal terms, and of savings (Box 1.1). This encourages investment and saving.

- **Fourth**, low and stable inflation tends to be associated with greater financial sector stability. This, in turn, supports macroeconomic stability. In particular, stable inflation is usually associated with lower long-term nominal interest rates. This can help reduce rollover or default risk and the
cost of financing for long-term investments. Stable inflation also reduces the risks faced by financial intermediaries that hold long-term nominal assets.

**Evolution of global inflation**

Globally, inflation has fallen sharply from its 1974 peak of 16.6 percent, to 2.6 percent in 2017. This decline began in advanced economies in the mid-1980s and in EMDEs in the mid-1990s. By 2000, global inflation had stabilized at historically low levels. Lower inflation has been accompanied by lower inflation volatility, especially among advanced economies. The current environment of low and stable inflation resembles that during the Bretton Woods fixed exchange
rate system in post-war period up to 1971 and during the Gold Standard of the early 1900s. This section discusses the developments in detail.

**Data.** The analysis rests on a comprehensive database of inflation measures and the key drivers of inflation. Data on headline, core, energy and food CPI inflation, PPI inflation and GDP deflators, as well as their components, are available for up to 175 countries for 1970-2017 (34 advanced economies and 141 EMDEs of which 27 are low-income countries). The data were assembled from a wide range of sources, including ILOSTAT, UNdata, OECDstat, International Financial Statistics, Haver Analytics, internal World Bank databases, and various editions of the IMF *World Economic Outlook* database. These inflation series are complemented with data on inflation targets, central bank independence, exchange rate regime, inflation expectations, and international trade and financial openness. Global inflation is defined as median CPI inflation, unless otherwise specified. Details of the database can be found in the Database Annex.

**Trend disinflation 1970-2017.** Since its peak in the mid-1970s, global inflation has been on a declining trend. Global inflation has fallen from a peak of 16.6 percent (annual average) in 1974 to 2.6 percent in 2017 (Figure 1.4). In EMDEs, inflation has declined from a peak of 17.3 percent (annual average) in 1974 to 3.5 percent in 2017 while, in LICs, it has fallen from a peak of 24.9 percent (annual average) in 1994 to 5.0 percent in 2017. The trend decline started earlier (in the mid-1980s) in advanced economies than in EMDEs and LICs (in the mid-1990s, Box 1.2).

In EMDEs, this disinflation process cut across all regions, including those with a history of persistently high inflation, such as Latin America and the Caribbean and Sub-Saharan Africa. The downward trend has manifested itself in all inflation measures, including headline CPI, core CPI, PPI, and GDP deflator inflation. By the early 2000s, this disinflation was largely completed, although it resumed after the global financial crisis at a milder pace.

The “near-universal” character of disinflation since the mid-1970s was already recognized by Rogoff (2003), but most other studies have focused on advanced economies. The widely shared disinflation in advanced economies has been attributed partly to common terms-of-trade shocks, such as oil price swings (Rogoff 2003). Among G7 economies, it may also have reflected changes in monetary policy regimes, including the increased focus on price stability, that also occurred during the early 1980s and early 1990s (Cecchetti et al. 2007; Levin and Piger 2006).

Other factors may have included sounder fiscal policies, deregulation, globalization and, in the 1990s, accelerating productivity growth in parts of the
FIGURE 1.4 Global inflation trends

Since its peak in the mid-1970s, global inflation has been on a decline. The decline began in the mid-1980s among advanced economies before moving to EMDEs and low-income countries in the mid-1990s. This disinflation process cut across all EMDE regions and manifested itself in all inflation measures. By the early 2000s, this disinflation was largely completed and resumed only after the global financial crisis, albeit at a more modest pace.

A. Global CPI inflation

B. Global CPI trend inflation

C. Median CPI headline inflation by region

D. Median CPI headline inflation by country group

E. Median CPI, PPI headline inflation, and the GDP deflator

F. Median core, food, and energy CPI inflation


Note: All inflation rates refer to year-on-year inflation.
A. Based on 153 countries. Last observation is 2017. Figures shows headline inflation.
B. Based on 77 countries, including 50 EMDEs. Figure shows median trend inflation, as defined in Stock and Watson (2016).
C. Horizontal bars lines reflect median inflation across all EMDEs over 1970-97 and 1998-2017. EAP = East Asia and the Pacific, ECA = Eastern Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = the Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.
D. Median of inflation trend of 25 advanced economies, 97 EMDEs (excluding LICs) and 27 LICs. Last observation is 2017Q1.
E. Based on data for inflation in 39 countries, including 15 EMDEs.
F. Based on data for inflation in 47 countries, including 18 EMDEs.

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BOX 1.2 Inflation in low-income countries

Inflation in low-income countries has declined sharply over the past three decades, to a median of 5.0 percent in 2017 from a peak of 24.2 percent in 1994. This decline in inflation was broadly shared. It has been supported by a move to more flexible exchange rate regimes, greater central bank independence, lower government debt, and a more benign external environment.

The number of low-income countries (LICs) has almost halved since 1994. As of 2018, 34 countries were classified as “low income” according to the World Bank definition, down from 64 in 1994, following the graduation of 31 mostly metals-exporting and transition economies to middle-income status (Annex 1.2). Today, LICs are predominantly agriculture-based, small, and fragile, and they tend to have weak institutions (World Bank 2015). All but seven of them are located in Sub-Saharan Africa.

Today’s LICs have made large strides in stabilizing their economies over the past five decades, with sharp declines in inflation and inflation volatility. This box documents the achievements in terms of inflation. Chapter 6 delves into the features of LIC inflation and quantifies its drivers in depth. Against this backdrop, this box discusses the following questions.

- How has inflation evolved in LICs?
- What factors have supported inflation developments in LICs?

Evolution of inflation

Among LICs, median inflation has fallen by two-thirds since 1970, to 5.0 percent in 2017—broadly in line with inflation developments in other EMDEs. The inflation decline has been broad-based across countries as well as inflation components. As a result, the wide heterogeneity of inflation among LICs in the 1990s has narrowed sharply, to a range of 6-18 percent in 2017.

1970s to 1990s. Throughout these three decades, median inflation among LICs was 9-10 percent. While this was broadly in line with inflation in other EMDEs, LIC inflation underwent bouts of sharp spikes (to 25 percent), especially in the early 1990s, amid exchange rate crises. In half of the years between 1970 and 2000, the majority of LICs had double-digit inflation.
2000s. During the 2000s, median inflation in LICs fell rapidly, to 5.0 percent in 2017 from a peak of 24.2 percent in 1994 (Figure 1.2.1). This decline was broad-based and narrowed some of the wide heterogeneity in inflation among LICs. In one-third of LICs, inflation in 2017 was less than one-third its level in 1970 and, in an even larger number (58 percent) of LICs, inflation in 2017 was less than one-third of its 1994 level. By 2008, the two hyperinflation episodes in LICs (with inflation in excess of 1,000 percent) had also subsided. In 2017, inflation was in single-digits in more than three quarters of LICs, compared with less than one-fifth in 1994. Since 1970, core, food price and energy price inflation have also declined, as has inflation volatility (although it remains well above inflation volatility in other EMDEs).
Factors supporting inflation developments

In every year since 2000, except 2002 and 2017, LIC inflation has exceeded inflation in other EMDEs. This difference has been attributed to a number of factors, of which three have been particularly closely examined: fiscal policy, supply shocks, and uncertainty about monetary policy transmission.

**Fiscal policy.** For LIC governments with weak revenue-raising capabilities and the absence of well-functioning capital markets, inflation may become an important source of financing fiscal deficits (Baldaci, Hillman, and Kojo 2004). The presence of large fiscal deficits or high government debt in LICs can cause fiscal dominance—with fiscal policy relying on accommodative monetary policy to ensure fiscal sustainability (Baldini and Poplawski-Ribeiro 2011, Weidmann 2013). In almost every year between 1992 and 2002, two-thirds of LICs had higher debt-to-GDP ratios than the one-third of non-LIC EMDEs with the highest debt levels. In half of the years between 1995 and 2017, the median fiscal deficit in LICs was above that in non-LIC EMDEs. Weak institutions (Bleaney, Morozumi and Mumuni 2016) and political instability (Aisen and Veiga 2006) may reinforce the negative association between budget deficits and inflation.

**Supply shocks.** LIC economies are particularly vulnerable to frequent supply shocks, especially weather-related ones. Agricultural sectors tend to be large, poor transport links prevent risk sharing, and food forms a larger share of household consumption (Bleaney and Francisco 2018; Cachia 2014; Chapter 6). As a result, for example, rainfall appears to significantly affect economic growth in EMDEs in Sub-Saharan Africa but not elsewhere (Barrios, Bertinelli and Strobl 2010).

**Uncertainty about monetary policy transmission.** In LICs, credit and other financial markets tend to be shallow, contract enforceability limited and information asymmetries pervasive, and many LICs retain elements of financial repression in the form of interest rate controls (Mishra, Montiel, Spilimbergo 2012). This can impair monetary policy transmission (IMF 2015; Mishra and Montiel 2013).

Since 2000, improvements in LIC policies and a benign global macroeconomic environment have supported the decline in LIC inflation. That said, policy frameworks in the median LIC remain generally weaker than those in other EMDEs.
**BOX 1.2 Inflation in low-income countries (continued)**

**Improved policies.** Inflation has tended to be lower in LICs with lower public debt ratios; fixed exchange rate regimes; and higher degrees of central bank independence and transparency (Figure 1.2.2). Since 1970, monetary policy frameworks have strengthened in LICs. The index of central bank independence (available for ten LICs) doubled between 1998, when the series starts, and 2014, when the series ends. In 1970, all but two LICs had pegged exchange rates whereas, in 2017, only half of LICs (14 out of 29 with available data) had fixed exchange rate regimes, as defined in Shambaugh (2004). Fiscal pressures on monetary policy also appear to have eased. Government debt has declined from a peak of 123 percent of GDP, on average, in 2003 to 52 percent of GDP, on average, in 2017—broadly in line with the average non-LIC EMDE. In addition, the relationship between fiscal positions and inflation appears to be nonlinear: in a low-inflation environment, fiscal deficits tend to be less inflationary (Catao and Terrones 2005; Lin and Chu 2013). As a result, the current low-inflation environment may help further mute the pressures from fiscal dominance on inflation in LICs.

**More benign external environment.** LIC economies, on average, have become more open to trade and finance since the 1970s although they remain less open than other EMDEs (IMF 2011a).\(^1\) Higher capital account openness, in particular, has been associated with lower inflation whereas there has been little difference between LICs that have been highly open to trade and those that have not. Despite a growing number of LICs switching to floating exchange rate regimes, exchange rates have been considerably more stable since 1998 than in the preceding two decades. This has helped lower LIC inflation volatility and inflation.

**Conclusion**

LIC inflation and inflation volatility have fallen sharply during the past three decades, broadly in line with other EMDEs. The decline has been broad-based across countries, as well as across components of inflation. Both better policies—such as greater central bank independence and transparency, a shift away from pegged exchange rate regimes, and lower government debt burdens—and a more benign global macroeconomic environment have supported the inflation decline in LICs.

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\(^1\) In the average LIC, trade (exports plus imports) has amounted to 58 percent of GDP since 1970 whereas, in the average non-LIC EMDE, it has amounted to 83 percent of GDP; international financial assets and liabilities amounted to 114 percent of GDP in the average LIC compared with 256 percent of GDP in the average non-LIC EMDE.
FIGURE 1.2.2 Factors supporting falling inflation in LICs

The decline in LIC inflation has been supported by improved policies, greater openness to trade and finance, and a more benign macroeconomic environment.

A. Central bank transparency index

B. Number of LICs, by exchange rate regime

C. Government debt

D. Exchange rate volatility

E. Financial and trade openness

F. Inflation, by country characteristics


Note: Data for 29 low-income countries and 83 other EMDEs.

A.C. Unweighted averages.

B. Exchange rate regime as defined as in Shambaugh (2004).

D. Exchange rate volatility is the cross-country average of the standard deviation of nominal effective appreciation during each time period.

F. Median year-on-year inflation in LICs during 1998-2017, by country characteristics. “High” indicates pegged exchange rate regimes (Peg) or above-median financial openness, central bank transparency, and government debt. “Low” indicates floating exchange rate regimes (Peg) or below-median financial openness, central bank transparency and government debt.

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world (Rogoff 2003; IMF 2006). Studies of disinflation in EMDEs have focused on specific policy experiments in individual countries, such as the introduction of inflation targeting, greater exchange rate flexibility, or macroeconomic stabilization programs (Mishkin 2000; Bernanke et al. 2001; Mishkin and Schmidt-Hebbel 2007; Aizenmann, Chinn, and Ito 2011).

1970s. In the wake of two major oil crises—the quadrupling of oil prices in 1973 and the doubling of oil prices in 1979-80—global median inflation tripled from 4.4 percent in 1970 to 13.7 percent in 1980. During the Arab-Israeli war in 1973, global oil prices quadrupled to about $12 per barrel. Around the time of the Iranian revolution, oil prices more than doubled in 1979-80 to about $36 per barrel. Some advanced-economy central banks, freed in 1971 from the constraints of the Bretton Woods system of fixed exchange rates, aimed to support economic activity with monetary expansion. The elimination of the nominal anchor of fixed exchange rates set off an inflationary wage-price spiral with weak economic growth (often termed “stagflation”). Among EMDEs, accommodative monetary policy facilitated a spillover of inflation from advanced-economies (IMF 2011b).

1980s. In advanced economies, monetary policy tightening in the late 1970s and early 1980s helped rein in inflation, to a median of 3 percent by 1986 from its peak of 15 percent in 1974, and establish central bank credibility, although often at the cost of deep recessions. In the United States, for example, short-term interest rates almost quadrupled between end-1976 and mid-1981 (Annex 1.4). In the wake of these interest rate increases, U.S. output contracted by more than 2 percent between early 1981 and mid-1982. In parts of advanced-economy Europe, central banks responded more strongly and earlier to rising inflation. Disinflation was, in several countries, less pronounced than in the United States but was also accompanied by output losses in the early 1980s.

In EMDEs, disinflation was delayed by persistent large fiscal and current account deficits, often in conjunction with fixed exchange rate regimes, deteriorating terms of trade for commodity exporters, and political disruptions (Dornbusch 1986; Edwards 1989). For example, for several decades, Argentina, Brazil, Chile, Israel, Mexico, Peru, and Uruguay had chronically high inflation of more than 20 percent for five or more consecutive years. Multiple stabilization programs were attempted, typically resulting in recessions (Calvo and Végh 1994).

1990s. In the second half of the 1980s and during the 1990s, many EMDEs implemented macroeconomic stabilization programs and structural reforms to improve economic efficiency. These initiatives often included the removal or easing of foreign exchange market controls, trade liberalization, tighter fiscal

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3 During the Arab-Israeli war in 1973, global oil prices quadrupled to about $12 per barrel. Around the time of the Iranian revolution, oil prices more than doubled in 1979-80 to about $36 per barrel.
policy, and stronger fiscal and monetary policy frameworks. In EMDEs across Europe, Central Asia, and South Asia, inflation soared as previously centrally planned economies collapsed and the accompanying price and exchange rate liberalization released pent-up demand pressures. Subsequent stabilization efforts were associated with deep output losses. As transition economies exited high and even hyper-inflation during 1989-94, output declined sharply—e.g., cumulatively by 16 percent in Uzbekistan and 75 percent in Georgia—often amid civil wars and trade embargoes (Fisher, Sahay, and Végh 1996). That said, within two years, on average, these economies started growing again (Figure 1.5). In Latin America and the Caribbean, renewed stabilization programs that centered around sound fiscal discipline and greater central bank independence gained traction and inflation declined.

2000s. The disinflation of the 1980s and 1990s paused in the early 2000s in the runup to the global financial crisis, partly as a result of rapidly rising energy and food prices. The global financial crisis, however, ushered in a renewed period of mild disinflation and, in many advanced economies, spells of negative inflation. Post-crisis, deflation or low inflation was unusually pervasive across advanced economies: in 2015, inflation was negative in more than half of advanced economies and, in 2016, inflation was in the low single digits in three quarters of advanced economies (Figure 1.6). This raised concerns about low inflation, or possibly even deflation, becoming entrenched in inflation expectations. To reduce the risk of falling into a deflationary environment, advanced-economy central banks implemented exceptionally accommodative monetary policy after the global financial crisis, including through unconventional measures. Chapter 4 explores the interaction between inflation expectations and inflation in detail. In EMDEs, inflation fell within target or below target ranges in 60 percent of inflation-targeting economies (from less than 50 percent in 2007), making room for monetary policy rate cuts to support economic activity. In 80 percent of EMDEs, inflation in the second quarter 2018 ranged between 0.8 and 6.7 percent (year-on-year), compared with a range of 3.9 and 23.9 percent in the second quarter of 2008.

Broad-based disinflation. The disinflation over the past three to five decades has been broad-based across country groups and reflected in headline inflation, core inflation, energy and food price inflation. Domestic food and energy prices constitute a large share of domestic consumption price baskets. Food prices have been an important contributor to the persistent and steady decline in global inflation over the past fifty years, whereas energy prices mainly have contributed to declining inflation during major oil price plunges.

- Food prices contributed about 5.5 percentage points to the almost 14 percentage point decline in global headline inflation between 1974 and 2017. This was in addition to food prices’ important role in cyclical swings
in headline inflation around this general disinflationary trend. Yet, food consumer price inflation has reflected global food commodity price developments only to a limited degree. Especially in advanced economies, the estimated pass-through from international food prices to domestic food prices has been modest (Furceri et al. 2015, Figure 1.7).

• Energy prices have contributed to global disinflation only in episodes of major oil price plunges, most recently in 2014-16. Cumulatively, energy prices contributed 3.2 percentage points to the almost 14 percentage point decline in headline global inflation between 1974 and 2017. While energy price inflation has clearly fallen from its 1970s peaks, it was broadly stable through the 1990s and 2000s.
Subsidies, offsetting exchange rate fluctuations, and a growing domestic services content of cost, drove a wedge between domestic food and energy prices and global commodity prices. Domestic energy price inflation was even less homogeneous across EMDEs than domestic food inflation, possibly reflecting a wide variety of fuel subsidy schemes. Domestic food and energy prices have a
FIGURE 1.7 Components of inflation

The disinflation over the past three decades was broad-based in its components, reflected in headline inflation, core inflation, and food price inflation, and cutting across advanced economies and EMDEs.

A. Median food inflation in EMDEs by region

B. Median energy inflation in EMDEs by region

C. Median food price inflation and global food commodity price inflation

D. Median energy price inflation and global energy commodity price inflation

E. Correlations of domestic inflation cycle with global commodity price cycle

F. Correlations of inflation cycle with global commodity price cycle

Source: Pink Sheet, World Bank.

A.B. EAP = East Asia and the Pacific, ECA = Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa. Weights are food and energy weights used to calculate CPI. Weights are weights of food (A) and energy (B) in CPI baskets. Inflation refers to year-on-year inflation.

C.D. Energy and food commodity price inflation from the World Bank’s Pink Sheet of commodity prices.

E. Figure shows correlation of detrended headline CPI and GDP deflator with detrended global energy and food price inflation. Detrended using Hodrick-Prescott filter.

F. Figure shows correlation between detrended domestic headline, energy, and food price inflation with detrended global energy and food price inflation. Detrended using Hodrick-Prescott filter.

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sizeable tradable component because many countries import energy and food products, but the share of nontradable domestic services (such as logistics and retail) in domestic food and energy prices is growing. As a result, the correlation of domestic food and energy prices with domestic headline inflation has increased (Furceri et al. 2015). Chapter 6 examines in greater depth the contribution of policies to food prices, in particular.

Declining inflation volatility. Trend disinflation has been accompanied by a trend decline in inflation volatility across all EMDE regions, measures of inflation, and inflation components. Inflation volatility is measured as the time-varying volatility of trend and cyclical inflation (Stock and Watson 2016). CPI inflation volatility has fallen in both advanced economies and EMDEs (Figure 1.8). While most of the volatility decline has reflected declining volatility of the trend component of inflation, which approximates the volatility of core inflation, declining cyclical inflation, which captures temporary shocks, has also contributed. Declining trend inflation volatility in part reflects the lower volatility of structural economic shocks. The significant decline in macroeconomic volatility in advanced economies between the mid-1980s and the global financial crisis has been labeled the “Great Moderation.”

Differences in inflation volatility among the major groups of economies persist but have narrowed somewhat. EMDEs, especially LICs, have continued to experience higher inflation volatility than advanced economies. Partly because of the inflation swings around economic liberalization in the early 1990s and partly because of domestic conflict, inflation volatility in Europe and Central Asia (ECA), South Asia (SAR), and Sub-Saharan Africa (SSA) was high until 1997, but has since declined sharply in ECA and SSA. In SAR, it remains elevated because of the high volatility of food prices, which account for a large share of the region’s CPI basket (46 percent).

Declining inflation expectations. Well-anchored inflation expectations can ensure that trend inflation remains unaffected by temporary shocks. In both advanced economies and EMDEs, long-term (five-year-ahead) inflation expectations have declined over the past three decades. In advanced economies, inflation expectations have remained stable at about 2 percent per year since 2000, after declining rapidly in the 1990s, with little cross-country variation (Figure 1.9). In EMDEs, inflation expectations decreased markedly in the

4Stock and Watson (2003), Bernanke (2004), and Clark (2009). In the United States, the Great Moderation has been attributed to smaller variance of shocks and positive and stable technological shocks (“good luck”), new inventory processes and labor supply shocks that reduced wage and marginal cost pressures (“structural change”), and more stabilizing monetary policy (“good policies;” Fernández-Villaverde, Guerrón-Quintana, and Rubio-Ramírez 2010).
FIGURE 1.8 Global inflation volatility

Trend disinflation was accompanied by a trend decline in inflation volatility that cut across EMDE regions, measures of inflation, and inflation components.

A. Median CPI and PPI inflation volatility

B. Energy, PPI, and global oil price volatility

C. Inflation volatility, by country group

D. Inflation volatility, by region

E. Inflation volatility, by region

F. Median food and energy inflation volatility, by country group

Source: Pink Sheet, World Bank.

Note: Volatility of cyclical components of inflation, as estimated by Stock and Watson (2016). Trend inflation is defined as the part of inflation that follows a permanent stochastic trend while cyclical inflation is a serially uncorrelated transitory component of inflation. Inflation refers to year-on-year inflation.

A. Balanced sample of 28 countries. The latest data point is 2017Q1. AE stands for advanced economies.

C. Sample includes 27 advanced economies, 44 EMDEs, 10 LICs.

D.E. EAP = East Asia and the Pacific, ECA = Eastern Europe and Central Asia, LAC = Latin America and the Caribbean, MNA = Middle East and North Africa, SAR = South Asia, and SSA = Sub-Saharan Africa.

F. Volatility defined as cross-country median of standard deviation. Weights is the weight of food and energy in CPI consumption baskets.

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second half of the 1990s, but then trended up during 2005-14 before retreating somewhat over the following three years. The increase in inflation expectations during 2005-14 was somewhat more pronounced in countries with low central bank transparency than in those with high transparency. Throughout the past three decades, cross-country variation in inflation expectations across EMDEs exceeded the variation across advanced economies. Chapter 4 discusses the drivers of inflation expectations in detail.

**Historical precedent.** The current low and stable global inflation environment resembles inflation during the Bretton Woods fixed exchange rate system in the post-war period until 1971, and during the gold standard of the early 1900s—both of which provided nominal anchors to countries across the globe (Figure 1.10). In all three periods, global inflation was below 5 percent for an extended
time span (7-19 years). The loss of a nominal anchor at the end of both of these earlier regimes was followed by a period of high inflation until the widespread implementation of inflation targeting and strengthening central bank credibility helped anchor expectations again (Bernanke et al. 2001; Rose 2007; Beyer et al. 2009). However, the post-crisis period of extremely low global inflation differs from the Bretton Woods fixed exchange rate regimes and the gold standard in its lower inflation volatility.

**Long-term correlates of inflation**

Several structural changes have accompanied global disinflation over the past four to five decades. Inflation has, on average, declined more in countries participating more in global value chains, that moved to inflation targeting regimes, with more independent and transparent central banks, and more open capital accounts.

Inflation is often affected by unexpected short-term shocks. But, over time, wages and prices adjust and inflation reverts to its long-term trend. This trend is determined by monetary and fiscal policies, institutional frameworks, and structural features of an economy.⁵

The Phillips curve summarizes the response of inflation to unexpected short-term shocks. Demand-side inflationary pressures include monetary and fiscal policy as well as asset price swings that can affect consumption through wealth effects. Supply-side factors include raw material (energy and food) price shocks, wage growth, and currency depreciation. The role of these drivers of short-term fluctuations in inflation is discussed in detail in Chapters 2 and 3.

Empirically, variants of the Phillips curve have been used to model inflation dynamics.⁶ Wage Phillips curve models link wage growth to labor market slack (or broader economic slack) and wage bargaining power (Phillips 1958; Gali 2010; Khan 1980). Price Phillip curve models link price inflation to unit labor cost or, more generally, labor market slack and material cost (Bhattarai 2016; Blanchard and Gali 2008). Open-economy Phillips curve models include external

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⁵ Monetary policy can cause changes in real activity if inflation expectations are unchanged or adapt with a lag to monetary policy changes (Taylor 1980; Rotemberg 1982; Calvo 1983) or if the wage and price setting adapt with a lag to monetary policy changes (Sims and Zha 1998).

⁶ Evidence for a Phillips curve relationship has been found in Batini, Jackson, and Nickell (2005); Rumber (2007); Osorio and Unsal (2013); Ciccarelli and Mojon (2010); Eickmeier and Pijnenburg (2013); Gamber and Hung (2001); Guerrieri, Gust, and López-Salido (2010); Bianchi and Civelli (2015); Ihrig et al. (2010); Milani (2012); Zhang (2015); and Nguyen et al. (2017). Evidence that the link between inflation and output gaps has declined was found in Roberts (2006); Mishkin (2007); and Szafranek (2017).
cost-push factors such as foreign inflation, commodity prices, import prices, exchange rates, and external demand-pull factors represented by global output gaps (Draghi 2015; Abbas, Bhattacharya, and Pasquale 2016).

Long-term structural factors can affect how inflation and inflation expectations respond to short-term shocks and at what level inflation settles absent such shocks. Chapter 4 documents how the presence of inflation targeting regimes has helped better anchor inflation expectations. Among EMDEs, other supporting factors have included greater central bank credibility, greater trade openness and lower government debt.

These long-term correlates of inflation are the focus of the remainder of this chapter. They have changed significantly over the past four to five decades.
Global trade and financial flows have more than doubled since 1970 as many economies have liberalized trade regimes and capital accounts. Many economies have adopted inflation targeting and moved away from fixed exchange rate regimes, while strengthening fiscal frameworks and liberalizing labor markets.

In EMDEs, similar structural changes have taken place as in advanced economies, although somewhat later and, in some respects, to a lesser degree. For example, by 1998, when Poland became the first EMDE to adopt a full inflation-targeting regime, more than one-quarter of advanced economies had already switched to inflation targeting. During 2000-14, central bank independence and transparency improved in both the median advanced economy and EMDE, but the increase was considerably more pronounced (2.25 index points) in advanced economies than in EMDEs (1 index point) and central bank independence and transparency in the median EMDE remains only one-third of its level in the median advanced economy. Similarly, whereas the increase in trade openness in EMDEs occurred broadly in step with advanced economies, the increase in financial integration during the 1980s and 1990s was considerably more pronounced in advanced economies than in EMDEs.

Trends in long-term drivers have contributed to global disinflation. Inflation has, on average, been lower and declined by more in countries that have been more open to trade, that have had (or have switched to) inflation targeting regimes, that have had more independent and transparent central banks, and more open capital accounts. This section presents these correlations in descriptive statistics and, more formally, in regression analysis and frames them in the context of the literature.

**Trade integration**

**Literature.** Trade integration—increased openness to international trade—is typically accompanied by higher shares of imports in consumption and production and lower prices (compared with a closed economy), owing to competitive pressures from foreign producers. Increasing trade integration may also account for the rising international comovement in inflation, as discussed in Chapter 2. The impact on the responsiveness of inflation to domestic economic

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7 Yellen (2006); Romer (1993); Terra (1998); Lane (1997); Al Naseer, Sachsida, and Mário (2009); Vuletin and Zhu (2011). In particular, the increased trade integration of China into the global trading system, since its WTO accession in 2001, may have reduced inflation globally (Frankel 2007; IMF 2016; Eickmeier and Kühnlenz 2013). Meanwhile, the rising role of services, which are less subject to external shocks, may have helped reduce inflation volatility, but the increasing productivity gap between tradables and nontradables with relatively subdued wage growth might have lifted inflation rates (Roncaglia de Carvalho 2014; Lünnemann and Mathä 2005).
slack (i.e., the slope of the Phillips curve) is ambiguous: greater foreign competition reduces firms’ ability to raise prices and wages in response to domestic demand pressures, hence flattening the Phillips curve; alternatively, if greater foreign participation in domestic markets increases competitive pressures, it could encourage a faster response to demand pressures, hence steepening the Phillips curve.\(^8\) Greater trade openness appears to be associated with lower inflation volatility.\(^9\)

Trade in intermediate goods—a proxy for integration into global value chains—may be more informative about international competitive pressures on inflation than trade in final goods (Lombardo and Ravenna 2014; Burstein, Kanz, and Tesar 2008). Global value chain integration has facilitated the adoption of “just-in-time” inventory practices and has been associated with lower inflation volatility (Hakkio 2013). It has also been associated with a greater role of global factors in domestic inflation and greater international synchronization of inflation (Auer, Borio and Filardo 2017).

**Trends in trade integration.** Over the past four to five decades, global trade openness (the sum of exports and imports relative to GDP) has increased by more than half—to 74 percent of global GDP in 2016, from almost 50 percent of global GDP in 1970. In the median EMDE, trade openness has increased from almost 50 percent of GDP in 1970 to 72 percent of GDP in 2016. Similarly, in the median advanced economy, trade openness has risen from 47 percent of GDP in 1970 to 80 percent of GDP in 2016. The expansion of trade by EMDEs has been accompanied by rapidly rising trade integration among EMDEs, with China becoming the largest trading partner for one-fifth of countries in this group (World Bank 2016). The most rapid expansion of trade occurred in the 1990s and early 2000s (Figure 1.11).

Since the 1990s, trade integration has fostered the creation and expansion of global value chains, especially among advanced economies. As a result, the share of foreign value added embodied in exports in advanced economies (backward integration) increased from 10 percent in the 1970s to about 30 percent on average during 2000–16. While less rapidly and somewhat later, the share of foreign value added in domestic exports in EMDEs also increased in the 1990s and 2000s to 10 percent in 2016, from 1.5 percent in 1990.

**Correlation with inflation.** Inflation levels and volatility have typically been lower in economies and time periods with greater trade openness. The full

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sample was split into country-year pairs in the bottom and top quartiles of trade-to-GDP ratios and shares of foreign value added in exports. Median inflation was 4 percentage points lower and half as volatile in the top quartile than in the bottom quartile of trade-to-GDP ratios. Inflation was also more than 3 percentage points lower and one-fifth as volatile in the top quartile than in the bottom quartile of global value chain participation.
A bivariate panel regression suggests that, in countries where trade openness increased by 10 percentage point of GDP over the past four decades—about the median in the sample—inflation declined (although insignificantly) by 0.2 percentage point more than average over the same period. This relationship was even weaker among EMDEs alone (Tables A.1.3.1 and A.1.3.2, Annex 1.3).

**Financial openness**

**Literature.** In theory, financial openness could raise or depress inflation volatility. If capital flows help smooth fluctuations in consumption in a financially open economy, they can moderate domestic demand swings that might otherwise generate inflationary or disinflationary pressures. This would reduce inflation volatility. Conversely, procyclical capital inflows could themselves generate larger domestic demand swings and cause greater volatility in output and inflation.

Empirically, greater capital account openness has been associated with lower inflation. Multiple studies have found in large cross-sections of countries that greater capital account openness has been accompanied by lower average inflation (Badinger 2009; Gruben and McLeod 2002; Aizenman, Chinn, and Ito 2008). This pattern has been attributed to a stronger anti-inflation bias of central banks amid sharper tradeoffs between output growth and inflation (Badinger 2009), or to a greater interest rate elasticity of money demand (Gruben and McLeod 2002).

**Trends in financial openness.** Advanced economies liberalized their capital accounts almost fully between 1970 and 2000, whereas capital account liberalization in EMDEs has proceeded at a more guarded pace (Figure 1.12). In the median advanced economy, the Chinn and Ito (2017) index of capital account openness, which ranges between 0 to 1, increased to 0.9 in 2017 from 0.4 in 1970. In the median EMDE, this index temporarily increased from 0.2 to 0.4 in the mid-1990s, but then declined again as restrictions were re-imposed in the aftermath of the Asian crisis. Similarly, capital account openness in EMDEs increased again in the mid-2000s until the global financial crisis, but narrowed again thereafter. Over the same period, financial integration surged: in EMDEs, the share of international assets and liabilities rose by one-quarter from 32 percent of GDP, on average, during the 1970s, to 40 percent of GDP, on average, during the 2010s. In advanced economies, similarly, the share of international assets and liabilities doubled to 94 percent of GDP.

**Correlation with inflation.** Capital account openness has been associated with lower inflation and inflation volatility. The country-year pairs with the top quartile of most open capital accounts had, on average, 12 percentage points (10
FIGURE 1.12 Capital account openness and inflation

Over the past five decades, advanced economies have liberalized their capital accounts and, at a slower pace, EMDEs have partially liberalized their capital accounts. Greater capital account openness has been associated with lower and more stable inflation.

A. Index of capital account openness

B. International assets and liabilities

C. Inflation, by capital account openness

D. Inflation, by international assets and liabilities

E. Correlation between disinflation and changes in capital account openness index (1980s-2010s)

F. Correlation between disinflation and changes in international assets and liabilities (1980s-2010s)

Sources: IMF Direction of Trade Statistics, World Bank World Development Indicators.
Notes: Capital account openness is defined as in Chinn and Ito (2008). The index ranges from 0 (closed capital account) to 1 (open capital account). Inflation refers to year-on-year inflation.
A.B. Medians (A) or unweighted averages (B)
C.D. Columns indicate the median inflation levels and inflation volatility in country-year pairs with a Chinn-Ito Index (C) or a sum of international assets and liabilities relative to GDP (D) in the top quartile over 173 economies (C) or 175 economies (D) during 1970-2017. Horizontal bars indicate countries in the bottom quartile. Financial integration is defined as the sum of international assets and liabilities in percent of GDP. The difference in inflation levels and volatility between high and low capital account openness and financial assets and liabilities is statistically significant at the 1 percent level.
E.F. Blue bars show the coefficient estimates from bivariate panel regressions of change in average annual inflation between the 1980s and 2010s and the change in the decadal average Chinn-Ito index (E) or the change in the sum of international assets and liabilities relative to GDP (F) over the same period (Tables A.1.3.1 and A.1.3.2). Vertical lines are ±1.64 standard errors of the coefficient estimate.

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percentage points for EMDEs) lower inflation, and lower volatility, than the bottom quartile of country-year pairs with the least open capital accounts. Similarly, inflation in countries and years with international assets and liabilities relative to GDP in the top quartile of the sample was less than half (and volatility was one-fifth) its level of those in the bottom quartile. The difference in inflation levels may have reflected the disinflation in advanced economies after their capital accounts had been largely liberalized. In EMDEs, capital account openness has also been associated with lower inflation, but this relationship has been less pronounced than in advanced economies.

Again, the panel regression suggests that a 0.5 point increase in the capital account openness index over the past four decades was associated, on average globally, with a 4.7 percentage point stronger disinflation and, among EMDEs, with a 4.0 percentage point stronger disinflation (Tables A.1.3.1 and A.1.3.2, Annex 1.3). Such an increase in capital account openness would be approximately in line with the top quartile for advanced economies (0.58 point increase) and the top decile in EMDEs (0.53 point increase) over the past four decades. Similarly, in EMDEs, an increase in international assets and liabilities by 30 percentage points of GDP—the median increase between the 1980s and 2010s—was associated with a statistically significant 1.5 percentage point stronger disinflation over the past four decades (Tables A.1.3.1 and A.1.3.2, Annex 1.3).

**Monetary policy frameworks and exchange rate regimes**

**Literature.** Both pegged exchange rate regimes and inflation targeting monetary policy regimes—if supported by other policies—can provide the nominal anchor for inflation expectations that can help ensure low and stable inflation (Bernanke and Mishkin 1997; Fischer 2001; Mussa et al. 2000). Particularly for countries with weak institutions, a formal pegged exchange rate regime can signal a commitment to monetary and fiscal policy discipline. Implementation of such a strategy may not be straightforward, however. The level of the exchange rate at which the domestic currency is pegged is especially important if domestic inflation exceeds inflation in the country whose currency forms the peg: the domestic economy will then continue losing international competitiveness until the inflation rates converge. Even after the inflation rates have converged, the domestic economy may be burdened by the loss of competitiveness that has occurred since the peg was established. These issues may give rise to pressures that test the viability of the peg.

For countries with sufficiently strong institutions to implement credible inflation targeting regimes, this can anchor expectations at the inflation target.
Thus, it can ensure that temporary shocks to inflation—caused, for example, by exchange rate swings or food price spikes—remain temporary, without being passed through to trend or core inflation.

*Pegged exchange rate regimes* have been associated with lower inflation than other exchange rate regimes (Bleaney and Fielding 2002; Ghosh et al. 1997). In transition economies during the 1990s and 2000s, the switch to a pegged exchange rate regime was associated with disinflation (Domaç, Peters, and Yuzefovichî 2003). The lower inflation achieved by pegging the exchange rate has, in some EMDEs, been at the cost of higher volatility of output growth and inflation (Bleaney and Fielding 2002) whereas, in broader samples during an earlier period, pegged exchange rate regimes were associated with more stable inflation (Ghosh et al. 1997; Moreno 2001). That said, any difference between inflation and its volatility in pegged and more flexible exchange rate regimes may partly reflect the highly diverse nature of more flexible regimes that includes countries with a wide range of institutional arrangements (Rose 2011).

In advanced economies, *inflation targeting regimes* have been associated with limited lasting effects on inflation levels and volatility but with lower inflation persistence. In seven advanced countries, the shift to inflation targeting in the 1990s was not always accompanied by significantly lower inflation rates or inflation volatility (Ball and Sheridan 2005; Bernanke et al. 2001; Lin and Ye 2007). Among a broader and more recent sample of advanced economies, the adoption of inflation targeting was associated with lower inflation within two years but at the cost of higher inflation volatility (Fang, Miller and Lee 2012; Levin, Natalucci and Piger 2004). In addition, inflation targeting was accompanied by a more modest response of inflation to exchange rate and oil price shocks (Mishkin and Schmidt-Hebbel 2007). Several studies have attributed declining inflation persistence in advanced economies in the early 2000s to inflation targeting or its introduction (Benati 2008; Canarella and Miller 2017). Widespread adoption of inflation targeting regimes has been shown to help promote global economic stability (Rose 2007; Taylor 2014).

In EMDEs, in contrast to advanced economies, inflation targeting regimes have been associated with significantly lower and more stable inflation (Fang, Miller, and Lee 2012). The introduction of such regimes has been associated with significantly larger drops in inflation than in other EMDEs (Gonçalves and Salles 2008). This reduction of inflation has partly been attributed to better anchoring of inflation expectations and, in some EMDEs, to lower inflation persistence (Batini and Laxton 2007; Canarella and Miller 2017; Gerlach and Tillman 2012). That said, some studies have found that the effectiveness of inflation targeting in lowering inflation in EMDEs varies widely by country.
characteristics, including fiscal positions and the length of time since adoption of inflation targeting (Mishkin 2000, 2008b; Lin and Ye 2009).

**Trends in exchange rate and inflation targeting regimes.** Over the past four to five decades, inflation-targeting monetary policy regimes have become widespread, while pegged exchange rate regimes, which were predominant up to the 1970s, have receded. In 1990, New Zealand was the only economy implementing inflation targeting. But a growing number of advanced economies and EMDEs have subsequently adopted inflation targeting regimes, in an effort to replace the nominal anchor offered by pegged exchange rates. The number of inflation-targeting central banks had risen to 14 by 2000 and 35 by 2017 (Figure 1.6 and 1.13) while the share of EMDEs relying on pegged exchange rate regimes fell by one-third between 1970 (84 percent of countries) and 2017 (54 percent). Many inflation-targeting central banks, especially in EMDEs, have brought inflation within target ranges while also lowering the mid-points of target ranges (Figures 1.6 and 1.13). The transition from fixed to floating exchange rate regimes was smoother in some countries (e.g., Chile) than in others (e.g., Brazil) where it was followed by exchange rate crises (Annex 4.3).

**Correlation with inflation.** Among countries with pegged exchange rate regimes or inflation-targeting monetary policy frameworks, inflation was, on average, 3-4 percentage points lower than under other exchange rate and monetary policy regimes (Figure 1.14). This was most evident among EMDEs: In EMDEs, fixed exchange rate regimes and inflation-targeting regimes were associated with 3-4 percentage point lower inflation whereas, in advanced economies, the difference was less than 2 percentage points. Compared with other exchange rate and monetary policy regimes, inflation targeting regimes were also associated with lower inflation volatility, while pegged exchange rate regimes were not.

A panel regression suggests that a switch to an inflation targeting regime tended to be accompanied by 6.5 percentage points more disinflation (9.1 percentage point more for EMDEs), over the past four decades, than average (Table A.1.3.1). One quarter of advanced economies and one-tenth of EMDEs in the sample made the switch to an inflation targeting regime over this period. A switch to a pegged exchange rate regime had no statistically significant impact among EMDEs.

**Central bank independence and transparency**

**Literature.** A stability-oriented monetary policy and exchange rate regime can be bolstered by central bank independence and transparency. A more independent central bank is in a more credible position to achieve monetary policy targets, even at the expense of other economic policy targets. More transparent central
bank operations, strategy, and communications can safeguard the legitimacy of the central bank, enhance public understanding of and confidence in sound monetary policy, promote informed discussion among market participants and the broader public, and more effectively guide and stabilize inflation expectations.

Empirically, central bank transparency has been found to help anchor inflation expectations in advanced economies (van der Crijisen and Demertzis 2007; Demertzis and Hallett 2007). In these economies, central bank transparency has reduced inflation expectations and, therefore, inflation and inflation uncertainty
Weber (2016; Siklos 2003; Demertzis and Hallett 2007). More narrowly, among 87 advanced and emerging market economies, greater detail in central bank forecasts has been accompanied by lower inflation, except in countries with exchange rate-targeting regimes (Chortareas, Stasavage, and Sterne 2001). That said, Cecchetti and Krause (2002) find that in 63 advanced and emerging market economies, a long history of low inflation is more important to macroeconomic stability than any particular institutional arrangement. The impact on inflation persistence remains ambiguous (Dincer and Eichengreen 2010).

**Trends in central bank independence and transparency.** Central bank independence and transparency have increased considerably over the past two decades, especially in EMDEs (Figure 1.15). In the median EMDE, the index of central bank independence and transparency has risen more than one-and-a-half-fold since 1990, to 5.4 in 2014. Notably, the turnover rate of heads of

---

**FIGURE 1.14** Monetary framework, exchange rate regime, and inflation

Among countries with pegged exchange rate regimes or inflation-targeting monetary policy frameworks, inflation was lower and less volatile, and has declined more strongly since the 1970s, than under other exchange rate and monetary policy regimes.

A. Inflation, by monetary policy and exchange rate regime

<table>
<thead>
<tr>
<th>EX regime</th>
<th>Monetary policy</th>
<th>Inflation level</th>
<th>Peg</th>
<th>IT</th>
<th>Non-peg</th>
<th>Non-IT</th>
</tr>
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<tbody>
<tr>
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</tbody>
</table>

B. Difference in disinflation associated with switch in exchange rate regime and monetary policy regime (1980s-2010s)

Sources: Caceres, Carrière-Swallow, and Gruss (2016); Shambaugh (2016); World Bank World Development Indicators; World Bank.

Notes: Pegged exchange rates are defined, based on a de facto classification, as exchange rates fluctuating within a +/-2 percent band or at most one one-time devaluation over the preceding 11-month period relative to a country-specific reference currency (Shambaugh 2004). Inflation targeting regimes ("IT") are defined as in Caceres et al. (2016) and the IMF Annual Report on Exchange Arrangements and Exchange Restrictions. Inflation refers to year-on-year inflation.

A. Columns show median inflation in countries with pegged or inflation targeting monetary policy regimes during 1970-2017. Horizontal bars indicate median inflation in countries without pegged or inflation-targeting monetary policy regimes during the same period. The difference in inflation levels and volatility between inflation targeting and other regimes is statistically significant at the 1 percent level.

B. Blue bars show the coefficient estimates from bivariate panel regressions of changes (between 1980-89 and 2010-17) in inflation on a switch (over the same period) to an inflation-targeting regime or to a pegged exchange rate regime (Tables A.1.3.1 and A.1.3.2). Vertical lines are ±1.64 standard errors of the coefficient estimate. The difference in inflation levels and volatility between high and low central bank independence and transparency is statistically significant at the 1 percent level.

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central banks fell by one third among EMDEs between 1990 and 2016, with the most widespread improvements in EAP and ECA.\footnote{For sources and definitions of data on turnover rates, see Database Annex.}

**Correlation with inflation.** On average, country-year pairs ranking in the top quartile of the index of central bank independence and transparency have had 4 percentage points lower inflation (3 percentage points for EMDEs) and one-half to one-fifth of the inflation volatility of country-year pairs ranked in the bottom quartile of the sample. These differences are most pronounced in EMDEs. A panel regression suggests that a 1-point improvement in the Dincer and Eichengreen (2014) central bank independence and transparency index—the median improvement in EMDEs and advanced economies over the past four decades—was accompanied by 1-1.2 percentage point stronger-than-average disinflation over the same period.

**Fiscal frameworks**

**Literature.** When options for private domestic and foreign borrowing by governments are limited or costly, central banks may be compelled to finance fiscal deficits. Unless such deficit financing is accompanied by crowding out of private credit, money supply and inflation will rise, exchange rate pressures will build, and the central bank’s room to achieve monetary policy goals will be restricted (Sargent and Wallace 1981).

Empirically, the evidence for such a link between fiscal deficits and inflation has been inconclusive, but it appears to be stronger for countries with pre-existing high inflation or during high-inflation episodes. In a large sample of countries, wider fiscal deficits have been associated with higher inflation, especially in countries in which inflation was high to begin with (Fischer, Sahay, and Végh 2002) or where money supply was large relative to GDP (Catao and Terrones 2001). Similarly, rising debt has been associated with higher inflation in countries with already-high initial debt levels (Kwon, McFarlane, and Robinson 2009; Bleaney 1999). Turkey in the late 1980s is an example of a country in which the monetization of large fiscal deficits resulted in high inflation (Rodrik 1990).

**Trends in fiscal frameworks.** Over the past four to five decades, trends in government debt have diverged between advanced economies and EMDEs (Figure 1.16). Government debt has steadily increased in advanced economies to 68 percent of GDP, on average, in 2017. In contrast, in EMDEs, government debt has fallen to 49 percent of GDP in 2017, well below its peak of 72 percent in 1994 despite a post-crisis reversal of the earlier decline. In EMDEs, lower
Over the past three decades, central banks have become more independent and transparent. Greater central bank independence and transparency has been associated with lower and more stable inflation.

Sources: Dincer and Eichengreen (2014), World Bank World Development Indicators.

Notes: Central bank independence and transparency index (CBI) is defined as in Dincer and Eichengreen (2014), extrapolated as described in Database Annex. The index ranges from 0 (least independent and transparent) to 15 (most independent and transparent). AEs stands for advanced economies. Inflation refers to year-on-year inflation.

Columns indicate the median inflation levels and inflation volatility in country-year pairs with a central bank independence and transparency index (CBI) in the top quartile of the sample. Bars denote medians for country-year pairs in the bottom quartile. The difference in inflation levels and volatility between high and low central bank independence and transparency is statistically significant at the 1 percent level.

Blue bars show the coefficient estimates from bivariate panel regressions of changes in average inflation between the 1980s and 2010s on the change in average central bank independence index over the same period (Tables A.1.3.1 and A.1.3.2). Vertical lines are ±1.64 standard errors of the coefficient estimate.

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government debt may have been associated with reduced financing needs, including from central banks. Meanwhile, the number of countries adopting fiscal rules has risen to 88 countries (including 49 EMDEs) in 2017, from six in 1985 (including two EMDEs) when the data series starts.

**Correlation with inflation.** There has been little difference, on average, between inflation in countries with government debt-to-GDP ratios in the top and bottom quartile of the sample. However, countries with government debt in the lowest quartile have had considerably lower inflation volatility. Reflecting the
FIGURE 1.16 Government debt and inflation

Over the past five decades, government debt has grown in advanced economies, especially after the global financial crisis. In EMDEs, it has fallen below early 1990s peaks. Higher government debt has been associated with higher inflation volatility in EMDEs.

A. General government debt

B. Countries with fiscal rules

C. Inflation, by government debt

D. Correlation between disinflation and changes in government debt (1980s-2010s)

Sources: IMF Fiscal Rules Dataset, IMF World Economic Outlook database, World Bank World Development Indicators.
Note: Inflation refers to year-on-year inflation.
A. Median across countries
C. Columns indicate the median inflation levels and inflation volatility in country-year pairs with government debt in the top quartile of the sample. Horizontal bars denote medians for country-year pairs in the bottom quartile.
D. Blue bars show the coefficient estimates from bivariate panel regressions of changes (between 1980-89 and 2010-17) in inflation on average government in percent of GDP in the 1980s. Vertical lines are ±1.64 standard errors of the coefficient estimate.

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wide range of correlations between inflation and government debt, the panel regression also finds no statistically significant relationship between the initial level of government debt and disinflation over the past four decades (Table A.1.3.1). While low government debt per se was not unambiguously associated with stronger disinflation, inflation has been lower in countries with fiscal rules than in those without (Figure 1.16).

Labor and product markets

Literature. In 40 advanced and emerging market countries during the 1970s, wage indexation was associated with a greater impact of shocks on inflation (Fischer 1983). Such wage indexing also affects inflation persistence: widespread
wage indexing, possibly enforced by highly collectivized wage bargaining, can entrench short-term inflation shocks into longer-term inflation trends and inflation expectations (Taylor 1979).

Beyond wage indexation, labor market deregulation has been associated with lower inflation persistence (Biroli, Mourre, and Turrini 2010). In the Euro Area, in particular, arrangements that facilitate labor market flexibility—such as lower employment protection, less union density, and more limited collective bargaining—have been found to reduce inflation persistence (Jaumotte and Morsy 2012). A similar result was found for a broader OECD sample (Geronikolaou, Spyromitros, and Tsintzos 2016).

Greater product market flexibility can enhance competition and vice versa. By making wages and prices more flexible, including by deregulating administrative prices, it reduces and make more transitory the real effects of monetary policy and, hence, reduces the incentive for central banks to stimulate in order to boost growth and employment (Rogoff 2003). As a result, inflation expectations and inflation could be lower. Empirically, there is some tentative evidence of lower inflation persistence among advanced economies with greater product market flexibility (Biroli, Mourre, and Turrini 2010).

Trends in labor and product markets. Since 2000, labor market flexibility has increased in both advanced economies and EMDEs (Figure 1.17). For example, in EMDEs, union membership has declined sharply to 5-15 percent of the labor force in 2013, well below the 2000 level (15-35 percent). In some EMDEs with already-elevated wage bargaining coverage, it has expanded further, but it remains well below advanced-economy levels where it has receded somewhat since 2008.

Correlation with inflation. Lower union membership has been associated with lower inflation and inflation volatility in EMDEs (Figure 1.17). In EMDEs in the bottom third of the sample for union membership, inflation was about 1 percentage point lower, on average, and inflation volatility was less than half of that in the top third of the sample. For advanced economies, in contrast, the difference was modest.

Economic structure

Literature. Unless commodity-reliant economies can fully stabilize output growth and exchange rate swings, they may face greater macroeconomic

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11 These measures are unavailable for a panel of countries from the 1970s-1990s. Hence, labor market variables were not included in the panel regression.
volatility, including inflation volatility, as a result of volatile commodity prices (Bayoumi and Ostry 1997). Conversely, countries that rely heavily on food imports may be subject to greater global food price volatility. However, the consequences of resource reliance for macroeconomic stability depend on policy frameworks: monetary policy independence and financial openness may mitigate the volatility caused by global commodity price swings into resource-based economies (Aizenman, Chinn, and Ito 2009).

**Economic structure in EMDEs.** About two-thirds of EMDEs rely heavily on commodity exports. In these countries, the commodity sector accounts for 30-80 percent of exports, 20-70 percent of government revenues and 5-20 percent of GDP. The fall in commodity prices from their peaks in early 2011...
has encouraged some economic diversification. In 2016, the share of exports accounted for by commodities in these countries had fallen to 25-70 percent.

**Correlation with inflation.** The oil price plunge during 2014-16 helped reduce inflation, particularly among EMDEs with a high share of energy imports in GDP. For every additional 10 percentage points of GDP in higher energy imports, disinflation over the past four decades was about 0.7 percentage point steeper. In contrast, higher net food imports were associated with slower disinflation over the past four decades.

**Other factors**

In some countries, disinflation has been attributed to population aging and growing digitalization of services.

**Population aging.** In Japan, population aging may have contributed to chronically low inflation as the burden of rising pension bills weighed on consumption of the working-age population, assets sales of older households depressed asset prices, and shifts towards lower-risk household assets (especially household holdings of government bonds) by older households reduced the funding envelope for fixed investment.\(^{12}\) Studies based on broader groups of countries have been less conclusive.\(^{13}\)

**Digitalization of services.** In some advanced economies, disinflation has been attributed partly to growing digitalization of services, including e-commerce or sharing services (Goolsbee and Klenow 2018). While electronic sales by enterprises may still be modest, they have grown rapidly (Ciccarelli and Osbat 2017). By introducing cheaper distribution channels and increasing price transparency, these services may increase competitive pressures and, by increasing efficiency, generate cost savings (Dong, Fudurich, and Suchanek 2017). However, they may foster market concentration and the emergence of “superstar firms” that reduce competitive pressures in the longrun (Autor et al. 2017).\(^{14}\) Empirical studies have found little evidence of significant deflationary pressures from such digitalization (Charbonneau et al. 2017). For example, using big-data techniques, Cavallo and Rigobon (2016) and Cavallo (2017) found that inflation in online retail prices closely matched official U.S. price indices. In

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\(^{12}\) Andersen, Botman, and Hunt (2014); Imam (2013); Katagiri (2012).

\(^{13}\) While the Japan-specific studies referred to in the preceding footnote agree that population aging has been deflationary, studies based on groups of OECD countries are mixed: Yoon, Kim and Lee (2014), Bobeica et al. (2017), and Inoue et al. (2016) find a negative relationship between the population share of elderly and inflation while Juselius and Tákáts (2015) find the opposite.

\(^{14}\) Rapid technological change has also raised concerns that inherent quality improvements are underestimated and, hence, price levels and inflation are overestimates. Empirical studies have found little evidence to support this hypothesis (Cavallo 2017).
eight other G20 countries, the evolution of online prices has also been similar to that of offline prices, although possibly with more frequent but smaller price changes.\textsuperscript{15}

\textbf{Conclusion}

The chapter documents the wide-spread (across countries) and broad-based (across components) decline in global inflation over the past four to five decades. Global inflation has fallen from a peak of 16.6 percent (annual average) in 1974 to 2.6 percent in 2017 and further to 2.3 percent in the second half of 2018. In advanced economies, it has fallen steadily since the mid-1980s and in EMDEs since the mid-1990s. In EMDEs, inflation has declined from a peak of 17.3 percent (annual average) in 1974 to 3.5 percent in 2017 and, in LICs, from 24.9 percent (annual average) in 1994 to 5.0 percent in 2017. By 2000, global inflation had stabilized at historically low levels before the global financial crisis set off a period of renewed disinflation. Lower inflation has been accompanied by lower inflation volatility, especially in advanced economies.

The global disinflation has been broad-based. It has occurred in most countries, all EMDE regions, all measures of inflation and all components of inflation. The current low-and-stable inflation episode resembles that during the Bretton Woods fixed exchange rate system in the post-war period until 1971 and during the gold standard of the early 1900s. When these historical exchange rate systems faltered, inflation surged. In today’s context also, there are also reasons to believe that structural factors that have supported disinflation over the past five decades may be fading.

Global disinflation has been supported a confluence of structural, cyclical and policy related factors. A major structural change has been the unprecedented international trade and financial integration along with rapid technological progress. In the median EMDE, like in the median advanced economy, trade has increased by half since 1970, to 75 percent of GDP in 2017 and international assets and liabilities have more than tripled, to 166 percent of GDP in 2016 (although still only half the level in advanced economies).

On the policy front, the adoption of stronger monetary, exchange rate and fiscal policy frameworks has changed policymakers’ approach to price stability. Twenty-three EMDEs have followed in the footsteps of Poland, the first EMDE to introduce an inflation targeting monetary policy framework in 1998. Reforms of labor and product markets have made them more flexible by improving

\textsuperscript{15}Cavallo (2017); Gorodnichenko, Sheremirov and Talavera (2016); Gorodnichenko and Talavera (2017).
competition and reducing price rigidities. Technological changes have been transforming production processes in ways that also affect the formation of prices. In addition to these long-term structural changes, severe global and country-specific shocks have depressed inflation for an extended period.

The gains of the past fifty years in terms of inflation are by no means guaranteed. Inflation can easily make a comeback if the fundamental structural and policy changes that have compressed inflation over the past five decades may lose momentum or even reverse. However, as long as strong monetary policy frameworks are supported by sound fiscal policies and institutional structures, it would be possible to keep in check the inflationary implications of fluctuations in business and financial cycles, and movements in commodity prices.

EMDEs are particularly vulnerable to rising external inflation pressures. Their inflation expectations are less well-anchored than in advanced economies. In the absence of strong monetary policy frameworks, exchange rate movements can amplify inflation pressures. Hence, a temporary, externally-driven inflation surge can translate into an increase in inflation that EMDE central banks would struggle to rein in. If that happens, little support for macroeconomic stabilization may be forthcoming from fiscal policy since EMDE fiscal positions are vulnerable to rising borrowing costs when investors reassess risks.

Future research could take two directions. First, the relative contributions of long-term structural changes to global disinflation over recent decades could be more formally quantified. This could be done in a general equilibrium framework, since most regression models are poorly suited to uncovering the relationships between such slow moving variables. Second, future work could examine more formally the degree of comovement in long-term inflation trends, as Chapters 2 and 3 currently do for comovement in short-term inflation movements. This could be set in the context of a more refined measure of trend inflation such as trends of different lengths that could be identified in frequency domain analysis.
ANNEX 1.1 The effects of inflation on inequality and poverty

Poorer households may suffer greater welfare losses from inflation than wealthier households. In general, they are less able to protect the real value of their income and assets from the impact of inflation. While the evidence of a positive correlation between inflation and inequality or poverty is mixed at the aggregate level, the linkages are more established at the household level. The adoption of a credible monetary policy regime that maintains low and stable inflation may help reduce both poverty and inequality. In addition, targeted pro-poor fiscal interventions and structural reforms to improve access to financial services for the poor could further mitigate any adverse effects of inflation on inequality and poverty.

Introduction

Inflation can have adverse economic effects on households and other sectors of the economy through both direct and indirect channels. Its effects can also differ among different groups of households. For example, poorer households tend to be less able to protect the real value of their income and assets from the impact of anticipated inflation than wealthier households as they are more reliant on wage income, have less access to interest-bearing accounts, and are unlikely to have significant holdings of other financial or real assets apart from cash. They may also face a higher or more volatile rate of inflation than wealthier households, due to differences in the composition of their consumption baskets—for instance, poorer households may be relatively more exposed to food price volatility. Less directly, there are close links between inflation, monetary policy, and growth. If high inflation results in tighter monetary policy, or lower economic growth, it can thereby indirectly affect both poverty and inequality.

If the negative effects of inflation fall disproportionately on the poor, it could worsen poverty rates, inequality, or both. Furthermore, as inflation has typically been higher in emerging market and developing economies (EMDEs) than in advanced economies over the past half-century, any negative effects arising from inflation on inequality and poverty may be larger in EMDEs. While the empirical evidence at the aggregate level is somewhat mixed, the negative effects at the household level are more established. Policy measures to control inflation or mitigate its regressive effects, such as the adoption of a credible monetary policy regime, and targeted pro-poor fiscal interventions, have the potential to attenuate inequality and poverty. For EMDEs that are implementing structural reforms and macroeconomic stabilization policies, the potentially beneficial

1 Fischer and Modigliani (1978) document 25 direct and 25 indirect channels through which inflation can affect different sectors of the economy.
effects of controlling inflation may offset some of the negative effects associated with such policies.

Against this background, this annex addresses the following questions:

• What are the direct channels through which inflation affects inequality and poverty at the household level?

• What are the indirect channels through which inflation affects inequality and poverty?

• What is the impact of inflation on overall inequality and poverty?

• What are the major policy implications?

**Direct channels from inflation to inequality and poverty**

Inflation can have different effects on different groups of households. In a survey of almost 32,000 households in 38 countries, Easterly and Fischer (2001) found that the poor were much more likely than the rich to state that inflation was a problem. The composition of income, assets, and consumption baskets tends to be such that poorer households suffer greater losses in the real value of their income and wealth as a result of inflation than wealthier households, so that inflation leads to increases in inequality. However, the very poor—households living below the global poverty line of $1.90 per day—may be less vulnerable to inflation as they have minimal wage income or assets. Inflation is also closely linked to monetary policy and economic growth, and can indirectly affect poverty and inequality.

**Composition of income.** In advanced economies, the poor tend to rely more heavily on wage income, transfers and pensions, and less on income from capital than higher-income households (Erosa and Ventura 2002; Figure A.1.1.1). As wages tend to lag price inflation, inflation can reduce the real value of nominal wages, reducing incomes of the poorest households relative to those of the richest. This also shifts income away from labor income towards profits, which, given the distribution of income between rich and poor, will also tend to worsen inequality (Laidler and Parkin 1975; Fischer and Modigliani 1978). Poorer households may also be less likely to benefit from indexed wages (e.g. through unions), or through inflation-proof benefits such as health insurance (Bulir 2001). The impact of inflation on pensions and transfers depends on their prevalence in society, as well as the level of indexation. Welfare payments in most developed countries have some form of indexation, although adjustments tend to lag inflation, which can result in erosion of real incomes for some income groups in the short-run (Minarik 1979; Burdick and Fisher 2007).
While the channels outlined above also apply to EMDEs, households in EMDEs often rely heavily on ‘non-monetary income’ such as subsistence farming or barter. For example, in Brazil, non-monetary income accounts for more than a quarter of total income among the poorest fifth of households. Being non-monetary, this source of income is less vulnerable to inflation than wage income. For households living below the poverty line of $1.90 a day per head, non-
monetary income may form most of their income, reducing their vulnerability to inflation.

**Composition of assets during sustained high inflation.** The poor tend to hold most of their assets in cash, and have less access to financial products which can protect them against inflation, as these products typically have some entry cost associated with their use (Kahn 1997; Mulligan and Sala-i-Martin 2000a; Erosa and Ventura 2002). For example, in the United States, most households have a transactions or current account at a financial institution, with 94 percent of the poorest 20 percent of households holding one. However, a much smaller number of households have savings products, and the distribution is very skewed: the wealthiest 20 percent of households are four times as likely as the poorest to hold certificates of deposit, and six times as likely to hold savings bonds. The very richest households (top 10 percent) are twelve times as likely as the poorest 20 percent to hold equities and 23 times as likely to hold pooled investment funds. New financial technologies are beginning to broaden access to financial services for poorer households (Demirgüç-Kunt et al. 2018). The differences are even more stark when considering differences in wealth. While an inability to protect against inflation is unlikely to affect the very poor, as their holdings of cash will be minimal, episodes of high- and especially hyper-inflation could tip some households into poverty by eroding the value of their savings, and lead to greater inequality (Cysne, Maldonado, and Monteiro 2005; Areosa and Areosa 2016).

**Composition of assets during unexpected spells of inflation.** A surprise increase in inflation can erode the real value of assets. As the wealthy tend to be net creditors, such an episode of unanticipated inflation could lead to a reduction in their wealth, and a corresponding increase in the wealth of net debtors by reducing the real value of their debt (Palmer and Barth 1977). In practice, this channel is unlikely to benefit the poorest households as they tend to have minimal holdings of assets and liabilities (Romer and Romer 1998). For example, in Brazil, 0.9 percent of the poorest decile of households have a mortgage and 6.3 percent have a credit card, compared with 6.1 percent and 44.2 percent, respectively, for the wealthiest decile. This channel seems unlikely to have much of an impact on poverty rates, particularly in EMDEs. It may have some impact on inequality by eroding the real value of assets among the top income percentiles. For example, in a study of U.S. households, Doepke and Schneider (2006) find that unanticipated inflation has tended to benefit young, middle-class households with fixed-rate mortgage debt, but hurt older and wealthier households. However, holders of equities, who tend to be in the upper income deciles, typically fare better as these instruments and the associated income streams are more inflation-proof.
Composition of consumption baskets. While measures of consumer price inflation are calculated using a basket of goods that is representative of the average consumer, the actual composition of consumption baskets varies significantly by income group—either because households choose different goods and services or because they use differently priced versions of the same goods and services. For example, the bottom quintile of households (by income) in EMDEs spend roughly half of their income on food, compared with just 20 percent for the top quintile. This difference is more pronounced in EMDEs than in advanced economies, as the share of food in total consumption is much smaller in general in the latter.

In addition to differences in the composition of consumption baskets, other factors can play a role. Using data from 5 million retail scanner transactions, Kaplan and Schulhofer-Wohl (2017) find that differences in the prices paid for the same goods explain two thirds of the heterogeneity in inflation rates among U.S. households. High-income households are more able to substitute away from higher quality goods towards lower-quality goods during times of economic crisis, and can also take greater advantage of discounts from bulk purchases and sales, as they do not face the same liquidity constraints as the poor (Argente and Lee 2016; Orhun and Palazzolo 2018).

In general, the evidence suggests that inflation rates vary among income groups, although there is disagreement about whether these effects are temporary or permanent. Some studies have found substantial, long-term differences in effective inflation rates between the poorest and wealthiest households, with inflation rates faced by the poor outpacing those faced by the rich by between 0.4 to 0.8 percentage point a year (Levell and Oldfield 2011; Kaplan and Schulhofer-Wohl 2017; Weichenrieder and Gurer 2018). Other studies have found significant cyclical, but not permanent, differences in inflation rates between income groups (Hobijn and Lagakos 2005; Oosthuizen 2007), with some evidence that more vulnerable groups are prone to greater variability in inflation (McGranahan and Paulson 2006). In addition, the choice of deflator used in the calculation of the poverty line or the indexation of welfare benefits can affect incomes of the poor (Gibson, Le, and Kim 2017). Adjusting for different rates of inflation for different groups can also have a material impact on inequality measures (Weichenrieder and Gurer 2018).

The special case of food price inflation. While the poor in EMDEs are more affected by increases in food prices than higher-income households, a large number of the poor in EMDEs are food producers as well as consumers. A rise in food prices could therefore raise incomes for these households. More than one-fifth of households around and below the poverty line are net food sellers in the average EMDE, and would therefore benefit from higher food prices.
However, in aggregate the majority of the poor in EMDEs and LICs are net buyers of food, and as a result, food price spikes tend to raise poverty overall. For example, the rise in food prices between 2006 and 2008 is estimated to have increased the number of poor by 105 million (Ivanic and Martin 2008). This topic is covered in Chapter 6.

Indirect channels from inflation to inequality and poverty

**Economic growth.** Inflation can indirectly affect poverty and inequality through its impact on economic growth. Historically, low and stable inflation, combined with well-anchored inflation expectations, has been associated with greater short-term stability of output and employment growth and higher long-term economic growth (Bruno and Easterly 1998; Eggoh and Khan 2014; Figure A.1.1.2). These effects also seem to be non-linear, with several studies finding a negative relationship between inflation and growth if inflation is higher than a certain threshold, but no relationship when inflation is below that threshold (Barro 1996; Khan and Senhadji 2001). Several channels account for the beneficial effects of low and stable inflation on economic activity, including reduced uncertainty for investors and households, greater pricing transparency, and greater financial stability (Box 1.1). In turn, higher economic growth typically reduces poverty.

Stronger economic growth has generally been found to be beneficial for the poor, and has been associated with steeper declines in poverty rates (Dollar and Kraay 2004; Dollar, Kleineberg, and Kraay 2016). The relationship has been highly non-linear, with poverty responding less to growth when the initial poverty rate is high (Ravallion 2012; World Bank 2010). The relationship between economic development and inequality has been hypothesized by the so-called Kuznets curve, which proposes an inverse U-shape relationship (Kuznets 1955). At low levels of economic development inequality is low, with little differentiation between households. As economies develop, inequality tends to rise amid increasing differentials in productivity and pay between workers. Finally, inequality starts to fall beyond a certain level of development, as societies choose to reduce inequality through the use of taxes and transfer payments (Milanovic 1994). However, there is limited empirical evidence to support this theory with many studies showing no evidence of such a relationship (Gallup 2012). Piketty (2014) finds that growth in the recent episode of globalization has been accompanied by greater inequality in high-income countries.

**Conventional monetary policy.** Inflation can also have indirect effects on inequality and poverty through its close links with unemployment, growth, and monetary policy. It is well established that monetary policy has redistributive effects, although these may be temporary. Romer and Romer (1998) distinguish
between short-run and long-run effects. In the short run, expansionary monetary policy raises output, lowers unemployment and reduces poverty. However, the effects are only temporary, as a persistent expansion is inflationary, which requires monetary policy tightening, which in turn increases unemployment, causing poverty to rise again (a mechanism also modelled in a DSGE framework by Areosa and Areosa, 2016). Empirical results are somewhat mixed; Furceri et al. (2018) find that a contractionary monetary policy shock increases inequality in the short run, while Ballabriga and Davtyan (2017) find that it can lead to a decline in inequality. In the long run, however, credible monetary policy that results in low and stable inflation can improve outcomes for the poor, by providing favorable conditions for economic growth.

**Unconventional monetary policy.** More recently, unconventional monetary policy tools have been utilized by central banks in advanced economies amid concerns about persistently low inflation or deflation and about short-term interest rates close to their zero lower bound. While the channels through which these tools operate are similar to conventional tools, the strength of these channels may vary (Bank of England 2012). Empirical evidence thus far suggests that the impact of monetary expansion using unconventional tools on inequality is fairly neutral to negative (lowers inequality). The poor benefit from an increase in labor income via a reduction in unemployment and increase in wages, while for savers, the decrease in returns on assets is offset by increased capital gains (Casiraghi et al. 2018; Ampudia et al. 2018).
Effects of inflation on overall inequality and poverty

While the evidence on the effects via individual linkages suggests that poorer households are generally more adversely affected by inflation than wealthier ones, empirical results for the overall link between inflation and inequality are inconclusive. Much of the literature was produced in the late 1990s, with relatively few recent studies. Inflation trends have evolved substantially over the past 20 years, with a generalized downward trend globally. Results vary between single-country studies and cross-country studies, and between advanced economies and EMDEs. While correlations between the variables have been found, there is less evidence of clear causation from inflation to inequality and poverty, with some studies suggesting the causality goes the opposite direction.\(^2\)

In general, the literature suggests that slightly higher inflation is associated with mildly lower inequality in countries where inflation is already low (typically advanced economies), but that high inflation is associated with higher inequality in countries where inflation is already high (typically EMDEs).

**Single-country studies.** Parker (1998) surveys the early literature, based on twelve single-country studies, and finds that all but three show that higher inflation is associated with lower inequality (e.g., Ashworth 1994; Balke and Slottje 1994). However, almost all of these studies focus on advanced economies (mainly the United States), so the results may be less applicable to EMDEs. Other studies focusing on single advanced economies come to a similar conclusion (Doepke and Schneider 2006; Maestri and Roventini 2012), with the exception of Jantti and Jenkins (2010) who find little evidence of a relationship between inflation and income inequality in the United Kingdom. Single-country studies on EMDEs, such as India (Datt and Ravallion 1998), the Philippines (Blejer and Guerro 1990), and Brazil (Ferreira and Litchfield 2001), find that higher inflation is associated with a lower share of income held by the poor or higher inequality. Looking at seven single studies of advanced economies and EMDEs together, Bulir and Gulde (1995) find that the impact of inflation on different income groups within countries varies between countries, with a positive correlation between inflation and inequality more likely in LICs that have a less-developed financial sector.

**Cross-country studies.** Galli and van der Hoeven (2001) review both single-country and cross-country studies prior to 2000. They find that the time series studies (the majority of which focus on the United States) almost always find higher inflation to be associated with lower inequality, whereas the cross-

\(^2\)In a study of Brazil during 1981-93, a fall in inequality, despite being associated with declining inflation, was attributed to structural and policy changes including convergence of incomes between rural and urban areas, and social transfers to the poor (Ferreira and Litchfield 2001).
country studies find higher inflation to be associated with higher inequality and poverty (Figure A.1.1.2). A number of other studies using cross-country samples also document a positive correlation between inflation and income inequality (Romer and Romer 1998; Easterly and Fischer 2001; Agenor 2002; Albanesi 2007; Thalassinos et al. 2012). However, even studies that find statistically significant coefficients on inflation typically find little explanatory power of their models, and the relationship between the poverty rate and inflation is less apparent than the relationship with inequality.

Nonlinear relationship between inflation and inequality. These mixed empirical results may reflect nonlinear relationships between inflation and inequality or poverty. A number of studies find evidence of a non-linear relationship, with considerable differences in the correlation between inflation and inequality depending on the initial rate of inflation (Galli and van der Hoeven 2001; Bulir 2001; Monnin 2014; Siami-Namini and Hudson 2017). Bulir (2001) reports that countries in hyperinflation had Gini coefficients that were 8 points higher, on average, than countries with high, but not hyper-, inflation. The benefit of moving from hyperinflation to high inflation is significant, but moving from high inflation to very low inflation (less than 5 percent) had a negligible effect.

Policy recommendations

Maintain a low-inflation environment. While not definite, the evidence suggests that achieving stable and low inflation is associated with better outcomes for poverty and inequality, with the benefits greatest among low-income, high-inflation countries. Lowering income inequality by controlling inflation may be less costly than through other social choices (Bulir 2001). This suggests that the adoption of a credible monetary policy regime by policymakers in EMDEs can lead to improved inequality and poverty outcomes. The results are less clear-cut for advanced economies, where low inflation is already established, with some evidence that the opposite relationship holds, so that slightly higher inflation may reduce inequality.

Improve competition. Policymakers have a range of tools beyond monetary policy to improve income inequality and poverty, but few to address the effects arising specifically from inflation. Structural reforms to improve competition in the financial sector can lower costs and increase access to savings products that can help poorer households protect the real value of their assets from inflation (Beck, Demirgüç-Kunt, and Levine 2004; Claessens 2006). Such reforms have also been found to increase informal business ownership, employment, and income, with a larger benefit accruing to lower-income households (Bruhn and Love 2014).
Improve granularity in inflation measures and fiscal support. The calculation of alternative indexes of inflation for different income groups would provide greater information on the inflation rates actually experienced by the poor, and could be used as an alternative benchmark for indexing welfare payments. This would reduce the erosion of their real value if inflation for poorer households was higher than the economy-wide inflation rate. Finally, the use of targeted subsidies could help alleviate poverty and inequality if focused on products, particularly food items, which are disproportionately consumed by the poor and are prone to more volatile inflation.

ANNEX 1.2 Low-income countries

Low-income economies (LICs) are defined as those with gross national income (GNI) per capita, calculated using the World Bank Atlas method, of $995 or less in 2017; middle-income countries as those with GNI per capita between $996 and $12,055 in 2017; and high-income countries as those with GNI per capita of $12,056 or more in 2017. These classifications are revised in July of every year.

As of 2018, LICs include Afghanistan; Benin; Burkina Faso; Burundi; Central African Republic; Chad; Comoros; Congo, Dem. Rep.; Eritrea; Ethiopia; The Gambia; Guinea; Guinea-Bissau; Haiti; Korea, Dem. People's Rep.; Liberia; Madagascar; Malawi; Mali; Mozambique; Nepal; Niger; Rwanda; Senegal; Sierra Leone; Somalia; South Sudan; Syrian Arab Republic; Tajikistan; Tanzania; Togo; Uganda; Yemen, Rep.; Zimbabwe. Annual inflation data since 1970 is available for 27 of them (excluding Eritrea; Korea, Dem. Rep.; Somalia; South Sudan; Syria; Tajikistan; and Yemen).

In 1987, the first year, classifications were published, 49 economies (excluding most economies affiliated with the Soviet Union) were classified as LICs. Of today’s LICs, Senegal; Syria; Yemen and Zimbabwe were classified as middle-income countries in 1987. In addition to today’s low-income countries, Bangladesh, Bhutan, Cambodia, China, Equatorial Guinea, Ghana, Guyana, India, Indonesia, Kenya, Lao P.D.R., Lesotho, Maldives, Mauritania, Myanmar, Nig-eria, Pakistan, Sao Tome and Principe, Solomon Islands, Sri Lanka, Sudan, Vietnam and Zambia were classified as LICs in 1987.
ANNEX 1.3 Regression analysis

A series of bivariate regressions is estimated to identify the main correlates of the decline in inflation between the 1980s and the 2010s. The sample includes 73-77 countries (depending on the availability of the correlates of inflation), of which 49-53 countries are emerging market and developing economies. Countries with populations of less than 3 million are dropped since they tend to be outlier observations.

Specifically, the regression is estimated as $\Delta inflation_{it} = \alpha + \beta X_{it}$, with robust standard errors. All changes are between averages for 1980-89 and 2010-17. The constant $\alpha$ in this regression denotes the unconditional average decline in inflation over the three decades. To avoid multicollinearity, since most of the regressors are highly correlated with each other, the regression only estimates bivariate correlations.

The regressors $X_{it}$ include the change in trade openness (identified as trade in percent of GDP); the change in capital account openness (defined as the Chinn-Ito index of financial openness); the switch to an inflation targeting regime; the switch to a pegged exchange rate regime (as defined by Shambaugh 2004); the change in Dincer and Eichengreen’s (2014) central bank independence and transparency index; the switch to a status of being highly integrated into global value chains (as defined in Database Annex); the initial level of government debt in percent of GDP; net energy imports in percent of GDP; and net food imports in percent of GDP.
### TABLE A.1.3.1.A Correlates of change in CPI inflation: Full sample

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net food imports (percent of GDP)</td>
<td>0.3077**</td>
<td>[0.160]</td>
</tr>
<tr>
<td>Net energy imports (percent of GDP)</td>
<td>-0.0672***</td>
<td>[0.024]</td>
</tr>
<tr>
<td>Change to inflation targeting regime</td>
<td>-6.5383***</td>
<td>[2.285]</td>
</tr>
<tr>
<td>Change to pegged exchange rate regime</td>
<td>-3.3842*</td>
<td>[2.235]</td>
</tr>
<tr>
<td>Change in central bank transparency index (point increase)</td>
<td>-3.5727*** [0.714]</td>
<td>-3.8800*** [0.802]</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.1583*** [0.976]</td>
<td>-3.4944*** [0.830]</td>
</tr>
</tbody>
</table>

Observations 79 79 81 81
R-squared 0.068 0.036 0.129 0.048

### TABLE A.1.3.1.B Correlates of change in CPI inflation: Full sample

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in central bank transparency index (point increase)</td>
<td>-0.9784*** [0.370]</td>
<td></td>
</tr>
<tr>
<td>Change in trade openness (percentage points of GDP)</td>
<td>-0.0182 [0.026]</td>
<td></td>
</tr>
<tr>
<td>Change in capital account openness index (point increase)</td>
<td>-9.3815*** [2.199]</td>
<td></td>
</tr>
<tr>
<td>Change in international assets and liabilities (in percentage points of GDP)</td>
<td>-0.0003 [0.001]</td>
<td></td>
</tr>
<tr>
<td>Initial government debt (percent of GDP)</td>
<td>-0.0005 [0.023]</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-2.1583*** [0.976]</td>
<td>-3.4944*** [0.830]</td>
</tr>
</tbody>
</table>

Observations 77 80 80 81 77
R-squared 0.092 0.007 0.219 0.001 0.000

Note: *** indicates statistical significance at the 1 percent confidence level, ** at the 5 percent level, and * at the 10 percent level, respectively. Standard errors in square brackets. The dependent variable is the change between the average inflation rate during 2010-17 and the average inflation rate during 1980-89. All changes are between averages for 2010-17 and 1980-89. Inflation targeting regime and pegged exchange rate regime (as defined by Shambaugh 2016) are dummy variables. Euro Area economies are considered floating rate regimes. The central bank transparency index (0 = least, 15 = most) is from Dincer and Eichengreen (2014). The capital account openness index (0 = closed, 1 = open) is from Chinn and Ito (2008). Dummy variable for high participation in global value chains is defined in Database Annex.
TABLE A.1.3.2.A Correlates of change in CPI inflation: EMDEs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net food imports (percent of GDP)</td>
<td>0.3891***</td>
<td>[0.164]</td>
</tr>
<tr>
<td>Net energy imports (percent of GDP)</td>
<td>-0.0748**</td>
<td>[0.039]</td>
</tr>
<tr>
<td>Change to inflation targeting regime</td>
<td>-9.1011***</td>
<td>[3.001]</td>
</tr>
<tr>
<td>Change to pegged exchange rate regime</td>
<td>-2.8823</td>
<td>[2.921]</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.8778*** -4.0871*** -3.0054***</td>
<td>[1.044] [1.170] [1.105]</td>
</tr>
<tr>
<td></td>
<td>-4.1452***</td>
<td>[1.160]</td>
</tr>
<tr>
<td>Observations</td>
<td>46 46 47 47</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.125 0.027 0.176 0.030</td>
<td></td>
</tr>
</tbody>
</table>

TABLE A.1.3.2.B Correlates of change in CPI inflation: EMDEs

<table>
<thead>
<tr>
<th>Variables</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in central bank transparency index (point increase)</td>
<td>-1.2126**</td>
<td>[0.589]</td>
</tr>
<tr>
<td>Change in trade openness (percentage points of GDP)</td>
<td>-0.0101</td>
<td>[0.037]</td>
</tr>
<tr>
<td>Change in capital account openness index (point increase)</td>
<td>-8.9658***</td>
<td>[3.332]</td>
</tr>
<tr>
<td>Change in international assets and liabilities (in percentage points of GDP)</td>
<td>-0.0050**</td>
<td>[0.003]</td>
</tr>
<tr>
<td>Initial government debt (percent of GDP)</td>
<td>0.0122</td>
<td>[0.032]</td>
</tr>
<tr>
<td>Constant</td>
<td>-2.5910*** -4.4366*** -3.6367*** -4.1563*** -5.2233***</td>
<td>[1.326] [1.238] [1.017] [1.150] [2.334]</td>
</tr>
<tr>
<td>Observations</td>
<td>45 46 47 47 46</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.092 0.002 0.149 0.037 0.003</td>
<td></td>
</tr>
</tbody>
</table>

Note: *** indicates statistical significance at the 1 percent confidence level, ** at the 5 percent level, and * at the 10 percent level, respectively. Standard errors in square brackets. The dependent variable is the change between the average inflation rate during 2010-17 and the average inflation rate during 1980-89. All changes are between averages for 2010-17 and 1980-89. Inflation targeting regime and pegged exchange rate regime (as defined by Shambaugh 2016) are dummy variables. Euro Area economies are considered floating rate regimes. The central bank transparency index (0 = least, 15 = most) is from Dincer and Eichengreen (2014). The capital account openness index (0 = closed, 1 = open) is from Chinn and Ito (2008). Dummy variable for high participation in global value chains is defined in Database Annex.
ANNEX 1.4 Lessons from U.S. disinflation in 1979-82

U.S. inflation declined from double-digits in August 1979 to below 4 percent by end-1982. This disinflation highlighted the benefits of shifting central banks’ focus to price stability, building credibility, and establishing stabilizing monetary policy rules.

The Great Inflation of 1965-1982 has been described as the defining macroeconomic event of the second half of the 20th century (Bryan 2018). Siegel (1994) described it as “the greatest failure of American post-war history.” Meltzer (2005) attributed to the Great Inflation the fall of the Bretton Woods system of fixed exchange rates, the bankruptcy of the thrift industry (U.S. savings banks), heavy capital taxation, and a redistribution of wealth and income. The challenges associated with the subsequent disinflation transformed the understanding of the role of central banks and monetary policy.

- Against this backdrop, this annex discusses the following questions.
- How did U.S. disinflation evolve during the 1980s?
- What was the role of monetary policy in U.S. disinflation?
- What lessons have been drawn from U.S. disinflation?

Evolution of disinflation during 1979-82

By August 1979, U.S. inflation had reached 12 percent (Figure A.1.4.1). High inflation reflected multiple one-time jumps in key prices and accommodative demand policies that perpetuated high inflation. Oil prices rose seven-fold between December 1972 and January 1974 and tripled again between November 1978 and November 1979, amid supply disruptions around the Iranian revolution. From the 1960s, monetary policy was accommodative on the understanding that permanently lower unemployment could be “bought” with higher inflation—the standard understanding of the Phillips curve at the time (Bryan 2018). The resulting accommodative monetary policy stance combined with loose fiscal policy—e.g., to finance the Vietnam War, Great Society social spending, or the Kennedy tax cuts—to generate considerable domestic demand pressures.

By end-1982, inflation had declined to below 4 percent, in part thanks to an aggressive tightening of monetary policy, including a hike in the federal funds rate from 11 percent in August 1979 to a peak of 19 percent in July 1981.¹ In

¹ In parts of advanced-economy Europe, central banks responded more strongly and earlier than in the United States to rising inflation, but disinflation was also accompanied by output losses in the early 1980s (Beyer et. al. 2009; Söderström 2005; Miles et al. 2017; Berg et al. 2015; Nguyen et al. 2017).
October 1979, the Federal Reserve also overhauled its operations to switch from targeting the federal funds rate to targeting nonborrowed reserves. Over the same period, fiscal policy tightened by about 1 percentage point of GDP (Congressional Budget Office 2017). The disinflation was associated with two recessions, together termed the “Volcker recession”. In 6 out of 12 quarters of 1980-82, output contracted. The cumulative output losses during both recessions (peak-to-trough) amounted to more than 2 percent. Unemployment rates doubled from 6 percent in August 1979 to almost 12 percent at end-1982 (Figure A.1.4.1).

Role of monetary policy in U.S. disinflation

The stagflation of the 1970s, as well as the recessions during 1979-1982, have been attributed to varying degrees to changes in monetary policy. For example,
Barsky and Kilian (2002) argue that the stagflation that preceded the 1979-82 recessions was mostly attributable to excessively loose monetary policy, although compounded by oil price increases.

In particular, while the tripling of oil prices during 1978-79 is generally recognized as the trigger of the recession, the monetary policy response to the oil price spike deepened it. Bernanke, Gertler, and Watson (1997) showed that the non-accommodative monetary policy response to the oil price spike accounted for the disproportionate effect of the oil price spike on the economy. Rotemberg and Woodford (1997) also found that unexpectedly tight monetary policy in early 1982 deepened the 1982 recession.\(^2\)

The Federal Reserve’s switch in operational procedures allowed it to meet more effectively its reserve money growth targets.\(^3\) The shift was followed by considerable volatility and a sharp rise in the federal funds rate (Goodfriend 1983). It was eventually reversed by 1987 because of instability of the money demand function (Thornton 2004, Gilbert 1985).

**Lessons from U.S. disinflation**

The Great Inflation and the output losses during the subsequent disinflation have helped transform the understanding of a central bank’s role. It is now widely recognized that (i) monetary policy can only have short-term effects on real output (i.e., the Phillips curve changes over time); (ii) some monetary policy rules are more stabilizing than others, and (iii) central bank credibility that anchors inflation expectations is a critical precondition for effective monetary policy.

**Lack of long-term real-economy effects of monetary policy.** During the 1970s, monetary policy was guided by the Phillips curve, an empirical inverse relationship between (wage) inflation and unemployment. This relationship suggested that monetary policy could lower unemployment at the cost of higher inflation. However, as central banks sought to exploit this relationship, it became clear that the tradeoff existed only in the short-term: as inflation expectations adjusted, the Phillips curve shifted, possibly in a non-linear way (Akerlof et al. 2000). Hence, the inflation-unemployment tradeoff disappeared over the long-run. This meant that the persistent use of monetary policy to

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\(^2\) In contrast, Uhlig (2005) argues that the role of monetary policy has been exaggerated by previous authors’ methodology, in particular by imposing timing restrictions or the restriction of a negative relationship between inflation and growth. When such restrictions are lifted, Uhlig (2005) finds that monetary policy did not have a significant effect on growth during the “Volcker recession.”

\(^3\) In the previous operational procedures, money growth targets were achieved within some tolerance bands by guiding the federal funds rate. Under the new procedures, money growth targets were achieved by guiding nonborrowed reserves while maintaining the federal funds rate within a wide tolerance band (Poole 1982).
boost employment and output beyond their long-run potential was fruitless and simply raised inflation (Clarida, Gali, and Gertler 1999).

Switch to stabilizing monetary policy rules. The increasing awareness of central banks’ inability to achieve a sustained improvement in output led to an increased focus on monetary policy rules, in particular rules that emphasized the goal of stabilization. Indeed, Dennis (2006) showed that there was large uncertainty around estimated U.S. monetary policy rules before 1979 but, thereafter, U.S. monetary policy could be modelled more precisely. Other studies have also found evidence supporting a measurable change in U.S. monetary policy rules. In a DSGE model, Bianchi (2013) shows that the U.S. monetary policy regime switched from “dove” (favoring output growth over disinflation) to “hawk” (vice versa) in the second half of 1980. Clarida, Gali, and Gertler (2000) demonstrate that the U.S. monetary policy rule post-1979 responded more strongly to expected inflation than during the preceding period. This new rule ensured greater macroeconomic stability than earlier monetary policy rules. Oywang and Wall (2005) also document a structural change between the pre-Volcker and Volcker-Greenspan era in the effect of monetary policy across U.S. regions.

Establishing central bank credibility. Bernanke, Gertler and Watson (1997) note that, by guiding expectations, the choice of a credible monetary policy is key for macroeconomic stabilization, while acknowledging that econometric models typically find a modest role (about 20 percent) for monetary policy shocks—i.e. unexpected monetary policy changes—in explaining output movements. Blanchard (1984) demonstrated that a Phillips curve relationship explained actual disinflation and output losses reasonably well until end-1981 but not thereafter. He interpreted this as evidence that inflation expectations had initially remained unchanged from the Great Inflation while the Federal Reserve still lacked credibility.4 Research has also shown that the wrong monetary policy rule can undermine central bank credibility. Barro and Gordon (1983) demonstrate that rational households and investors will anticipate the behavior of central banks that systematically attempt to reduce unemployment by surprise monetary stimulus. To reduce unemployment, the central bank needs to engineer ever-greater inflation surprises. Taking this into account, the Fed’s monetary policy has arguably been guided, since 1979, by an informal inflation targeting framework even if its dual mandate was never abolished (Goodfriend 2003).

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4 With the benefit of more years of data, Alogoskoufis and Smith (1991) demonstrated the shift in the Phillips curve during the Volcker recession.
Conclusion

The experience of the Great Inflation of 1965-84, stagflation of the 1970s, and disinflation of 1979-82 transformed monetary policy in the United States and the understanding of monetary policy more broadly. The Phillips curve is no longer considered a useful policy tool, and instead it is recognized that a credible central bank can reduce inflation with fewer output losses. As a result, “the concept of credibility has become a central concern of the scholarly literature on monetary policy” (Blinder 2000; Bordo and Orphanides 2013) and inflation has become the “organizing focus of monetary policy” (Clarida, Gali, and Gertler 2000).

References


Inflation movements have become increasingly synchronized internationally over time: a common global factor accounts for about 22 percent of changes in national annual inflation rates in the period since 2001. Inflation synchronization has also become more broad-based: while it was previously much more pronounced among advanced economies than emerging markets and developing economies, it has become substantial in both groups over the past two decades. In addition, inflation synchronization has become significant across all inflation measures since 2001, whereas it was previously prominent only for inflation measures that included mostly tradable goods. Greater inflation synchronization over time has coincided with improvements in economic policy institutions in many countries, stronger global trade linkages, and greater similarity of monetary policy frameworks which trigger similar policy responses.

Introduction

Inflation has recently appeared to move in tandem among countries around the globe. As documented in the previous chapter, inflation and inflation volatility have trended down in advanced economies since the mid-1980s and in emerging market and developing economies (EMDEs) since the mid-1990s, regardless of the price index examined. A wide range of structural factors has contributed to declining inflation in recent decades. These factors appear both to have depressed inflation and to have changed the responsiveness of inflation to global and domestic shocks.

This chapter expands on this analysis by exploring the extent to which global and group-specific factors have driven movements in national inflation rates. A growing number of studies provides evidence on highly synchronized national inflation rates (Hakkio 2009; Cicarelli and Mojon 2010; Auer, Levchenko, and Sauré 2017). Some of these have also examined the extent of synchronization in other real and nominal variables, as well as inflation (Mumtaz, Simonelli, and Surico 2011).

In theory, a wide range of factors could be responsible for global synchronization of inflation, including common shocks, similar policy responses, and structural features of economies, including openness to international trade and financial flows. Early studies often highlighted the contribution of synchronized or

Note: This chapter was prepared by Jongrim Ha, M. Ayhan Kose, Franziska Ohnsorge, and Filiz Unsal.
coordinated monetary policies as a major source of inflation comovement, especially among advanced economies (Clarida, Gali, and Gertler 2002; Rogoff 2003). More recent work has emphasized the roles of international spillovers of technology and increased trade integration through global value chains (Henriksen, Kydland, and Suštek 2013; Auer, Borio, and Filardo 2017).

This chapter expands empirical research on the topic by addressing the following questions:

• How has inflation synchronization among countries evolved over the past four to five decades?

• Which goods and price indices have been associated with greater inflation synchronization?

• What country characteristics have been associated with greater inflation synchronization?

To answer these questions, the chapter examines synchronization in inflation using a dynamic factor model that allows the estimation of latent global and group-specific factors. In a unified framework, these factors capture commonalities in multiple measures of inflation in a large balanced sample of countries (25 advanced economies and 74 EMDEs) over a long period (1970-2017). The chapter makes four unique contributions to the literature.

First, it systematically explores the evolution of inflation synchronization among many countries and over time. It identifies a truly global inflation factor that captures common movements in inflation in a large sample of countries, including many EMDEs. This contrasts with earlier studies that typically included only advanced economies (Box 2.1). In this global sample, the evidence of increased global inflation synchronization since 2001 is unambiguous, whereas some earlier studies based on advanced-economy samples have found no such increase.

Second, in recognition of differences in economic structures and policy frameworks between EMDEs and advanced economies, the model explicitly allows for a role of an EMDE inflation factor distinct from an advanced-economy factor; the focus in the literature thus far has been on global factors.

Third, the chapter examines commonalities and differences in inflation synchronization among a wide range of inflation measures. By choosing price indices that differ in their tradables content, this allows for a more precise interpretation of the global factor and broadens the evidence for increased inflation synchronization since 2001.
BOX 2.1 Global inflation synchronization: A review

This box summarizes the evidence in the literature that inflation has become highly synchronized internationally over time. Global inflation synchronization depends on the frequency of common shocks; the strength of cross-border inflation spillovers, especially from major economies; the openness of economies to international trade and financial flows; and the extent to which there are similar policy frameworks among countries, generating similar policy responses. It is therefore not surprising that there is evidence of an increase in inflation synchronization in recent decades, since this has been a period of strengthening global economic linkages; increasingly developed and internationally integrated financial markets; and a growing prevalence of monetary policy frameworks focused on the objective of low and stable inflation.

Using a wide range of methodologies, a large literature has studied various aspects of inflation synchronization across countries and its evolution over time. This box provides a brief summary of what this literature says on the following questions:

• How has global inflation synchronization evolved over time?
• Which factors have contributed to global inflation synchronization?

How has global inflation synchronization evolved?

Many studies have documented the high degree of inflation synchronization in recent decades, mostly, but not exclusively, in advanced economies.¹ Some of these studies have also reported that the degree of synchronization has increased over the past three decades.

Existence of a global inflation factor. Several studies have documented that a global factor has accounted for a substantial proportion—ranging from 20 to 51 percent—of inflation variation among various groups of advanced economies, with the estimated contribution differing somewhat by inflation measure, time period, methodology, and sample composition (Table A.2.1). In a well-known study, Ciccarelli and Mojon (2010) extract a common global factor from CPI inflation of 22 OECD countries over the period 1960-2008. They find that the global factor accounts for almost

¹ The majority of studies on inflation synchronization employ variants of dynamic factor models developed by Stock and Watson (1999), Forni et al. (2001), and Kose, Otrok, and Whiteman (2003).
37 percent of the variance of national inflation rates. Ferroni and Mojon (2014) update this analysis through 2013, confirming a strong role for global factors among advanced economies.

Hakkio (2009) extracts a global factor from 19 OECD countries’ inflation rates for 1960-2008, but adds a regional factor and expands the set of inflation measures to include overall CPI inflation, cyclical CPI inflation, core CPI inflation, and cyclical core CPI inflation. He finds that the global factor explains, on average, 41 percent of cyclical inflation variation. Auer, Levchenko, and Sauré (2017) estimate a global inflation factor using a sample of 30 countries and find that the global factor accounts for 51 percent of inflation variation, half of which reflects common cost shocks propagated through input-output linkages (see also Auer and Mehrotra 2014).

These studies use considerably smaller and more homogeneous country samples than the sample used in this chapter. This helps to explain why, in their studies, the global factors account for larger shares of inflation variation (Figure 2.1.1). Nevertheless, the shares presented in this chapter are within the range—although towards the low end—of those reported in the literature.

While not explicitly quantifying the contribution of global factors to inflation variation, Cecchetti et al. (2007) document coincident inflation developments around the world, such as a wide-spread start of the Great Inflation in the late 1960s and a synchronized inflation stabilization in the mid-1980s.
Other studies estimate, typically in a Phillips curve framework, the impact of specific global variables on domestic inflation—with mixed success. For example, Eickmeier and Pijnenburg (2013), using data for 24 OECD countries during 1980-2007, estimated a Phillips curve model of domestic inflation using the global and idiosyncratic factors of output gaps and changes in unit labor costs. They found that the global factor of changes in unit labor costs have a notable impact on domestic inflation. Lodge and Mikolajun (2016) also found that global commodity prices were important determinants of inflation in 19 advanced economies, although other global variables were not.

In related work, Borio and Filardo (2007) and Auer, Borio, and Filardo (2017) showed that global inflation and the foreign output gap added explanatory power to conventional Phillips curve models of domestic inflation for a number of OECD countries. However, Gerlach et al. (2008) found that this result is not robust to the measurement of the global output gap, to controlling for additional variables, or to the estimation period. Ihrig et al. (2010) found that in estimates of the Phillips curve for 11 countries, the globalization hypothesis had little support. Kabukçuoğlu and Martínez-García (2018) model inflation expectations for 14 advanced economies in a Phillips curve framework augmented by the global output gap and global inflation. Their results for global output gaps are mixed—which they attribute to measurement error—but they still indicate a strong role of global inflation in domestic inflation.

**Evolution of global inflation synchronization over time.** Neely and Rapach (2011) extract a global factor and seven regional factors from CPI inflation in 64 mostly advanced economies during 1950-2009. They find that the global factor, on average, accounted for 35 percent of inflation variance, while the regional factors accounted for 16 percent—and that these shares have risen substantially since the 1980s. They document that the regional (world) factor increases in importance for a number of North American and European (Latin American and Asian) countries since 1980. Mumtaz and Surico (2012) estimate global and regional factors from 164 inflation indicators for 13 OECD economies during 1961-2004. They find that, in most countries, the degree of inflation synchronization has strengthened since the 1980s. Mumtaz, Simonelli, and Surico (2011) focus on an unbalanced panel of 36 countries between 1860 and 2007. They
show that the share of inflation variation due to the global factor has grown since 1985.³

**Which factors have contributed to global inflation synchronization?**

Several studies document strong economic policy institutions, trade openness, and financial development as factors associated with a higher degree of cross-country inflation synchronization. Two types of approaches have been employed. First, the country characteristics associated with a greater share of inflation explained by the global factor are analyzed. Second, sectoral, goods, or subnational factor decompositions are used to identify more granular patterns in inflation synchronization.

**Country characteristics.** Neely and Rapach (2011), in their sample of 64 mostly advanced economies during 1950-2009, correlate the share of CPI inflation variance accounted for by the global factor with country characteristics. They find that the share is higher in advanced economies with stronger economic policy institutions, more developed financial markets, lower inflation, and more independent central banks. Parker (2018) shows that energy prices appear to be less synchronized with global inflation factors in less developed economies. Ciccarelli and Mojon (2010) document that the impact of a global inflation factor on domestic inflation is stronger in countries with lower inflation. In a Phillips curve framework, Auer, Levchenko, and Sauré (2017) present evidence that cross-border trade in intermediate goods and services is the main channel through which global economic slack influences domestic CPI inflation; cost shocks propagated through input-output linkages account for about one-quarter of inflation variability.

**Sectoral decompositions.** Monacelli and Sala (2009) estimate the contributions of a global factor to inflation variance in a large cross-section of sectoral price data (948 CPI products) for four OECD countries during 1991-2004. They find that, on average, the global factor explains 15-30 percent of the variation in disaggregated consumer price inflation, the share being higher in sectors with greater trade openness. Förster and Tillmann

³ Using wavelet analysis, Bhanja et al. (2013) and Bhanja, Dar, and Tiwari (2016) document that inflation synchronization among G7 and Euro Area countries has increased over time.
BOX 2.1 Global inflation synchronization: A review (continued)

(2014) extract global, sectoral, and regional factors from CPI inflation in 40 mostly OECD countries from 1996-2011. They find that about two-thirds of overall inflation volatility is due to country-specific determinants. For CPI inflation net of food and energy, the global factor and the CPI basket-specific factor account for less than 20 percent of inflation variation. Only energy price inflation in advanced economies is dominated by common factors.

Parker (2018) extends Förster and Tillmann (2014) to 223 countries and territories over the 1980-2012 period. He finds that the global factor can explain around two-thirds of the variance of advanced economies’ inflation but only about one-fifth in middle-income countries and one-tenth in low income countries. Regardless of the country group, common factors account for a larger share of variability in energy and food price inflation than of house price inflation or, more broadly, headline CPI inflation.

**Subnational decompositions.** Beck, Hubrich, and Marcellino (2009) extract euro area, national, and subnational factors from subnational inflation rates from six euro area countries. They find that the euro area factor accounted for about half of inflation variation, while national and regional components accounted for 32 and 18 percent, respectively.

**Goods decompositions.** Auer, Levchenko, and Sauré (2017) show, for disaggregated PPI inflation for 30 mostly OECD countries and 17 sectors during 1995 to 2011, that the global factor explains nearly half of the fluctuations in PPI inflation in the average economy. They argue this PPI synchronization across countries is driven primarily by common sectoral shocks and amplified by input-output linkages.

**Conclusion**

The literature has documented that inflation is highly synchronized internationally, but that the degree of inflation synchronization varies with country characteristics and other factors, including the measure of inflation used. Findings have typically been restricted to headline CPI inflation, largely disregarding sectoral differences in inflation synchronization.

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4 Their novel dynamic hierarchical factor model allows a decomposition into a global factor, a factor specific to a given sub-component of the CPI (energy price inflation, food price inflation, and CPI inflation net of food and energy items), a country-group factor driving the particular CPI basket in either industrialized or emerging economies, and a country-specific component.
Fourth, the chapter studies a wide range of country characteristics that are conducive to high inflation synchronization; the literature often confines itself to only a few characteristics.

The chapter’s principal conclusions are as follows:

- The global inflation factor accounted, in the median country, for one-eighth (12 percent) of total variation in national inflation rates over the period 1970-2017. Its contribution was much more pronounced in the median advanced economy (24 percent) than in the median EMDE (10 percent), and negligible in the median low-income country (LIC).

- The global factor’s contribution to inflation variation was greater between 1970 and 1985—a period of two global oil price spikes and two global recessions—than between 1986 and 2000. Partly as a result of the 2008-09 global financial crisis and the 2014-16 oil price plunge, global inflation synchronization strengthened significantly in the period 2001-17. During this last period, the global factor explained 22 percent of national inflation in the full sample. It accounted for 18 percent of inflation variation in the median EMDE and 27 percent in the median advanced economy, compared with 7 and 22 percent, respectively, during 1986-2000. In LICs as well, the global factor’s contribution increased to 17 percent in 2001-17 from a 3-4 percent previously.

- In addition to global synchronization, group-specific inflation synchronization has emerged among both advanced economies and EMDEs. Like global inflation synchronization, group-specific inflation synchronization increased after 2000. Since 2001, the group-specific inflation factors have accounted for 8 percent of inflation variation in the median EMDE, one-third more than during 1986-2000, and for 21 percent in the median advanced economy, one-sixth more than during 1986-2000.

- Global inflation synchronization has broadened across different measures of inflation. In 1970-85, the extent of inflation synchronization was pronounced only for inflation measures with a large portion of tradable goods and services (import prices and producer prices); it has more recently become sizeable across all inflation measures. During 1970-2017, it was most pronounced for the inflation measures with the largest share of tradables: it was highest for import prices (54 percent), followed by PPI, headline CPI, GDP deflator, and core CPI (5 percent). Since 2001, it has grown to one-third even for core CPI inflation and growth of GDP deflator.

- Inflation synchronization has tended to be greater among countries with higher trade openness, greater commodity-import intensity and lower trade
concentration. Among EMDEs, the share of the global factor was particularly high in East Asia and Pacific (EAP), Latin America and the Caribbean (LAC), and in South Asia (SAR). Since 2001, however, systematic differences in the role of the global factor among countries with different characteristics have faded.

The next section documents the evolution of global and group-specific factors that have driven the increased synchronization of inflation rates. The subsequent section explores the synchronization across different measures of inflation, including headline and core consumer price inflation, and measures based on producer prices and import prices. The penultimate section examines the main factors that explain global synchronization of inflation. The final section concludes with a brief summary, a discussion of policy implications, and future research directions.

**Evolution of inflation synchronization**

Using results from estimates of a dynamic factor model, this section documents that global inflation synchronization has increased, both in degree and in breadth.

**Data and methodology**

The analysis is based on annual inflation data for 25 advanced economies and 74 EMDEs (including 16 LICs) during 1970-2017. In the benchmark estimation, inflation is measured as annual headline CPI inflation. In order to analyze the extent of synchronization in multiple measures of inflation, the database is augmented with core CPI inflation, PPI inflation, import price inflation, and GDP deflator growth for a subset of 38 countries (of which 13 are EMDEs; Table A.2.2).

A dynamic factor model is employed to decompose inflation in each country into a *global inflation factor* that is shared across all countries, an advanced-economy or EMDE factor that is shared within the respective groups (i.e., two *group-specific inflation factors*) and an *idiosyncratic inflation factor* that is unique to each individual country (see Annex 2.1 for details about the model and estimation). Dynamic factor models are designed to extract a small number of unobservable common elements from a large number of (observable) variables. Thus, the model allows a parsimonious representation of the data in terms of the unobservable common elements—typically referred to as factors. The degree of

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1 These types of models are used extensively to analyze global business and financial cycles (Kose, Otrok, and Whiteman 2008; Kose, Prasad, and Otrok 2012; Ha et al. 2017; Neely and Rapach 2011; Mumtaz and Surico 2012).
global inflation synchronization is simply measured by the share of the variance of national inflation attributable to the global factor. In a similar fashion, the extent of inflation synchronization within each country group is measured by the fraction of variance that is explained by the group-specific factor.²

**Inflation synchronization: Global and group factors**

**Behavior of the global and group-specific factors.** The model identifies a global inflation factor that, as expected, registers sharp movements around oil price spikes and global recessions (Figure 2.1). Within a year of the average global recession (such recessions having occurred in 1975, 1982, 1991, and 2009) and during the average oil price plunge (these having occurred in 1986, 1990-91, 1997-98, 2001, 2008, and 2014-16), annual global inflation had fallen by 0.5 and 0.2 percentage point, respectively, below its long-term trend. Conversely, in the average year preceding a global recession, global inflation was almost 2 percentage points above trend. The global factor moved in tandem with median inflation across countries.³ The advanced-economy and EMDE factors also exhibited common (although more muted) movements with their respective group-specific median inflation rates.

**Importance of the global inflation factor.** For the 1970-2017 period, the global inflation factor accounted for a sizeable share of within-country inflation variance, both in advanced economies and in EMDEs (Figure 2.2, Table 2.1). In the median country, the global factor accounted for 12 percent of inflation variation, but its role varies widely across and within country groups (from near-zero to 70 percent). For example, for the full sample period, the contribution of the global inflation factor was much greater in the median advanced economy (24 percent) than in the median EMDE (10 percent).

**Importance of group-specific inflation factors.** The group-specific factors have also played an important role in driving inflation. For example, in the median advanced economy, the group-specific factor accounted for 8 percent of inflation variation, in the period 1970-2017.

²The results are qualitatively robust to different de-trending methods (e.g., Hodrick-Prescott or Butter-Worth filter, the use of a three-factor model (including country-specific factors), and the use of quarterly data.

³For 90 percent of countries in the sample, the factor loadings on the global factor (coefficients associated with the global factor in the model) are positive (and statistically significant within 90 percent confidence intervals), indicating that national inflation rates generally move in tandem with the global factor. The remaining 10 percent of countries are mostly, although not exclusively, in Sub-Saharan Africa (Algeria, Cameroon, Democratic Republic of Congo, Gabon, Saudi Arabia, Central African Republic, Gambia, Mali, Niger, and Senegal). In these countries, the factor loadings on the global factor are not statistically significantly different from zero.
FIGURE 2.1 Global and group inflation factors

The global factor troughs around global recessions and oil price plunges. The global factor and, especially, the advanced-economy factor moves in tandem with median inflation across countries.

The contributions of the global inflation factor to inflation variation reported in this chapter are consistent with, but at the low end of, the range of estimates reported in other studies (see Box 2.1). Earlier studies have reported that the global inflation factor has contributed 20-50 percent to the variation in national inflation rates, with estimates differing depending on the methodology, sample periods, country groups, and data transformations. The differences in the estimates presented here may reflect the more extensive inclusion of EMDEs in the country sample in this study than in earlier work.

Evolution of inflation synchronization

Increasing synchronization over time. Global inflation synchronization has risen over the past four to five decades (Figure 2.2, Table 2.2). This is illustrated by estimates of the model for three approximately equal sub-periods: 1970-
**FIGURE 2.2 Contributions of global and group factors to inflation**

In the full sample period, 1970-2017, the global and group-specific inflation factors together explain around 16 percent of the variation in inflation rates, but more in the median advanced economy (32 percent) than in the median EMDE (13 percent). The share of inflation variance explained by the global factor declined after 1985 but rose again after 2000. Since 2001, the global inflation factor has accounted for a larger share of inflation variation in a greater number of countries than in the 1970s and 1980s.

**TABLE 2.1 Variance decompositions: Headline CPI, 1970-2017 (percent)**

<table>
<thead>
<tr>
<th>Factor</th>
<th>All countries</th>
<th>Advanced economies</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>11.9 (18.8, 2.9 - 29.4)</td>
<td>24.3 (25.6, 10.4 - 35.2)</td>
<td>10.4 (16.4, 2.2 - 21.8)</td>
</tr>
<tr>
<td>Group</td>
<td>3.9 (11.6, 0.7 - 16.6)</td>
<td>8.1 (12.7, 4.2 - 18.4)</td>
<td>2.1 (11.3, 0.5 - 12.7)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>27.2 (30.4, 14.0 - 44.2)</td>
<td>37.2 (38.3, 30.6 - 49.6)</td>
<td>21.4 (27.8, 11.5 - 41.8)</td>
</tr>
</tbody>
</table>

Notes: All numbers indicate percent contributions of global and group-specific factors to the variance of headline CPI inflation during 1970-2017. The contributions of global and group-specific inflation factors are estimated using the dynamic factor model described in Annex 2.1. The data set includes 99 countries (25 advanced economies “AEs”, 74 EMDEs including 16 LICs). In each pair of rows, the numbers in the first row indicates medians across countries. The first number in the second row (in parentheses) is the unweighted mean across countries. The second and third numbers in the second row (in parentheses) indicate inter-quartile ranges (25th and 75th percentiles).
1985, 1986-2000, and 2001-2017. The first period, 1970-1985, overlaps with the Great Inflation of 1965-1984 (Annex 1.4 in Chapter 1); the second, 1986-2000, was a period of widespread disinflation; and the third, 2001-17, was a period of low but typically stable inflation (Chapter 1).

The global factor’s contribution to inflation variation was sizeable—16 percent for the median country in the full sample—in 1970-85, when economies were considerably more energy-intensive than more recently and oil price spikes lifted inflation globally (Baffes et al. 2015). Then, it dipped to 10 percent during 1986-2000, as many countries implemented policies to rein in inflation, but in 2001-17 it rose beyond its level in 1970-85, to 22 percent for the median economy in the full sample and 18 percent for the median EMDE; for the median advanced economy it rose to 27 percent but remained below its level in 1970-85. Similarly, the contribution of the group factor to inflation variation has grown since the 1970s and 1980s, to 21 percent in the median advanced economy in 2001-17 (from 18 percent in 1970-85) and 8 percent in the median EMDE (from 6 percent).

Increasingly broad-based inflation synchronization. Global inflation synchronization has become more broad-based over time. During 1986-2000, for example, the global factor contributed more than 10 percent to inflation variation in around one-third of the countries in the sample (compared with half of the countries in 1970-85), while during 2001-17, this was the case in two-thirds of countries. The distribution of the contribution of the global factor has clearly shifted to the right between 1970-85 and 2001-17 for all country groups (Figure 2.2). The distribution of contribution of the group factor to inflation variation has only shifted to the right for advanced economies: for EMDEs, the distribution in 2001-17 resembled that in 1970-85. 

Inflation synchronization in LICs. Until 2000, the contribution of the global factor to inflation variation in LICs was negligible (3-4 percent in the median LIC). Since 2001, however, the global factor’s contribution has quintupled to 17 percent in the median LIC, to a level broadly in line with the median EMDE. The share of LICs with a contribution of the global factor to inflation variation in excess of 10 percent has risen from one-quarter before 2000 to two-thirds since 2001. In addition to the growing contribution of the common global factor to short-term inflation movements, global factors have also contributed

---

Footnote: These trends are robust to estimating the dynamic factor model by sub-sample periods of 15-year rolling-windows. The combined importance of global and group-specific factors declined until 2006, but has since increased again. The share of variance due to the global factor was often higher for rolling samples that overlapped with the post-2007 period, reflecting the highly synchronized movements in inflation across countries following the global financial crisis.
considerably to long-term inflation movements. Chapter 6 documents that a benign external environment was the main reason for the decline in trend inflation in LICs over the past two decades. Growing synchronization has coincided with LICs’ rapid integration into global trade networks as well as a shift towards greater exchange rate flexibility (Box 1.2 in Chapter 1).

### Extent of synchronization: Inflation and output

How high is the degree of global inflation synchronization reported here relative to the synchronization of other, comparable economic variables? To answer this question, it is useful to compare the extent of inflation synchronization with that of business cycles. A large literature reports that there is a global business cycle, evidenced by a high degree of synchronization of various measures of national economic activity, including output growth.

#### TABLE 2.2 Variance decompositions, over time: Headline CPI (percent)

<table>
<thead>
<tr>
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<tr>
<td><strong>All countries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>11.9</td>
<td>15.5</td>
<td>9.9</td>
<td>22.1</td>
</tr>
<tr>
<td></td>
<td>(18.8, 2.9 - 29.4)</td>
<td>(25.8, 4.1 - 40.1)</td>
<td>(16.2, 1.5 - 29.0)</td>
<td>(20.7, 8.6 - 30.9)</td>
</tr>
<tr>
<td>Group</td>
<td>3.9</td>
<td>7.9</td>
<td>6.7</td>
<td>9.0</td>
</tr>
<tr>
<td></td>
<td>(11.6, 0.7 - 16.6)</td>
<td>(12.2, 2.3 - 18.2)</td>
<td>(19.4, 2.8 - 22.0)</td>
<td>(13.7, 3.8 - 19.5)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>27.2</td>
<td>31.0</td>
<td>34.8</td>
<td>33.6</td>
</tr>
<tr>
<td></td>
<td>(30.4, 14.0 - 44.2)</td>
<td>(38.0, 18.3 - 59.5)</td>
<td>(35.6, 16.1 - 48.7)</td>
<td>(34.4, 19.0 - 49.3)</td>
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<tbody>
<tr>
<td><strong>Advanced economies</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>24.3</td>
<td>31.6</td>
<td>22.0</td>
<td>27.3</td>
</tr>
<tr>
<td></td>
<td>(25.6, 10.4 - 35.2)</td>
<td>(30.8, 10.8 - 39.7)</td>
<td>(22.9, 9.9 - 35.5)</td>
<td>(26.1, 21.6 - 32.9)</td>
</tr>
<tr>
<td>Group</td>
<td>8.1</td>
<td>18.0</td>
<td>15.7</td>
<td>20.5</td>
</tr>
<tr>
<td></td>
<td>(12.7, 4.2 - 18.4)</td>
<td>(18.1, 7.3 - 24.0)</td>
<td>(21.0, 4.9 - 33.6)</td>
<td>(22.7, 9.4 - 34.8)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>37.2</td>
<td>47.2</td>
<td>45.0</td>
<td>50.7</td>
</tr>
<tr>
<td></td>
<td>(38.3, 30.6 - 49.6)</td>
<td>(48.8, 36.3 - 64.6)</td>
<td>(43.9, 26.9 - 55.4)</td>
<td>(48.8, 39.1 - 62.8)</td>
</tr>
</tbody>
</table>

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</thead>
<tbody>
<tr>
<td><strong>EMDEs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>10.4</td>
<td>13.6</td>
<td>6.6</td>
<td>18.1</td>
</tr>
<tr>
<td></td>
<td>(16.4, 2.2 - 21.8)</td>
<td>(24.1, 2.9 - 38.9)</td>
<td>(14.0, 0.7 - 26.7)</td>
<td>(18.9, 5.8 - 30.3)</td>
</tr>
<tr>
<td>Group</td>
<td>2.1</td>
<td>6.3</td>
<td>6.4</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>(11.3, 0.5 - 12.7)</td>
<td>(10.3, 1.9 - 15.1)</td>
<td>(18.9, 2.7 - 19.0)</td>
<td>(10.7, 3.2 - 16.9)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>21.4</td>
<td>25.8</td>
<td>27.4</td>
<td>28.9</td>
</tr>
<tr>
<td></td>
<td>(27.8, 11.5 - 41.7)</td>
<td>(34.4, 13.8 - 52.3)</td>
<td>(32.9, 13.0 - 43.8)</td>
<td>(29.6, 17.2 - 39.4)</td>
</tr>
</tbody>
</table>

Note: All numbers indicate percentage contributions of the global and group-specific factors to the variance of headline CPI inflation. The contributions of global and group-specific inflation factors are estimated using the dynamic factor model described in Annex 2.1. The data set includes 99 countries (25 advanced economies, 74 EMDEs). In each pair of rows, the numbers in the first row indicate medians across countries. The first number in the second row (in parentheses) is the unweighted mean across countries. The second and third numbers in the second row (in parentheses) indicate inter-quartile ranges (25th and 75th percentiles).
Inflation trends to exhibit stronger global synchronization than output growth (Box 2.2). For the full sample of countries over the 1970-2017 period, the median contributions of the global factors to variations in inflation and output growth were 12 percent and 5 percent, respectively. The difference was somewhat more pronounced for EMDEs than for advanced economies. The global factor accounted for 10 percent of inflation variation in the median EMDE but only 3 percent of output growth variation. In the median advanced economy, the contribution of the global factor was also more sizeable for variations in inflation (24 percent) than in output growth (19 percent). Since 2001, the median contributions of the global factor to variation in inflation and output growth have both increased significantly, to 22 percent and 12 percent, respectively, for the full sample of countries.

**Synchronization across different measures of inflation**

The inflation synchronization discussed thus far refers to headline CPI inflation. However, the degree of inflation synchronization differs across various measures of inflation. To analyze these differences, a dynamic factor model is estimated using five measures of inflation with varying tradables content (headline CPI, core CPI, PPI, GDP deflator, and import prices).\(^5\) Separately, a common factor to represent nontradables inflation is extracted from the three measures with below-average tradables content (core CPI, headline CPI, and GDP deflator) and a common factor to represent tradables inflation is extracted from the three measures with above-average tradables content (import prices, headline CPI, and PPI). Global and group-specific factors for each inflation measure are estimated separately for annual data for 38 countries (25 advanced economies and 13 EMDEs) over 1970-2016.

**Inflation synchronization: Different measures**

**Behavior of global inflation measures.** Global factors were typically more volatile for inflation measures with greater tradables content.

- Global factors for PPI and for import price inflation tended to move together over the past four to five decades, but with considerably greater variability in the global factor for import price inflation—as may be

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\(^5\) In price indices for the United States, for example, the share of tradable goods and services is greatest for the PPI (54 percent), followed by the headline CPI (53 percent), GDP deflator (26 percent), and core CPI (15 percent), according to the U.S. Bureau of Labor Statistics. The classification of sectors into tradables and nontradables here follows the earlier literature: agriculture, hunting, forestry and fishing, mining and quarrying and manufacturing are classified as tradable sectors and the rest as nontradable (Knight and Johnson 1997).
国际通胀同步性比产出增长高，过去四到五十年来，在过去三个十年中，通胀同步性与产出增长的同步性已经变得可比。通胀和产出增长的同步性变化可能反映了全球冲击的性质和频率的变化以及结构性因素的变化，包括政策框架的演变。

相对而言，报告在本章中“高”通胀同步性是什么程度？与商业周期同步性程度的比较提供了对这个问题的可能参考标准。有关国际商业周期同步性的各种度量的大量文献报告了国际同步性的程度。本框研究通胀和产出增长的相对同步性，以解决以下问题：

- 通胀和产出增长的同步性有何差异？
- 什么主要因素可以解释通胀和产出增长的同步性差异？

通胀与产出同步性

全样本比较。为了比较通胀和产出的相对同步性，全球因素分别使用基线的两因素模型估计了99个国家在1970-2017期间。通胀的变动倾向于表现出比产出增长更强的同步性（图2.2.1）。具体来说，全球因素在这一时期对通胀和产出增长的贡献率中位数分别为12%和5%。这种差异反映了产出的弱同步性。

\[ \text{BOX 2.2 Global synchronization in inflation and output growth} \]

国际通胀同步性倾向于高于产出增长的上四到五十年。结果主要是由1970-85期间通胀同步性的大幅提高驱动的，因为这一期间经历了多个共同冲击。在过去三个十年中，产出增长的同步性程度有所提高，变得与通胀同步性类似。通胀和产出增长的同步性在时间上的差异可能反映了全球冲击的性质和频率的变化以及结构性因素的变化，包括政策框架的演变。

相对而言，报告在本章中“高”通胀同步性程度是什么？与商业周期同步性程度的比较提供了对这个问题的可能参考标准。有关国际商业周期同步性的各种度量的大量文献报告了国际同步性的程度。本框研究通胀和产出增长的相对同步性，以解决以下问题：

- 通胀的同步性程度与产出增长有何差异？
- 什么主要因素可以解释通胀和产出增长的同步性差异？

通胀与产出同步性

全样本比较。为了比较通胀和产出的相对同步性，全球因素分别使用基线的两因素模型估计了99个国家在1970-2017期间。通胀的变动倾向于表现出比产出增长更强的同步性（图2.2.1）。具体来说，全球因素在这一时期对通胀和产出增长的贡献率中位数分别为12%和5%。这种差异反映了产出的弱同步性。

\[ \text{1} \text{This is consistent with the findings in earlier theoretical and empirical studies (Henriksen, Kydland, and Suišek 2013; Mumtaz, Simonelli, and Surico 2011; Wang and Wen 2007). For instance, Wang and Wen (2007) offer sticky-price and sticky-information New Keynesian models to explain inflation synchronization that is high and well in excess of output synchronization; neither model can account for the phenomenon. They conclude that neither nominal rigidities nor monetary shocks are likely sources of inflation synchronization.}\]
growth synchronization in both advanced economies and EMDEs: the global factor accounted for 10 percent of inflation variation in the median EMDE but only 3 percent of output growth variation. In contrast, in the median advanced economy, the contribution of the global factor was sizeable for variations in inflation (24 percent) and output growth (19 percent). This result is consistent with findings in earlier studies.2

Inflation and output synchronization over time. Over the past three decades, the degree of synchronization of output growth has grown to become comparable to that for inflation (Figure 2.2.1). During 1970-85, inflation synchronization (with a median variance contribution of the global factor of 16 percent) was stronger than output growth synchronization (5 percent). During 1986-2000, however, the median share of the global factor in the variance of inflation declined to 10 percent, while the share of global output growth factor remained low (6 percent), with wide differences across countries. Since 2001, the median contributions of the global factors to variation in output growth and inflation have both increased significantly, to 12 percent and 22 percent, respectively. For the median advanced economy, the share is now greater for output growth (34 percent) than for inflation (27 percent). For the median EMDE, the global factor still contributed more to inflation variation (18 percent) than to output growth variation (7 percent).

The trends in the relative importance of global and group-specific factors over time were similar for output growth and inflation. Both output growth and inflation were explained more by global factors than group-specific factors during 1970-85, but the relative importance of the group-specific factors increased during the 1986-2000 period.3 However, since 2001, the global factors have again become more important than group-specific factors for both output and inflation. While these trends were similar in direction, they were more pronounced for inflation than for output growth.

Evolution of global factors for output and inflation. Around the global oil price spikes in the 1970s and the oil price plunge in the mid-2010s, global

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2 For example, among 60 mostly advanced economies, a global factor accounts for 25-50 percent of the variance of output growth (Kose, Otrok, and Whiteman 2003).

3 This is consistent with the findings on the “decoupling of macroeconomic variables between advanced economies and EMDEs” reported by Kose, Otrok, and Prasad (2012).
BOX 2.2 Global synchronization in inflation and output growth (continued)

FIGURE 2.2.1 Synchronization in output growth and inflation

Global inflation synchronization has been stronger than global synchronization of output growth, especially in EMDEs. In advanced economies, inflation synchronization has been comparable to, or lower than, output growth synchronization since the mid-1980s.

A. Contribution of global factor to output growth and inflation variation, 1970-2017

B. Contribution of global factor to output growth and inflation variation, over time

C. Contribution of global factor to output growth and inflation variation: Advanced economies

D. Contribution of global factor to output growth and inflation variation: EMDEs

E. Contribution of global and group factors to output and inflation variation, over time

F. Contribution of global and group factors to output and inflation variation, by country group

Note: Contribution of global and group factors to variance of real output growth and to inflation in 99 economies, including 25 advanced economies (AEs) and 74 EMDEs, including 16 LICs, based on a two-factor dynamic factor model (Annex 2.1).
Click here to download data and charts.
BOX 2.2 Global synchronization in inflation and output growth (continued)

(and group-specific) factors for output growth and for inflation moved in opposite directions, possibly indicating a major role of global supply shocks as the main drivers of global business and inflation cycles during these episodes. On the other hand, around global recessions and slowdowns, especially around the global financial crisis in 2008-09, the two global factors moved in tandem, probably due to demand shocks. This time-varying correlation between the two global factors is clearly observed for EMDE-specific factors (Figure 2.2.2).

Reasons for differences in inflation and output growth synchronization

Henriksen, Kydland, and Suštek (2013) examine this question in an international business cycle model with common technology shocks as well as cross-border technology spillovers. In their model, central banks’ policy rules are combined with a no-arbitrage condition between domestic and foreign interest rates to render current prices (and interest rates) a function of expected future output. This results in a stronger cross-country correlation in prices than in output.

Alternatively, the difference in the degrees of synchronization may reflect the nature of global shocks or differential impacts of cross-border spillovers of shocks on inflation and output. If movements in the prices of internationally traded goods, such as swings in commodity prices, play an important role as global shocks, their impact on inflation could be greater and more immediate than their impact on output. Indeed, the degree of inflation synchronization is much higher than that of output growth during the 1970-85 period, a period which witnessed multiple global shocks associated with sharp movements in oil prices.

Considering that cross-border spillovers of shocks can drive global synchronization in inflation and in output, structural changes can also influence real and nominal linkages across countries. For instance, the strong degree of output synchronization among advanced economies during 2001-17, which was slightly more pronounced than inflation synchronization during the same period, can partly reflect widespread and major economic disruptions during the global financial crisis.
expected for goods prices that are heavily exposed to, if not determined in, global markets (Figure 2.3). During global recessions and episodes of large oil price swings, the global PPI and import price factors exhibited sharper movements than the global headline CPI factor. With a larger share of nontradable goods and services prices in the GDP deflator, the global factor

**Conclusion**

Is the degree of inflation synchronization reported in this chapter “high”? A comparison with output growth synchronization suggests that the answer is a qualified yes. Since 1970, global inflation synchronization has been more than twice as large as global output synchronization. The difference may reflect a multitude of shocks to internationally traded prices that affected domestic inflation more directly than output or technology spillovers that affected prices more than output because central banks responded proactively to shocks. Over time, both inflation and output synchronization have risen.


**FIGURE 2.3 Global inflation factors: Various inflation measures**

Global factors for PPI and import price inflation have tended to move together over the past four to five decades, and have been considerably more volatile than the global factor for headline CPI inflation. With a larger share of nontradable goods and services prices in the GDP deflator, the contribution of the global factor to variations in GDP deflator growth has been smaller and considerably less volatile than those for PPI and import price inflation. The contribution of the global factor to core CPI inflation variation—which contains the largest share of nontradable goods and services among the inflation measures used here—has been the smallest among various inflation measures.

- Since the mid-1980s, the global factor for core CPI inflation—which contains the largest share of nontradable goods and services among the inflation measures examined here—has been less volatile than those for the other inflation measures. This may reflect the exclusion of energy prices (which tend to comove globally), as well as strengthened monetary policy frameworks and better-anchored inflation expectations as a growing number

for this measure has been considerably less volatile than those for headline CPI, PPI, and import price inflation.
of central banks succeeded in lowering inflation from high levels and began to employ inflation-targeting frameworks (as discussed in Chapter 1 and Chapter 4). The decoupling of core inflation from other inflation measures was also reflected in declining correlations between the global factors for core CPI and other measures of inflation. Thus, the correlation of the global factor for core CPI inflation with that for import price inflation halved between 1970-85 (0.8) and 2001-16 (0.4), while the correlation of PPI or headline CPI inflation with import price inflation remained high, at around 0.7-0.9.

**Contribution of global factors to inflation variation.** The estimated global factor’s contribution to inflation variation was higher in inflation measures with greater tradable goods and services content (Figure 2.3, Table 2.3). For example, the global factor’s contribution to inflation variation was largest for import prices (54 percent in the median country) and smallest for core CPI inflation (5 percent). Inbetween these two extremes, the global factor’s contribution to variation in PPI inflation was 42 percent and that for GDP deflator growth was in the order of 13 percent, which was comparable to that for headline CPI inflation.

**Contribution of group-specific factor to inflation variation.** In contrast to the results for the global factor, the group-specific inflation factor contributed more to variation in inflation measures with less tradables content: it was largest for the core CPI, followed by the GDP deflator, the headline CPI, PPI, and import prices. The median contribution of the group-specific factor to the variation in core CPI inflation was 14 percent—considerably more than that of the global factor (5 percent). For GDP deflator growth, the median contributions of global and group-specific factors were similar, at 13 and 12 percent, respectively. For import prices and PPI, the contributions of group-specific factors were negligible (less than 5 percent).

**Evolution of inflation synchronization: Different measures**

Trends in inflation synchronization over time were similar across the five inflation measures (Figure 2.4; Table A.2.3). During 1970-85, the role of the global inflation factor was sizeable for all five inflation measures except core CPI inflation; global inflation synchronization weakened during 1986-2000, but returned in the 2000s to levels similar to those of 1970-85. During 1970-85, the median contribution of the global inflation factor was 68 percent for inflation variation in import prices, followed by PPI (52 percent) and core CPI (8 percent).

During 1970-85, the contribution of the global factor to inflation variation was much greater than that of the group-specific factor for all inflation
### TABLE 2.3 Variance decompositions: Various inflation measures (percent)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Import Prices</th>
<th>PPI</th>
<th>Headline CPI</th>
<th>GDP Deflator</th>
<th>Core CPI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>54.4</td>
<td>42.1</td>
<td>15.7</td>
<td>12.6</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td>(51.8, 45.6-66.1)</td>
<td>(41.1, 15.3-61.7)</td>
<td>(22.9, 6.2-36.5)</td>
<td>(18.7, 3.2-30.5)</td>
<td>(12.5, 1.7-15.4)</td>
</tr>
<tr>
<td>Group</td>
<td>2.1</td>
<td>3.2</td>
<td>9.1</td>
<td>12.1</td>
<td>14.1</td>
</tr>
<tr>
<td></td>
<td>(8.5, 1.1-15.1)</td>
<td>(6.6, 0.9-8.8)</td>
<td>(12.8, 3.4-21.4)</td>
<td>(16.0, 4.6-25.5)</td>
<td>(18.8, 2.9-26.6)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>63.2</td>
<td>49.9</td>
<td>34.1</td>
<td>35.3</td>
<td>26.3</td>
</tr>
<tr>
<td></td>
<td>(60.4, 51.5-70.4)</td>
<td>(45.2, 19.7-67.3)</td>
<td>(35.7, 25.4-44.6)</td>
<td>(33.8, 19.1-45.0)</td>
<td>(27.2, 10.9-40.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor</th>
<th>Advanced economies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>54.4</td>
</tr>
<tr>
<td></td>
<td>(52.7, 45.6-66.1)</td>
</tr>
<tr>
<td>Group</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>(7.5, 1.4-15.1)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>63.2</td>
</tr>
<tr>
<td></td>
<td>(60.2, 49.5-72.5)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>56.9</td>
</tr>
<tr>
<td></td>
<td>(48.2, 40.2-64.9)</td>
</tr>
<tr>
<td>Group</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>(12.8, 0.7-13.1)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>61.4</td>
</tr>
<tr>
<td></td>
<td>(61.1, 57.0-65.5)</td>
</tr>
</tbody>
</table>

Note: The contributions of global and group inflation factors to inflation variance are estimated with a two-factor dynamic factor model for each for the five different inflation measures: Import prices, PPI, Headline CPI, GDP deflator, and Core CPI (Annex 2.1). The sample includes 38 countries (25 advanced economies, 13 EMDEs), except for import prices, which are only available for 21 countries (17 advanced economies and 4 EMDEs). In each pair of rows, the first number in the first row indicates medians across countries. The first number in the second row (in parentheses) is the unweighted mean variance share across countries. The second and third numbers in the second row (in parentheses) indicate inter-quartile ranges (25th and 75th percentiles). Results for headline inflation may differ from Tables 2.1 and 2.2 because of a smaller sample size, to match the sample with available data for other measures of inflation.
measures except core CPI inflation. During 1986-2000, however, the global factor’s contribution fell below 10 percent for all five measures while the contribution of the group-specific factor rose to match or even exceed that of the global factor for virtually all inflation measures. Since 2001, the contribution of the global inflation factor has risen to around two-thirds for PPI inflation variation and to around one-third for core CPI inflation and GDP deflator growth variation.

Inflation synchronization: Tradable versus nontradable goods and services

Similar results are obtained from an exercise that extracts separate global and group-specific factors for mainly tradables (headline CPI, PPI, import prices) and mainly nontradables (headline CPI, GDP deflator, core CPI) inflation measures. The global factor accounted for a much larger share of tradables inflation (40 percent) than nontradables inflation variation (13 percent, Figure 2.5, Table 2.4). The median contribution of the group-specific factor to inflation variation was similarly low for the nontradables sector as for the tradables sector (6 percent). The differences between contributions of global and group-specific factors to tradables and nontradables inflation were larger for advanced economies than for EMDEs.

---

6 The results are robust to the exclusion of the headline CPI from the estimation of the global factor for the nontradable sector.
**FIGURE 2.5 Global and group inflation factors: Tradables and nontradables**

Global inflation factors for tradable and nontradable goods moved broadly together until the late 1990s when the nontradables factor stabilized while the tradables factor did not. The share of inflation variance explained by the global inflation factor is greater for tradable goods than for nontradable goods, and larger for advanced economies than for EMDEs. Group-specific inflation synchronization is stronger for nontradable goods and services than for tradables.

A. Global inflation factors: Tradables and nontradables inflation

B. AE-specific inflation factors: Tradables and nontradables inflation

C. EMDE-specific inflation factors: Tradables and nontradables inflation

D. Contributions of global and group factors to tradables and nontradables inflation variation


Notes: The global and group inflation factors for tradeable and nontradeable goods are estimated with the 2-factor dynamic factor model for 1970-2016 (Annex 2.1). The common factor from three measures for domestic inflation (import prices, PPI, and headline CPI) is used as a proxy variable for the common component for tradable goods. Similarly, common factors for headline CPI, core CPI, and GDP deflator are extracted as a proxy for global inflation factor for nontradable goods. The data are de-trended annual inflation for 25 advanced economies (AEs) and 13 EMDEs for the period of 1970-2016.

Click here to download data and charts.

**Sources of inflation synchronization**

A wide range of factors could be responsible for global synchronization of inflation. This section starts with a brief conceptual discussion of three broad factors that could explain inflation synchronization: shocks, policy responses, and structural changes. This discussion is followed by an analysis of country-specific structural and policy-related features that correlate with inflation synchronization.
Chapter 2

Inflation: Evolution, Drivers, and Policies

Conceptual considerations

**Shocks.** Inflation synchronization across countries could be driven by common shocks that spread evenly (or at least simultaneously) across countries, and/or by country-specific shocks that spill over from one country or a subset of countries to others. Commodity price shocks, internationally correlated productivity shocks, other cost-push shocks, and real demand shocks that trigger global recessions or expansions could all affect national inflation rates widely and often in the same direction, which would represent inflation synchronization. For example, the 2009 global recession was followed by a prolonged period of globally depressed inflation. Other shocks could affect countries asymmetrically. For example, oil price shocks would affect oil importers and oil exporters differently (Baffes et al. 2015).

Similarly, a recession in a relatively large economy could have greater spillover effects on activity and inflation in its close trading partners than elsewhere.

### TABLE 2.4 Variance decompositions: Tradables and nontradables (percent)

<table>
<thead>
<tr>
<th>Factor</th>
<th>Nontradable sector</th>
<th>Tradable sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All countries</td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>13.2</td>
<td>40.1</td>
</tr>
<tr>
<td></td>
<td>(19.3, 4.3 - 31.6)</td>
<td>(36.7, 14.5 - 53.6)</td>
</tr>
<tr>
<td>Group</td>
<td>5.9</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>(10.9, 0.7 - 15.4)</td>
<td>(7.2, 1.7 - 9.8)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>30.2</td>
<td>45.7</td>
</tr>
<tr>
<td></td>
<td>(30.2, 13.3 - 41.8)</td>
<td>(43.9, 24.1 - 62.8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor</th>
<th>Advanced economies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>17.9</td>
</tr>
<tr>
<td></td>
<td>(21.5, 9.3 - 32.1)</td>
</tr>
<tr>
<td>Group</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>(11.3, 2.8 - 16.6)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>33.7</td>
</tr>
<tr>
<td></td>
<td>(32.8, 20.0 - 43.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Factor</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>7.8</td>
</tr>
<tr>
<td></td>
<td>(15.2, 2.5 - 21.0)</td>
</tr>
<tr>
<td>Group</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>(10.0, 0.2 - 8.5)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>(25.2, 8.7 - 39.8)</td>
</tr>
</tbody>
</table>

Note: The global and group inflation factors for tradeable and nontradable goods and services are estimated with the baseline two-factor dynamic factor model for 1970-2016 (Annex 2.1). The common factor from three measures for domestic inflation (import prices, PPI, and headline CPI) is used as a proxy variable for the common component for tradable goods. Similarly, common factors for headline CPI, core CPI, and GDP deflator are extracted as a proxy for global inflation factor for nontradable goods. The sample include annual inflation in 38 countries (25 advanced economies and 13 EMDEs) for the period of 1970-2016. Long-term trend (15-year moving average) is eliminated from annual inflation rates. For each pair of rows, the number in the first row indicates medians across countries. The first number in the second row (in parentheses) is the unweighted mean across countries. The second and third numbers in the second row (in parentheses) indicate inter-quantile ranges (25th and 75th percentiles).
(Huidrom, Kose, and Ohnsorge 2017). Exchange rate changes, especially ones that go beyond movements warranted by real-economy developments, such as domestic currency crises or confidence shocks, will also tend to pass through into national inflation rates asymmetrically (Shambaugh 2008). Traded goods account, on average, for over 60 percent of consumer baskets in EMDEs, and 47 percent of consumer baskets in advanced economies. Hence, exchange rate movements would tend to affect consumer prices directly and significantly. The extent of such exchange rate pass-through is discussed in detail in Chapter 5.

Similar policy responses. Earlier studies have often highlighted the contribution of correlated or coordinated monetary policies as a main source of inflation comovement, especially among advanced economies (Clarida, Gali, and Gertler 2002; Rogoff 2003). Even if there is no deliberate coordination of policies, similar monetary policy frameworks can trigger similar policy responses to global shocks. This policy synchronicity would then translate into inflation synchronicity.

For example, a growing number of countries has introduced inflation-targeting monetary policy frameworks. In many of these countries, inflation targets have been lowered over the past three decades, and in advanced economies the targets are now virtually universally at or around 2 percent (Chapter 1). In EMDEs, inflation targeting has been associated with lower inflation, and a switch to inflation targeting has been associated with larger declines in inflation (Fang, Miller, and Lee 2012; Gonçalves and Salles 2008). Henriksen, Kydland, and Šustek (2013) develop an international business cycle model with technological spillovers in which central banks’ Taylor rules trigger monetary policy responses to productivity shocks that are similar across countries. As a result, their model generates movements in inflation that are synchronized across countries.

Structural changes. Over the past four to five decades, the degree of global integration in trade and financial markets has grown rapidly (Chapter 1). These structural changes have often strengthened cross-country spillovers of real and nominal shocks, which have in turn led to more synchronized movements in inflation.

- **Stronger trade linkages** increase an economy’s exposure to external shocks. With growing trade linkages, import prices have accounted for rising shares of global production costs and domestic prices of final goods and services. As a result, domestic inflation has become more sensitive to global shocks that raise or lower import prices (Bianchi and
The results in the previous section indicate that inflation synchronization has been greater for measures with larger tradables content and, since 2001, has increased across inflation measures. These findings likely reflect the fact that prices are more likely to be internationally determined in sectors with strong trade linkages to global markets where they are subjected to common demand and supply shocks (Karagedikli, Mumtaz, and Tanaka 2010; Parker 2018). Over time, the impact of global shocks in traded goods prices tends to be passed through to other prices, with the degree and speed of the pass-through depending on country characteristics, including trade and financial openness and the credibility of the central bank’s inflation objective (Chapter 5).

- **Rapidly expanding global supply chains** allow global supply and demand shocks as well as commodity price swings to ripple through global input-output linkages and global labor markets and cause comovement in national inflation rates (Rogoff 2003; Auer, Borio, and Filardo 2017).

- **Greater international competition** has made *domestic inflation less sensitive to domestic output gaps*, flattening Phillips curves (Eickmeier and Pijnenburg 2013; Carney 2017; Kabukçuoğlu and Martínez-García 2018).

- **Financial linkages.** Increased international integration of financial markets has been accompanied by greater synchronization of financial conditions—including financial stress—across countries (Neely and Rapach 2011; Carney 2017). As financial stress spreads (or recedes) across global financial markets, it tightens (or loosens) credit and financial conditions in a wide range of countries. As a result, movements in domestic demand and disinflationary or inflationary pressures are also synchronized across countries.

- **Technological changes**, in addition to deepening supply chains, can also help globalize markets for nontradable service sectors. This may extend and deepen the impact of global forces on domestic inflation (Henriksen, Kydland, and Suštek 2013; Carney 2017).

**Country-specific features**

The results in the previous sections indicate that, since 2001, the global factor has accounted for 27 percent of domestic inflation variation in advanced

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7 This study is broadly in line with the literature that investigates the role of international input-output linkages in driving synchronization of global business cycles (Kose and Yi 2006; di Giovanni and Levchenko 2010; Johnson 2014). Martínez-García (2015) develops a new open-economy macro model for the United States and 38 of its trading partners. The model can account for inflation synchronization even in the absence of common shocks, simply through the presence of strong spillovers associated with trade linkages.
economies and 18 percent in EMDEs. Similarly, the group factor has grown in importance such that, since 2001, it has accounted for 21 percent in the median advanced economy and 8 percent in the median EMDE. However, there has been wide heterogeneity in these shares across countries, especially among EMDEs, pointing to the importance of country characteristics (Monacelli and Sala 2009; Neely and Rapach 2011). This section briefly examines the country-specific correlates of the contribution of the global and group-specific factors to EMDE inflation variation.

Correlates of the contribution of the global factor. The global factor has generally contributed more to inflation variation in advanced economies than in EMDEs and, among EMDE regions, has contributed most in EAP, LAC, and SAR. The global inflation factor also explains a larger share of inflation variation in commodity-importing and in more trade-open EMDEs (Figure 2.6). Lower trade openness and the heavy reliance on commodity exports in three-quarters of LICs may, in part, explain the weak inflation synchronization in LICs.

A panel regression of the contribution of global or group factors to inflation variation on indicators of integration into the global economy and policy frameworks helps identify those features that are most significantly correlated with greater inflation synchronization. The dataset includes annual data for 25 advanced economies and 58 EMDEs (of which 16 LICs) for 1970-2017. The results suggest that the global factor was significantly more important for inflation in countries with higher trade openness, greater commodity-import intensity, and lower trade concentration (Table A.2.4). This is consistent with studies that have attributed inflation synchronization to trade or supply chain integration in advanced economies (Box 2.1).

Evolution of the contribution of the global factor over time. The cross-country heterogeneity in the contribution of the global factor to inflation variation seems to have been a phenomenon of the 1970s-90s that largely disappeared in the 2000s. During 1970-85, as in the full-sample period, higher trade openness, commodity importer status, and a more flexible exchange rate regime were each associated with greater contributions of the global factor to inflation. Since 2001, these differences have become less pronounced: the range of contributions of the global factor narrowed from 0-87 percent in 1970-85 to 0-58 percent in 2001-17, without any evidence of systematic differences by country characteristics (Figure 2.6, Table A.2.4).

---

8 See Monacelli and Sala (2009); Karagedikli, Mumtaz, and Tanaka (2010); Martínez-García (2015); and Auer, Borio, and Filardo (2017). For instance, in a Phillips curve framework, Auer, Borio, and Filardo (2017) present evidence that cross-border trade in intermediate goods and services is the main channel through which global economic slack influences domestic CPI inflation.

9 In the regression analysis, this loss of systematic differences is apparent in the lack of statistically significant coefficients in the subsample for 2001-17 in Table A.2.4.
Correlates of the contribution of the EMDE factor. Overall, the contributions of the EMDE-specific factor to inflation variation were more homogeneous than those for the global factor and have, if anything, also become more homogeneous over time. That said, there are some systematic differences by country characteristics. In particular, the group factor contributed more to inflation variation in commodity exporters as well as countries with pegged exchange rates (Figure 2.6, Table A.2.5). However, these correlates have shifted over time such that, since 2001, the exchange rate regime has no longer been...
systematically correlated with the contribution of the group factor. Instead, since 2001, as a growing number of EMDEs shifted towards inflation-targeting monetary policy regimes, a systematic negative correlation has emerged between the contribution of the group factor to inflation variation and inflation targeting.

Conclusion

This chapter has examined three questions about the extent of global inflation synchronization.

How has inflation synchronization evolved over time? Inflation has become increasingly synchronized globally: 18 percent (in the median EMDE) to 27 percent (in the median advanced economy) of inflation variation since 2001 has been accounted for by the global factor. Over the past four decades, an EMDE-specific factor has emerged that has explained about 8 percent of EMDE inflation variation since 2001, one-quarter higher than in the 1970s although still below the contribution of an advanced-economy factor (21 percent). Inflation synchronization varies widely across countries but has become more broad-based over time. During 1986-2000, the global factor contributed more than 10 percent to inflation variation in around one-third of the countries in the sample; by 2001-2017, this share had risen to two-thirds.

Which goods and price indices have been associated with greater inflation synchronization? Inflation synchronization has become more pronounced across inflation measures over time. While the global factor continues to contribute much more to inflation measures with a higher tradables content (import prices and the PPI) than to measures with a lower tradables content (core and headline CPI and the GDP deflator), this contribution has risen for all inflation measures: to two-thirds for PPI inflation and around one-third for core CPI inflation and GDP deflator growth.

Which country characteristics have been associated with greater inflation synchronization? Countries differ widely in the degree to which global factors and, to a lesser extent, group factors, account for domestic inflation variation. The global factor has accounted for a larger share of domestic inflation variation in countries that have been more open to global trade, relied on commodity imports, had more concentrated trade, were more economically developed or were EMDEs in the EAP, LAC, and SAR regions. That said, over the past four to five decades, this heterogeneity has narrowed such that, since 2001, no country characteristic appears to systematically account for greater contributions of global factors. Since 2001, the EMDE group factor has explained a greater share of inflation variability in EMDEs that did not have inflation-targeting monetary policy frameworks.
The increased synchronicity of global inflation could pose challenges for policymakers. Inflation synchronization in and of itself need not warrant policy intervention (IMF 2018). However, it increases the risk of policy errors when the appropriate response to excessively low or high inflation differs depending on the origin (domestic or foreign) of the underlying inflation shock (Hartmann and McAdam 2018). In the context of exchange rate pass-through, this issue is explored in detail in Chapter 5.

Inflation synchronization raises concerns that central banks’ control over domestic inflation may have weakened (Carney 2017). Heads of major advanced-economy central banks have acknowledged the need to consider the global environment in setting monetary policy (Bernanke 2007; Draghi 2015; Carney 2015). Weaker monetary policy transmission would increase the burden on fiscal policy to respond to excessive or deficient domestic demand. It would also increase the need for product and labor market flexibility to be able to adjust before relative price changes driven by foreign shocks turn into general inflation. Global inflation synchronization could also strengthen the case for coordinated policy action (IMF 2018). A coordinated response to uncomfortably low or high global inflation could amplify the impact of policies advanced by an individual country.

Future research could take two directions. First, it could delve further into the sources of the inflation synchronization that has been documented here. Synchronization could be generated by common shocks that affect all countries, or by country-specific shocks that spill over between countries. This chapter—as well as the next one—is agnostic about these two sources. Second, this chapter estimates synchronization in short-term inflation movements, not in long-term inflation trends. Yet, as documented in Chapter 1, inflation has trended down steeply around the world over the past four decades. Future research could aim to quantify the extent of synchronization in these long-term inflation trends.
ANNEX 2.1 Methodology and database

Dynamic factor model

Following Kose, Otrok, and Prasad (2012), this paper decomposes fluctuations in inflation into one or more latent factors in the context of a dynamic factor model. Dynamic factor models are designed to extract a small number of unobservable common elements from the covariance or co-movement between (observable) macroeconomic time series across countries. Thus, the model allows for a parsimonious representation of the data in terms of the unobservable common elements—typically referred to as factors. From a theoretical standpoint, dynamic factor models are appealing because they can be framed as reduced-form solutions to a standard Dynamic Stochastic General Equilibrium (DSGE) model.

This chapter estimates two types of common driving forces in fluctuations in global inflation.

- **Global inflation factor**: The broad common elements in inflation fluctuations across countries.

- **Group-specific inflation factors**: Common elements in the cyclical inflation fluctuations in the countries in a particular group. Here, it is assumed national inflation rates are explained by a “country group” factor, advanced-economy and EMDE factors.

- **Residual (“idiosyncratic”) factors**: These capture elements in the fluctuations of an individual variable in a country that cannot be attributed to the other factors.

Thus, the inflation equation for each country takes on the following form:

\[ \pi_{i,t} = \beta^{i}_{Global} f_{t}^{Global} + \beta^{i}_{Group} f_{t}^{Group} + \epsilon_{i,t} \]

where \( \pi_{i} \) denotes inflation in country \( i \); the global, and group factors are represented by \( f_{t}^{Global} \) and \( f_{t}^{Group} \) respectively; and the coefficients before them (\( \beta \)), typically referred to as factor loadings, capture the sensitivities of the macroeconomic series to these factors. The error terms (\( \epsilon_{i,t} \)) are assumed to be uncorrelated across countries at all leads and lags. Both error terms and factors follow an autoregressive process. The model is estimated using Bayesian techniques as described in Kose, Otrok, and Whiteman (2003).

The importance of each factor in explaining inflation is measured by the fraction of total variance of inflation due to the respective factor. This is computed by
applying the variance operator to each equation in the system. Specifically, for inflation in country $i$:

$$\text{Var}(\pi_i) = (\beta^{i,\text{Global}})^2 \text{Var}(f^{\text{Global}}) + (\beta^{i,\text{Group}})^2 \text{Var}(f^{\text{Group}}) + \text{Var}(\varepsilon_{i,\pi})$$

Since there are no cross-product terms between the factors, the variance in inflation attributable to the global factor is:

$$\frac{(\beta^{i,\text{Global}})^2 \text{Var}(f^{\text{Global}})}{\text{Var}(\pi_i)}$$

The variance shares due to the group factors and idiosyncratic terms are calculated using a similar approach.

**Regression analysis between variance contribution of the inflation factors and country characteristics**

To explore the relations between the impact of global and group-specific inflation factors on domestic inflation, the contribution for the global and group factors in individual countries are regressed on a variety of indicators for country characteristics. They include a variety of variables on the structure of an economy as well as policy frameworks. The variables include dummy variables for above-average commodity import intensity, income groups, and regions; dummy variables for exchange rate and monetary policy regimes; measures of trade and financial openness (trade-to-GDP ratio, capital account openness index by Chinn and Ito 2017, index for trade concentration) and degree of participation in global value chain (share of foreign value added in exports); and measures of central-bank independence and transparency and turnover ratio of central bank heads. A more detailed description on the country characteristics is provided in Database Annex.

The regression analysis starts with a set of bi-variate regressions that include a variable of interest and constant as explanatory variables for the global or group factor’s variance share of inflation. Based on the results from bi-variate regressions, multi-variate regression is estimated using Bayesian model averaging (baseline) or multivariate least squares (for robustness). Considering the fact that regional dummy variables are highly correlated with other structural and policy variables, each set of multi-variate regressions are executed with and without the regional dummy variables. The estimations are conducted for the full sample (1970-2017) as well as for three subsamples (1970-1985, 1986-2000, 2001-17). The list of countries are summarized in Table A.2.3.
### TABLE A.2.1 Factor models for inflation synchronization in the literature

<table>
<thead>
<tr>
<th>Related work</th>
<th>Inflation measures</th>
<th>Data coverage</th>
<th>Empirical framework (Economic factors)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciccarelli and Mojon (2010)</td>
<td>Headline CPI</td>
<td>22 OECD countries (1960-2008, quarterly)</td>
<td>Static factor model (one global factor)</td>
<td>A simple average of 22 OECD countries' inflation, which they call global inflation, accounts for almost 70 percent of the variance of inflation in these countries between 1980:1 and 2008:2. At business cycle frequencies, the variance explained by global inflation is about 37 percent on average and much larger in numerous countries. Second, domestic inflation reverts to the global component. Third, countries that have experienced stronger commitment to price stability (such as Germany) global inflation has a lesser impact on domestic inflation than in those with weaker inflation discipline (such as Italy).</td>
</tr>
<tr>
<td>Hakkio (2009)</td>
<td>Headline and core CPI</td>
<td>30 OECD and 6 non-OECD countries (1960-2008, quarterly)</td>
<td>Principal Component Analysis (global and regional factors)</td>
<td>The first common factor is an important determinant of national inflation rates in industrial countries and in non-industrial and regional inflation rates (with R2's of regressions of national inflation on the first common factor averaging 0.71). The commonality of industrial inflation rates appears to reflect the commonality of macro variables that are determinants of inflation.</td>
</tr>
<tr>
<td>Auer, Levchenko, and Sauré (2017)</td>
<td>Sectoral PPI</td>
<td>30 countries (1995-2011, monthly)</td>
<td>Dynamic factor model (global, sectoral, country factors)</td>
<td>For the median country, the global component accounts for 51 percent of the variance of the PPI. Input-output linkages account for half of this global component of PPI inflation. On average, a shock that raises inflation by 1 percent in the other countries in the world other than the country under observation raises domestic PPI by 0.19 percent. PPI synchronization across countries is driven primarily by common sectoral shocks and input-output linkages amplify co-movement primarily by propagating sectoral shocks.</td>
</tr>
<tr>
<td>Parker (2018)</td>
<td>Sub-components of Headline CPI</td>
<td>223 countries (unbalanced panel) (1980-2010, quarterly)</td>
<td>Dynamic hierarchical model (global, index-specific, group factors)</td>
<td>Global inflation accounts for a large share of the variance of national inflation rates in OECD countries. For medium income countries the share of national inflation variance explained by global factors is in the order of 15 to 20 percent, falling to around 10 percent for low income countries. Higher income, greater financial sector development and more transparent central banks are associated with a larger influence of global inflation. Relatively rich countries with deep domestic capital markets and good monetary policy are likely to be better able to mitigate idiosyncratic, domestic shocks. Global inflation factors also have greater influence on national inflation rates of countries with fixed exchange rates. There is a more marked influence of global energy and food prices on the respective national inflation rates. Housing prices appear for the most part idiosyncratic and unrelated to global factors.</td>
</tr>
</tbody>
</table>
Related work | Inflation measures | Data coverage | Empirical framework (Economic factors) | Results
--- | --- | --- | --- | ---
Mumtaz and Surico (2012) | Headline CPI other inflation indicators | 10 advanced economies (1961-2004, quarterly) | Dynamic factor model (global and country factors) | The historical decline in the level and persistence of inflation is shared by most countries. An international factor tracks the level and persistence of national inflation rates reasonably well. The rise and fall of national contributions to inflation fluctuations are not synchronized across economies and their timing confirms conventional wisdom on the conduct of national policies: income policies and accommodative monetary policies are associated with periods of volatile inflation in the UK, the United States, Italy, and Japan. The fall in inflation predictability is a common feature of the industrialized world since the late 1980s. Differences in the pace of productivity growth appear important to explain differences in the national factors. International comovements in money growth are significantly related to international comovements in inflation.

Neely and Rapach (2011) | Headline CPI | 64 countries (1950-2009, annual) | Dynamic factor model (global and regional factors) | The global factor explains 35 percent of annual inflation variability on average across the 64 countries, the regional factor explains 16 percent of inflation variability on average, and the country-specific component explains 49 percent. While the world factor explains about a third of inflation variability on average across countries, its importance within that group varies substantially (83 percent of inflation variability in Canada; less than 10 percent of inflation volatility in some other countries). The global inflation factor more strongly influences advanced economies with strong institutions, developed financial markets, low average inflation, and independent central banks. The relative importance of the factors is fairly stable over the two subsamples of 1951-79 and 1980-2009, although the regional (global) factor clearly increases in importance for a number of North American and European (Latin American and Asian) countries during the second subsample.

Forster and Tillmann (2014) | Headline, food and energy CPI | 101 economies (1996Q1-2011Q4) | Hierarchical factor model | About two thirds of overall inflation volatility is due to country-specific determinants. For CPI inflation net of food and energy, the global factor and the CPI basket-specific factor account for less than 20 percent of inflation variation. Only energy price inflation is dominated by common factors.

Karagedikli, Mumtaz and Tanaka (2010) | CPI of 28 product categories | 14 advanced economies (1998Q1-2008Q2) | Dynamic factor model | Category-specific (for 28 product categories) factors account for a large part of the comovement in the prices of goods in advanced economies which are intensive in internationally traded primary commodities; but this is less evident for other traded goods. Both the world factor and the category-specific factors become more significant in explaining the movement in the relative prices in the second half of the sample (2003-08).
**TABLE A.2.1** Factor models for inflation synchronization in the literature *(continued)*

<table>
<thead>
<tr>
<th>Related work</th>
<th>Inflation measures</th>
<th>Data coverage</th>
<th>Empirical framework (Economic factors)</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferroni and Mojon (2018)</td>
<td>Headline CPI</td>
<td>22 OECD countries (1991Q1-2013Q3)</td>
<td>Forecasting model suite</td>
<td>The share of volatility explained by Global Inflation remains dominant. In a (pseudo) out-of-sample exercise, Global Inflation remains the only variable that can help to improve 1-year-ahead inflation forecast relative to univariate models. Commodities prices do not seem to be better predictors of domestic inflation dynamics than measures of Global Inflation.</td>
</tr>
<tr>
<td>Henriksen, Kydland and Suštek (2013)</td>
<td>Headline CPI</td>
<td>6 advanced economies (1974Q1-2006Q4)</td>
<td>Bilateral correlations</td>
<td>Fluctuations in nominal variables—aggregate price levels and nominal interest rates—are documented to be substantially more synchronized across countries at business cycle frequencies than fluctuations in real output. Specifically, for the period 1960.Q1-2006.Q4 the average bilateral correlation of price levels is 0.52, that of short-term nominal interest rates 0.57, while that of real GDP is only 0.25.</td>
</tr>
<tr>
<td>Wang and Wen (2006)</td>
<td>Headline CPI</td>
<td>18 advanced economies</td>
<td>Correlations</td>
<td>The average cross-country correlation of inflation is significantly and systematically stronger than that of output, while the cross-country correlation of money growth is essentially zero. Yet, movements in the money stock are not significantly and systematically correlated across countries. Neither the new Keynesian sticky-price model nor the sticky-information model can fully explain the data.</td>
</tr>
</tbody>
</table>
### TABLE A.2.2 List of countries

#### A. Full-sample country group (Headline CPI inflation)

<table>
<thead>
<tr>
<th>Group</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced economies (25)</td>
<td>Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, South Korea, Luxembourg, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States</td>
</tr>
<tr>
<td>EMDEs (58)</td>
<td>Algeria, Antigua and Barbuda, Arab Rep., Bahamas, Bahrain, Bangladesh, Barbados, Belize, Bhutan, Botswana, Cabo Verde, Cameroon, China, Colombia, Congo, Rep., Cote d'Ivoire, Dominica, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Fiji, Gabon, Grenada, Guatemala, Honduras, Hungary, India, Indonesia, Iran, Islamic Rep., Jordan, Kenya, Kuwait, Lesotho, Libya, Malaysia, Maldives, Mauritius, Morocco, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Philippines, Samoa, Saudi Arabia, Seychelles, South Africa, Sri Lanka, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Thailand, Trinidad and Tobago, Tunisia, and Vanuatu</td>
</tr>
<tr>
<td>LICs (16)</td>
<td>Benin, Burkina Faso, Burundi, Central African Republic, Comoros, Ethiopia, Gambia, Guinea, Madagascar, Mali, Nepal, Niger, Rwanda, Senegal, Tanzania, and Togo</td>
</tr>
</tbody>
</table>

Note: Numbers in the parenthesis indicate the number of countries in each group. EMDEs exclude LICs.

#### B. Sub-sample country group (five inflation measures)

<table>
<thead>
<tr>
<th>Group</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced economies (25)</td>
<td>Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Rep., Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom, and United States</td>
</tr>
<tr>
<td>EMDEs (13)</td>
<td>Arab Rep., Egypt, El Salvador, Hungary, India, Indonesia, Iran, Islamic Rep., Kuwait, Pakistan, Panama, Philippines, South Africa,</td>
</tr>
</tbody>
</table>

Note: Numbers in the parenthesis indicate the number of countries in each group.
## TABLE A.2.3 Variance decompositions, over time: Various inflation measures—Panel A. Import Prices (Percent)

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<th></th>
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<td>8.7</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(62.6, 54.5 - 74.9)</td>
<td>(15.5, 3.1 - 24.5)</td>
<td>(49.2, 42.6 - 63.3)</td>
</tr>
<tr>
<td></td>
<td>77.5</td>
<td>77.5</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
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<td>(25.7, 2.8 - 44.5)</td>
<td>(13.7, 6.1 - 19.2)</td>
</tr>
<tr>
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<td>11.4</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(10.7, 13.9)</td>
<td>(18.5, 8.7)</td>
<td>(11.4, 4.7)</td>
</tr>
<tr>
<td></td>
<td>37.6</td>
<td>37.6</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(41.2, 18.5 - 58.8)</td>
<td>(44.5, 24.5 - 63.3)</td>
<td>(62.9, 46.6 - 77.6)</td>
</tr>
<tr>
<td>Global + Group</td>
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<td>11.4</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(10.7, 13.9)</td>
<td>(18.5, 8.7)</td>
<td>(11.4, 4.7)</td>
</tr>
<tr>
<td></td>
<td>37.6</td>
<td>37.6</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(41.2, 18.5 - 58.8)</td>
<td>(44.5, 24.5 - 63.3)</td>
<td>(62.9, 46.6 - 77.6)</td>
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<td>8.7</td>
<td>67.7</td>
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<td>(13.6, 6.1 - 18.4)</td>
<td>(60.9, 44.3 - 63.3)</td>
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<tr>
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<td>66.3</td>
<td>66.3</td>
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<tr>
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<td>(64.4, 52.0 - 77.6)</td>
<td>(64.4, 52.0 - 77.6)</td>
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<tr>
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<td>11.4</td>
<td>67.7</td>
</tr>
<tr>
<td></td>
<td>(8.7, 10.5)</td>
<td>(18.5, 8.7)</td>
<td>(11.4, 4.7)</td>
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<td>39.1</td>
<td>67.7</td>
</tr>
<tr>
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<td>(52.3, 34.8 - 69.2)</td>
<td>(60.8, 48.6 - 77.6)</td>
</tr>
<tr>
<td>Global + Group</td>
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<td>70.1</td>
<td>70.1</td>
</tr>
<tr>
<td></td>
<td>(63.5, 56.7 - 76.8)</td>
<td>(31.4, 23.8 - 41.4)</td>
<td>(31.4, 23.8 - 41.4)</td>
</tr>
<tr>
<td>EMDEs</td>
<td>8.2</td>
<td>12.9</td>
<td>49.4</td>
</tr>
<tr>
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<td>(13.2, 2.5 - 22.5)</td>
<td>(13.9, 5.0 - 21.8)</td>
</tr>
<tr>
<td></td>
<td>13.9</td>
<td>13.9</td>
<td>49.4</td>
</tr>
<tr>
<td></td>
<td>(13.9, 5.0 - 21.8)</td>
<td>(13.9, 5.0 - 21.8)</td>
<td>(13.9, 5.0 - 21.8)</td>
</tr>
</tbody>
</table>

Note: The contribution of global and group inflation factors to inflation variance is estimated over the three sub-sample periods using a two-factor dynamic factor model for each of the five different inflation measures: Import prices, PPI, Headline, GDP deflator, and Core CPI. The data set includes 38 countries (25 advanced economies, 13 EMDEs) except import prices for 21 countries (17 advanced economies, and 4 EMDEs). The first argument in the first row indicates unweighted median across countries. The first argument in the second row (in parentheses) indicate inter-quartile ranges (25th and 75th percentiles) of variance shares.
<table>
<thead>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
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<td>52.3</td>
<td>5.2</td>
<td>67.2</td>
</tr>
<tr>
<td></td>
<td>(41.1, 15.3 - 61.7)</td>
<td>(45.2, 22.1 - 67.5)</td>
<td>(9.2, 2.3 - 11.2)</td>
<td>(61.4, 55.1 - 76.4)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
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<td>7.3</td>
<td>16.7</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td>(3.2, 0.9 - 8.8)</td>
<td>(12.6 , 2.2 - 18.3)</td>
<td>(22.5, 7.1 - 29.9)</td>
<td>(6.1, 1.3 - 8.1)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>49.9</td>
<td>65.0</td>
<td>24.9</td>
<td>71.3</td>
</tr>
<tr>
<td></td>
<td>(45.2, 19.7 - 67.3)</td>
<td>(54.8, 32.9 - 81.0)</td>
<td>(30.0, 16.1 - 42.7)</td>
<td>(63.9, 54.9 - 82.1)</td>
</tr>
<tr>
<td><strong>Advanced economies</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Global</strong></td>
<td>56.1</td>
<td>62.1</td>
<td>4.0</td>
<td>71.7</td>
</tr>
<tr>
<td></td>
<td>(48.4, 33.9 - 63.7)</td>
<td>(50.0, 27.5 - 70.7)</td>
<td>(9.0, 2.3 - 8.3)</td>
<td>(68.3, 65.8 - 77.0)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>4.5</td>
<td>7.1</td>
<td>20.7</td>
<td>5.9</td>
</tr>
<tr>
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<td>(13.2, 3.2 - 23.1)</td>
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<td>(6.8, 1.1 - 8.4)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>60.6</td>
<td>71.7</td>
<td>35.8</td>
<td>77.3</td>
</tr>
<tr>
<td></td>
<td>(51.6, 31.2 - 68.1)</td>
<td>(58.1, 38.9 - 85.1)</td>
<td>(34.5, 19.1 - 52.1)</td>
<td>(69.1, 66.8 - 87.8)</td>
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<tr>
<td><strong>EMDEs</strong></td>
<td>16.2</td>
<td>33.7</td>
<td>6.9</td>
<td>49.4</td>
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<tr>
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<td>(28.3, 11.1 - 40.4)</td>
<td>(36.9, 12.9 - 57.8)</td>
<td>(9.8, 3.1 - 11.6)</td>
<td>(49.0, 27.6 - 63.4)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>1.4</td>
<td>11.4</td>
<td>13.2</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>(4.7, 0.8 - 4.0)</td>
<td>(11.6, 2.2 - 16.6)</td>
<td>(11.7, 5.2 - 15.9)</td>
<td>(4.8, 2.4 - 7.4)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>22.6</td>
<td>50.3</td>
<td>20.0</td>
<td>57.6</td>
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<tr>
<td></td>
<td>(33.0, 13.5 - 41.0)</td>
<td>(48.4, 31.5 - 70.0)</td>
<td>(21.4, 14.9 - 26.6)</td>
<td>(53.9, 41.2 - 66.6)</td>
</tr>
</tbody>
</table>

Note: The contribution of global and group-inflation factors is estimated over the three sub-sample periods with the dynamic factor model (2-factor model) for each for the five different inflation measures: Import prices, PPI, Headline, GDP deflator, and Core CPI. The data set includes 38 countries (25 advanced economies, 13 EMDEs) except import prices for 21 countries (17 advanced economies and 4 EMDEs). The first argument in the first row indicates unweighted median across countries. The first argument in the second row (in parenthesis) is the mean variance share across countries. The second and third arguments in the second row (in parenthesis) indicate inter-quartile ranges (25th and 75th percentiles) of variance shares.
### TABLE A.2.3 Variance decompositions, over time: Various inflation measures—Panel C. Headline CPI (Percent)

<table>
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<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global</strong></td>
<td>15.7 (22.9, 6.2 - 36.5)</td>
<td>18.7 (28.2, 10.3 - 42.4)</td>
<td>4.0 (5.8, 1.9 - 7.5)</td>
<td>32.8 (30.8, 19.5 - 44.7)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>9.1 (12.8, 3.4 - 21.4)</td>
<td>8.6 (14.5, 3.8 - 22.9)</td>
<td>5.7 (9.5, 4.8 - 10.3)</td>
<td>19.1 (20.2, 10.3 - 24.7)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>34.1 (35.7, 25.4 - 44.6)</td>
<td>42.9 (42.7, 25.0 - 56.7)</td>
<td>12.1 (15.3, 8.1 - 19.0)</td>
<td>55.2 (51.2, 47.7 - 60.8)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global</strong></td>
<td>21.4 (23.7, 11.0 - 36.6)</td>
<td>20.0 (27.3, 8.7 - 42.6)</td>
<td>4.3 (6.2, 1.9 - 7.6)</td>
<td>37.0 (35.0, 28.8 - 44.9)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>11.5 (14.0, 4.1 - 24.1)</td>
<td>19.8 (18.9, 4.3 - 29.7)</td>
<td>5.5 (6.4, 4.7 - 7.0)</td>
<td>17.3 (16.6, 9.1 - 19.9)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>35.9 (37.7, 31.1 - 44.8)</td>
<td>45.1 (46.1, 28.3 - 59.1)</td>
<td>12.0 (12.6, 7.8 - 14.6)</td>
<td>54.4 (52.8, 48.5 - 58.3)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Global</strong></td>
<td>11.6 (21.4, 3.4 - 36.3)</td>
<td>17.4 (30.0, 13.8 - 41.9)</td>
<td>3.2 (5.1, 1.0 - 5.2)</td>
<td>18.1 (21.0, 3.4 - 24.7)</td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>7.7 (10.4, 0.9 - 11.8)</td>
<td>6.8 (6.2, 3.2 - 8.6)</td>
<td>10.2 (15.5, 5.7 - 19.2)</td>
<td>25.6 (30.4, 12.4 - 42.6)</td>
</tr>
<tr>
<td><strong>Global + Group</strong></td>
<td>25.6 (31.9, 16.7 - 43.9)</td>
<td>26.2 (36.2, 23.0 - 45.1)</td>
<td>12.6 (20.6, 10.1 - 27.8)</td>
<td>59.2 (48.3, 28.8 - 64.7)</td>
</tr>
</tbody>
</table>

Note: The contribution of global and group-inflation factors is estimated over the three sub-sample periods with the dynamic factor model (2-factor model) for each for the five different inflation measures: Import prices, PPI, Headline, GDP deflator, and Core CPI. The data set includes 38 countries (25 advanced economies, 13 EMDEs) except import prices for 21 countries (17 advanced economies and 4 EMDEs). The first argument in the first row indicates unweighted median across countries. The first argument in the second row (in parenthesis) is the mean variance share across countries. The second and third arguments in the second row (in parenthesis) indicate inter-quartile ranges (25th and 75th percentiles) of variance shares. Results differ from Tables 1 and 2 because of a smaller sample size to match the sample with available data for other measures of inflation.
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<th>Advanced economies</th>
<th>EMDEs</th>
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</tr>
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<td></td>
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<td>(25.9, 5.5 - 43.0)</td>
<td>(16.7, 3.1 - 28.8)</td>
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<td>7.1</td>
</tr>
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<td>(16.0, 4.6 - 25.5)</td>
<td>(18.6, 5.8 - 28.3)</td>
<td>(11.7, 3.4 - 18.8)</td>
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<td>Global + Group</td>
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<td>45.3</td>
<td>25.0</td>
</tr>
<tr>
<td></td>
<td>(33.8, 19.1 - 45.0)</td>
<td>(43.3, 19.9 - 63.2)</td>
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<td>(27.1, 9.4 - 42.1)</td>
<td>(18.1, 3.4 - 28.9)</td>
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</tr>
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<td></td>
<td>(15.9, 3.5 - 25.0)</td>
<td>(13.8, 5.0 - 23.0)</td>
<td>(11.5, 3.4 - 15.9)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>33.6</td>
<td>37.8</td>
<td>29.7</td>
</tr>
<tr>
<td></td>
<td>(37.3, 18.1 - 45.8)</td>
<td>(39.3, 19.9 - 59.3)</td>
<td>(28.4, 15.9 - 42.8)</td>
</tr>
<tr>
<td>Global</td>
<td>9.3</td>
<td>9.8</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>(18.0, 2.2 - 26.1)</td>
<td>(23.7, 1.9 - 44.5)</td>
<td>(14.2, 3.1 - 15.5)</td>
</tr>
<tr>
<td>Group</td>
<td>9.5</td>
<td>19.6</td>
<td>7.1</td>
</tr>
<tr>
<td></td>
<td>(16.2, 6.2 - 25.5)</td>
<td>(27.5, 9.1 - 44.5)</td>
<td>(12.0, 3.4 - 18.8)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>33.7</td>
<td>54.9</td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>(34.2, 22.2 - 37.4)</td>
<td>(51.2, 32.5 - 70.1)</td>
<td>(26.2, 10.5 - 35.9)</td>
</tr>
</tbody>
</table>

Note: The contribution of global and group inflation factors is estimated over the three sub-sample periods with the dynamic factor model (2-factor model) for each for the five different inflation measures: Import prices, PPI, Headline, GDP deflator, and Core CPI. The data set includes 38 countries (25 advanced economies, 13 EMDEs) except import prices for 21 countries (17 advanced economies and 4 EMDEs). The first argument in the first row indicates unweighted median across countries. The first argument in the second row (in parenthesis) indicate inter-quartile ranges (25th and 75th percentiles) of variance shares.
**TABLE A.2.3** Variance decompositions, over time: Various inflation measures — Panel E. Core CPI (Percent)

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>All countries</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>4.7</td>
<td>8.4</td>
<td>5.4</td>
<td>29.8</td>
</tr>
<tr>
<td></td>
<td>(12.5, 1.7 - 15.4)</td>
<td>(14.2, 6.9 - 14.5)</td>
<td>(17.5, 1.3 - 29.1)</td>
<td>(27.8, 9.7 - 42.1)</td>
</tr>
<tr>
<td>Group</td>
<td>14.1</td>
<td>16.5</td>
<td>10.6</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>(18.8, 2.9 - 26.6)</td>
<td>(18.9, 5.2 - 31.8)</td>
<td>(15.3, 3.1 - 25.6)</td>
<td>(5.8, 2.1 - 7.7)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>26.5</td>
<td>28.6</td>
<td>31.3</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
<td>(27.9, 10.9 - 40.4)</td>
<td>(29.6, 11.6 - 44.3)</td>
<td>(29.2, 11.9 - 44.9)</td>
<td>(30.0, 13.8 - 46.9)</td>
</tr>
<tr>
<td>Advanced economies</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Global</td>
<td>7.9</td>
<td>8.5</td>
<td>5.3</td>
<td>31.9</td>
</tr>
<tr>
<td></td>
<td>(14.5, 3.1 - 21.4)</td>
<td>(16.0, 7.7 - 22.6)</td>
<td>(16.1, 2.3 - 26.3)</td>
<td>(29.5, 25.0 - 44.1)</td>
</tr>
<tr>
<td>Group</td>
<td>17.7</td>
<td>16.9</td>
<td>17.9</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>(21.9, 8.7 - 34.8)</td>
<td>(21.0, 5.2 - 35.7)</td>
<td>(17.1, 2.3 - 29.2)</td>
<td>(5.8, 2.0 - 5.4)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>34.6</td>
<td>40.1</td>
<td>31.8</td>
<td>35.1</td>
</tr>
<tr>
<td></td>
<td>(34.9, 18.9 - 46.4)</td>
<td>(35.5, 13.2 - 53.7)</td>
<td>(30.9, 20.6 - 46.6)</td>
<td>(33.0, 20.6 - 47.7)</td>
</tr>
<tr>
<td>EMDEs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Global</td>
<td>1.7</td>
<td>10.1</td>
<td>26.3</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>(8.0, 1.3 - 9.1)</td>
<td>(8.9, 2.5 - 12.9)</td>
<td>(26.2, 0.7 - 29.1)</td>
<td>(23.3, 0.6 - 29.0)</td>
</tr>
<tr>
<td>Group</td>
<td>2.9</td>
<td>9.4</td>
<td>7.0</td>
<td>6.4</td>
</tr>
<tr>
<td></td>
<td>(11.5, 1.5 - 13.5)</td>
<td>(11.5, 5.3 - 19.2)</td>
<td>(6.9, 4.6 - 10.9)</td>
<td>(7.6, 4.2 - 13.2)</td>
</tr>
<tr>
<td>Global + Group</td>
<td>11.8</td>
<td>17.2</td>
<td>22.4</td>
<td>11.8</td>
</tr>
<tr>
<td></td>
<td>(15.0, 3.0 - 16.5)</td>
<td>(18.7, 5.6 - 27.5)</td>
<td>(24.9, 5.9 - 33.6)</td>
<td>(22.9, 1.1 - 31.1)</td>
</tr>
</tbody>
</table>

Note: The contribution of global and group inflation factors is estimated over the three sub-sample periods with the dynamic factor model (2-factor model) for each for the five different inflation measures: Import prices, PPI, Headline, GDP deflator, and Core CPI. The data set includes 38 countries (25 advanced economies, 13 EMDEs) except import prices for 21 countries (17 advanced economies and 4 EMDEs). The first argument in the first row indicates unweighted median across countries. The first argument in the second row (in parenthesis) is the mean variance share across countries. The second and third arguments in the second row (in parenthesis) indicate inter-quartile ranges (25th and 75th percentiles) of variance shares.
**TABLE A.2.4** Correlates of the variance share of the global inflation factor

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>1970-85</th>
<th>1986-2000</th>
<th>2001-17</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMDE</strong></td>
<td>0.03 (0.07)</td>
<td>0.033 (0.09)</td>
<td>0.01 (0.04)</td>
<td>-0.02 (0.06)</td>
</tr>
<tr>
<td><strong>GDP per capita</strong></td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td><strong>Commodity exporter</strong></td>
<td>-0.11** (0.04)</td>
<td>-0.059 (0.06)</td>
<td>0.04 (0.04)</td>
<td>-0.02 (0.04)</td>
</tr>
<tr>
<td><strong>Inflation target</strong></td>
<td>-0.06 (0.05)</td>
<td>-0.09 (0.07)</td>
<td>0.07 (0.04)</td>
<td>-0.03 (0.05)</td>
</tr>
<tr>
<td><strong>Exchange rate peg (R)</strong></td>
<td>0.004 (0.02)</td>
<td>0.003 (0.03)</td>
<td>0.002 (0.02)</td>
<td>0.001 (0.02)</td>
</tr>
<tr>
<td><strong>Exchange rate peg (S)</strong></td>
<td>-0.05 (0.04)</td>
<td>-0.11** (0.05)</td>
<td>-0.02 (0.03)</td>
<td>0.03 (0.03)</td>
</tr>
<tr>
<td><strong>Trade openness</strong></td>
<td>0.001** (0.00)</td>
<td>0.001 (0.00)</td>
<td>0.00 (0.00)</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td><strong>Trade concentration</strong></td>
<td>-0.33** (0.12)</td>
<td>-0.58*** (0.17)</td>
<td>-0.004 (0.1)</td>
<td>-0.047 (0.10)</td>
</tr>
<tr>
<td><strong>Financial openness</strong></td>
<td>0.06 (0.07)</td>
<td>0.13 (0.09)</td>
<td>0.02 (0.06)</td>
<td>0.088 (0.06)</td>
</tr>
<tr>
<td><strong>Global value chain</strong></td>
<td>-0.003 (0.00)</td>
<td>-0.004 (0.00)</td>
<td>-0.001 (0.00)</td>
<td>-0.001 (0.00)</td>
</tr>
<tr>
<td><strong>Debt to GDP ratio</strong></td>
<td>-0.001 (0.00)</td>
<td>-0.001 (0.00)</td>
<td>0.002** (0.00)</td>
<td>0.00 (0.00)</td>
</tr>
<tr>
<td><strong>Central bank independence and transparency</strong></td>
<td>-0.004 (0.01)</td>
<td>-0.027* (0.01)</td>
<td>-0.01 (0.01)</td>
<td>-0.003 (0.01)</td>
</tr>
</tbody>
</table>

Notes: Results of an ordinary least squares regression of the variance share of the global factor in inflation variation on a number of country characteristics as explanatory variables. The global factor is estimated with the dynamic factor model described in Annex 2.1 for the period of a full sample (1970-2017) and three sub samples (1970-85, 1986-2000, 2001-17). The global factor is estimated in a sample of 99 countries (25 advanced economies, 74 EMDEs including 16 LICs). Of these, 25 advanced economies and 58 EMDEs are included in this regression. The numbers in parentheses refer to standard errors (*** p<0.01, ** p<0.05, *p<0.1). Inflation targeting regimes (IT) are defined as in IMF (2016). A value of 1 indicates the existence of an inflation targeting regime, a value of 0 its absence. Exchange rate regime (R) are based on Ilzetzki, Reinhart and Rogoff (2017) and Exchange rate regime (S) is based on Shambaugh (2004). A higher value indicates greater exchange rate flexibility. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2006). Trade concentration is on product concentration and diversification indices of exports and imports by UNCTAD. Central independence and transparency is based on Dincer and Eichengreen (2014). A higher value indicates greater central bank independence and transparency. The EMDE dummy equals 1 for any EMDE and 0 for any other country. Dependent variables are based on median values over the country-specific sample periods except that the variables on exchange rate and inflation target are based on the mode. For details on the data definitions, refer to the Data Annex.
### TABLE A.2.5 Correlates of the variance share of the group inflation factor

<table>
<thead>
<tr>
<th></th>
<th>All</th>
<th>1970-85</th>
<th>1986-2000</th>
<th>2001-17</th>
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</thead>
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<tr>
<td>EMDE</td>
<td>-0.13*</td>
<td>0.00</td>
<td>-0.17</td>
<td>-0.20**</td>
</tr>
<tr>
<td></td>
<td>(0.07)</td>
<td>(0.02)</td>
<td>(0.11)</td>
<td>(0.10)</td>
</tr>
<tr>
<td>LIC</td>
<td>0.00</td>
<td>-0.02</td>
<td>0.04</td>
<td>-0.25**</td>
</tr>
<tr>
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<td>(0.06)</td>
<td>(0.04)</td>
<td>(0.1)</td>
<td>(0.13)</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Commodity exporter</td>
<td>0.09**</td>
<td>-0.02</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.03)</td>
<td>(0.06)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Inflation target</td>
<td>-0.07</td>
<td>0.005</td>
<td>-0.12</td>
<td>-0.07*</td>
</tr>
<tr>
<td></td>
<td>(0.05)</td>
<td>(0.05)</td>
<td>(0.08)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Exchange rate regime (S)</td>
<td>0.13***</td>
<td>0.06**</td>
<td>0.20***</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(0.04)</td>
<td>(0.03)</td>
<td>(0.05)</td>
<td>(0.03)</td>
</tr>
<tr>
<td>Trade openness</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Trade concentration</td>
<td>0.10</td>
<td>0.11</td>
<td>0.20</td>
<td>-0.17*</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.10)</td>
<td>(0.16)</td>
<td>(0.09)</td>
</tr>
<tr>
<td>Financial openness</td>
<td>-0.10</td>
<td>0.04</td>
<td>-0.19**</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.05)</td>
<td>(0.09)</td>
<td>(0.05)</td>
</tr>
<tr>
<td>Global value chain</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Debt to GDP ratio</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
</tr>
<tr>
<td>Central bank independence and transparency</td>
<td>0.01</td>
<td>0.02**</td>
<td>0.03**</td>
<td>-0.01</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
<td>(0.01)</td>
</tr>
</tbody>
</table>

Notes: Results of an ordinary least squares regression of the variance share of the EMDE factor in inflation variation on a number of country characteristics as explanatory variables. The global factor is estimated with the dynamic factor model described in Annex 2.1 for the period of a full sample (1970-2017) and three sub samples (1970-85, 1986-2000, 2001-17). The global factor is estimated in a sample of 99 countries (25 advanced economies, 74 EMDEs including 16 LICs). Of these, 25 advanced economies and 58 EMDEs are included in this regression. The numbers in parentheses refer to standard errors (*** p<0.01, ** p<0.05, *p<0.1). Inflation targeting regimes (IT) are defined as in IMF (2016). A value of 1 indicates the existence of an inflation targeting regime, a value of 0 its absence. Exchange rate regime (R) are based on Ilzetzki, Reinhart and Rogoff (2017) and Exchange rate regime (S) is based on Shambaugh (2004). A higher value indicates greater exchange rate flexibility. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2006). Trade concentration is on product concentration and diversification indices of exports and imports by UNCTAD. Central independence and transparency is based on Dinoer and Eichengreen (2014). A higher value indicates greater central bank independence and transparency. The LIC dummy equals 1 for any LIC and 0 for any other country. The EMDE dummy equals 1 for any EMDE and 0 for any other country. Dependent variables are based on median values over the country-specific sample periods except that the variables on exchange rate and inflation target are based on the mode. For details on the data definitions, refer to the Data Annex.
References


CHAPTER 3
Sources of Inflation: Global and Domestic Drivers

This chapter examines the key drivers of fluctuations in global and domestic inflation. It finds, first, that global demand shocks and oil price shocks have been the main drivers of variations in global inflation. Global demand shocks have become increasingly more important in explaining global inflation movements since 2001. Second, domestic shocks have explained the lion’s share of domestic inflation variation. Domestic supply shocks have accounted for a larger share of inflation variance than other domestic shocks, but their importance has declined since the 1970s and 1980s. Global shocks have been responsible for around one-quarter of the variation in domestic inflation. Third, global shocks have contributed more to domestic inflation variation in advanced economies than in emerging market and developing economies. They have been a more important source of domestic inflation movements in countries with stronger global trade and financial linkages, greater dependence on commodity imports, and fixed exchange rate regimes.

Introduction

Since 1970, global inflation—defined here as the median of national inflation rates—has undergone considerable swings around a pronounced downward trend. These swings in inflation have often been associated with cyclical fluctuations in the global economy or with sharp movements in oil prices (Figure 3.1). Between the early 1970s and the mid-1990s, inflation rose in many emerging market and developing economies (EMDEs) amid jumps in oil prices, currency crises, and price liberalization programs that followed economic collapse (especially in the countries of the former Soviet Union, Chapter 1). Conversely, short-lived oil price plunges in the mid-1980s and early 1990s were accompanied by declines in inflation in both advanced economies and EMDEs.

The period since the global financial crisis has been marked by an unusually pronounced and broad-based disinflation around the world. About 80 percent of countries worldwide experienced disinflation in 2008-09 and three-quarters of EMDEs experienced another bout of disinflation in the 2010s—the highest proportions since the 1980s. Roughly 80 percent of advanced economies and 40 percent of EMDEs experienced outright deflation—also exceptionally high proportions (Figure 3.2).

Notes: This chapter was prepared by Jongrim Ha, M. Ayhan Kose, Franziska Ohnsorge and Hakan Yilmazkuday. Annex 3.1 was prepared by Wee Chian Koh. Background materials for the literature review were provided by Atsushi Kawamoto.
Chapter 3: Inflation: Evolution, Drivers, and Policies

FIGURE 3.1 Global and domestic inflation

Since 1970, global inflation has undergone considerable swings around a pronounced downward trend. These swings often coincided with global recessions or slowdowns and recoveries or with large oil price fluctuations.

A growing body of research has examined the roles played by a wide range of global and domestic shocks in driving fluctuations in domestic inflation. The theoretical literature has extended the closed-economy macroeconomic models to open-economy settings that establish linkages between global shocks and movements in domestic inflation. Empirical studies have estimated the roles played by different types of global and domestic disturbances in explaining domestic inflation variation. The results from studies using Philips curve models have been mixed whereas studies using VAR-based methodologies have generally identified sizeable contributions of global shocks to domestic inflation. Studies for the Euro Area have found a particularly important role for the commodity price plunge of 2014-16 (Annex 3.1). This research program has typically focused on one shock or transmission channel without quantifying its importance relative to other shocks. Moreover, while the literature has established the importance of a global factor in driving domestic inflation, it has not provided a detailed analysis of the underlying drivers of global and domestic inflation. Although global demand, supply and oil price shocks have all been mentioned as important drivers of global inflation, their quantitative importance has not been examined in a unified setup.

Against this background, this chapter studies the main drivers of movements in global and domestic inflation. In particular, it addresses the following questions.

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1 For theoretical studies, see Kabukçuoğlu and Martínez-García (2018); Gali and Monacelli (2008); Martínez-García and Wynne (2010). For empirical work, see Rogoff (2003); Borio and Filardo (2007); Bianchi and Civelli (2015); Altansukh et al. (2017) and Eickmeier and Kühl (2016).
What have been the main drivers of global inflation?

What have been the main drivers of domestic inflation?

How have the main drivers of domestic inflation differed by country characteristics?

This is the first study in the literature to present a comprehensive examination of the roles of the main drivers of the global and domestic inflation for a large panel of countries over several decades. In particular, the chapter makes the following contributions to the literature.
• **Rich model, rich set of shocks.** The chapter is the first study to examine, in a single, consistent framework, both global and domestic inflation and both global and domestic sources of variation in domestic inflation. It estimates a series of Factor-Augmented Vector Autoregression (FAVAR) models to quantify the roles of global demand, global supply, oil price, and a wide range of domestic shocks in driving global and domestic inflation. Domestic shocks include domestic demand, domestic supply, monetary policy and exchange rate shocks.

• **Global sample and long series.** The chapter is the first to employ data for a large and globally diverse sample of countries (55 countries, including 26 EMDEs) that allows an analysis of inflation dynamics in both advanced economies and EMDEs over a long time period (1970-2017).

• **Historical context.** The chapter employs event studies to analyze the movements in global and domestic inflation during major economic events since 1970. By putting the post-crisis disinflation into historical context, the chapter highlights its exceptional severity.

• **Country characteristics.** In addition, the chapter considers a wide range of country characteristics that are associated with differing contributions of global and domestic shocks to domestic inflation variability.

The chapter’s principal conclusions are as follows.

• The past decade witnessed a pronounced and broad-based disinflation that depressed global inflation well below its (downward) trend. Exceptionally large fractions of both advanced economies (more than three-quarters) and EMDEs (more than one-half) were in outright deflation at some point during 2010-17. Rapid decelerations or accelerations in global inflation have tended to coincide with turning points of the global business cycle or sharp movements in global oil prices.

• Global demand and oil price shocks have accounted for 40 percent, each, of the variation in global inflation since 1970. The relative importance of global demand shocks has increased since the Great Moderation (1986-00) to account for 60 percent of global inflation variation during 2001-17. The 2014-16 oil price plunge, however, was a major source of post-crisis global disinflation.

• On average during the past four to five decades, domestic shocks accounted for about three quarters of domestic inflation variation. The most important domestic shocks were supply shocks. They accounted for more of domestic inflation variation than any other domestic shocks and about as much as all global shocks combined. Since 2001, however, the role of
domestic supply shocks has declined. Global demand and oil price shocks were the main source of global shocks’ contributions to domestic inflation variation. During 1970-2017, they accounted for about 14 and 8 percent, respectively, of domestic inflation variation whereas global supply shocks played a minor role. Since 2001, however, in part as a result of the global financial crisis and the 2014-16 oil price plunge, the contributions of global demand and oil price shocks have increased to 22 and 17 percent, respectively of domestic inflation variation.

- The contribution of global shocks to domestic inflation variation was larger in advanced economies and those countries with higher trade and financial openness, fixed exchange rate regimes, and greater reliance on commodity imports. In EMDEs, the median contribution of global shocks to domestic inflation variances in countries with fixed exchange rate regimes, and with greater trade and financial openness was more than twice that in other EMDEs.

The next section examines the behavior of inflation during major events of the past four to five decades and puts the current episode of broad-based disinflation in historical context. The following section examines the main drivers of global inflation, in particular global demand, global supply and oil price shocks. The subsequent two sections estimate the role of global and domestic shocks in driving movements in domestic inflation. The final section concludes with a discussion of policy implications and directions for future research.

**Evolution of global and domestic inflation**

It is important to distinguish at the outset between disinflation and deflation. *Disinflation* refers to a period of slowing, but still positive, inflation. Deflation refers to a decrease in an overall price level, or a negative inflation rate.

Over the past half century, global inflation has experienced significant movements. Some of these were disinflation episodes that were generally associated with global recessions or economic slowdowns or with large declines in global oil prices. For the purposes of this historical exploration here, global inflation is defined as the median of national trend inflation rates of 25 advanced economies and 40 EMDEs during 1970-2017.

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2 Federal Reserve Bank of San Francisco (1999); Rogoff (2003); Goodfriend and King (2005); Coibion and Gorodnichenko (2015); Cogley, Matthies and Sbordone (2015).

3 In the event study, global inflation is defined as median inflation among 65 countries. The trend is defined as nine-quarter centered moving average as in Ball (1994). For the econometric model below, global inflation is estimated using a dynamic factor model. The estimation of a global factor model requires a balanced sample which restricts the sample size.

Since the 1970s, there have been six oil price plunges. In 1986, 1990-91, 1997-98, 2001, 2008, and 2014-16, prices dropped by more than 30 percent over a seven-month period (Baffes et al. 2015). Conversely, there have been 14 oil price spikes (of which nine were reversed within two quarters), periods in which oil prices jumped by more than 30 percent over a seven-month period. Many of these episodes were associated with conflict (e.g., the first Gulf war in the early 1990s or the Libyan conflict in the mid-2000s) or geopolitical tensions (e.g., the Iranian revolution in the 1970s).

Global disinflation during global recessions. Global inflation has fallen following sharp declines in global output, with a lag of 1-3 years. During global recessions, median global trend inflation declined 3 percentage points, on average, between the year before the trough of the global recession and the year after. The most recent global recession, in 2009, was followed by a pronounced drop in inflation (2.3 percentage points on a median basis, from 4.7 percent initial inflation). The disinflation was more than twice as steep among EMDEs as among advanced economies, but from a higher starting rate. Despite a quick rebound in both groups after 2009, inflation remained low throughout the 2010s—around 5 percent in EMDEs, and 2 percent in advanced economies (Figure 3.3).

Global inflation around global expansions. With few exceptions, global trend inflation increased in the runup to peaks of global expansions, with a slowdown after the business cycle turned (Figure 3.4). In the two years preceding the business cycle peak, median trend inflation rose by about 2.2 percentage points, on average over all cyclical peaks since 1970. In the runup to the most recent global business cycle peak in 2008Q2, EMDE inflation rose considerably faster (by about 2 percentage points) than advanced-economy inflation (0.2 percentage point) in the two years before the peak. These inflation accelerations were followed by steep subsequent declines during global recessions or slowdowns.

Global disinflation during oil price plunges. Two of the six oil price plunges since 1970—1985-86 and 2014-16—largely reflected supply decisions by
OPEC. The organization raised output limits when faced with growing oil supply from non-OPEC producers, in Mexico and the North Sea in the 1980s and the U.S. shale oil industry in the 2000s. The other four episodes predominantly reflected weak demand amid global recessions or slowdowns (World Bank 2015). On average during all six episodes, median global inflation slowed by around 1 percentage point, between the year before the trough of oil prices and the year after. The 2014-16 oil price plunge was followed by a modest fall in global trend inflation, which was already low to begin with. In the two years to the trough of the most recent oil price plunge of 2014-16, the decline in EMDE inflation was broadly on par with that in advanced-economy inflation.
Global inflation around oil price spikes. Following oil price spikes, global trend inflation rose, on average across the spikes, by 2.4 percentage point within a year. The impact of the supply-driven oil price spikes in the 1970s and 1980s was much more pronounced (3.5 percentage point, on average, within a year) than the impact of the largely demand-driven oil price increases of the 1990s and 2000s (1.1 percentage point, on average, within a year). The steady rise in oil prices during 2004Q3-2008Q2 (when oil prices tripled) was associated with only a modest increase in trend inflation (about 1.4 percentage points), which mostly reflected sharply rising inflation in EMDEs.

Drivers of global inflation

The event study discussion above suggests that global inflation has exhibited significant movements over the global business cycle and oil price swings. Global business cycles are driven by shocks related to global supply and demand, and oil price shocks. This section quantifies the contributions of these shocks to global inflation variation.

Methodology

Model and data. A Factor-Augmented Vector Autoregression (FAVAR) model is estimated with three global variables: global inflation, global output growth, and global oil price growth—all expressed in quarter-on-quarter growth rates over 1970-2017, in seasonally adjusted annualized terms, with two lags (Annex 3.3).
Global inflation is defined as the common factor for de-trended headline CPI inflation estimated using a dynamic factor model. In parallel, the global output factor is defined as the common factor for real GDP growth estimated in a separate dynamic factor model (Figure 3.5). The database for quarterly inflation and output includes the largest country sample possible over the period 1970-2017. Global oil price growth is proxied by quarter-on-quarter growth rates of nominal oil price in U.S. dollar terms (average of Dubai, WTI, and Brent prices) as in Baffes et al. (2015).

**Evolutions of the global inflation and output factors.** The global inflation factor was highly volatile until the 1990s (Figure 3.5). It stabilized at low levels in the 1990s and early 2000s before declining further during the global financial crisis and remaining low through the post-crisis period. In line with the event study above, the global inflation factor typically declined during global recessions and slowdowns. It fell sharply during the global financial crisis and after the 1975 and 1991 global recessions. Similarly, the global output factor registered significant declines during global recessions and slowed during global slowdowns. Oil price spikes during the 1970s and early 1980s as well as before the global financial crisis coincided with rising global inflation.

**Identification of shocks.** Global demand shocks, global supply shocks and oil-price shocks are identified using a set of sign restrictions on interactions between these three variables during the first four quarters of impulse responses. The restrictions to identify the structural shocks are consistent with theoretical predictions (Fry and Pagan 2011) and follow other empirical studies in the literature although earlier studies differ in the types of variables and structural shocks they focus on.

- A positive global demand shock is assumed to increase global output growth, global inflation, and oil price growth. This is consistent with similar assumptions in earlier work. Melolinna (2015) assumes that a demand shock raises output, inflation and domestic interest rates. Charnavoki and Dolado (2014) assume that a demand shock raises output, inflation and commodity prices. Gambetti, Pappa, and Canova (2005) assume that a

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4 The selection of countries included in the estimation of the global inflation and output growth factors reflects data availability. A balanced set of inflation series is available for 47 countries between 1970 and 2017 (accounting for 67 percent of global GDP in 2017) and that of output series is available for 29 countries (accounting for 66 percent of global GDP in 2017). The results are robust to using a smaller set of countries (25 countries, accounting for 63 percent of global GDP in 2017) with available data for both inflation and output growth. The global inflation factor behaves in line with (detrended) median or average inflation and the results are robust to defining global inflation as cross-country median or average inflation. The results are also robust to using real oil prices or nominal energy prices (Annex 3.3).

5 The results are robust to imposing these sign restrictions for two quarters.
(government) demand shock raises output, inflation, domestic interest rates and money demand. Ferroni and Mojon (2014) assume that a positive global demand shock raises output, global inflation and commodity prices, and appreciates the exchange rates of five G7 economies and the Euro Area. The results presented here are robust to imposing an additional (positive) sign restriction on domestic interest rates.

- A positive global non-oil supply shock (hereafter “global supply shock”) is assumed to raise global output and oil price growth but to reduce global inflation. This is consistent with assumptions used by other studies. Charnavoki and Dolado (2014) assume that a negative non-commodity

**FIGURE 3.5 Global inflation and global output growth**

Inflation comovement (captured by the contribution of a global factor to inflation variance) has been stronger than output growth comovement. For both inflation and output growth, this comovement declined between 1970-85 and 1986-2000 but subsequently rebounded.

Sources: World Bank.
A.B. Global inflation factor is extracted from 47 de-trended national inflation rates using a dynamic factor model.
B.D. Variance shares of inflation (B) and output growth (D) accounted for by the global inflation factor (B) or global output factor (D) are unweighted cross-country averages or medians.
C.D. Global output growth factor is extracted from 29 de-trended national output growth rates using a dynamic factor model.
Click here to download data and charts.
supply shock that raises input cost, reduces output and commodity prices and raises inflation. Gambetti, Pappa, and Canova (2005) assume that a positive supply (technology) shock raises output but reduces inflation, domestic interest rates and money demand. Ferroni and Mojon (2014) assume that a positive supply shock raises output, reduces inflation and appreciates the exchange rates of five G7 economies and the Euro Area.

- A positive oil price shock is defined as raising oil prices and global inflation but depressing global output growth. This assumption also closely follows other studies. Melolinna (2015), Charnavoki and Dolado (2014), and Ferroni and Mojon (2014) assume that a positive cost (commodity price) shock reduces output and raises commodity prices and inflation. Baumeste and Peersman (2013) assume that a negative oil supply shock that raises the price of oil reduces output and oil consumption.

Correlates of global shocks

The model identifies a series of global demand, global supply, and oil price shocks from 1972 onwards (Figure 3.6). These shocks have often been associated with turning points in the global business cycle and sharp movements in oil prices.

Global demand shocks. Negative global demand shocks were associated with global recessions (1982, 1991, and 2009) and slowdowns (1998 and 2000-01). Large positive global demand shocks often coincided with the year before the global economy began to slide into a global recession or slowdown.

Oil price shocks. Positive oil price shocks were associated with oil supply disruptions during the mid-1970s (1973-74), the Iranian revolution (1979), the Iran-Iraq War (1979-80), the First Persian Gulf War (1990), Venezuelan unrest (2002-03), as well as militant attacks on pipelines in Iraq and Nigeria, and legal disputes over oil production in Venezuela (2007-08, Hamilton 2011; Baffes et al. 2015). Negative oil price shocks were associated with major OPEC decisions to end production restraint amid the development of new sources of oil supply (1986), the normalization of oil prices after the First Persian Gulf War (1991), the global slowdown around the Asian Crisis (1997-1998) and U.S. recessions (1990-91 and 2001). In 2014-16, OPEC’s decision to abandon production restraint amid rising output from unconventional sources also constituted a negative oil price shock (Baffes et al. 2015).6

6 Changes in global demand can also trigger oil price movements, such as the collapse in oil prices during the global recession of 2009. In the framework used here, these would be captured as global demand shocks.
Negative global demand shocks have been associated with global recessions and slowdowns. Negative oil price and global supply shocks have been associated with major supply disruptions and changes in OPEC policy. Negative global supply shocks have been associated with the disruptions following the oil price spikes of 1973 and 1979 and the global recessions or slowdowns in 1998, 2001, and 2009.

A. Global demand shocks

B. Historical contribution of global demand shocks to global inflation

C. Global supply shocks

D. Historical contribution of global supply shocks to global inflation

E. Oil price shocks

F. Historical contribution of oil price shocks to global inflation

Note: The structural shocks and their historical contributions are estimated with the global FAVAR model discussed in Annex 3.3.
Global supply shocks. The widespread rise in inflation during the 1970s and early 1980s has been partly attributed to negative global supply shocks that compounded the impact of oil price shocks (Charnavoki and Dolado 2014). In the 1990s, global supply shocks were modest. The global economic recovery starting in the late 1990s into the mid-2000s, however, has been attributed to positive global supply shocks associated with rising productivity linked to advances in information technology and widespread trade liberalization programs in EMDEs (Charnavoki and Dolado 2014).

The role of global shocks in global CPI inflation

Impact of global shocks on global inflation. A positive one-standard-deviation global demand shock (corresponding to an 1.2 percentage point increase in annual global output growth) raised annual global inflation by 0.9 percentage point after one quarter and, cumulatively, by 5 percentage points after two years (Figure 3.7). Similarly, a positive one-standard deviation oil price shock (corresponding to an increase in annual oil price growth by around 70 percentage points) raised annual global inflation by 4.4 percentage points after two years. Although global supply shocks have been modest over the sample period, a positive one-standard-deviation global supply shock reduced annual global inflation by 2.6 percentage point within two years.

Contributions of global shocks to global inflation variation. Global demand shocks and oil price shocks, in almost equal measure, have been the main drivers of global inflation variation since the 1970s (Figure 3.8). These two types of shocks together have accounted for about 80 percent of the variation in global inflation since the 1970s, each contributing about 40 percent. In contrast to global inflation, the variance of global output growth has been driven mostly by global demand shocks (accounting for 60 percent of growth variance during the full sample period), with a more modest role for oil price shocks (accounting for 22 percent of growth variation). As one would expect, fluctuations in oil prices mostly reflect shocks specific to oil prices (accounting for 76 percent of oil price variation) over the sample period.

Evolution of the contributions of global shocks to global inflation variation. Results from the estimations of the model for three equally-sized sub-periods

7 The direction of the impact of global shocks on inflation is determined by the sign restrictions for the first four quarters but their magnitude and persistence remain of interest.

8 These numbers refer to the variance decompositions for 1-year-ahead forecast errors of global inflation. Over a medium- to long-term (5-10 years) forecasting horizon, the variance contribution of the global demand shocks (44 percent) is slightly greater than that of oil price shocks (38 percent) since global demand shocks are somewhat more persistent than oil price shocks. This is consistent with the results of Melolinna (2015) for the Euro Area, the United Kingdom and the United States, who finds similar responses of inflation to global shocks over the past four decades.
indicate that the overall impact of global shocks on global inflation has changed over time (Figure 3.8). The first period, 1970-1985, overlaps with the Great Inflation of 1965-1984 (Annex 1.4 in Chapter 1); the second period, 1986-2000 overlaps with a period of wide-spread disinflation; and the third period, 2001-17, coincides with a period of low but typically stable inflation (Chapter 1). A one-standard deviation oil price shock or global demand shock elicited the largest response during 1970-85 (a cumulative 5 and 8 percentage points, respectively, after two years). During 1986-2000, these impacts were considerably less (2 and 3 percentage points, respectively) but, since 2001, they have doubled again (to 4 and 6 percentage points, respectively). The impact of global supply shocks on global inflation has steadily decreased over time.

**Evolution of contributions of global shocks to global inflation variation.** Global shocks have differed in their variability over the three subperiods. This, as well as changing responses of global inflation to these shocks, was reflected in shifts in the contribution of global shocks to global inflation variability over time. In particular, the contribution of supply shocks to global inflation variability has receded over time while that of global demand shocks has strengthened (Figure 3.8). Global supply shocks were the main source (42 percent) of, in this case modest, global inflation variability during 1986-2000. Since 2001, however, the variance share of global supply shocks has fallen to 7 percent.
Conversely, the contribution of global demand shocks to global inflation variability has grown to 60 percent since 2001, partly reflecting the global recession of 2009 and the global slowdown of 2001. During the past decade, 2008-17, global demand shocks accounted for three-quarters of global inflation variation. However, the 2014-16 oil price plunge had a significant impact on global inflation: oil price shocks have accounted for 57 percent of global inflation variability since 2010 whereas global demand shocks have accounted for only 30 percent.\(^9\)

\(^9\)This is in line with ECB (2015), Sussman and Zohar (2015), and Berganza, Boralla and del Rio (2018). For instance, ECB (2015) estimates that the decline in Euro Area headline CPI inflation to zero in 2015 from 1.4 percent in 2013 was mostly driven by energy price developments.
The role of global shocks in different measures of global inflation

The importance of oil prices for inflation partly reflects the sizeable share of energy in consumer baskets and, therefore, headline CPI inflation (Altansukh et al. 2017). On average, energy accounts for around 20 percent of headline CPI weights. To explore the role of energy and other tradables in the contribution of global shocks to inflation, the same FAVAR exercise is conducted for global core CPI inflation and global producer price inflation. Producer price indices (PPI) tend to have a larger tradables content than headline CPI indices whereas core CPI indices tend to have a smaller tradables content than headline CPI indices (Chapter 2).

Impact of global shocks on global core and PPI inflation. Global PPI inflation is more sensitive to global demand shocks than global headline, let alone core, CPI inflation. A positive one-standard-deviation global demand shock would raise global PPI inflation by almost twice as much as global CPI—headline or core—inflation over the following two years (Figure 3.9). Global PPI inflation appears to be also somewhat (one-and-a-half to two times) more sensitive, albeit not statistically significantly more, to oil price shocks than global CPI—headline or core—inflation. All three measures respond broadly similarly to a global supply shock.

Relative contributions of global shocks to inflation variability. The contribution of global demand shocks to global inflation variation was similar across all three measures (45-50 percent) but the relative contributions of oil price and global supply shocks differed (Figure 3.9). The smaller energy content may account for the modest contribution of oil price shocks to global core CPI inflation variation (20 percent)—about half the contribution to headline CPI inflation variation. Less affected by energy and other tradables prices shocks, core CPI inflation reflects an important role for global supply shocks: global productivity shocks or their cross-country spillovers, as captured by global supply shocks, appear to have been the main source of variation in core CPI inflation (38 percent), more than twice as much as for PPI inflation (14 percent) and headline CPI inflation. Over the past four to five decades, the impact of global demand, supply and oil price shocks on global core inflation has become steadily more muted, with global demand shocks the predominant source of global shocks. This may reflect better anchoring of inflation expectations associated with shift towards more resilient monetary policy frameworks (Chapter 4).

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10 This estimate is based on the average share of housing, water, electricity, gas and other fuels in CPI baskets for 71 advanced economies and EMDEs (Source: OECD).

11 For example, the share of tradable goods and services in the United States is the greatest for the PPI (54 percent), followed by headline CPI (53 percent), and core CPI (15 percent, U.S. Bureau of Labor Statistics).
CHAPTER 3

INFATION: EVOLUTION, DRIVERS, AND POLICIES

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Drivers of domestic inflation

The previous section established that global demand shocks and oil price shocks have been the main drivers of the variation in global inflation. This section examines the roles of global shocks along with domestic shocks in explaining the variation in domestic inflation.

Methodology

Model and data. The FAVAR model above is expanded to include four country-specific variables, along with the three global variables (global inflation, global real output growth, and oil prices): headline CPI inflation; output growth; nominal interest rates (3-month Treasury-bill rates or monetary policy rates); and nominal effective exchange rates. The extension of the model here follows earlier work by Forbes, Hjortsoe, and Nenova (2018, 2017) and Conti, Neri and Nobili (2015). All the variables are seasonally adjusted quarterly growth rates (except interest rates) between 1970 and 2017. The model is estimated on a country-by-country basis for 29 advanced economies and 26 EMDEs. For details of the model and dataset, see Annex 3.3.

Identification of shocks. On top of the three global shocks (global demand, global supply, and oil price shocks) identified in the global block of the FAVAR model, four types of domestic shocks are specified: domestic supply; domestic...
demand; monetary policy; and exchange rate shocks. The shocks are identified under the following assumptions:

- For global inflation, global output growth and oil price growth, the same sign restrictions described in the previous section are imposed.

- Global variables are assumed to affect country-specific variables contemporaneously (without any sign restrictions) but the feedback from country-specific variables to global variables is assumed to be delayed by at least one quarter (block zero restriction).

To identify domestic shocks, a set of sign restrictions is imposed on the contemporaneous impulse responses of country-specific variables (Annex 3.3).

- A positive domestic demand shock is assumed to raise domestic output growth and inflation. This is consistent with, but less restrictive than, sign restrictions of Gambetti, Pappa, and Canova (2005), who also impose the assumption that a positive demand shock raises money demand; Forbes, Hjortsoe, and Nenova (2018) and Conti, Neri and Nobili (2015), who also impose the assumptions that a demand shock raises interest rates and appreciates the domestic currency; and of Ferroni and Mojon (2014), who also assume that a positive demand shock depreciates the domestic currency. The results presented here are robust to an additional positive sign restriction on the response within one quarter of short-term interest rates to a positive domestic demand shock increase.

- A positive domestic supply shock raises domestic output growth but reduces inflation. This is consistent with sign restrictions of Forbes, Hjoertsoe, and Nenova (2018) and Gambetti, Pappa, and Canova (2005), who also impose a restriction that a positive supply shock reduces interest rates and money demand; and of Ferroni and Mojon (2014), who also assume that a positive supply shock appreciates the exchange rate.

- A contractionary (positive) monetary policy (or short-term rate) shock triggers nominal effective appreciation, lower output growth and lower inflation. This is consistent with sign restrictions of Forbes, Hjoertsoe, and Nenova

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12 Gambetti, Pappa, and Canova (2005), for instance, show that a combination of technology, demand, and monetary shocks explains variations in the persistence and volatility of inflation in G7 countries.

13 Conti, Neri and Nobili (2015) and Canova and Paustian (2011) argue that sign restrictions imposed on the contemporaneous relationships among variables are robust to several types of model misspecification. The results here are also robust to imposing sign restrictions for two quarters, as in Forbes, Hjortsoe, and Nenova (2017).

- The impact of a positive *exchange rate shock* (corresponding to an appreciation of the domestic currency) is unrestricted. Forbes, Hjoertsoe, and Nenova (2018) impose the restriction that a positive exchange rate shock reduces inflation and interest rates. Other authors do not impose sign restrictions on responses to exchange rate shocks (Ferroni and Mojon 2014; Conti, Neri and Nobili 2015; Gambetti, Pappa, and Canova 2008; Melolinna 2015).

The sign restrictions imposed in this chapter are therefore standard except in the identification of domestic demand shocks and of exchange rate shocks. Some studies put sign restrictions on the impact of domestic demand shocks on domestic interest rates (or monetary policy rates) while others do not. For lack of a clear economic motivation to impose this restriction to all the countries, this chapter refrains from imposing sign restrictions. That said, the results are robust to the imposition of additional sign restrictions, as done in several other studies (Annex 3.3). Separately, the sign restrictions used here could lead to ambiguity between domestic monetary shocks and domestic demand shocks (Fry and Pagan 2011). In practice, however, the number of Bayesian draws that are subject to such ambiguity (i.e., where all variables have exactly the same directional response to the two shocks) is less than 1 percent for virtually all countries. Finally, also for lack of economic motivation, no sign restrictions are imposed on exchange rate responses. This could also potentially create ambiguity between exchange rates and other shocks. However, the results are robust to eliminating any potentially ambiguous draws.

**The role of global shocks in domestic inflation**

**Overall impact of global shocks on domestic inflation.** Global shocks had a significant impact on domestic inflation, although the impact was somewhat more muted than for global inflation (Figure 3.10). A negative one-standard-deviation global demand shock (about one-third the size of the average negative demand shock of 2008-09) or oil price shock (about the size of the average negative oil price shock of 2014-15) was associated with lower inflation in the median country by 0.5 percentage point after a quarter and around 1.5 percentage points after two years on a cumulative basis. A negative one-standard-deviation global supply shock raised domestic inflation by around 0.4 percentage point after a quarter, and 1.1 percentage points after two years.
Broad-based impact of global shocks on domestic inflation. The impact of global shocks on domestic inflation was statistically significant for many countries. In 90 percent of countries, domestic inflation responded significantly within a quarter to global demand, global supply, and oil price shocks. In three quarters of countries, the cumulative responses of domestic inflation after two years to global demand shocks were statistically significant; in more than 60 percent of countries, the cumulative responses to global supply or oil price shocks after two years were statistically significant (Figure 3.10).

Impact of global shocks on domestic inflation in advanced economies and EMDEs. The impulse responses of domestic inflation to global shocks were comparable across the two groups of countries, although they ranged much more
widely among EMDEs than advanced economies (Figure 3.10). Inflation in the median country in both groups increased by around 1.5 percentage points two years after a positive 1-standard-deviation oil price shock and decreased by around 1 percentage point two years after a positive 1-standard-deviation global supply shock. The response of domestic inflation after two years in the median EMDE to a positive 1-standard-deviation global demand shock was somewhat smaller (1 percentage point) than in the median advanced economies (1.8 percentage points). However, the range of impact among EMDEs was much wider (from 0.5 to 4 percentage points) such that the difference between advanced economies and EMDEs was not statistically significant.

Relative contribution of global shocks to domestic inflation variation. In the full sample period, global shocks accounted for over a quarter of domestic inflation variance (27 percent) in the median country, but with wide heterogeneity (contributions ranging from 0 to 70 percent). As found by other studies (Conti, Neri and Nobili 2015; Parker 2018), the main global shocks transmitted to domestic inflation were global demand shocks and oil price shocks. In the median country, they accounted for 14 and 8 percent, respectively, of domestic inflation variation (Figure 3.11).

Consistent with the results presented in Chapter 2, the contribution of global shocks to domestic inflation variation was considerably larger (33 percent on median) in advanced economies—with both global demand shocks and oil price shocks important—than in EMDEs (14 percent). The greater contribution of global shocks to advanced economy inflation may reflect their stronger global trade and financial linkages, more deeply integrated supply chains, more diversified export bases, and more similar monetary policy regimes. EMDEs are a more heterogeneous group of countries that may be expected to respond in a widely heterogeneous manner to external shocks (Cárdenas and Levy-Yeyati 2011).

Evolution of the role of global shocks in domestic inflation

Country-specific FAVAR models are estimated over the three sub-periods of 1970-85, 1986-2000, and 2001-17. The results suggest that the role of global shocks in domestic inflation has strengthened considerably since 2001 in an era of rapidly deepening global trade and financial integration (Chapter 1).

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14 Using a panel of 72 countries, Choi et al. (2018) also find similar point estimates for advanced economies and EMDEs, although the effect of oil price shocks is more precisely estimated for advanced economies than for EMDEs.

15 In Chapter 2, the global inflation factor accounts for 12 percent of domestic inflation variation during 1970-2017. This share cannot be easily compared with the results reported here because of the differences in samples and methodologies. The estimation in Chapter 2 reflects a much larger sample than here where the estimation requires quarterly data.
**Evolution of impact of global shocks on domestic inflation.** The response of domestic inflation to global shocks has risen since 2001, after falling slightly during 1986-2000 (Figure 3.11). The impulse responses of domestic inflation to oil price shocks during 2001-17 were similar to those in the 1970s and early 1980s, after falling to virtually nil during 1986-2000. The impulse responses to global demand shocks were larger during 2001-17 than during 1986-2000 but somewhat more moderate than those during 1970-85, although not statistically significantly so. Finally, since the mid-1980s, the impulse responses to global supply shocks have been modest, and significantly smaller than during the 1970s and early 1980s.

**Evolution of the relative contribution of global shocks to domestic inflation variation.** The contribution of global shocks to domestic inflation variation depends on both the responsiveness of domestic inflation to global shocks and on the magnitude and frequency of global shocks.\(^{16}\) Since 2001, the contribution of global shocks to domestic inflation variation has grown significantly (to 43 percent, from 20-23 percent previously), and in all country groupings (to more than one-half in advanced economies and one-quarter in EMDEs), as a result of considerably larger global demand and oil price shocks. To a large extent, this may reflect the impact of the global financial crisis, propagated through global supply chains and trade networks, and the 2014-16 oil price plunge (Baffes et al. 2015; Nguyen et al. 2017). Nevertheless, the contribution of global supply shocks has decreased over time, from 10 percent during 1970-85 to less than 5 percent since 1986.

**Domestic drivers of domestic inflation**

Notwithstanding the increase since 2001 in the contribution of global shocks to domestic inflation variation, domestic shocks remained the main source of domestic inflation variation. Over the full sample period, domestic shocks accounted for about three-quarters of domestic inflation variation in the median country (about one-seventh in the median EMDE; two-thirds of domestic inflation variation in the median advanced economy). Domestic supply shocks were the largest domestic source of inflation variation. In EMDEs, for example, domestic supply shocks alone contributed more than half as much to domestic inflation variation as all global shocks combined.

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\(^{16}\) The evolution of the volatility of the structural shocks can be indirectly measured by the standard deviation of the structural shocks for sub-periods of interests. The standard deviation of oil prices shocks halved from 1970-1985 (1.45 percent) to 1986-2000 (0.78 percent) and remained low during 2001-2017 (0.72 percent). The standard deviation of global demand shocks also decreased from 1970-85 to 1986-2000 (from 1.06 to 0.79 percent) but increased again to 1.1 percent during 2001-2017. The standard deviation of global supply shocks evolved in a similar pattern to that of oil price shocks.
FIGURE 3.11 Contributions of global shocks to domestic inflation

Global shocks account for around a quarter of domestic inflation variation, but considerably more in advanced economies (one-third) than in EMDEs (one-seventh). Since 2001, however, this contribution has grown in all country groups—to more than one-half in advanced economies and one-quarter in EMDEs—as a result of considerably larger global demand shocks.

A. Contribution of total global shocks to domestic inflation: 1970-2017

B. Contribution of total global shocks to domestic inflation: 2001-17

C. Contribution of global shocks to domestic inflation variation, over time

D. Impulse response of domestic inflation to global shocks, over time

E. Contribution of global shocks to domestic inflation variation, over time: Advanced economies

F. Contribution of global shocks to domestic inflation variation, over time: EMDEs


A.-C.E.F. Figure shows a median shares of country-specific inflation variance accounted for by global shocks (global demand, global supply, oil prices) based on country-specific FAVAR models discussed in Annex 3.3 estimated for 29 advanced economies and 26 EMDEs for 1970-2017, unless otherwise noted.

D. Cumulative impulse responses of domestic inflation after two years, following 1 standard deviation shocks. Orange diamonds indicate medians and blue bars the 25-75th percentile of country-specific impulse responses.

Click here to download data and charts.
An abundant literature has explored the role of various domestic drivers of inflation in a wide range of country samples and methodologies (Annex 3.1). The methodology used in this chapter quantifies the four most commonly discussed domestic shocks (domestic demand and supply, monetary policy and exchange rates) in a consistent framework after controlling for global shocks.

**Correlates of domestic shocks**

The model identifies a series of domestic supply, domestic demand, monetary policy, and exchange rate shocks from 1972 onwards. These estimated shocks...
have tended to be associated with turning points of domestic business cycles, dynamics of productivity growth, monetary policy decisions, and developments during financial crises.

**Domestic demand shocks.** Negative domestic demand shocks have been closely associated with domestic recessions (Figure 3.12). The demand shocks were more pronounced when domestic recessions overlapped with global recessions. Global recessions may have amplified domestic recessions by generating spillovers through trade and financial links. Ferroni and Mojon (2014) also find that Euro Area disinflation during 2008-09 was largely a reflection of negative demand shocks caused by the global financial crisis.

**Domestic supply shocks.** Negative supply shocks appear to be associated with low (or negative) productivity growth. They were also particularly pronounced around financial crises. Indeed, Forbes, Hjortsoe, and Nenonva (2018) identify strong negative supply shocks in the United Kingdom during the global financial crisis. Currency, debt, and banking crises may have caused severe disruptions to economic activity that were reflected in these negative supply shocks.

**Monetary policy shocks.** Accommodative monetary policy shocks were associated with policy interest rate cuts. Similarly, contractionary monetary policy shocks were associated with policy rate hikes, especially when they were implemented around business-cycle troughs. Many monetary policy rate hikes, around business cycles peaks, were not identified as contractionary, suggesting that they were largely an endogenous response to inflationary pressures. The model correctly identifies the aggressive U.S. monetary policy tightening in 1979-1982 (Annex 1.4 of Chapter 1) as well as the monetary policy loosening in major Euro Area countries in the early- to mid-2010s in response to the Euro Area sovereign debt crisis (Conti, Neri and Nobili 2015).

**Exchange rate shocks.** As expected, exchange rate shocks were most pronounced during currency crises. They were also significant during debt and banking crises but about one-fifth and one-half, respectively, of the size of exchange rate shocks during currency crises.

**The role of domestic shocks in explaining domestic inflation**

**Overall impact of domestic shocks on domestic inflation.** The estimated response of domestic inflation to domestic demand shocks is slightly stronger than its response to global demand shocks: a one-standard-deviation positive domestic demand shock raised annual domestic inflation by 1.6 percentage points within two years (Figure 3.13).\(^{17}\) In the median country, domestic supply shocks

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\(^{17}\) Many studies document a growing role of domestic demand shocks in explaining domestic inflation variation (Leeper, Sims, and Zha 1996; Domaç and Yücel. 2005; Ahmad and Pentecost 2012; Nguyen et al. 2017).
shocks had about twice the impact of global supply shocks on domestic inflation. A one-standard-deviation positive domestic supply shock reduced domestic inflation by about 2.5 percentage point after two years.\textsuperscript{18} The impact of monetary policy shocks was comparable to that of domestic demand shocks: a one-standard-deviation increase in short-term interest rates reduced domestic

\textsuperscript{18}A role for supply shocks has been found by Globan, Arčabić, and Sorić (2015); Ahmad and Pentecost (2012); and Nguyen et al. (2017).
inflation by 2 percentage points after two years. The impact of exchange rate shocks was smaller (less than 1 percentage point after two years) than that of other domestic shocks.

**Broad-based impact of domestic shocks on domestic inflation.** The effects of domestic demand, supply and monetary policy shocks were broad-based: the cumulative impacts after two years were statistically significant in 92 percent of countries. As explored in Chapter 5, monetary shocks are an important source of exchange-rate fluctuations and are often associated with a larger exchange rate pass-through to domestic prices than other types of shocks. In contrast, few countries display a statistically significant response of domestic inflation to pure exchange rate shocks, in part due to the wide range of sources of exchange rate shocks and the wide range of country characteristics that determine the effects of such shocks on inflation. Possibly reflecting the higher level and volatility of inflation in EMDEs, the response of domestic inflation to domestic shocks was stronger in the median EMDE than in the median advanced economy, although the difference was not statistically significant.

**Relative contribution of domestic shocks to domestic inflation.** In the median country in the full sample period, domestic shocks contributed more than three times as much as global shocks to domestic inflation variation. Domestic shocks accounted for two thirds of the variation in domestic inflation in advanced economies, and 85 percent in EMDEs (Figure 3.14). In contrast to global supply shocks, which played a limited role in global and domestic inflation variation, domestic supply shocks accounted for a greater variance share of domestic inflation (26 percent) than every other type of domestic shock and, in EMDEs, a greater share than all global shocks combined. The predominant role of domestic supply shocks is consistent with previous studies.

Domestic demand shocks and monetary policy shocks, each accounted for around 15 percent and exchange rate shocks for about 17 percent of domestic

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19 The transmission of monetary policy has been extensively documented, especially for advanced economies. The recent literature includes Disyatat and Vonginsirikul (2003); Maćkowiak (2007); Osorio and Unsal (2011); Elbourne and Haan (2009); Globan, Arčabić, and Sorić (2015); Tena and Salazar (2008); Mallick and Sousa (2012); Mishra, Montiel, and Sengupta (2016); Ngalawa and Viegi (2011); and Nguyen et al. (2017).

20 In part, the wide range of impulse responses for exchange rate shocks reflects the fact, being largely unrestricted, they capture a large variety of shocks.

21 Supply shocks, which tend to be associated with changes in relative prices, have tended to be more important than shifts in demand. Nguyen et al. (2017) found that the main drivers of inflation dynamics in SSA countries in the previous 25 years had been shocks to domestic supply, the exchange rate, and monetary variables. In 33 mostly EMDE countries between 1986 and 2010, Osorio and Unsal (2013) estimated that domestic shocks explain the majority (around 70 percent) of inflation variation. For EU countries, the evidence is mixed. Vašíček (2011) estimate that global shocks were the main drivers of inflation in the Czech Republic, Hungary, Poland and Slovakia during 1998-2007.
FIGURE 3.14 Evolution of the impact of domestic shocks on inflation

During 1970-2017, domestic supply shocks explained about one-quarter of domestic inflation variation in both advanced economies and EMDEs. Other domestic shocks contributed less and in almost equal measure to domestic inflation variation. The contribution of domestic shocks, especially of exchanges rate and domestic supply shocks, to domestic inflation variation has decreased over time.

A. Contribution of global and domestic shocks to domestic inflation

B. Contribution of global and domestic shocks to domestic inflation, over time

C. Contribution of global and domestic shocks to domestic inflation, over time: Advanced economies

D. Contribution of global and domestic shocks to domestic inflation, over time: EMDEs

E. Impulse response of domestic inflation: Domestic demand and supply shocks, over time

F. Impulse response of domestic inflation: Monetary policy and exchange rate shocks, over time


Note: Figure shows median share of country-specific inflation variance accounted for by domestic shocks (domestic demand, supply, exchange rates and interest rates) based on country-specific FAVAR models discussed in Annex 3.3, estimated for 29 advanced economies and 26 EMDEs for 1970-2017.

E,F. Orange diamonds indicate the median and blue bars the 25-75th percentile of country-specific impulse responses. Cumulative impulse responses after two years for 1970-85 (70-85), 1986-2000 (86-00), and 2001-17 (01-17).

Click here to download data and charts.
inflation variation. The variance share of domestic supply shocks was somewhat more pronounced in EMDEs (30 percent) than in advanced economies (25 percent). In both advanced economies and EMDEs, the other three types of domestic shocks contributed in broadly equal measure (but always more in EMDEs than in advanced economies) to domestic inflation variation.

**Evolution of the role of domestic shocks in domestic inflation**

**Evolution of impact of domestic shocks on domestic inflation.** Since the mid-1980s, the sensitivity of domestic inflation to domestic shocks has declined (Figure 3.14). During 2001-17, the responses of domestic inflation to all four types of domestic shocks were half or less of those during 1970-85. These declines largely occurred during the Great Moderation and, in contrast to the response to global shocks, there has not been a rebound in the response to domestic shocks since 2001. The impact of exchange rate shocks, which was modestly negative during 1970-85, all but disappeared during 2001-17. It is possible that a gradual improvement in the anchoring of inflation expectations has contributed to this lower responsiveness of inflation to domestic shocks. The role of inflation expectations is explored in detail in Chapter 4.

**Evolution of relative contribution of domestic shocks to domestic inflation variation.** Since 2001, the contribution of domestic shocks to domestic inflation variation has declined to 53 percent, from 77-80 percent during the preceding decades. This decline affected all types of domestic shocks broadly similarly. As a result, domestic supply shocks have remained the main source of domestic inflation variation since 2001, accounting for 16 percent of total domestic inflation variation. This broad-based decline in the contribution of all domestic shocks since 2001 is particularly evident in EMDEs. In contrast, in advanced economies, the contribution of supply shocks has shrunk considerably more than that of other shocks such that, since 2001, domestic supply shocks have contributed less to advanced-economy domestic inflation than monetary policy shocks.

**Cross-country variation in the role of global and domestic shocks in domestic inflation**

**Role of global shocks.** The role of global factors in explaining domestic inflation has varied widely across countries. The median contribution of global shocks was considerably larger in countries that were open to global trade and finance and were commodity importers (Figure 3.15). Monetary policy and exchange rate regimes also mattered: global shocks were more important inflation drivers in countries without inflation-targeting regimes and with fixed exchange rate
Global shocks have been a more important source of domestic inflation movements in countries with stronger global trade and financial linkages, greater dependence on commodity imports, and fixed exchange rate regimes. These results do not qualitatively change when the results are based on average across countries. They are mostly consistent with earlier studies.
was particularly sizeable (20 percent or more) for EMDEs with above-median trade and financial openness, with fixed exchange rate regimes and without inflation-targeting regimes. The variance share of global oil price shocks was particularly sizeable in countries, especially EMDEs, that were commodity importers open to trade and international finance, with fixed exchange rates and without inflation-targeting regimes. The variance share of global supply shocks was particularly large in EMDEs with less independent central banks.

**Conclusion**

Over the past decade—since the global financial crisis of 2008-09 and the oil price plunge of 2014-16—global inflation has been exceptionally low. The results in this chapter suggest that the recent decline in global inflation stemmed in part from severe global recession and that it was prolonged by the oil price plunge. Global demand shocks accounted for most of the variation in global inflation variation since 2008 while oil price swings accounted for 60 percent since 2010.

More broadly than the post-crisis period, this chapter has explored systematically, in a unified framework, the roles of domestic and global demand, supply and commodity price shocks, as well as monetary policy and exchange rate shocks, in explaining movements in global and domestic inflation. The following are the key findings.

First, this chapter highlighted the role of global demand shocks and oil price shocks in explaining variations in global inflation since 1970. Oil price shocks and global demand shocks together contributed 80 percent (about 40 percent each) to the variation in global inflation in this period. The roles of global demand shocks and oil price shocks have strengthened considerably over this time, while that of global supply shocks has receded.

Second, global shocks have accounted for about one-quarter of domestic inflation variation since the 1970s, but with wide heterogeneity across countries. The role of these global shocks was considerably larger (33 percent) in the median advanced economy—with global demand shocks and oil price shocks

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23 Bianchi and Civelli (2015) find that the impulse responses of inflation to global slack are higher in countries more open to trade and with higher business cycle integration. Theoretical considerations developed by Martinez-Garcia and Wynne (2010) suggest that inflation is less responsive to domestic slack in countries more open to trade. Andrews, Gal, and Witheridge (2018) also find that a high level of global value chain integration can strengthen the transmission of global shocks by accentuating the impact of global economic slack on domestic inflation.

24 Berganza, Boralla and del Rio (2018) find that the direct effects of falling oil prices have been greater in countries with a larger share of oil in the CPI, and higher energy taxation (usually in the form of unit tax rates), as well as depreciations after the oil price drop.
about equally important—than in the median EMDE (14 percent) where only global demand shocks played a major role.

Third, it follows that domestic shocks have accounted for about three quarters of domestic inflation variation, and more in EMDEs. In contrast to global supply shocks, which played a limited role in global and domestic inflation variation, domestic supply shocks accounted for 26 percent of inflation variation and, in EMDEs, for more than any other type of domestic shock. Domestic demand and monetary policy shocks explained about 15 percent, each, of domestic inflation variation.

Fourth, the contribution of global shocks to domestic inflation variation tended to be higher in EMDEs without inflation targeting regimes, more open capital accounts, greater trade openness and global value chain participation.

Policymakers need to build resilience to global shocks since their importance as a source of domestic inflation variation has grown over time. This is particularly relevant for policy makers in small open economies with deep or rapidly growing integration into global trade and financial networks and supply chains. A menu of policy options is available to offset the impact of global shocks in EMDEs. These includes active use of countercyclical policies as well as strengthening institutions, including through greater central bank independence. In addition, ample fiscal space and a sound long-term framework for fiscal sustainability can ensure that fiscal policy can support macroeconomic stabilization.

Future research could examine more formally the role of country characteristics. This could be done in a regression framework or by conditioning impulse responses on country characteristics. In addition, changes in the role of global and domestic shocks in domestic and global inflation could be examined in greater detail, e.g., by allowing for time-varying coefficients or dynamic factor loadings.
ANNEX 3.1 Literature Review: Drivers of Domestic Inflation

The evidence for a major contribution of global shocks to domestic consumer price inflation is mixed but strongest for global commodity price shocks, particularly in the case of the oil price collapse of 2014-16. The role of global factors, whether global demand and supply shocks or global commodity price shocks, appears to be stronger in countries that are more open to trade, more integrated into global supply chains, and with a greater share of traded goods in the CPI basket. The literature on the impact of domestic shocks in EMDEs suggests that they explain a substantial portion of the variance of inflation. Domestic supply shocks are at least as important as shocks to demand, but the role of demand shocks has been growing. In EMDEs, the transmission of monetary shocks to inflation is hampered by underdeveloped financial markets as well as institutional weaknesses.

A large literature has documented the growing role of global factors in domestic inflation. While strong comovement of inflation among countries is a well-established finding, explanations vary: spillovers from global demand; common supply or commodity price shocks; and trade and financial linkages (Chapter 2). Meanwhile, empirical studies have also typically found an important, albeit diminishing, role of domestic shocks in domestic inflation. Domestic monetary policy is, over the long run, the determining factor for domestic inflation, a principle recognized in the numerical inflation targets set for central banks in many countries. That said, non-monetary factors, on the demand and supply sides of the economy, and movements in foreign exchange rates can drive short- and medium-term movements in inflation. With increasing globalization, external factors may play a more prominent role (Table A.3.1). Against this background, this box presents a brief survey of the literature to address the following questions:

- How much do global shocks contribute to domestic inflation, and how does the contribution differ by country characteristics?
- How much have oil price shocks contributed to post-crisis inflation?
- What is the relative importance of global and domestic shocks in inflation dynamics?

The role of global shocks in domestic inflation

Empirical studies have documented the role of global shocks in the dynamics of domestic inflation in individual countries using two approaches: a Phillips curve framework; and structural (SVAR) or factor-augmented (FAVAR) vector autoregressive models. Phillips curve-based evidence on the role of global factors
has been mixed, possibly reflecting measurement error in global output gap estimates. In contrast, VAR-based studies have typically found an important contribution of global shocks, especially commodity price shocks, to inflation.¹

**Phillips curve framework.** A group of studies has tested the hypothesis that inflation is driven by global slack, in addition to, or instead of, domestic slack. The results have been mixed.

- **Global output gap matters.** Borio and Filardo (2007), in a sample of 15 OECD economies during 1985-2005 find that both global inflation and the global output gap add explanatory power to conventional Phillips curve models of domestic inflation.² Filardo and Lombardi (2014) also find an important role for global demand shocks, in part transmitted through global commodity price shocks, in inflation in Asian countries. Altansukh et al. (2017) test for structural breaks in the correlation between the components (energy, food, core) of domestic and trade-weighted foreign inflation in 13 OECD countries during 1970-2013. They find that the short-run sensitivity of headline inflation to foreign energy inflation has increased significantly, but that the synchronization of movements in core inflation has not.

- **Global output gap does not matter.** In contrast, Ihrig et al. (2010) find that in estimates of the Phillips curve for a subset of 11 OECD countries during 1977-2005, the sensitivity of inflation to the global output gap was generally insignificant and often of the wrong sign and that the sensitivity of inflation to domestic output gaps had remained unchanged over time. Similarly, in a broader sample of 24 OECD economies during 1980-2007, Eickmeier and Pijnenburg (2013) find a statistically significant impact on domestic inflation only for global unit labor cost growth—not global output gaps. Mikolajun and Lodge (2016) estimate Phillips curves augmented by global output gaps, global inflation and global commodity prices for 19 OECD countries and find little support for a significant role of global economic slack in domestic inflation.³ Kabukçuoğlu and Martínez-García (2018)

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¹ In a rare study using micro data, Andrade and Zachariadis (2016) find that individual prices adjust to global shocks more slowly than to domestic shocks.

² Some studies have examined the role of other external shocks, such as U.S. monetary policy shocks. Using a SVAR framework, Maćkowiak (2007) analyzed the importance of external shocks in the determination of output and inflation in eight Asian countries between 1986 and 2000, and found that external shocks explained nearly half of the variation in inflation.

³ Moreover, the results suggest that the importance of global inflation in forecasting domestic inflation has its roots solely in its ability to capture slow-moving trends in inflation rates. In the Phillips curve context, the same role is performed by domestic forward-looking inflation expectations.
model inflation expectations for 14 OECD countries in a Phillips curve framework that is augmented by the global output gap and global inflation. Again, they find no robustly statistically significant role for global output gaps—which they attribute to measurement error—although a significant role for global inflation.

**Vector autoregressive models.** Vector-autoregressive models have more successfully demonstrated a significant role for global developments in driving domestic inflation. Ciccarelli and Mojon (2010) attribute a third of inflation variation to global factors in 22 OECD countries during 1960-2008. Neely and Rapach (2011) attribute more than half of inflation variation in 64 countries during 1951-2009 to international (global and regional) factors. Mumtaz, Simonelli and Surico (2011) found that the growing share of inflation variation contributed by global factors in 36 mostly advanced economies since 1960. Commodity price shocks are also an important driver of inflation. Using a structural dynamic factor model for Canada, Charnavoki and Dolado (2014) find that global demand, supply and commodity price shocks played an important role in Canadian inflation during 1975-2010. Furceri, Loungani, and Zdjienicka (2018), in a sample of 34 advanced economies during the 2000s, find that a hypothetical 10 percent increase in global food inflation would have raised domestic inflation by about 0.5 percentage point after a year, but that the estimated impact had declined over time and become less persistent.

**The role of global oil price shocks in post-crisis domestic inflation**

**Euro Area evidence.** Using a Bayesian VAR model, ECB (2017) documents a particularly pronounced contribution of global demand and oil supply shocks to Euro Area inflation in 2008-09 and 2014-16. The authors argue that commodity price movements were the main driver of the global common factor in inflation. However, also in a Bayesian VAR model for the Euro Area, Conti, Neri and Nobili (2015) find that inflation during 2013-14 was depressed as much by monetary and demand shocks as by oil price movements.

**Evidence from the 2014-16 oil price plunge.** A recent group of studies focus on the 70 percent drop in the price of oil from the peak in July 2014 to the trough in January 2016. World Bank (2015, 2018) and Sussman and Zohar (2015) attributed the oil price decline largely to a positive oil supply shock, as OPEC decided to protect its global oil market share amid growing U.S. shale oil production. Weak demand played a more prominent role in the subsequent decline in late 2015-2016. Berganza, Boralla and del Rio (2018) documents that extremely low inflation since the Great Recession has in part reflected the sharp decline in oil prices during 2014-16.
The role of country characteristics

Carney (2015) voiced broader concerns among central banks that increased competition from overseas and global financial market integration may have changed the relationship between inflation and domestic economic conditions. Several studies, discussed here, have established empirically that global factors play a greater role in driving domestic inflation in countries with greater trade and global value chain integration, and with a greater share of goods in the CPI whose prices are highly correlated with global shocks.

Trade integration. Auer, Borio and Filardo (2017) estimate a Phillips curve model for producer price inflation, augmented by global slack, for 18 OECD countries for 1982-2006. The significantly positive coefficient estimate of the interaction between global slack and global value chain participation indicates that global value chains form an important transmission channel from global slack to domestic inflation. In time-varying-coefficient VAR models, Bianchi and Civelli (2015) find that the impulse responses of inflation to global slack are larger in more trade-open economies and in those with higher business cycle integration. Theoretical considerations developed by Martinez-Garcia and Wynne (2010) suggest that inflation will generally be less responsive to domestic slack the more open the economy is to international trade.

Exposure to food and energy price shocks. Furceri, Loungani, and Zdzienicka (2018) provide evidence that the global food price shocks of the 2000s had a bigger impact on domestic inflation in EMDEs than in advanced economies. They attribute this to the greater share of food in the consumption baskets of EMDEs, and the weaker anchoring of inflation expectations in EMDEs than in advanced economies. Berganza, Boralla and del Río (2018) find that the post-crisis oil price drop depressed global inflation between 2014 and 2016. The direct effects of falling oil prices were greater in countries with larger shares of oil in the CPI and higher energy taxation (usually in the form of per-unit tax rates), as well as in countries where currency depreciation were associated with the oil price drop.

The role of domestic shocks in domestic inflation

In the past two decades, empirical studies have typically found an important, albeit diminishing, role of domestic shocks in domestic inflation. A summary of selected empirical studies on the importance of domestic shocks on inflation dynamics is provided in Annex 3.4.

Evidence on advanced economies. Several studies have offered evidence that domestic shocks play a key role in domestic inflation dynamics. Globan, Arčabić and Sorić (2015) found, for non-eurozone new EU member states, that short-
run inflation dynamics could be explained mainly by domestic factors, even if foreign shocks became the major driver of inflation in the medium-term. Bobeica and Jarociński (2017), using a medium-scale reduced-form VAR, document that domestic shocks can explain both the “missing disinflation” and “missing inflation” episodes in the U.S. and the Euro Area in the 2010s. However, Pain, Koske, and Sollie (2006) found, for OECD countries since the mid-1990s, that the sensitivity of inflation to domestic economic conditions had declined.

**Evidence on EMDEs.** Studies on EMDEs have similarly found that domestic shocks play a predominant role in domestic inflation dynamics, even if the role of global shocks may have grown. For EU countries, the evidence is mixed with Vašíček (2011) arguing that global shocks were the main drivers of inflation in the Czech Republic, Hungary, Poland and Slovakia during 1998-2007 but Halka and Kotlowski (2017) finding that domestic shocks played an important role in inflation dynamics in the Czech Republic, Poland and Sweden, including by transmitting global demand shocks through the domestic output gap. For Asia, Osorio and Unsal (2013) estimated that domestic shocks explain around 70 percent of total variation in domestic inflation in 33 countries.

**The role of monetary policy in domestic inflation**

There is an extensive literature on the transmission of monetary policy to the domestic economy. One of the challenges that this research has had to address is the simultaneity between monetary policy and economic developments: monetary policy responds to the economy, as well as vice versa (Leeper, Sims, and Zha 1996; Gertler and Karadi 2015). Most studies of the transmission of monetary policy to the economy have focused on advanced economies. Using structural model frameworks, many of these studies have shown that monetary policy explains a substantial part of the variation in domestic inflation, with statistical significance. The literature has evolved by developing more advanced empirical frameworks that purport to address the problem of simultaneity. Surveys of this work are provided by Boivin, Kiley, and Mishkin (2010), Benati and Goodhart (2010), and Bhattarai and Neely (2016). The evolution of estimation strategies is discussed by Ramey (2016) and Stock and Watson (2017).

**Evidence on EMDEs.** The evidence on the transmission of monetary policy to macroeconomic conditions is less clear for EMDEs than for advanced economies. For instance, Canova and De Nicolo (2002) show that monetary disturbances explain large portions of output and inflation fluctuations in the G7 economies. The explanatory power of monetary disturbances for output variability in Germany, Canada, the UK and Italy was found to exceed 22 percent and for inflation variability in the US, UK, Japan and Italy it was found to exceed 54 percent.
economies. A group of earlier studies focused on challenges that EMDEs face in the implementation of monetary policy and specific channels of monetary policy transmission. These challenges include higher default risk, underdeveloped financial markets, and weaker institutions. While the interest-rate and asset-price channels of monetary policy transmission are limited, and sometimes insignificant (Mohanty and Turner 2008; Vonnák 2008), some studies have found that the exchange rate channel plays a significant role in EMDEs (Neaime 2008; Bhattacharya, Patnaik and Shah 2011). In LICs, because of undeveloped financial markets, monetary policy transmission relies heavily on the bank lending channel. The evidence on its effectiveness is mixed.

The role of domestic demand and supply shocks in domestic inflation

A number of studies have examined non-monetary macroeconomic shocks as drivers of domestic inflation. Domestic demand shocks include, for example, unanticipated changes in government spending, while domestic supply shocks include unanticipated changes in the availability of goods or services resulting from such factors as severe weather events, labor strikes, and changes in productivity. The effects of such shocks on prices may be transitory or permanent, depending partly on the nature of the shock and partly on the monetary policy regime, and the anchoring of inflation expectations.

Evidence on advanced economies. Melolinna (2015) uses a FAVAR framework to study inflation dynamics in the euro area, the United Kingdom and the United States. The results suggest that headline inflation in the three economies had reacted in a similar fashion to macroeconomic shocks over the previous four decades, with demand shocks having the most persistent effects. Gambetti, Pappa, and Canova (2005) examined the dynamics of U.S. output and inflation using a structural time-varying coefficient VAR. They found that a combination of technology, demand, and monetary shocks explained variations in the persistence and volatility of inflation. These and other studies have found that, along with monetary policy shocks, real macroeconomic shocks, both demand and supply, help to explain inflation dynamics in advanced economies.

Evidence on EMDEs. A number of empirical studies have analyzed the effects of supply and demand shocks on inflation in EMDEs. A broad finding is that supply shocks, which tend to be associated with changes in relative prices, have

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5 For Hammond, Kanbur, and Prasad (2009); Mishra, Montiel and Spilimbergo (2012).
6 Frankel (2011); Agenor and Aynaoui (2010); Wu, Luca and Jeon (2007).
7 Mishra, Montiel and Sengupta (2016); Mishra and Montiel (2012); Disyatat and Vongsinsirikul (2003); Golenelli and Rovelli (2005); Catao and Pagan (2010); Singh and Kalirajan (2007); Aleem (2010).
tended to be more important than shifts in demand but that the role of demand shifts has grown. Mohanty and Klau (2001), in a study of 14 EMDEs during the 1980s and 1990s, found significant effects from supply shocks, especially from those affecting food prices. A number of studies focus on regional groups of EMDEs.

- **Asia.** Osorio and Unsal (2013), using a set of global VAR and SVAR models, studied the drivers of inflation in 33 Asian countries during 1986-2010. They found that supply shocks explained around 45 percent of total variation in cyclical inflation, and monetary shocks around 35 percent, but that the role of demand factors had increased since 2000. Dua and Gaur (2009) investigated the determinants of inflation in the framework of an open-economy Phillips curve model for eight Asian countries during 1990-2005. They found that agriculture-related supply shocks were a significant determinant of inflation for EMDEs but not for advanced economies.

- **Sub-Saharan Africa.** Nguyen et al. (2017) analyzed inflation dynamics in SSA countries using a global VAR model. They found that in the previous 25 years, the main drivers of inflation had been shocks to domestic supply, the exchange rate, and monetary variables, but that, in the latest decade, domestic demand pressures and global shocks had played larger roles than previously. Similarly, using the SVAR framework of Blanchard and Quah (1989), Ahmad and Pantecost (2012) studied inflation dynamics in 22 African countries. They found that the most important source of inflation was demand shocks, which accounted for between 50 and 90 percent of inflation variation in all countries.

- **Middle East.** Hasan and Alogeel (2008) found, for Saudi Arabia and Kuwait between 1964 and 2007 that, in the long run, inflation in trading partners was the main factor affecting inflation, with a smaller contribution from exchange rate pass-through. The estimated impacts of domestic demand and monetary shocks were confined to the short run. Kandil and Morsy (2010) studied the determinants of inflation in Gulf Cooperation Council countries during 2003-2008, using a model that included domestic and external factors. They found that binding capacity constraints (supply side) and government spending (demand side) both helped to explain short-term movements in inflation.

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8 Note, however, that the supply and demand shocks include external factors, e.g. commodity-price shocks and inflation spillovers from other Asian countries. The contribution to inflation of domestic supply shocks varied from one country to another, between zero and 40 percent.
<table>
<thead>
<tr>
<th>Paper</th>
<th>Sample</th>
<th>Sample Period</th>
<th>Methodology</th>
<th>DD</th>
<th>DS</th>
<th>MP</th>
<th>ER</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amisano and Tristani (2007)</td>
<td>Euro area</td>
<td>1970Q1-2004Q4</td>
<td>DSGE</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td>Inflation targeting and monetary policy shocks explain 76 percent and 9 percent of inflation variation, respectively. Tax and technology shocks are less important.</td>
</tr>
<tr>
<td>Bobeica and Jarociński (2017)</td>
<td>Euro Area, US</td>
<td>1990Q1-2014Q4</td>
<td>BVAR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>Domestic shocks are more important in the missing inflation episode whereas global shocks are more important in the missing disinflation episode.</td>
</tr>
<tr>
<td>Canova and de Nicolò (2002)</td>
<td>G7</td>
<td>1973-1995</td>
<td>VAR</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
<td>Monetary shocks are the dominant source of output and inflation fluctuations in three of the seven countries.</td>
</tr>
<tr>
<td>Conti, Neri, and Nobili (2017)</td>
<td>Euro Area</td>
<td>1995Q1-2015Q3</td>
<td>BVAR</td>
<td>✓</td>
<td></td>
<td></td>
<td>✓</td>
<td>Foreign shocks (oil supply and global demand) and aggregate demand are the main drivers of inflation; monetary policy is less important.</td>
</tr>
<tr>
<td>Gambetti, Pappa, and Canova (2005)</td>
<td>US</td>
<td>1970-2002</td>
<td>SVAR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Technology, demand, and monetary shocks can explain the variation in inflation, with technology contributing 25 percent, demand 17 percent, and monetary 14 percent, on average.</td>
</tr>
<tr>
<td>Globan, Arčabić and Sorić (2015)</td>
<td>Bulgaria, Croatia, Czech Republic, Hungary, Latvia, Lithuania, Poland, and Romania</td>
<td>2001-2013</td>
<td>SVAR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Foreign shocks are the major factor in explaining inflation dynamics in the medium run, while the short run inflation dynamics is mainly influenced by domestic shocks.</td>
</tr>
<tr>
<td>Mumtaz, Zabczyk, and Ellis (2011)</td>
<td>UK</td>
<td>1964Q1-2005Q1</td>
<td>FAVAR</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>Supply shocks are the key drivers of inflation, with monetary policy shocks having a small initial impact but slowly increases over time.</td>
</tr>
<tr>
<td>Pain, Koske, and Sollie (2006)</td>
<td>OECD countries</td>
<td>1985-2005</td>
<td>VAR</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td>The sensitivity of inflation to domestic economic conditions has declined whereas the sensitivity to foreign economic conditions has risen, working through import prices.</td>
</tr>
</tbody>
</table>

Notes: DD stands for Domestic demand, DS stands for Domestic supply, MP stands for Monetary policy, and ES stands for Exchange rate.
### TABLE A.3.1. Literature review: Drivers of inflation—Panel B. Studies on EMDEs

<table>
<thead>
<tr>
<th>Paper</th>
<th>Sample</th>
<th>Sample Period</th>
<th>Methodology</th>
<th>DD</th>
<th>DS</th>
<th>MP</th>
<th>ER</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmad and Pentecost (2012)</td>
<td>22 African countries</td>
<td>1980-2015</td>
<td>SVAR</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
<td>Demand shocks account for between 50 percent and 90 percent of inflation variation, while domestic supply shocks account for about 10 percent to 40 percent.</td>
</tr>
<tr>
<td>Dua and Gaur (2010)</td>
<td>Japan, Hong Kong, Korea, Singapore, Philippines, Thailand, China, and India</td>
<td>1990s-2005</td>
<td>Open Economy Philips Curve</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>Output gap is important in explaining inflation in almost all the countries. In developing countries, agricultural supply shocks are important but not so in advanced economies.</td>
</tr>
<tr>
<td>Halka and Kotlowski (2017)</td>
<td>Czech Republic, Poland and Sweden</td>
<td>2000Q1-2014Q2</td>
<td>SVAR</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td></td>
<td>Domestic shocks are important in inflation dynamics with transmission via the domestic output gap and exchange rate channel.</td>
</tr>
<tr>
<td>Hasan and Alogeel (2008)</td>
<td>Saudi Arabia and Kuwait</td>
<td>1966-2007</td>
<td>ECM</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td>In the long run, inflation in trading partners is the main driving factor of inflation, with significant but lower contribution from exchange rate pass-through. Demand shocks and money supply shocks are important in the short run, but tend to dissipate quickly.</td>
</tr>
<tr>
<td>Jongwanich, Wongcharoen, and Park (2016)</td>
<td>China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand, and Vietnam</td>
<td>2000Q1-2015Q2</td>
<td>SVAR</td>
<td>√</td>
<td></td>
<td></td>
<td></td>
<td>Cost-push factors such as oil and food prices are more important in explaining PPI than CPI. On the other hand, for CPI, demand-pull factors still explain much of the inflation.</td>
</tr>
</tbody>
</table>

Notes: DD stands for Domestic demand, DS stands for Domestic supply, MP stands for Monetary policy, and ES stands for Exchange rate.
### Table A.3.1 Literature review: Drivers of inflation—Panel B. Studies on EMDEs (continued)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Countries</th>
<th>Sample Period</th>
<th>Methodology</th>
<th>DD</th>
<th>DS</th>
<th>MP</th>
<th>ER</th>
<th>Main results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kandil and Morsy (2010)</td>
<td>Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates</td>
<td>1970-2007</td>
<td>VECM</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
<td>Inflation in major trading partners is an important foreign factor. In addition, oil revenues have reinforced inflationary pressures through growth of credit and aggregate spending.</td>
</tr>
<tr>
<td>Khan and Hanif (2012)</td>
<td>Pakistan</td>
<td>1992-2011</td>
<td>SVAR</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>Supply shocks explain 48 percent of variation in inflation, while the share of real demand shocks was around 10 percent and the remaining 42 percent attributed to nominal shocks.</td>
</tr>
<tr>
<td>Mohanty and Klau (2001)</td>
<td>14 EMDEs</td>
<td>1981Q1-1999Q4</td>
<td>Open Economy Philips Curve</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td>Output gap is a significant determinant of inflation. Supply side factors and import prices (especially food prices, via the exchange rate channel) are also important, but money supply is less relevant.</td>
</tr>
<tr>
<td>Neaime (2008)</td>
<td>Egypt, Jordan, Turkey, and Lebanon, Morocco, and Tunisia</td>
<td>1990s-2000s</td>
<td>VAR</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>In Egypt and Turkey, the exchange rate played a dominant role in the transmission mechanism of monetary policy, while for Jordan, Lebanon, Morocco, and Tunisia it was the interest rate.</td>
</tr>
<tr>
<td>Nguyen et al. (2017)</td>
<td>33 Sub-Saharan African countries</td>
<td>1988-2013</td>
<td>VAR</td>
<td></td>
<td></td>
<td>√</td>
<td></td>
<td>Main drivers of inflation have been domestic supply shocks and shocks to exchange rate and monetary variables. However, in recent years, domestic demand and global shocks have played a larger role in driving inflation.</td>
</tr>
<tr>
<td>Osorio and Unsal (2013)</td>
<td>33 Asian countries</td>
<td>1986-2010</td>
<td>GVAR, SVAR</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>Monetary and supply shocks are the main drivers of inflation, but more recently demand shocks are increasing in importance.</td>
</tr>
<tr>
<td>Porter (2010)</td>
<td>China</td>
<td>1996Q1-2010Q1</td>
<td>BVAR</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
<td>Global shocks are more important than domestic demand and monetary conditions.</td>
</tr>
</tbody>
</table>

Notes: DD stands for Domestic demand, DS stands for Domestic supply, MP stands for Monetary policy, and ES stands for Exchange rate.
**ANNEX 3.2 Event Studies**


**Disinflation episodes.** Country-specific disinflation episodes are defined, using a variation of Ball (1994), as quarters in which the nine-quarter centered moving average of headline CPI inflation (quarter-on-quarter, seasonally adjusted) declines by at least 1 percentage point from the peak to trough. A trough is the quarter in which trend inflation is lower than in the previous four quarters and the following four quarters. A peak is defined as the quarter in which trend inflation is above the previous four quarters and the following four quarters. This yields 190 disinflation episodes and 179 inflation episodes in 34 advanced economies, and 719 disinflation episodes and 729 inflation episodes in 134 EMDEs during 1970-2017:3.
ANNEX 3.3 Methodology and Database

Global block

This chapter employs a Factor-Augmented Vector Autoregression (FAVAR) model. In a first step, a global block is estimated in isolation to examine the roles of different types of global shocks in driving global inflation. In a second step, the global block is combined with a country-specific block to compare the roles of global and domestic shocks in driving domestic inflation.

The global block includes three variables: global inflation, global output growth and oil price growth (for precise variable definitions, see below). All variables are detrended using a 60-quarter centered moving average. Global output growth and global inflation correspond to the global output growth and global inflation factors estimated separately using the following dynamic factor models:

\[ Y_t^i = \beta_{Y,global}^i f_t^Y,global + \varepsilon_{Y,i}^t \]
\[ \pi_t^i = \beta_{\pi,global}^i f_t^{\pi,global} + \varepsilon_{\pi,i}^t \]

where \( \pi_t^i \) and \( y_t \) are inflation and output growth in country \( i \) in quarter \( t \), respectively, while \( f_t^{\pi,global} \) and \( f_t^Y,global \) are the global common factors for inflation and output growth in quarter \( t \), respectively.\(^2\)

In its structural form, the FAVAR model is represented by:

\[ B_0 Z_t = \alpha + \sum_{i=1}^{L} B_i Z_{t-i} + \varepsilon_t \]

where \( \varepsilon_t \) is a vector of orthogonal structural innovations, and \( Z_t \) consists of global inflation (\( f_t^{\pi,global} \)), global output growth (\( f_t^Y,global \)), and oil price growth (\( \Delta op \)). The vector \( \varepsilon_t \) consists of a shock to the global supply of goods and services (“global supply shock”), a shock to the global demand of goods and services (“global demand shock”), and a shock to oil prices (“oil price shock”).

The chapter follows the methodology in Charnavoki and Dolado (2014) in using sign restrictions in order to identify global demand, global supply, and oil

---

\(^1\) The main assumptions in the estimation of the global factors follow those in Kose, Otrok, and Whiteman (2008) and Kose, Otrok, and Prasad (2012).

\(^2\) The model is specified in terms of growth, not levels, since the variable of interest (inflation) is itself a growth rate.
price shocks. Postulating that $B_0^{-1}$ in our model has a recursive structure such that the reduced form errors ($u_t$) can be decomposed according to $u_t = B_0^{-1} \varepsilon_t$, the sign restrictions that are imposed over the first four quarters can be written as follows:

$$
\begin{bmatrix}
  u^Y_{t, \text{global}} \\
  u^\text{OilPrice}_{t} \\
  u^\pi_{t, \text{global}}
\end{bmatrix} =
\begin{bmatrix}
  + & - & + \\
  + & + & + \\
  + & + & -
\end{bmatrix}
\begin{bmatrix}
  \varepsilon^\text{GlobalDemand}_t \\
  \varepsilon^\text{OilPrice}_t \\
  \varepsilon^\text{GlobalSupply}_t
\end{bmatrix}
$$

where a positive global demand shock increases global output, global inflation and oil prices; a positive oil price shock increases oil prices and global inflation but reduces global output growth, and a positive global supply shock increases global output growth and oil price growth but reduces global inflation.

Structural shocks are assumed to have unit variance, and the magnitude of each shock is defined as a one-standard-deviation increase in the identified structural shocks. Based on the full sample results, it is estimated that a one-standard deviation shock to global demand represents a 1.2 percentage point increase in global output growth; a one-standard-deviation global supply shock represents a 0.9 percentage point increase in global inflation; and a one-standard-deviation oil price shock a 70 percentage points increase in oil price growth.

The model is estimated by using quarterly data with two lags as in Charnavoki and Dolado (2014). The lag length is supported by statistical tests (AIC and SIC criteria). Alternative specifications with three or four lags were tested, and the robustness of the VAR estimation results were confirmed. In the Bayesian estimation, the estimation first searches for 1,000 successful draws out of at least 2,000 iterations with 1,000 burn-ins; the results reported here are based on the median of these 1,000 successful draws, along with 16-84 percent confidence intervals.

**Domestic block**

To compare the impact of global and domestic shocks, the model is, in a second step, expanded by a country-specific block. The country-specific block includes four domestic variables: inflation, output growth, nominal effective exchange rates, and nominal short-term interest rates (or policy rates). The model is estimated with two lags (identified as optimal lag length according to the SIC and AIC criteria) on a country-by-country basis and median results and interquartile ranges are presented. The results are robust to using averages instead of medians.
Similar to Forbes, Hjortsoe, and Nenova (2018, 2017), the global block and the country-specific block are combined as follows:

\[
\begin{bmatrix}
    u_{t}^{Y, \text{global}} \\
    u_{t}^{\text{OilPrice}} \\
    u_{t}^{\pi, \text{global}} \\
    u_{t}^{Y, \text{domestic}} \\
    u_{t}^{\pi, \text{domestic}} \\
    u_{t}^{\text{InterestRate}} \\
    u_{t}^{\text{ExchangeRate}}
\end{bmatrix}
= \begin{bmatrix}
    + & - & + & 0 & 0 & 0 & 0 \\
    + & + & + & 0 & 0 & 0 & 0 \\
    + & + & - & 0 & 0 & 0 & 0 \\
    * & * & * & + & + & - & * \\
    * & * & * & + & - & - & * \\
    * & * & * & * & * & + & * \\
    * & * & * & * & * & * & +
\end{bmatrix}
\begin{bmatrix}
    e_{t}^{\text{GlobalDemand}} \\
    e_{t}^{\text{OilPrice}} \\
    e_{t}^{\text{GlobalSupply}} \\
    e_{t}^{\text{DomesticDemand}} \\
    e_{t}^{\text{DomesticSupply}} \\
    e_{t}^{\text{MonetaryPolicy}} \\
    e_{t}^{\text{ExchangeRate}}
\end{bmatrix}
\]

where * stands for an unrestricted initial response. While country-specific shocks do not affect global variables contemporaneously, global shocks can affect country-specific variables (without any sign or zero restrictions).

A positive country-specific supply or a positive country-specific demand shock increases country-specific output growth. Country-specific inflation falls by a positive country-specific supply shock. A positive interest rate shock (corresponding to a contractionary monetary policy) initially increases both the domestic interest rate and the exchange rate, and decreases output growth and inflation. Finally, a positive exchange rate shock (corresponding to the appreciation of the domestic currency) is assumed to increase the exchange rate, but other effects on domestic variables are left unrestricted.

In the median country, a positive one-standard-deviation domestic demand shock increases domestic output growth by 1.6 percentage points. A one-standard-deviation positive supply shock decreases domestic inflation by 1.1 percentage points. A one-standard-deviation positive (contractionary) monetary

---

3 Using a country-specific SVAR framework with sign restrictions into global and domestic variables in 26 advanced economies for the period of 1992-2015, Forbes, Hjortsoe, and Nenova (2018) identify domestic demand, supply, and monetary policy, and exchange rate shocks along with global permanent and temporary shocks as drivers of domestic inflation and exchange rates. Conti, Neri and Nobili. (2015) similarly identify global and domestic structural shocks using cross-country data in Euro Area between 1995 and 2005. In line with those studies, this chapter identifies global and domestic macroeconomic shocks as drivers of inflation. However, this chapter differs from these earlier studies in estimating latent global factors and augmenting country-specific VAR models with these global factors. Instead of estimating the standard single-equation, country-specific Phillips curve, which includes unemployment or output gap as core explanatory variables for inflation, the FAVAR model in this chapter includes domestic and foreign drivers of inflation and allows feedback loops over time among variables. The model is thus expected to enhance the explanatory power for domestic inflation and reduce concerns about omitted variables in single-equation, country-specific Phillips curves.
policy shock increases short-term interest rates (or policy rates) by 0.27 percentage point. A positive one-standard-deviation exchange-rate shock represents a 15 percentage point increase (appreciation) in nominal effective exchange rates appreciation.

Results for the roles of global and domestic shocks in explaining the variation in domestic inflation are presented as median point estimates across countries. Interquartile ranges indicate the range from the 25th and 75th quartile of country-specific estimates (e.g. Forbes, Hjortsoe, and Nenova 2017).

Bayesian estimation

The system is estimated on a country-by-country basis. The Bayesian estimation searches for 1,000 successful draws out of at least 2,000 iterations with 1,000 burn-ins. The results shown in the chapter are based on the median of these 1,000 successful draws and 68 percent confidence intervals at the country level, although alternative presentation methodologies (e.g., the median target as in Fry and Pagan, 2011) are considered as a robustness check. In the Bayesian estimation, Minnesota priors proposed by Litterman (1986) are used; since the Minnesota prior assumes that the variance-covariance matrix of residuals is known, the entire variance-covariance matrix of the VAR is estimated by ordinary least squares. For the actual estimation, the identification strategy through the algorithm introduced by Arias, Rubio-Ramirez, and Waggoner (2014) is used, where the standard Cholesky-decomposition is employed together with an additional orthogonalisation step that is necessary to produce a posterior draw from the correct distribution for SVAR coefficients.

Database

The sample includes 29 advanced economies and 26 EMDEs with at least 10 years (40 quarters) of continuous data for the variables in the domestic block, but the sample period differs across countries (Table A.3.3.1). Long-term components of quarterly growth rates are proxied by 15-year moving average, benchmarking Stock and Watson (2012).


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4 Focusing on cross-country medians mitigates concerns that, for the United States and China, the domestic block might affect the global block contemporaneously.

5 Unit-root tests of 55 quarterly inflation rates indicate that most of the country-specific inflation rates are either stationary or trend-stationary at 5 percent significance level. Based on these results, long-term trends in inflation rates are eliminated. As in Chapter 2, the results are qualitatively robust to different detrending methods (e.g., Hodrick-Prescott or Butter-Worth filter).
Global inflation is defined as the global common factor of quarter-on-quarter headline CPI inflation (seasonally adjusted) in a sample of 47 advanced economies and EMDEs. For robustness, the estimation is repeated using core inflation and PPI inflation, similarly defined.

Oil price growth is the quarter-on-quarter growth rate of nominal oil prices (average of Dubai, WTI, and Brent).

Domestic inflation is quarter-on-quarter, seasonally adjusted headline CPI inflation.

Domestic output growth is quarter-on-quarter, seasonally adjusted real GDP growth.

Domestic interest rates are quarter-on-quarter differences in 3-month treasury-bill rates or monetary policy rates.

Nominal effective appreciation is quarter-on-quarter appreciation in trade-weighted nominal exchange rates against 52 currencies, as provided by the Bank for International Settlements.

Robustness exercises

Since the FAVAR estimation in this chapter rests on various assumptions about the relationships among endogenous variables, several robustness checks on the assumptions are performed. The results presented in this chapter are robust to the following changes.

Alternative measures of global inflation and global output in the estimation of global block: (i) global inflation and output factors estimated with an identical group of 25 countries and (ii) median GDP growth and inflation rates among countries.

Alternative measures of oil prices in the global block: real oil prices and nominal energy prices.

Use of averages, instead of medians, in reporting all country-specific results on the contribution of global and domestic shocks to domestic inflation (Table A.3.3.2).

An alternative number of periods (i.e., two-quarters) in imposing sign restrictions in identifying country-specific structural shocks.

Alternative sign restrictions: positive domestic demand shocks lead to contemporaneous increases in country-specific short-term interest rates (or policy rates).
• Alternative presentations of 1,000 successful draws following Fry and Pagan (2011): instead of presenting the median across 1,000 successful draws, use of the draw that is closest to the median across 1,000 successful draws (i.e., the median target). The same strategy has been applied to calculate the corresponding 68 percent confidence sets, again by following Fry and Pagan (2011).

• Country-specific FAVAR estimation results during the period of 2001-2017 instead of full-sample results.

### TABLE A.3.3.1 List of countries and sample periods

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample Period</th>
<th>Country</th>
<th>Sample Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>1988:3 - 2017:4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Countries with at least 40-quarters of data have been included.
### TABLE A.3.3.2 Contribution of domestic shocks to domestic inflation

#### Panel A. By income groups

<table>
<thead>
<tr>
<th></th>
<th>All countries</th>
<th>AEs</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Total Global Shocks</td>
<td>27.7</td>
<td>32.5</td>
<td>33.3</td>
</tr>
<tr>
<td>Total Domestic Shocks</td>
<td>72.3</td>
<td>67.5</td>
<td>66.7</td>
</tr>
<tr>
<td>Domestic Demand Shock</td>
<td>14.5</td>
<td>13.8</td>
<td>12.9</td>
</tr>
<tr>
<td>Domestic supply Shock</td>
<td>26.0</td>
<td>24.4</td>
<td>25.2</td>
</tr>
<tr>
<td>Monetary Policy Shock</td>
<td>14.4</td>
<td>14.2</td>
<td>13.2</td>
</tr>
<tr>
<td>Exchange Rate Shock</td>
<td>17.3</td>
<td>15.1</td>
<td>15.4</td>
</tr>
</tbody>
</table>

#### Panel B. By sub period

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
</tr>
<tr>
<td>Total Global Shocks</td>
<td>23.2</td>
<td>30.3</td>
<td>20.6</td>
</tr>
<tr>
<td>Total Domestic Shocks</td>
<td>76.8</td>
<td>69.7</td>
<td>79.4</td>
</tr>
<tr>
<td>Domestic Demand Shock</td>
<td>15.5</td>
<td>13.5</td>
<td>13.9</td>
</tr>
<tr>
<td>Domestic supply Shock</td>
<td>28.3</td>
<td>26.2</td>
<td>31.1</td>
</tr>
<tr>
<td>Monetary Policy Shock</td>
<td>14.4</td>
<td>14.0</td>
<td>14.4</td>
</tr>
<tr>
<td>Exchange Rate Shock</td>
<td>18.7</td>
<td>16.1</td>
<td>19.9</td>
</tr>
</tbody>
</table>

Notes: The table shows median across countries share of country-specific inflation variance accounted for by domestic shocks (domestic demand, supply, exchange rates and interest rates) and global shocks based on country-specific FAVAR models estimated for 29 advanced economies and 26 EMDEs for 1970-2017 (Panel A) and for three subsamples (Panel B).
References


In an interconnected world, fulfilling the Federal Reserve’s objectives under its dual mandate requires that we pay close attention to how our own actions affect other countries and how developments abroad, in turn, spill back into U.S. economic conditions.

Stanley Fischer (2015)
PART B

INFLATION

Expectations and Pass-Through
Inflation expectations play a critical role in enabling the proper formulation of monetary policy. As such, it is essential for policymakers to have a good understanding of how inflation expectations are determined. This chapter provides a comprehensive examination of the determination and evolution of inflation expectations, with a focus on emerging market and developing economies (EMDEs). It finds that long-term inflation expectations in EMDEs are not as well anchored as those in advanced economies, despite notable improvements during the past two decades. Indeed, in EMDEs, long-term inflation expectations are more sensitive to both domestic and global inflation shocks. However, EMDEs tend to be more successful in anchoring inflation expectations in the presence of an inflation-targeting regime, high central bank transparency, strong trade integration, and a low level of public debt.

Introduction

Inflation expectations play a critical role in the effective implementation of monetary policy. A central bank is more likely to be successful in achieving low and stable inflation if it can anchor economic agents’ long-term inflation expectations close to its inflation objective. This is because inflation expectations are key in the transmission of monetary policy, as they affect current inflation through their impact on the setting of wages and prices (Bernanke et al. 2001). Measures of inflation expectations are therefore important yardsticks in assessing the credibility of a central bank in meeting its inflation objective.

Given the importance of inflation expectations for monetary policy, it is essential for central banks to have a good understanding of how they are affected by domestic and global shocks. This is especially critical for central banks in emerging market and developing economies (EMDEs), since these economies tend to experience more pronounced business and financial cycles than advanced economies, and therefore may face greater challenges in anchoring expectations.

There is a rich theoretical and empirical literature on inflation expectations. Theoretical studies have examined how public and private information is used by economic agents in formulating inflation expectations. A large body of empirical work has tested the predictions of theoretical models and assessed how firmly inflation expectations are anchored, by measuring the sensitivity of

Notes: This chapter was prepared by M. Ayhan Kose, Hideaki Matsuoka, Ugo Panizza, and Dana Vorisek. Yohei Okawa provided background material for a country case study in Annex 4.5.
expectations to various shocks, such as macroeconomic news shocks or oil or other price shocks. The literature, however, has mainly focused on advanced economies.

This chapter presents the first comprehensive analysis of the evolution and determinants of inflation expectations in EMDEs with an emphasis on three main questions:

- How does the degree of anchoring of inflation expectations differ between advanced economies and EMDEs?
- How sensitive are inflation expectations to global and domestic shocks?
- What are the main determinants of the degree of anchoring of inflation expectations?

The chapter makes several contributions to the literature on inflation expectations. First, it employs a large and diverse sample of countries (24 advanced economies and 23 EMDEs) for a period of close to three decades. Second, it analyzes the sensitivity of long-term inflation expectations to global and domestic inflation shocks using a time-varying parameter regression model. Third, it examines the determinants of the degree of anchoring of expectations using a dynamic panel regression framework. Fourth, it complements the empirical analysis with case studies that examine the role of inflation targeting in stabilizing inflation expectations in three EMDEs. In addition, it provides a summary of the literature with a special focus on empirical studies on the anchoring of inflation expectations in EMDEs.

The chapter begins by discussing the measurement of inflation expectations, comparing survey-based and market-based measures. Survey-based measures have the advantage of being able to incorporate the views of large groups of economic agents or to canvass different types of agents. Market-based measures (that is, measures based on comparisons of certain yields in financial markets) have the advantage of being available at a higher frequency and more extensive range of horizons than survey-based measures.¹

The following section reviews the theoretical and empirical literature on the formation and anchoring of inflation expectations. Despite a lack of consensus on the theoretical framework that best captures the behavior of inflation expectations, the empirical literature has concluded that an inflation-targeting regime helps improve the anchoring of expectations in both advanced economies and EMDEs.

¹ For background on market- and survey-based measures of inflation expectations, see Coibion et al. (2018) and Grothe and Meyler (2018) for the United States and the Euro Area, and Sousa and Yetman (2016) for EMDEs.
The next section examines trends in long-term (five-year-ahead) inflation expectations in advanced economies and EMDEs, from the 1990s to the present. It then assesses the anchoring of inflation expectations. It finds that while the expectations have become more firmly anchored during the past decade in both advanced economies and EMDEs, this has been less evident in EMDEs than in advanced economies. It also reports that inflation expectations in EMDEs are more sensitive to both global and domestic shocks than are inflation expectations in advanced economies, although sensitivity to global shocks has fallen in both groups of economies and sensitivity to domestic shocks has fallen in EMDEs.

The subsequent section identifies the main factors that determine the anchoring of inflation expectations. It presents evidence that inflation expectations are better anchored in both advanced economies and EMDEs when the central bank employs an inflation-targeting regime and is highly transparent. For EMDEs, low public debt and a high degree of trade openness are also associated with better anchoring of expectations, while the use of a fixed exchange-rate regime is associated with weaker anchoring of expectations. These results suggest that the institutions and framework of monetary policy, the macroeconomic environment (including fiscal policy), and structural characteristics all matter for the anchoring of long-term inflation expectations in EMDEs.

The penultimate section presents case studies on the experience of inflation targeting in Brazil, Chile, and Poland. The conclusions of the case studies are in line with the empirical findings. In Brazil, less-than-ideal fiscal conditions and worsening central bank transparency during part of the inflation-targeting period may have impeded the anchoring of expectations. By contrast, the combination of high central bank credibility and an effective fiscal framework may have helped anchor expectations in Chile. In Poland, the transition to a flexible exchange-rate regime concurrent with the adoption of inflation targeting may have helped to anchor expectations.

The final section concludes with a summary of major findings and a discussion of future research directions.

**Measuring inflation expectations**

Robust measurement is key to evaluating inflation expectations, and typically two sources exist. Survey-based measures are derived from surveys of households, firms, or professional forecasters, in which respondents are asked about their expectations for inflation at various horizons. Market-based measures are calculated from the prices of assets linked to prospective inflation. Each measure has its own advantages and drawbacks.
Survey-based measures

Surveys of households and firms. Among advanced economies, commonly referenced surveys of households’ inflation expectations include the University of Michigan’s Surveys of Consumers (monthly frequency for the United States), the European Commission’s consumer survey for the countries of the European Union (monthly), and the Bank of England’s consumer survey (quarterly) for the United Kingdom. High-frequency surveys of households’ or firms’ inflation expectations are also conducted by Australia, Canada, the Czech Republic, Italy, Japan, Republic of Korea, New Zealand, and Sweden. Among EMDEs, survey-based measures of households’ or firms’ expectations are produced by central banks in East Asia (e.g., Indonesia, the Philippines, and Thailand), Europe and Central Asia (e.g., Kazakhstan and Turkey), and in India and South Africa.

Surveys of professional forecasters. The most commonly used survey of professional forecasters is produced by Consensus Economics, which incorporates the views of more than 700 professional forecasters in 85 advanced economies and EMDEs. Consensus Economics publishes short-term expectations at a monthly frequency and long-term expectations at a semi-annual or quarterly frequency. Other surveys of professional forecasters include the Survey of Professional Forecasters by the Federal Reserve Bank of Philadelphia, which provides data on expectations up to 10 years ahead, and the European Central Bank’s Survey of Professional Forecasters. Central banks in several other economies (e.g., Argentina, Brazil, Iceland, Indonesia, Israel, Mexico, South Africa, and Turkey) also produce professional survey-based measures of inflation expectations. Surveys of inflation expectations in EMDEs typically have smaller samples than those in advanced economies, but the number of EMDEs included in Consensus Economics’ surveys has increased over time, from seven in 1990 to 52 in 2018.

Differences between surveys of households or firms and surveys of professional forecasters. On average, households’ and firms’ inflation expectations are higher than professional forecasters’ expectations in both advanced economies and EMDEs (Figure 4.1). The volatility of households’ inflation expectations is also

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2 Most survey results are presented as median responses. Discrepancies among respondents can be informative as a proxy of inflation uncertainty (Mankiw, Reis, and Wolfers 2003; Miles, Panizza, Reis, and Ubide 2017).

3 For the European Union, a dataset on inflation expectations has been collected by the European Commission since 2003. While it has been used for research purposes, it has not yet been published (Arioli et al. 2017). Some central banks (e.g., those of China, Romania, and Poland) release survey results showing the percentage of respondents who expect inflation to change.

4 In addition, Germany’s Ifo Institute has provided data on five-year-ahead inflation expectations for more than 70 countries since the end of 2014.

5 The IMF’s World Economic Outlook has the broadest country coverage of long-term inflation projections (39 advanced economies and 154 EMDEs).
larger than that of professional forecasts. Households’ beliefs about past inflation are found to be a strong predictor of their inflation expectations (Jonung 1981; Malmendier and Nagel 2016). Households’ inflation expectations are thus more backward looking than professional forecasters’ expectations.6

Several reasons for these differences have been suggested. First, households’ and firms’ expectations are subject to “sticky information,” and are updated more slowly than those of professional forecasts (Carroll 2003). Second, household surveys give the same weight to “informed” and “uninformed” consumers. Because uninformed consumers likely give excess weight to goods that are purchased frequently (e.g., food) or have highly visible price changes (e.g., gasoline), their assessment of inflation expectations can be biased upward when the prices of these products increase (Coibion and Gorodnichenko 2015; Coibion, Gorodnichenko, and Kamdar forthcoming; Sousa and Yetman 2016). Yet, surveys of households and firms also have important advantages relative to surveys of professional forecasters—for instance, they can be designed to include a large number of respondents, and have the flexibility to canvass different types of economic agents. For surveys of professional forecasters, bias may arise from respondents’ reluctance to reveal their expectations about inflation because they consider the information private (Cunningham, Desroches, and Santor 2010).

**Market-based measures**

The most commonly used market-based measure of inflation expectations is the break-even inflation rate—i.e., the difference between yields on comparable nominal and inflation-indexed bonds. In general, however, this difference consists of four components: expected inflation, an inflation risk premium, a liquidity premium, and other factors (Hördahl 2009; Christiansen, Dion, and Reid 2004). Hence, extracting expected inflation requires the use of strong assumptions, and any estimate of expected inflation is necessarily imprecise (Galati, Heemeijer, and Moessner 2011).

Another common market-based measure is the inflation swap rate based on derivative instruments, which again includes not only inflation expectations, but also the inflation risk premium and liquidity premium. A key advantage of the swap rate is that, unlike for break-even inflation rates, liquidity has a limited impact on its movements (Grothe and Meyler 2018). Both types of market-based measures have the advantage of being available at very high frequencies,

6 Afrouzi et al. (2015) and Kabundi, Schaling, and Some (2015) document that in New Zealand and South Africa, some firms do not understand the central bank’s objective function. Hence, even if professional forecasters’ expectations are well anchored by inflation targeting in these countries, the same is not necessarily true of firms’ inflation expectations. The latter may be more important for actual inflation because firms may incorporate expected marginal costs into their product prices.
FIGURE 4.1 Survey-based measures of inflation expectations: Country evidence

Inflation expectations derived from surveys of households tend to be higher, and their volatility larger, than inflation expectations derived from surveys of professional forecasters. This finding holds for both advanced countries and EMDEs where both types of surveys are conducted.

A. 1-year-ahead inflation expectations, selected advanced economies, average

B. 1-year-ahead inflation expectations, selected EMDEs, average

C. Volatility of 1-year-ahead inflation expectations, selected advanced economies

D. Volatility of 1-year-ahead inflation expectations, selected EMDEs

E. 5-year ahead inflation expectations, selected advanced economies, average

F. 5-year-ahead inflation expectations, South Africa

Sources: Bank of Japan; Bloomberg; Bureau of Economic Research, South Africa; Central Bank of the Philippines; Consensus Economics; Haver Analytics; International Monetary Fund; Reserve Bank of India; Reserve Bank of New Zealand; University of Michigan; World Bank.
A.C. Sample period is 2006H1-2018H1.
B.D. Sample period is 2007H2-2018H1.
C.D. Volatility is measured by standard deviation.
E. Sample period is 2009H1-2018H1.
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which may help policymakers develop an understanding of how inflation expectations are formed, and may be calculated at a wider range of forecast horizons than is possible using surveys. However, swap markets in EMDEs are typically insufficiently developed to allow such a measure to be reliably extracted. Therefore, central banks in several large EMDEs (e.g., Brazil, Chile, Colombia, Mexico, Peru, Poland, the Russian Federation, South Africa, Thailand, and Turkey) typically derive their market-based measures of inflation expectations from inflation-indexed government bonds (Sousa and Yetman 2016; De Pooter et al. 2014).

Differences between survey-based and market-based measures. In terms of the level of inflation expectations, those derived from surveys of professional forecasters are not systematically higher or lower than market-based measures (Figure 4.2). However, professional forecasters’ inflation expectations tend to be close to central bank inflation forecasts, as has been shown for New Zealand and United States (Coibion and Gorodnichenko 2015). In addition, the volatility of professional forecaster-based expectations tends to be lower than market-based expectations. During periods of market stress, break-even inflation rates can be particularly volatile because “flight-to-liquidity” flows raise demand for government bonds sharply. This could push nominal yields to extremely low levels and put strong downward pressure on measured break-even inflation rates (Hördahl 2009). Relative to survey-based measures of inflation expectations, an advantage of market-based measures is that they cannot be influenced by poorly crafted surveys.

Expectations measure used in this chapter

Due to the breadth of its country coverage and length of its time coverage, the main long-term inflation expectations series used in this chapter are the survey-based, five-year-ahead expectations produced on a semi-annual basis by Consensus Economics. In the empirical work, the change in long-term inflation expectations is measured as the difference between five-year-ahead inflation expectations in the current period and five-year-ahead inflation expectations in the previous period (i.e., six months prior).

Literature on inflation expectations

Theories of inflation expectations have mainly focused on how expectations reflect public and private information. There remain different views on which
FIGURE 4.2 Survey-based and market-based measures of inflation expectations: Country evidence

Across countries, inflation expectations derived from surveys of professional forecasters are not systematically higher or lower than market-based measures of expectations. However, the volatility of market-based inflation expectations tends to be higher than that of survey-based expectations in both advanced economies and EMDEs.

A. 5-year-ahead inflation expectations, selected advanced economies, average

B. 5-year-ahead inflation expectations, selected EMDEs, average

C. Volatility of inflation expectations, selected advanced economies

D. Volatility of inflation expectations, selected EMDEs

Sources: Bloomberg, Consensus Economics, International Monetary Fund, World Bank.
A.-D. Market-based inflation expectations are inflation swap rates (five-year, five-year forward) for advanced economies and break-even inflation rates (five-year-ahead) for EMDEs.
A.C. Sample period is 2007H1-2018H1.
B.D. Sample period is 2012H2-2018H1.
C.D. Volatility is measured by standard deviation.

conceptual framework is best. Empirical studies, most of which have focused on advanced economies, concentrate on testing the implications of the theoretical literature and on evaluating the degree of expectation anchoring.

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8 Coibion, Gorodnichenko, and Kamdar (forthcoming) and Mankiw and Reis (2018) survey the literature on the formation of expectations. Annex 4.1 presents a brief overview of how views on the linkages between inflation expectations and monetary policy have evolved over time.

9 Annex 4.2 lists a number of empirical studies on the evolution, determinants, and anchoring of inflation expectations in advanced economies and EMDEs.
Conceptual considerations

The theoretical literature on the determinants of inflation expectations ranges from models that assume agents have “full-information rational expectations” (FIRE) to models that allow for constraints on agents’ ability to process information.\(^\text{10}\) There is still no consensus on an ideal framework to describe how inflation expectations are determined (Mankiw and Reis 2018).

With its simple formulation of the relationship between inflation and economic activity, the New Keynesian model has been used extensively in policy and academic circles. However, it has also been subject to criticism—in particular, that it does not take into account the constraints that economic agents typically face in forming their expectations about inflation. For example, Friedman (1979) argues that FIRE does not explain how “economic agents derive the knowledge which they then use to formulate expectations.”

FIRE models have also been criticized for their inability to explain the persistence of inflation that is usually found in the data. These criticisms have led to two alternate approaches in modelling the role of information in the formation of inflation expectations: the sticky-information model and the noisy-information model. In the sticky-information model, forecasts are updated slowly because acquiring information is costly (Mankiw and Reis 2002). The assumption of sticky-information flow can be rationalized in terms of an “epidemic” model of news diffusion (Carroll 2003).\(^\text{11}\)

Models of noisy information and rational inattention instead assume that economic agents continuously update their information but either receive imperfect “noisy” signals or do not pay attention to all news (Woodford 2002; Sims 2003; Maćkowiak and Wiederholt 2009; Coibion, Gorodnichenko, and Kamdar 2018). Departures from the full-information assumption can also be rationalized in the context of “learning” models which assume that agents need to use statistical methods to learn about the central bank’s objective function and the overall structure of the economy (Evans and Honkapohja 2009).\(^\text{12}\)

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\(^{10}\) Agents with FIRE are assumed to understand perfectly the structure and functioning of the economy and the policymakers’ objective function (Bernanke 2007).

\(^{11}\) In the “epidemic” model, households’ inflation forecasts are affected by media and professional inflation forecasts.

\(^{12}\) Coibion, Gorodnichenko, and Kamdar (forthcoming) discuss models featuring other departures from full-information rational expectations, including bounded-rationality and adaptive-learning models. Models with bounded rationality assume that agents build a simplified model of the world, paying attention to only some of the relevant variables. Adaptive-learning models assume that agents behave like econometricians, using the available information at the time of the forecast and following a specific updating mechanism.
On the operational side, the assumption that a fraction of firms is not fully rational and instead sets prices using a rule of thumb that depends on past inflation led to the development of the hybrid New Keynesian Phillips curve. In this specification, current inflation depends on both expected and lagged inflation (Fuhrer and Moore 1995; Gali and Gertler 1999). In particular, the model takes into account backward- and forward-looking inflation expectations (i.e., inflation expectations are determined by past inflation and by expectations about those variables viewed as determining actual inflation). Some specifications of the model also control for foreign inflation (e.g., IMF 2016).

Besides fitting the data better, the hybrid New Keynesian Phillips curve is well suited to the reality of constantly evolving economic structures. While the standard New Keynesian Phillips curve implies that long-run inflation expectations do not respond to news because the public knows the long-run equilibrium, the hybrid curve is consistent with an environment in which the structure of the economy is not perfectly understood by policymakers or the public. The hybrid curve also can fit environments in which the central bank’s objective function is not completely known by economic agents or it is not optimal for all agents to constantly update their information (Bernanke 2007; Afrouzi et al. 2015).\footnote{The presence of lagged inflation in the hybrid New Keynesian Phillips curve signifies that the central bank is not fully credible; this lack of credibility impairs the effectiveness of monetary policy (Ball 1995; Woodford 2005).}

Learning models and models of noisy information also allow for a more sophisticated formalization of the drivers of expectation anchoring. For example, these types of models imply that long-run expectations will be well anchored—and thus will not respond to news—if private agents are confident about their estimates of future inflation. In an inflation-targeting framework, the anchoring of expectations is therefore related to the public’s confidence that the central bank is willing and able to reach the target.\footnote{Demertzis and Viegi (2008) present a model in which a monetary policy regime with well-defined objectives (such as an inflation target) could help improve the anchoring of inflation expectations.}

**Empirical evidence**

**Formation of expectations.** One strand of studies examines the empirical relevance of the sticky-information and noisy-information models. Mean inflation forecasts from professional forecasters, consumers, firms, and central bankers have all been found to respond to macroeconomic shocks with a delay (Coibion and Gorodnichenko 2012). Because mean forecasts adjust gradually, it
is possible to predict ex post forecast errors using ex ante changes in mean expectations (Coibion and Gorodnichenko 2015). Carroll (2003) shows that households’ inflation expectations are updated slowly, and are updated in part based on media coverage of professional forecasters’ inflation projections.

Another strand of studies examines the relevance of forward- and backward-looking expectations in the hybrid New Keynesian Phillips curve. Backward-looking inflation expectations have been shown to not matter (i.e., the associated coefficient is not statistically significant) if the trend inflation is determined by the long-run inflation target (Cogley and Sbordone 2008). Similarly, if the new Keynesian model accounts for positive trend inflation, price-setting firms become more forward-looking and the inflation rate becomes less sensitive to current economic conditions as trend inflation increases (Ascari and Sbordone 2014).

**Anchoring of inflation expectations in advanced economies.** A transparent central bank communicates to the public its intent, strategy, assessments, procedures and policies in an open, clear and timely manner. An inflation-targeting regime provides a disciplined framework that helps improve monetary policy transparency. Broadly, the empirical work on advanced economies suggests that monetary regimes that increase central bank transparency, including through inflation targeting, are associated with a decrease in the persistence of movements of inflation away from trend.

For example, in Canada, New Zealand, Sweden, and the United Kingdom, inflation persistence disappeared after the adoption of an inflation-targeting regime (Benati 2008). In the United States, on the other hand, where inflation targeting had not yet been adopted, the persistence parameter remained low but positive and statistically significant. These results are corroborated by Gürkaynak, Levin, and Swanson (2010), who show that the response of market-based inflation expectations to macroeconomic news was larger in the United States than in Sweden and the United Kingdom. They also show that in the United Kingdom, expectations became better anchored after the Bank of England’s monetary policy was made operationally independent in May 1997. Moreover, increased trust in the European Central Bank has been associated

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15 Bernanke (2007) argues that the decline in the volatility of the trend component of inflation, as estimated by the approach of Stock and Watson (2007, 2016), is consistent with the view that inflation expectations have become better anchored. Employing the New Keynesian model, Ascari and Sbordone (2014) show that the inflation rate becomes less sensitive to current economic conditions when trend inflation makes price-setting firms more forward-looking. Trend inflation could instead be measured with long-term inflation expectations (Clark and Nakata 2008; Garnier, Mertens, and Nelson 2015; Mertens 2016).
with a decline in uncertainty about future inflation in the Euro Area, thus contributing to the anchoring of inflation expectations (Christelis et al. 2016).  

Other research studies the conditions under which inflation may not be well anchored under an inflation-targeting regime. For example, even with an inflation-targeting framework, expectations have not been well anchored in New Zealand when forecasters did not understand the central bank’s objective function (Afrouzi et al. 2015). Inflation expectations in 10 advanced economies have not been as well anchored during periods of persistently below-target inflation than during periods when inflation is close to target (Ehrmann 2015).

Several studies have examined whether inflation expectations became unanchored during and after the global financial crisis, which was followed by a wave of unconventional monetary policy actions. During the period immediately following the crisis, market-based inflation expectations in the United States and the United Kingdom became more sensitive to macroeconomic news, but neither survey-based nor market-based long-term inflation expectations in the Euro Area became unanchored (Galati, Heemeijer, and Moessner 2011; Galati, Poelhekke, and Zhou 2011).

During a longer post-crisis period in the Euro Area, when inflation fell and was persistently below target, there is evidence that the anchoring of inflation expectations weakened (Grishchenko, Mouabbi, and Renne 2017; Garcia and Werner 2018). The findings, which are based on different methodologies and different measures of inflation expectations, are less consistent for the United States, where anchoring is alternately found to have improved and to have deteriorated significantly in the post-crisis period (Ciccarelli, Garcia, and Montes-Galdón 2017; Grishchenko, Mouabbi, and Renne 2017). Overall, given the size of the shocks during the crisis, expectations in advanced economies remained fairly well anchored (Miles et al. 2017).

**Anchoring of inflation expectations in EMDEs.** Evidence on the anchoring of inflation expectations in EMDEs is more limited, but some studies also suggest that inflation targeting plays a role (Annex 4.2). Using monthly survey data from

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16 An alternative way to assess the anchoring of inflation expectations is to employ Stock and Watson’s (2007, 2016) approach, which decomposes the inflation process into trend and volatility components. Data for Japan, the United Kingdom, and the United States show that shocks to trend inflation are persistent (and can be modelled as a unit root process) but that the volatility of trend inflation declined markedly during the 1980s (Miles et al. 2017). These findings are consistent with the finding that inflation expectations have become more firmly anchored than in the past, though not perfectly so.

17 Strohsal and Winkelmann (2015) examine the anchoring of inflation expectations as well as the sensitivity to news shocks using a sample of four advanced economies. They find that the degree of anchoring did not change during the crisis.
Consensus Economics for a sample of 22 EMDEs and 14 advanced economies in a structural VAR model, Davis (2014) finds evidence that the introduction of inflation targeting is associated with a statistically significant reduction in the response of 12-month-ahead inflation expectations to shocks in both oil prices and observed inflation. Using market-based measures of inflation expectations for Brazil, Chile, and Mexico, De Pooter et al. (2014) document that long-term inflation expectations became better anchored in these countries over the preceding decade, especially in Chile and Mexico. While they do not specifically test for the role of inflation targeting, they ascribe this result to recent improvements in the credibility of these countries’ central banks.

IMF (2016) estimates a hybrid New Keynesian Phillips curve using data from a large sample of countries (24 advanced economies and 20 EMDEs). It reports that although the coefficient on lagged inflation (backward-looking expectations) started declining in the mid-1990s, there was a reversal in this trend in the aftermath of the Great Recession, with the coefficient returning close to its value in the early 1990s. This study also finds that the sensitivity of inflation expectations to macroeconomic news (proxied by the difference between expected and realized inflation) is negatively correlated with standard measures of central bank independence and transparency, and that expectations become better anchored when countries adopt an inflation-targeting regime. IMF (2018) reports that multiple measures of the degree of anchoring of inflation expectations point to an improvement in the anchoring of expectations over the past two decades. However, there has been considerable heterogeneity in the extent of anchoring across emerging market economies.

In the context of Brazil, the literature examines a wide range of factors that might diminish the beneficial effects of inflation targeting on anchoring, broadly

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18 Estimations that allow for time-varying coefficients indicate that, while inflation expectations are better anchored in advanced economies than in EMDEs, anchoring has improved in both groups over time (IMF 2016). Other studies offer similar findings. Capistrán and Ramos-Francia (2010) and Mehrotra and Yetman (forthcoming) conclude from data for a large sample of EMDEs that inflation targeting has affected inflation expectations. Studies of Mexico, Brazil, and South Africa find that the adoption of inflation targeting has helped anchor expectations in each case (Carrasco and Ferreiro 2013, Cerisola and Gelos 2009, and Reid 2009, respectively). However, Kabundi, Schaling, and Some (2015) show that, in South Africa, even with inflation targeting, expectations of price and wage setters (businesses and trade unions) were higher than the upper bound of the official target band, while expectations of analysts were within the target band. This study also finds that expectations of price and wage setters were substantially influenced by lagged inflation but that those of analysts were not.

19 IMF (2018) focuses on four measures: absolute deviation of three-year-ahead inflation forecast from target, variability of inflation forecasts, dispersion of inflation forecasts, and sensitivity to inflation shocks. In the context of a small macroeconomic model, IMF (2018) also shows that better-anchored inflation expectations reduce inflation persistence and limit the pass-through of currency movements to domestic prices.
concluding that central bank transparency, central bank credibility, and the country’s fiscal position are all important in shaping inflation expectations. de Mendonça and Galveas (2013) show that, when controlling for central bank transparency, the forward-looking and hybrid specifications of the Phillips curve are more suitable for explaining current inflation than the purely backward-looking specifications. Yet inflation expectations react more strongly to actual inflation, exchange-rate movements, and output shocks when there is a problem of central bank credibility (Cortes and Paiva 2017). A deterioration in the fiscal position could also impede the anchoring of inflation expectations because of fears that monetary policy will be constrained, especially in cases where high interest rates imply unstable public debt dynamics (Cerisola and Gelos 2009; de Mendonça and Veiga 2014).

**Inflation expectations: Trends and anchors**

Inflation expectations can provide valuable evidence about the credibility of a central bank. As documented by many studies, there is a close link between inflation expectations and monetary policy effectiveness. The more credible households and firms consider the central bank, the more likely inflation expectations are well anchored. In turn, well-anchored inflation expectations are found to support the effectiveness of monetary policy. Assessing and improving the degree of anchoring of inflation expectations are thus critical tasks for monetary policymakers.

**Evolution of inflation expectations**

In both advanced economies and EMDEs, long-term (five-year-ahead) inflation expectations have fallen during the past two to three decades. After declining rapidly during the 1990s, inflation expectations in advanced economies have remained stable at around 2 percent a year since the mid-2000s, with very little cross-country variation (Figure 4.3). In EMDEs, inflation expectations decreased markedly in the second half of the 1990s. Though they have not regained their mid-1990s peak, expectations trended upward from 2005 to 2014, before retreating somewhat in recent years. Throughout the entire sample period, inflation expectations in EMDEs displayed wider cross-country dispersion than in advanced economies, as did measures of central bank transparency. However, the rise in inflation expectations during 2005-14 coincided with an improvement in central bank transparency in EMDEs as a group.

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20 Using a dynamic stochastic general equilibrium model calibrated to the United States, Eusepi and Preston (2018a, 2018b) conclude that government liabilities can reduce the effectiveness of monetary policy in controlling inflation in economies with high government debt under imperfect knowledge.
Differences in anchoring between advanced economies and EMDEs. If inflation expectations are well anchored, they should be relatively insensitive to news, because economic agents assume that transitory shocks do not affect inflation over the long run. The degree of anchoring can be assessed empirically by regressing changes in five-year-ahead inflation expectations on macroeconomic news. Relevant news can be proxied by inflation shocks—the difference between realized inflation and short-term inflation expectations in the previous period (i.e., six months prior). Following earlier studies, this chapter employs two simple empirical strategies to study the extent of anchoring inflation expectations: a panel regression model with country and time fixed effects, and a time-varying model that provides a flexible framework to track time variation in the degree of anchoring (Annex 4.3). The first approach provides an overview of how well expectations are anchored in different country groups (e.g., advanced economies versus EMDEs) and time periods. The second approach shows how country-specific and time-varying measures of the degree of anchoring have evolved.

The empirical exercises produce three major results. First, the sensitivity of long-term (five-year-ahead) inflation expectations to inflation shocks in both advanced economies and EMDEs is greater than zero for the 1990-2018 period, indicating imperfect anchoring of inflation expectations (Figure 4.4; Annex 4.4). Second, the sensitivity is lower in advanced economies than in EMDEs, and the difference in sensitivity between these two groups is statistically significant. This finding, which indicates that expectations are better anchored in the advanced economies, is consistent with the view that monetary policy is less credible in EMDEs than in advanced economies.

Third, in both country groups, inflation expectations have become better anchored over time (i.e., coefficients for both country groups are statistically significantly smaller in the latter time periods). Especially during 2005-18, expectations in advanced economies are found to have been very well anchored (the coefficient is not statistically significantly different from zero). In EMDEs,

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21 The sensitivity of long-term inflation expectations to inflation shocks is used in this chapter to measure the degree of anchoring of inflation expectations. This measure is employed in several previous studies (Beechey, Johannsen, and Levin 2011; Galati, Podhke, and Zhou 2011; Gürkaynak, Levin, and Swanson 2010; IMF 2016; García and Werner 2018; De Pooter et al. 2014). Other previous studies employ different measures of anchoring of inflation expectations: the deviation of long-term inflation expectations from an inflation target (Buono and Formai 2018; Bordo and Siklos 2017), variance of inflation expectations (Grishchenko, Mouabbi, and Renne, 2017), and dispersion of inflation forecasts (Capistrán and Ramos-Francia 2010). These measures are highly correlated (IMF 2018). The measure employed here is useful for at least three reasons: it is available for a large sample of countries, it can be used in a time-varying model, and the findings using it can be compared to others in the literature.
FIGURE 4.3 Long-term inflation expectations

Long-term (five-year-ahead) inflation expectations in advanced economies declined during the 1990s. Since the mid-2000s, they have remained stable at around 2 percent, with limited cross-country variation. Inflation expectations in EMDEs also fell in the second half of the 1990s, but have risen somewhat since 2005, and remain higher than in advanced economies. Inflation expectations in EMDEs also display wider cross-country dispersion. Among EMDEs, those with highly transparent central banks have relatively lower expectations.

Sources: Consensus Economics, Dincer and Eichengreen (2014), International Monetary Fund, World Bank.
A. Inflation expectations are five-year-ahead expectations of annual inflation.
B. Based on a sample of 24 advanced economies during 1990H1-2018H1.
C. Based on a sample of 24 advanced economies.
D. F. Based on a sample of 23 EMDEs.
E. Share of economies with declines in inflation expectations, 1995-2018
F. High (low) transparency countries are defined as those with central bank transparency above the 75th (below the 25th) percentile of EMDEs.

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anchoring improved markedly during 2005-18, despite the slight increase in inflation expectations in these economies since 2005.

Roles of global and domestic shocks in anchoring inflation expectations

The time-varying model described above is extended to estimate the response of inflation expectations to shocks from two sources, global and domestic. Examples of domestic shocks include unexpected electoral outcomes, wage disputes, and currency movements. Global shocks (surprises) could stem from sudden movements in food prices, oil prices, global economic activity, and financial conditions in major advanced economies. In the model, a global inflation shock is defined as the first principal component of national inflation shocks for the full sample of countries (Annex 4.3). A domestic inflation shock is defined as the residual from a regression of the national inflation shock on the global inflation shock.

The regressions produce four major results (Figure 4.5). First, for the median economy in each country group, the sensitivity of inflation expectations to both types of shocks is positive, indicating imperfect anchoring. Second, in the case of advanced economies, there was a gradual decline in the sensitivity of inflation expectations to global shocks from the 1990s to the late 2000s, followed by a large one-time drop during the global financial crisis. There was a much less pronounced downward trend in the sensitivity of inflation expectations to domestic shocks than to global shocks. These results imply that, in advanced economies, the improved anchoring of expectations has been partly driven by the reduction in the sensitivity of inflation expectations to global shocks.

Third, for EMDEs, the sensitivity of inflation expectations to domestic shocks gradually fell during 2005-12, and since 2012 has been stable. There has also been a slight decline in the sensitivity of expectations to global shocks since 2000. Finally, inflation expectations appear to be more sensitive to both global and domestic shocks in EMDEs than in advanced economies, implying weaker anchoring of expectations in the former group. The robustness of the results is tested by replacing the global shock, as described above, with an oil price shock, food price shock, global liquidity shock and global output gap shock. These exercises lead to broadly consistent findings with the headline results.

De Pooter et al. (2014) examine how foreign and domestic news surprises affect (market-based) inflation expectations in Brazil, Chile, and Mexico, using daily data. In their framework, foreign news surprises stem from macroeconomic developments in the United States and China and fluctuations in oil and food prices. They report that U.S. non-farm payroll data releases have a significant impact on long-term inflation expectations in Chile and Mexico, while there is no corresponding impact in Brazil. The impact of news related to oil and food prices is not statistically significant.
FIGURE 4.4 Sensitivity of inflation expectations to inflation shocks

The sensitivity of long-term inflation expectations to inflation shocks has fallen in the past decade in both advanced economies and EMDEs but remains comparatively higher in EMDEs. A similar pattern is observed when measuring the sensitivity of expectations using a time-varying model.

A. Sensitivity of inflation expectations to inflation shocks

B. Sensitivity of inflation expectations to inflation shocks, all countries

C. Sensitivity of inflation expectations to inflation shocks, advanced economies

D. Sensitivity of inflation expectations to inflation shocks, EMDEs

A.-D. Inflation expectations are five-year-ahead expectations of annual inflation. Inflation shocks are defined as the difference between realized inflation and short-term inflation expectations in the previous period.
A. Sensitivity is estimated using a panel regression of the change in five-year-ahead inflation expectations on inflation shocks, as described in Annex 4.3. Bars denote medians and vertical lines denote 90 percent confidence intervals. Based on a sample of 24 advanced economies and 23 EMDEs during 1990H2-2018H1.
B.-D. Time-varying sensitivity is estimated by regressing the change in five-year-ahead inflation expectations on inflation shocks, as described in Annex 4.3. Solid lines denote the median of estimates and the dotted lines indicate the median of 68 percent confidence intervals.
B. Based on a sample of 24 advanced economies and 23 EMDEs during 2000H1-2018H1.
D. Based on a sample of 23 EMDEs during 2000H1-2018H1.

Determinants of anchoring expectations

The improved anchoring of five-year-ahead inflation expectations over time in advanced economies and EMDEs, as suggested by the time-varying model in the previous section, may be associated with policy reforms aimed at increasing central bank credibility since the early 1990s (Mishkin 2007). Using the estimated sensitivity of inflation expectations above as a dependent variable,
Inflation shocks can be associated with both global and domestic factors. Long-term inflation expectations in EMDEs are more sensitive to both global and domestic shocks than are inflation expectations in advanced economies.

Sources: World Bank.
A.-F. Inflation expectations are five-year-ahead expectations of annual inflation.
A.-F. Time-varying sensitivity is estimated by regressing the change in five-year-ahead inflation expectations on inflation global and domestic shocks, as described in Annex 4.3. Solid lines denote the median of estimates and the dotted lines indicate the median of 68 percent confidence intervals.
E.F. Based on a sample of 23 EMDEs during 2000H1-2018H1.
panel regression models are used to assess which factors determine the degree of anchoring of expectations (Annex 4.3). Explanatory variables in the models include the presence of an inflation-targeting regime, central bank transparency, the presence of a fixed exchange-rate regime, financial openness, trade openness, and fiscal sustainability.

**Inflation targeting and central bank transparency.** If central banks in advanced economies are perceived as credible, it is possible for them to successfully anchor inflation expectations without explicit inflation targets or formal transparency rules. However, in EMDEs, where central banks still need to build credibility, explicit targets and transparency rules are more likely to be necessary to anchor expectations. The regression results show that the coefficient on inflation targeting is statistically significant and negative, meaning it is associated with lower sensitivity of inflation expectations to shocks (Figure 4.6). For central bank transparency, the coefficient is only statistically significant and negative for the full sample of countries and the EMDE sub-sample. Central bank transparency has improved in EMDEs over the past two decades. In advanced economies, while the degree of central bank transparency is higher than EMDEs, it has not changed much during this period.

**Financial integration and exchange-rate regime.** Financial integration appears to exert a disciplining effect on macroeconomic policy (Tytell and Wei 2004; Gupta 2008; Kose et al. 2010). For example, integration could raise the cost of loose monetary policy in the form of larger capital outflows. On the other hand, more financially open economies are more vulnerable to external shocks, which may make it more difficult for policymakers to anchor inflation expectations. The results indicate that the correlation between financial openness and the anchoring of inflation expectations is not statistically significant for the full sample of countries or for the EMDE subsample. However, as documented above, long-term inflation expectations in EMDEs are more sensitive to global shocks. Hence, large external shocks could offset the benefits of financial integration to anchoring expectations in EMDEs.

The use of pegged exchange rates might be a signal for a credibility crutch in countries with limited monetary policy credibility (Levy Yeyati, Sturzenegger, and Reggio 2010). As is well-known from the impossible trinity argument, employing a fixed exchange-rate regime when capital movements are free could

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23 Capistrán and Ramos-Francia (2010) also find that inflation targeting affects inflation expectations only in EMDEs, with no effect on the dispersion of inflation expectations in advanced economies. They argue that given the recent relative stability of inflation in advanced economies, professional forecasters may have homogeneous views about future inflation, so that the dispersion remains unchanged even after the introduction of an explicit inflation target.
FIGURE 4.6 Determinants of the sensitivity of inflation expectations to shocks

Long-term inflation expectations in EMDEs are found to be better anchored in the presence of an inflation targeting regime, a high degree of central bank transparency, low public debt, and a high degree of trade openness.

A. Impact of inflation-targeting regime (dummy) on sensitivity of inflation expectations

B. Impact of one-unit increase in central bank transparency index on sensitivity of inflation expectations

C. Impact of fixed exchange-rate regime (dummy) on sensitivity of inflation expectations

D. Impact of one-unit increase in financial openness index on sensitivity of inflation expectations

E. Impact of 10 percentage point increase in public debt-to-GDP ratio on sensitivity of inflation expectations

F. Impact of 10 percentage point increase in trade openness (import penetration) on sensitivity of inflation expectations


A.-D. Inflation expectations are five-year-ahead expectations of annual inflation. Bars denote coefficients of panel regressions of 24 advanced economies and 23 EMDEs using annual data for 1995-2016, as described in Annex 4.3. Vertical lines denote 90 percent confidence intervals.

D. Financial openness x exchange-rate regime is the interaction of these two explanatory variables.

E.F. Bars denote coefficients of group mean panel fully modified OLS (FMOLS) and group mean dynamic OLS (DOLS) regressions of 24 advanced economies and 23 EMDEs using annual data for 1995-2016, as described in Annex 4.3. Vertical lines denote 90 percent confidence intervals.

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hamper the independence of monetary policy. While the exchange-rate regime by itself does not appear to be relevant for anchoring inflation expectations, the results show that when financial openness is interacted with the fixed exchange-rate regime dummy, the interaction term becomes significant. This result suggests that the exchange-rate regime does matter for anchoring inflation expectations in more financially open economies.

**Trade integration.** Trade integration could affect inflation expectations through competition in product markets that could increase the responsiveness of domestic prices to shocks. For example, one line of research finds that higher price flexibility steepens the Phillips curve, reducing the short-run output gain from a monetary expansion, and lowering the incentive for central banks to adopt inflationary policies (Romer 1993; Rogoff 2006). Alternatively, outsourcing of labor through global value chains may reduce the responsiveness of wages to domestic labor market conditions and hence flatten the Phillips curve (Blanchard, Cerutti, and Summers 2015; Blanchard 2016; Miles et al. 2017). However, at least for the United States, lower marginal costs, rather than globalization, are the key driver of the flattening of the Phillips curve.

The regression results show that the correlation between import penetration and sensitivity of inflation expectations to shocks is negative and statistically significant for the sub-sample of EMDEs. Thus, for EMDEs only, the anchoring of inflation expectations improves as import penetration rises, consistent with theories suggesting that globalization is associated with improved anchoring.

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24 The impossible trinity is the argument that a country cannot have more than two of the following fixed exchange rate, free capital movement, and independent monetary policy. As a result, countries with inflation targeting regimes typically also operate with flexible exchange rates (De Gregorio 2009a).

25 The baseline regressions use Chinn and Ito’s (2017) *de jure* measure of financial openness and Shabaugh’s (2004) classification of exchange-rate regime. The baseline results do not change when a *de facto* measure of capital account liberalization (sum of foreign assets and liabilities as percent of GDP) and an alternative measure of exchange-rate regime classification (from Ilzetzki, Reinhart, and Rogoff 2017) are used as explanatory variables.

26 The empirical literature examining whether globalization affects domestic inflation produces mixed results. For example, Calza (2009) and Ihrig et al. (2010) find no robust evidence that global slack affects the parameters of the inflation process. Gaiotti (2010) finds that the flattening of the Phillips curve is due to globalization. In contrast, Borio and Filardo (2007) argue that global slack may become a key driver of domestic inflation, while Auer, Borio, and Filardo (2017) show that the rise of global value chains has amplified the importance of global slack in driving domestic inflation. Forbes (2018) suggests that inflation models should allow key global factors, including global slack, to adjust over time. As a robustness check, government effectiveness (measured by the World Bank’s Worldwide Governance Indicators) is also included as an explanatory variable in the regressions here. It is not statistically significant.

27 Using a New Keynesian model, Martínez-García (2017) argues that the impact of globalization on monetary policy effectiveness is underestimated if one uses the standard trade openness measures and that what matters is the elasticity of substitution between locally produced and imported goods.
Fiscal sustainability. Inflation expectations are unlikely to be well anchored if there are questions about fiscal sustainability because of fears that monetary policy will be constrained, especially in cases where high interest rates imply unstable public debt dynamics. The regression results for the full sample of countries, and for the EMDE sub-sample, are consistent with this prediction, showing a positive and statistically significant correlation between the ratio of public debt to GDP and the sensitivity of long-term inflation expectations to inflation shocks.28

Anchoring expectations: Country experiences

The findings from the empirical exercises on the degree and determinants of inflation anchoring in advanced economy and EMDE country groups are broadly consistent with the behavior of inflation expectations at the country level. Yet there are still lessons to be learned from individual countries’ experiences.

Among advanced economies, the sensitivity of inflation expectations to inflation shocks tends to be lower under inflation targeting. Yet, at the country level, inflation targeting does not necessarily guarantee firm anchoring of inflation expectations (Figure 4.7). In Canada, New Zealand and the United Kingdom, for instance, the sensitivity of expectations to inflation shocks has been close to zero since 2000. In these countries, the early introduction of inflation targeting may have helped anchor expectations.29 Japan has had difficulty anchoring expectations after introducing its inflation-targeting regime in 2013, perhaps because of its recent history of persistently low inflation. Inflation expectations are not as well anchored under persistently below-target inflation as when inflation is close to target (Ehrmann 2015).

In the Euro Area, where the ECB’s main objective since its inception in 1999 has been to maintain price stability (defined as inflation of less than, but close to, 2 percent in the medium term), the sensitivity of inflation expectations was

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28 de Mendonça and Veiga (2014) argue that even under an inflation-targeting regime, interest rate hikes to reach target inflation imply increases in the primary surplus required for stabilizing the public debt, and that this fiscal deterioration could constrain monetary policy. These authors also show that the public-debt-to-GDP ratio has a statistically significant relationship with deviation between inflation and its target.

29 New Zealand, Canada, the United Kingdom, and Korea introduced inflation targeting in 1990, 1991, 1992, and 1998, respectively. Afrouzi et al. (2015) argue that expectations (based on firm-level data rather than those of professional forecasters) are not well anchored in New Zealand because forecasters do not understand the central bank’s objective function. Yetman (2017) and Beaudry and Ruge-Murcia (2017) find that the implementation of inflation targeting in Canada and the United Kingdom has been more successful than that in other inflation targeting countries.
lower than that in the United States in 2005 (Beechey, Johannsen, and Levin 2011). This pattern reversed in 2010-15, when sensitivity in the United States was close to zero—lower than that in the Euro Area—due in part to persistent undershooting of the ECB target, and perhaps also to the U.S. Federal Reserve’s adoption of an official inflation target in 2012.\footnote{Garcia and Werner (2018) find that there has been a decline in the extent of anchoring inflation expectations in the Euro Area since 2013.}

The record of EMDE central banks in anchoring inflation expectations under inflation-targeting regimes has been mixed. Annex 4.5 provides case studies for Brazil, Chile, and Poland. In Brazil, although long-term inflation expectations have been relatively stable under the inflation-targeting regime that began in 1999, the sensitivity of expectations to shocks remains elevated relative to that in Chile and Poland. Less-than-ideal fiscal conditions and worsening central bank transparency during part of the inflation-targeting period may have contributed to this outcome (Cerisola and Gelos 2009; de Mendonça and Galveas 2013; de Mendonça and Veiga 2014).

Chile, in contrast, has had considerable success; the sensitivity of inflation expectations to shocks has for some years been close to the median for advanced economies. The gradual introduction of inflation targeting in the 1990s gave the central bank time to build its credibility. From the outset of the inflation-targeting regime, the central bank pursued a robust communications effort that included the publication of a quarterly Monetary Policy Report with strong analytical content.\footnote{For instance, the Central Bank of Chile’s quarterly inflation report included, from its inception, inflation forecasts with confidence intervals displayed in fan charts of the type pioneered by the Bank of England (Mishkin 2007).} Chile’s adoption of an inflation target as part of a comprehensive, credible macroeconomic policy framework may have helped generate favorable macroeconomic outcomes (De Gregorio, Tokman, and Valdés 2005; Valdés 2007).

Poland has also succeeded with inflation targeting, which it began in 1999, even though domestic financial markets were immature and the central bank had limited knowledge of monetary policy transmission at the time of introduction. The transition to a flexible exchange-rate regime concurrent with the adoption of inflation targeting may have helped to anchor expectations. Over time, inflation expectations fell, eventually settling near the policy target rate, and the sensitivity of expectations to shocks became quite low.

In India and South Africa, the sensitivity of inflation expectations to shocks fell markedly after the introduction of inflation targeting. In South Africa, the
Inflation targeting does not guarantee the anchoring of long-term inflation expectations. However, sensitivity to inflation shocks in advanced economies with inflation targets tends to be low. The success of EMDE central banks in anchoring inflation expectations under inflation targeting has been mixed.

A. Sensitivity of inflation expectations to inflation shocks, advanced economies (1)

B. Sensitivity of inflation expectations to inflation shocks, advanced economies (2)

C. Sensitivity of inflation expectations to inflation shocks, Europe and Central Asia

D. Sensitivity of inflation expectations to inflation shocks, Latin America

E. Sensitivity of inflation expectations to inflation shocks, India

F. Sensitivity of inflation expectations to inflation shocks, South Africa

A-F. Inflation expectations are five-year-ahead expectations of annual inflation. Time-varying sensitivity is estimated by regressing long-term inflation forecast revisions on inflation shocks. Vertical lines denote 68 percent confidence intervals. Model is described in Annex 4.3.
B. Euro Area here comprises Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, and Spain.

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combination of inflation targeting and consistently high central bank transparency may have been key to anchoring expectations.\footnote{Kabundi, Schaling, and Some (2015) and Miyajima and Yetman (2018) show that, even in the presence of inflation targeting framework, expectations of price setters (business and unions) in South Africa are higher than the upper bound of the official target band, while expectations of analysts are within the target band. In addition, expectations of price setters put a greater weight on past inflation, whereas analysts’ expectations are more forward looking.} In India, however, lagged inflation, as well as current and lagged changes in fuel and food prices, have been found to significantly affect inflation expectations (Benes et al. 2017; Patra and Ray 2010).

Mexico has been less successful than Chile in anchoring inflation expectations under an inflation-targeting regime. The Bank of Mexico did not publish its own inflation forecasts for several years after adopting inflation targeting (Batini and Laxton 2006; De Pooter et al. 2014). Over time, however, the central bank’s communication strategy has improved, and it now publishes its inflation forecasts and releases the minutes of its monetary policy meetings (Carrasco and Ferreiro 2013). Finally, in Russia, high, positive sensitivity of inflation expectations to inflation shocks may reflect low central bank transparency (Dincer and Eichengreen 2014). However, Russia is relatively new to inflation targeting, having introduced the regime in 2015.

**Conclusion**

This chapter contributes to the literature on inflation expectations in EMDEs by answering three questions. First, how does the degree of anchoring of long-term inflation expectations differ between advanced economies and EMDEs? Second, how sensitive are inflation expectations to global and domestic shocks? Third, what are the main determinants of the degree of anchoring of inflation expectations? The principal conclusions are:

- Long-term inflation expectations have declined and become more firmly anchored in the past two decades in both advanced economies and EMDEs. However, anchoring in EMDEs remains notably weaker than in advanced economies. This finding is consistent with the view that monetary policy is less credible in EMDEs than in advanced economies.

- Long-term inflation expectations in EMDEs are more sensitive to both global and domestic shocks than are inflation expectations in advanced economies. The sensitivity of EMDE inflation expectations to domestic shocks gradually fell between 2005 and 2012 and has since been mostly stable, while the sensitivity of EMDE inflation expectations to global shocks has fallen slightly since 2000. In advanced economies, a large drop in the
sensitivity of inflation expectations to global shocks in the wake of the
global financial crisis followed a steady decline from the late 1990s to the
late 2000s; there has been a much less pronounced downward trend in
sensitivity to domestic shocks. These findings suggest that the improvement
in the anchoring of inflation expectations in advanced economies is partly
due to the decline in sensitivity to global shocks.

• The institutional and monetary policy environment matters for the
anchoring of inflation expectations, as do the general macroeconomic
environment and the structural characteristics of the economy. The chapter
finds that the presence of an inflation-targeting regime and a rise in central
bank transparency are associated with better anchoring of long-term
inflation expectations. For EMDEs, lower public debt and greater trade
openness are also associated with better anchoring of expectations. This
finding implies that the anchoring of inflation expectations in EMDEs
depends not only on monetary policy, but also on structural factors and
fiscal policy. Case studies for Brazil, Chile, and Poland provide examples of
these multiple factors at work. In Brazil, for instance, fiscal policy, together
with backtracking on central bank transparency for a period, may have held
back progress on improving the anchoring of inflation expectations. In
Chile, a highly transparent central bank, together with a credible
macroeconomic framework, may have contributed to the central bank’s
success in achieving well-anchored inflation expectations. And in Poland,
the simultaneous adoption of inflation targeting and a floating exchange-
rate regime may have helped anchor expectations.

Although inflation expectations have become significantly better anchored
during the past decade, the results show that there is still room for improvement,
especially in EMDEs. While inflation targeting seems to have been useful in
reducing the sensitivity of inflation expectations to shocks, inflation targeting
should not be considered necessary or sufficient for improved anchoring of
expectations. The overall macroeconomic policy framework, including fiscal
conditions and the transparency of the central bank, is also important for
success.

These findings point to several research avenues to explore. First, research could
examine the determinants of a wider range of measures of inflation expectations
in EMDEs. This research direction would be particularly worthwhile if data
availability could be improved. Second, it would be useful to consider non-
linearities between institutional factors and the anchoring of inflation
expectations. In addition, there is a need to investigate how complementarities
between institutional factors and fiscal and monetary policy frameworks help
improve the anchoring of inflation expectations.
ANNEX 4.1 A Primer on Expectations and Monetary Policy

The effectiveness of monetary policy depends on expectations, particularly about the future policy stance. Moreover, there is broad agreement that economic agents form their expectations by extracting signals from their experience of actual policies. Over time, there has been an evolution of views on this topic, which is reflected in the development of the models describing the links between expectations and monetary policy. This Annex presents a brief history of the evolution of views on the topic.

Traditional Keynesian models

The birth of modern macroeconomics is usually associated with the publication of Keynes’ General Theory of Employment, Interest and Money in 1936. However, the backdrop for Keynes’s analysis was the Great Depression, a period of low or negative inflation, and stagnant nominal wages (Samuelson and Solow 1960). The General Theory had little to say directly about the issue of inflation and, for simplicity, assumed that money wages were fixed. As the economy recovered, and with World War II posing a new set of challenges due to higher government expenditure, Keynes later discussed the trade-off between excess demand and wage and price inflation (Keynes 1940).

By the 1950s, inflation was becoming more of a problem for policymakers, and Phillips (1958) provided a breakthrough, with statistical evidence on a negative relationship between the unemployment rate and wage inflation in the United Kingdom. The Phillips curve became a standard feature of subsequent Keynesian macroeconomic models. Samuelson and Solow (1960) famously developed the notion of a policy trade-off between reduced unemployment (or increased output) and lower inflation. However, they also pointed out that this trade-off might not be stable.

Friedman (1968) established that adaptive inflation expectations would disrupt this trade-off. A change in the expected rate of inflation would shift the short-run Phillips curve, and over time output and unemployment would return to their long-run equilibrium values, regardless of the rate of inflation. Keynesian modelers incorporated the concepts of endogenous expectations and the natural rate of unemployment (or, equivalently, potential output) into their estimated Phillips curves. Policymakers would no longer be able to run the economy “hot” without facing accelerating inflationary pressure.

Views advanced by Friedman and Phelps

Friedman (1968) forcefully argued that estimates of a stable relationship between inflation and unemployment would exist only when inflation
expectations were well anchored. He warned that any attempt to exploit the short-run relationship as if it were permanent would cause expectations to become unanchored, leading to a shift in the Phillips curve. Thus, starting at the natural rate of unemployment, a stimulative monetary policy would lead to higher inflation without any benefit in terms of lower unemployment in the long run.

Friedman’s point—made independently by Phelps (1967)—was that rational workers care only about real wages, and that real wages need to adjust so that labor supply equals labor demand at a uniquely determined natural rate of unemployment. An expansionary monetary (or fiscal) policy aimed at pushing unemployment below the natural rate would lead to an increase in aggregate demand, which would then feed into both higher prices and wages. If the increase in wages is smaller than the increase in prices, firms are willing to hire more workers because the real wage has decreased. However, workers will soon realize that their real wage has decreased, and request wage increases that match price inflation. The outcome is a rightward shift of the Phillips curve with an equilibrium characterized by higher inflation and unemployment back at the natural rate. In this framework, the short-run Phillips curve is negatively sloped, but it shifts up the vertical long-run Phillips curve.

In the expectations-augmented Phillips curve, inflation depends on expected inflation, as well as on the deviation between actual unemployment and the natural rate of unemployment. In the long run, expected inflation is always equal to actual inflation and unemployment is always at the natural rate. However, the short-run Phillips curve will move up as expectations adjust, eventually to a point where a new short-run Phillips curve crosses the vertical long-term curve. The new equilibrium will be characterized by higher inflation and no gains in terms of lower unemployment. Any attempt to keep the unemployment rate below its natural level would require a continuous acceleration of inflation. A corollary of the expectation-augmented Phillips curve is that, in the long run, the natural rate of unemployment is compatible with any rate of inflation and that the rate of inflation is completely driven by economics agents’ expectations of future inflation.

In the Friedman-Phelps formulation of the Phillips curve, there is a short-run trade-off between inflation and economic activity. Lucas (1972) introduced rational expectations about monetary policy itself into macroeconomic models. This led Sargent and Wallace (1975, 1976) to conclude that systematic monetary policy is irrelevant even in the short run. In this new classical approach, forward-looking agents incorporate policymakers’ reaction function into their expectations and thus make policy actions ineffective by fully anticipating them. In this view, only random (i.e., surprise) changes in monetary policy can affect the real economy.
New Keynesian model

It soon became clear that the policy irrelevance proposition required the assumption of fully flexible prices and wages. Pioneering work by Fischer (1977), Taylor (1980), Rotemberg (1982), and Calvo (1983) showed that in the presence of staggered contracts monetary policy can be effective even under the assumption of rational expectations. Calvo’s pricing model is one of the key building blocks of modern New Keynesian models. This workhorse model combines forward-looking optimizing agents with monopolistic competition and sticky prices. Although agents are assumed to have full-information rational expectations (FIRE), in the presence of distortions associated with market power and sticky prices, monetary policy can be welfare-enhancing and achieve an efficient allocation of resources.

In effect, the New Keynesian approach reverts to ideas first clearly expressed in the writings of Keynes’s contemporary, Hawtrey (e.g., Monetary Reconstruction 1923). Hawtrey argued that the effectiveness of monetary policy depends on expectations about the future policy stance and that agents form their expectations by extracting signals from the current policy actions. This view underlies the endogenous expectations in modern monetary economics (e.g., Woodford 2003).

The standard New Keynesian Phillips curve describes inflation as a function of expected inflation and the output gap (Galí and Gertler 1999). This curve is the basis of Bernanke’s (2007) statement that expectations “greatly influence actual inflation and thus the central bank’s ability to achieve price stability.” In addition, expectations affect the transmission of monetary policy through the term structure of interest rates and changes in asset prices. While the central bank can control the short-term nominal interest rate, investment and consumption decisions depend on the long-term real interest rate, which, in turn, depends on expectations about long-term inflation and future movements of the short-term nominal rate. Economic decisions are also affected by movements in asset prices (wealth effects), which again depend on expected real returns. A problem with the standard New Keynesian Phillips curve is that it does not fit the data well. Fuhrer (1997) documents that inflation expectations

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1 While the New Keynesian Phillips curve allows for a short-term tradeoff between inflation and unemployment, it maintains the neoclassical view that there is no long-run tradeoff. However, at low levels of inflation the long-run Phillips curve may become negatively sloped and allow for such a tradeoff (Akerlof, Dickens, and Perry 2000; Benigno and Ricci 2011). Blanchard (2016) argues that the Great Recession led to a substantial anchoring of inflation expectations and that now the U.S. Phillips curve looks more like the Phillips curve of the 1960s than the accelerationist Phillips curve of standard New Keynesian models.
are not significant in explaining inflation using a purely forward-looking model. Several studies employ the hybrid New Keynesian Phillips curve, in which current inflation depends on both expected and lagged inflation (Galí and Gertler 1999).
ANNEX 4.2 Studies on the Anchoring of Inflation Expectations

TABLE A.4.2.1 Studies on advanced economies

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<th>Results</th>
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<tr>
<td>Beaudry and Ruge-Murcia (2017)</td>
<td>Has inflation targeting been successful in Canada?</td>
<td>Australia, Canada, New Zealand, Sweden, United Kingdom, United States (1991-2016, monthly and quarterly)</td>
<td>Descriptive statistics</td>
<td>The implementation of inflation targeting in Canada has been particularly successful compared with the experiences of other inflation targeting countries and the United States.</td>
</tr>
<tr>
<td>Carroll (2003)</td>
<td>How are households’ inflation expectations formed?</td>
<td>United States (1981-2000, quarterly)</td>
<td>Regression of household expectations on professional forecasts or news</td>
<td>Household forecasts are affected by media and professional forecasts.</td>
</tr>
<tr>
<td>Coibion and Gorodnichenko (2015)</td>
<td>Was the absence of disinflation during the Great Recession linked to a change in inflation expectations?</td>
<td>United States (1981-2013, monthly)</td>
<td>Regression of difference between household and professional inflation expectations on the change in oil price</td>
<td>The absence of disinflation during 2009-11 can be attributed to rising inflation expectations, which were in turn affected by rising oil prices.</td>
</tr>
<tr>
<td>Ehrmann (2015)</td>
<td>How do inflation expectations behave under inflation targeting?</td>
<td>10 advanced economies (1990s-2014, monthly)</td>
<td>Regression of inflation expectations on lagged inflation and dummy variable for times of (persistently) low inflation</td>
<td>Inflation expectations are not as well anchored when inflation is persistently low as when inflation is around target; inflation expectations are more dependent on lagged inflation.</td>
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### TABLE A.4.2.1 Studies on advanced economies (continued)

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<th>Methodology</th>
<th>Results</th>
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<tbody>
<tr>
<td>Galati, Poelhekke, and Zhou (2011)</td>
<td>Did the global financial crisis affect inflation expectations?</td>
<td>Euro Area, the United Kingdom, and the United States (2004-09, daily)</td>
<td>Test for anchoring by regression of changes in inflation expectations on macroeconomic news</td>
<td>There is some evidence that market-based inflation expectations in the United Kingdom and the United States became more sensitive to macroeconomic news during the global financial crisis.</td>
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<tr>
<td>IMF (2016)</td>
<td>1. Have inflation expectations become increasingly sensitive to inflation outturns in recent years? 2. How do monetary policy frameworks affect the degree of anchoring of inflation expectations?</td>
<td>24 advanced economies and 20 EMDEs (1990s-2016)</td>
<td>1. Estimation of a hybrid New Keynesian Phillips curve (regression of actual inflation on inflation expectations, past inflation, and other control variables) 2. Test for anchoring by regression of changes in inflation expectations on macroeconomic news, using a time-varying parameter model</td>
<td>1. The coefficient on lagged inflation started declining in the mid-1990s, but this trend reversed in the aftermath of the Great Recession, and the coefficient is now similar to that in the early 1990s. 2. The sensitivity of inflation expectations to macroeconomic news is inversely correlated with standard measures of central bank independence and transparency; expectations become better anchored when countries adopt an inflation-targeting regime. Estimations that allow for time-varying coefficients indicate that, while expectations are better anchored in advanced economies, anchoring has improved in both advanced economies and EMDEs.</td>
</tr>
<tr>
<td>Authors</td>
<td>Questions</td>
<td>Economies (sample period and frequency)</td>
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<tr>
<td>Kumar et al. (2015)</td>
<td>Are firms’ inflation expectations well anchored?</td>
<td>New Zealand (2014Q3-2014Q4)</td>
<td>Quantitative survey of cross-section of firms</td>
<td>Firm managers display little anchoring of inflation expectations, despite 25 years of inflation targeting by the Reserve Bank of New Zealand. Managers are generally poorly informed about recent inflation dynamics. Their forecasts of future inflation reflect high levels of uncertainty and are volatile at both short and long-run horizons.</td>
</tr>
<tr>
<td>Johnson (2003)</td>
<td>Does inflation targeting affect long-term inflation expectations?</td>
<td>Australia, Canada, New Zealand, Sweden, and the United Kingdom (1990s, monthly)</td>
<td>Comparison of forecasts of actual inflation with predicted forecasts, which are derived by multiplying the estimated coefficients of Phillips curves using the same independent variables before and after the target announcement</td>
<td>Inflation targeting stabilizes long-term inflation expectations.</td>
</tr>
<tr>
<td>Strohsal, Melnick, and Nautz (2016)</td>
<td>Did the global financial crisis affect inflation expectations?</td>
<td>United States (2004-14, monthly)</td>
<td>Regression of deviations of long-term inflation expectations from the inflation target on observed inflation or news-driven short-term inflation expectations using a model with time-varying parameters</td>
<td>Inflation expectations in the United States became partially de-anchored during the global financial crisis, but this de-anchoring was temporary.</td>
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### TABLE A.4.2.2 Studies on EMDEs (some including advanced economies)

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<tr>
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<th>Methodology</th>
<th>Results</th>
</tr>
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<tbody>
<tr>
<td>Baskaya, Gulsen, and Kara (2012)</td>
<td>Are inflation expectations well anchored in Turkey?</td>
<td>Turkey (2006-12, monthly)</td>
<td>Regression of inflation expectations on the lagged inflation rate</td>
<td>Inflation expectations are more sensitive to inflation realization at higher levels, but this sensitivity has decreased over time.</td>
</tr>
<tr>
<td>Capistrán and Ramos-Francia (2010)</td>
<td>Does inflation targeting affect inflation expectations?</td>
<td>12 advanced economies and 13 EMDEs (1989-2006, monthly)</td>
<td>Regression of dispersion of inflation expectations on a dummy for inflation targeting, the actual inflation rate, and world average inflation</td>
<td>Inflation targeting affects inflation expectations only in EMDEs. There is no effect of inflation targeting on the dispersion of inflation expectations in advanced economies.</td>
</tr>
<tr>
<td>Carrasco and Ferreiro (2013)</td>
<td>Does inflation targeting anchor inflation expectations?</td>
<td>Mexico (2004-11, monthly)</td>
<td>Tests whether inflation expectations follow a normal distribution under inflation targeting using Shapiro-Wilk test, Jarque-Bera test, and Doornik-Hansen test. If the inflation expectations are anchored, they are assumed to follow a normal distribution where the mean is the inflation target and the variance is constant.</td>
<td>Inflation expectations are anchored to the inflation target.</td>
</tr>
<tr>
<td>Cerisola and Gelos (2009)</td>
<td>Does inflation targeting anchor inflation expectations? Is the inflation targeting framework supported by the perceived sustainability of public finances?</td>
<td>Brazil (2000-04, monthly)</td>
<td>Recursive OLS regression of inflation expectations on inflation target, lagged inflation rate, primary balance as a percent of GDP, and other control variables</td>
<td>The adoption of inflation targeting helped anchor expectations; the stance of fiscal policy was important in shaping inflation expectations.</td>
</tr>
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</table>
**TABLE A.4.2.2 Studies on EMDEs (some including advanced economies) (continued)**

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<tr>
<th>Authors</th>
<th>Questions</th>
<th>Economies (sample period and frequency)</th>
<th>Methodology</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Davis (2014)</td>
<td>Does inflation targeting anchor long-term inflation expectations?</td>
<td>14 advanced economies and 22 EMDEs (1990-2011, monthly)</td>
<td>SVAR to test whether 12-month-ahead inflation expectations respond to shocks to inflation and oil prices</td>
<td>The introduction of inflation targeting is associated with a statistically significant reduction in the response of short-term inflation expectations to shocks in oil prices and in observed inflation.</td>
</tr>
<tr>
<td>de Mendonça and Galveas (2013)</td>
<td>How does central bank transparency affect the central bank’s commitment to inflation targeting?</td>
<td>Brazil (2001-10, monthly)</td>
<td>Estimation of backward-looking, forward-looking, and hybrid New Keynesian Phillips curves (regression of actual inflation on inflation expectations, past inflation, and other control variables)</td>
<td>Given the degree of central bank transparency, the forward-looking and hybrid specifications of the Phillips curve are more suitable to explain current inflation.</td>
</tr>
<tr>
<td>de Mendonça and Veiga (2014)</td>
<td>Are fiscal imbalances a constraint to monetary policy?</td>
<td>Brazil (1999-2010, monthly)</td>
<td>Regression of the deviation between inflation and its target on the net public debt-to-GDP ratio and other control variables</td>
<td>The deviation of realized inflation from target inflation tends to be higher when the public debt-to-GDP ratio is larger.</td>
</tr>
<tr>
<td>De Pooter et al. (2014)</td>
<td>Are long-term inflation expectations in EMDEs well anchored?</td>
<td>Brazil, Chile, and Mexico (2000s-2013, daily)</td>
<td>Test for anchoring by regression of changes in inflation expectations on news</td>
<td>Long-term inflation expectations have become better anchored during the decade to 2013, especially in Chile and Mexico.</td>
</tr>
<tr>
<td>IMF (2018)</td>
<td>How has the extent of anchoring of inflation expectations evolved in recent decades?</td>
<td>19 EMDEs (2004-17, biannual)</td>
<td>Facts about four measures of inflation anchoring: absolute deviation of three-year-ahead inflation forecast from target, variability of inflation forecasts, dispersion of inflation forecasts, and sensitivity to inflation surprises</td>
<td>The degree of anchoring of inflation expectations has improved significantly over the past two decades. However, there is heterogeneity in the extent of anchoring across emerging markets.</td>
</tr>
<tr>
<td>Kabundi, Schaling, and Some (2015)</td>
<td>Are long-term inflation expectations of individual agents well anchored?</td>
<td>South Africa (2000-13, quarterly)</td>
<td>Estimation of a market-perceived inflation target of individual agents using panel regression with dummy variables</td>
<td>The inflation expectations of price setters (business and unions) are higher than the upper bound of the official target band, while the expectations of professional forecasters are within the target band. In addition, price setters’ expectations are associated with lagged inflation but analysts’ expectations are not.</td>
</tr>
<tr>
<td>Authors</td>
<td>Questions</td>
<td>Economies</td>
<td>Methodology</td>
<td>Results</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lei et al. (2015)</td>
<td>Do consumers and professional forecasters update their inflation forecasts with information from the news media?</td>
<td>China (2001-12, quarterly)</td>
<td>Regression of inflation expectations on news about prices</td>
<td>The news media can have a strong influence on inflation expectations.</td>
</tr>
<tr>
<td>Mehrotra and Yetman (forthcoming)</td>
<td>Are long-term inflation expectations well anchored?</td>
<td>23 advanced economies and 21 EMDEs (2005-12, monthly)</td>
<td>Estimation of the decay function such that inflation forecasts monotonically diverge from a long-run anchor toward actual inflation as the forecast horizon shortens</td>
<td>Inflation expectations have become more tightly anchored over time in both inflation targeting economies and those following other monetary policy regimes.</td>
</tr>
<tr>
<td>Minella et al. (2003)</td>
<td>Does inflation targeting anchor inflation expectations?</td>
<td>Brazil (2000-03, monthly)</td>
<td>Regression of inflation expectations on inflation target, lagged inflation rate, exchange rate, and other control variables</td>
<td>In Brazil, actual inflation was above the upper limit of the tolerance interval in 2001 and 2002 after the introduction of inflation targeting in 1999. Inflation expectations react significantly to both the inflation target and past inflation. The inflation-targeting regime has been successful in helping to anchor expectations.</td>
</tr>
<tr>
<td>Miyajima and Yetman (2018)</td>
<td>Are long-term inflation expectations of individual agents well anchored?</td>
<td>South Africa (2001-17, quarterly; 1993-2017, monthly)</td>
<td>Estimation of the decay function such that inflation forecasts monotonically diverge from a long-run anchor toward actual inflation as the forecast horizon shortens</td>
<td>Inflation expectations of businesses and trade unions are anchored to levels above the official target range although overall, inflation expectations have become more strongly anchored in South Africa in recent years.</td>
</tr>
<tr>
<td>Reid (2009)</td>
<td>Are long-term inflation expectations well anchored?</td>
<td>South Africa (2001-07, quarterly)</td>
<td>Test for anchoring by regression of changes in inflation expectations on macroeconomic news</td>
<td>Inflation expectations are well anchored in South Africa due to the inflation targeting framework.</td>
</tr>
</tbody>
</table>
**ANNEX 4.3 Methodology and Database**

**Methodology**

**Panel regressions**

If long-term expectations are well-anchored, they will not be highly responsive to macroeconomic news. The first panel of Figure 4.4 presents the results of a panel regression model that estimates the sensitivity of changes in long-term inflation expectations to macroeconomic news shocks. The change in long-term inflation expectations (dependent variable) is measured by the difference between five-year-ahead inflation expectations in the current period and five-year-ahead inflation expectations in the previous period. The macroeconomic news shock corresponds to an inflation shock (a regressor) that is measured by the difference between realized inflation and short-term inflation expectations in the previous period.¹

The model includes an interaction dummy variable to allow for different elasticities of inflation expectations in advanced economies and EMDEs:

\[
E_{t} \pi_{i,t+5} - E_{t-1} \pi_{i,t+5} = \beta_{1}(\pi_{i,t} - E_{t-1} \pi_{i,t}) + \beta_{2}D_{i}(\pi_{i,t} - E_{t-1} \pi_{i,t}) + \mu_{i} + \tau_{t} + \varepsilon_{i,t} \quad (1),
\]

where \(i\) denotes country and \(t\) refers to time. \(E_{t} \pi_{i,t+5}\) and \(E_{t-1} \pi_{i,t+5}\) are five-year-ahead inflation expectations in the current and previous periods, respectively. \(\pi_{i,t}\) refers to realized inflation and \(E_{t-1} \pi_{i,t}\) is short-term inflation expectations in the previous period. \(D_{i}\) is a dummy variable that is equal to 0 for advanced economies and 1 for EMDEs, implying that \(\beta_{1}\) and \((\beta_{1} + \beta_{2})\) are the estimated sensitivities for advanced economies and EMDEs, respectively. When the estimated sensitivity is small (i.e., \(\beta_{1}\) is not statistically significantly different from zero), inflation expectations are well anchored. The model includes country fixed effects (\(\mu_{i}\)) and time fixed effects (\(\tau_{t}\)) that are estimated for three periods: 1990H2-2004H2, 2005H1-18H1, and 1990H2-2018H1.²

**Regressions with time-varying parameters:**

**Country-specific models**

Panels B, C, and D of Figure 4.4 present the results of a time-varying model, estimated using a Kalman filter, that captures the time variation in the sensitivity of changes in long-term inflation expectations to inflation shocks. The model is a version of (1), but it includes time-varying coefficients:

¹ The model follows Beechy et al. (2011), Gürgaynak et al. (2010), and De Pooter et al. (2014).
² As there is no available data for most EMDEs in the early 1990s, the panel dataset is unbalanced. The sample was split at 2004 to produce two samples of roughly equal length.
\[ E_t \pi_{t+5} - E_{t-1} \pi_{t+5} = \alpha_t + \beta_t (\pi_t - E_{t-1} \pi_t) + \varepsilon_t, \varepsilon_t \sim iid N(0, \sigma_\varepsilon^2) \] (2),

where the measures of expected and realized inflation are same as those in (1). The model is estimated for each of the 24 advanced economies and 23 EMDEs in the sample, using semiannual data for 1990H1-2018H1 and 1995H1-2018H1, respectively. The time-varying parameters are assumed to follow a random walk.\(^3\)

\[ \alpha_t = \alpha_{t-1} + \xi_t, \xi_t \sim iid N(0, \sigma_\xi^2) \]

\[ \beta_t = \beta_{t-1} + \eta_t, \eta_t \sim iid N(0, \sigma_\eta^2) \]

where \(\alpha_t\) captures changes in long-term inflation expectations that are independent of inflation shocks and \(\beta_t\) measures the sensitivity of inflation expectations to inflation shocks.\(^4\) In other words, \(\alpha_t\) and \(\beta_t\) are assumed to be the sensitivity to the permanent and temporary shocks, respectively. As noted above, if forecasters believe that central bank’s monetary policy is credible, they do not react to inflation shocks. This implies that if \(\beta_t\) is not statistically significantly different from zero, inflation expectations are well anchored.

**Regressions with time-varying parameters: Global and domestic shocks**

A simple regression model with time-varying parameters is estimated to analyze the sensitivity of inflation expectations to global and domestic inflation shocks. The results are presented in Figure 4.5. The global inflation shock is defined as the first principal component of inflation shocks for the full sample of 24 advanced economies for 1990H2-2018H1 and 23 EMDEs for 1995H1-2018H1. The domestic inflation shock is defined as the residual from a regression of the inflation shock on the first principal component of inflation shocks, as in the following model:

\[ \pi_t - E_t \pi_{t-1} = \delta_t f_t + \epsilon_t \] (3),

where \(f_t\) is the first principal component of inflation shocks and \(\delta_t\) is the time-varying parameter. \(\delta_t f_t\) represents the global inflation shock and the remaining term \(\epsilon_t\) is defined as the domestic inflation shock. The sensitivity of five-year-ahead inflation expectations to global and domestic inflation shocks is then modeled as:

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\(^3\) IMF (2016) and Buono and Formai (2018) also estimate models with the time-varying parameters. IMF (2016) also uses a Kalman filter model, but does not include other factors (\(\alpha_t\)). Buono and Formai (2018) estimate their model over a rolling window in which the sample periods change over time.

\(^4\) The results remain robust when \(\alpha_t\) is not included in the model.
\[ E_t \pi_{t+5} - E_{t-1} \pi_{t+5} = \alpha_t + \beta_{1t} G_t + \beta_{2t} D_t + \varepsilon_t \quad (4), \]

where \( G_t (= \delta_t f_t) \) is the global shock and \( D_t (= \epsilon_t) \) is the domestic shock. Both (3) and (4) are estimated using a Kalman filter and with the assumption that the time-varying parameters follow a random walk.

### Panel cointegration regressions

The determinants of the degree of anchoring of inflation expectations are studied using a set of panel regression models. The results of these exercises, using annual data for 24 advanced economies and 23 EMDEs for 1995-2016, are presented in Figure 4.6. The degree of anchoring is measured as the sensitivity \( (\beta_t) \) of changes in long-term inflation expectations to inflation shocks (as estimated in (2) above). Six determinants are considered: the presence of an inflation-targeting regime, the degree of central bank transparency, the exchange-rate regime, financial openness, trade openness, and the degree of fiscal sustainability. Inflation-targeting regime and fixed exchange-rate regime are dummy variables for which the presence of the indicated regime equals one. Exchange-rate regime is determined using Shambaugh (2004). Central bank transparency and financial openness (capital account openness) are measured using indexes produced by Dincer and Eichengreen (2014) and Chinn and Ito (2017), respectively. Trade openness is measured as imports divided by domestic demand (domestic demand is defined as GDP + imports - exports). Fiscal sustainability is measured as the ratio of gross public debt to GDP.

The empirical exercise is undertaken in four steps. First, all variables are tested in a panel setting for unit roots. Some tests do not reject the null hypothesis of non-stationarity of trade openness and gross public debt-to-GDP ratio (Table A 4.4.2). Second, since some variables (including the inflation targeting dummy, the fixed exchange-rate regime dummy, and the financial openness index) are stationary, residual series are obtained from a panel regression of sensitivity of inflation expectations on these stationary variables. Specifically, the following model is estimated:

\[ \beta_{i,t} = \Theta_t + \phi_t + \gamma M_{P_{it}} + \delta X_{i,t} + \epsilon_{i,t} \quad (5), \]

where \( \beta_{i,t} \) is the time-varying estimate of the country-specific estimate of the elasticity of inflation expectations to inflation shocks, as explained in the discussion of regressions with time-varying parameters. \( M_{P_{it}} \) is either (i) a

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dummy variable that takes a value of one in countries with an inflation targeting framework or (ii) a measure of central bank transparency. $X_{i,t}$ includes a dummy variable that takes a value of one for countries with a fixed exchange-rate regime and financial openness index. $\theta_i$ captures country-fixed effects and $\varphi_t$ refers to time fixed effects.

Third, the existence of cointegration between the residuals from the panel regression in (5) and gross public debt-to-GDP ratio and trade openness is tested by employing the cointegration test of Pedroni (1999) (Table A.4.4.3). The results indicate that the residuals are cointegrated with the two variables. Fourth, following Pedroni (2000, 2001), a grouped mean fully modified OLS (FMOLS) regression model and a grouped mean dynamic OLS (DOLS) regression model are estimated to correct for endogeneity bias and serial correlation. The dependent variable is the estimated residual from the panel regression in (5). The independent variables are trade openness (measured by import penetration ratio) and gross public debt-to-GDP ratio.

### Database

**TABLE A.4.3.1 List of countries**

<table>
<thead>
<tr>
<th>Country Group</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced economies (24)</td>
<td>Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Korea, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, the United Kingdom, the United States</td>
</tr>
<tr>
<td>EMDEs (23)</td>
<td>Argentina, Bangladesh, Brazil, Chile, China, Colombia, the Arab Republic of Egypt, India, Indonesia, Islamic Republic of Iran, Kuwait, Malaysia, Mexico, Pakistan, Peru, Poland, Russia, Saudi Arabia, South Africa, Thailand, Tunisia, Turkey, Zambia</td>
</tr>
</tbody>
</table>

Note: The numbers in parentheses are the number of countries in the sample.
### TABLE A.4.3.2 Description of variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflation expectations (Advanced economies: 1990H1-2018H1 EMDEs: 1995H1-2018H1)</strong></td>
<td>Current year, one-year-ahead, one-year-ahead inflation forecasts based on surveys conducted biannually for 30 countries by Consensus Economics, complemented by current year, one-year-ahead, and five-year-ahead annual average headline CPI inflation forecasts produced biannually for 17 countries in the IMF’s World Economic Outlook database.</td>
<td>Consensus Economics, Consensus Forecast; IMF, World Economic Outlook database</td>
</tr>
<tr>
<td><strong>Central bank transparency (1995-2014)</strong></td>
<td>Index calculated from responses to 15 questions. To expand the sample, the index was extrapolated to 2015-16 using 2014 data.</td>
<td>Dincer and Eichengreen (2014)</td>
</tr>
<tr>
<td><strong>Exchange-rate regime (1995-2014)</strong></td>
<td>The exchange-rate regime classification developed in Shambaugh (2004) is used to determine whether a country has a pegged or flexible exchange rate. To expand the sample, the index was extrapolated to 2015-16 using 2014 data.</td>
<td>Shambaugh (2004)</td>
</tr>
<tr>
<td><strong>Financial openness (1995-2015)</strong></td>
<td>Index of de jure capital account openness. To expand the sample, the index was extrapolated to 2016 using 2015 data.</td>
<td>Chinn and Ito (2017)</td>
</tr>
<tr>
<td><strong>Gross public debt (1995-2016)</strong></td>
<td>Gross public debt divided by nominal GDP.</td>
<td>IMF, World Economic Outlook database</td>
</tr>
<tr>
<td><strong>Oil prices (1990H1-2017H2)</strong></td>
<td>Index is in nominal U.S. dollars.</td>
<td>World Bank, Commodity Price Data (The Pink Sheet)</td>
</tr>
<tr>
<td><strong>Food prices (1990H1-2017H2)</strong></td>
<td>Index is in nominal U.S. dollars.</td>
<td>World Bank, Commodity Price Data (The Pink Sheet)</td>
</tr>
</tbody>
</table>
## ANNEX 4.4 Estimation Results

### TABLE A.4.4.1 Sensitivity of long-term inflation expectations to inflation shocks

<table>
<thead>
<tr>
<th>A. 1990H2-2018H1</th>
<th>Dependent variable: Change in long-term inflation expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All countries</td>
</tr>
<tr>
<td>All countries</td>
<td>0.282***</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
</tr>
<tr>
<td>Advanced economies</td>
<td>0.159***</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
</tr>
<tr>
<td>EMDEs</td>
<td>0.425***</td>
</tr>
<tr>
<td></td>
<td>(0.030)</td>
</tr>
<tr>
<td>Observations</td>
<td>2,408</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.069</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. 1995H1-2004H2</th>
<th>Dependent variable: Change in long-term inflation expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All countries</td>
</tr>
<tr>
<td>All countries</td>
<td>0.423***</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
</tr>
<tr>
<td>Advanced economies</td>
<td>0.284***</td>
</tr>
<tr>
<td></td>
<td>(0.049)</td>
</tr>
<tr>
<td>EMDEs</td>
<td>0.554***</td>
</tr>
<tr>
<td></td>
<td>(0.048)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,139</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.119</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>C. 2005H1-2018H1</th>
<th>Dependent variable: Change in long-term inflation expectations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All countries</td>
</tr>
<tr>
<td>All countries</td>
<td>0.083***</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
</tr>
<tr>
<td>Advanced economies</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
</tr>
<tr>
<td>EMDEs</td>
<td>0.201***</td>
</tr>
<tr>
<td></td>
<td>(0.034)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,269</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.011</td>
</tr>
</tbody>
</table>

Note: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
A.-C. Results for the full sample of 47 countries, 24 advanced economies, and 23 EMDEs with country and time fixed effects.
### TABLE A.4.4.2 Panel unit root tests

**A. All countries**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sensitivity</td>
<td>-23.1</td>
<td>1167.2</td>
<td>560.8</td>
<td>-15.2</td>
<td>853.4</td>
<td>444.3</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross public debt</td>
<td>0.0</td>
<td>102.0</td>
<td>42.9</td>
<td>-4.9</td>
<td>405.2</td>
<td>78.2</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
<td>(0.27)</td>
<td>(1.00)</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration</td>
<td>-2.2</td>
<td>145.3</td>
<td>112.2</td>
<td>-0.9</td>
<td>96.1</td>
<td>89.2</td>
<td>(0.01)***</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.10)*</td>
<td>(0.19)</td>
<td>(0.42)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**B. Advanced economies**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sensitivity</td>
<td>-3.7</td>
<td>96.7</td>
<td>95.2</td>
<td>-0.4</td>
<td>71.8</td>
<td>98.4</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.34)</td>
<td>(0.01)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross public debt</td>
<td>1.1</td>
<td>38.2</td>
<td>14.2</td>
<td>-0.6</td>
<td>55.8</td>
<td>27.9</td>
<td>(0.86)</td>
<td>(0.26)</td>
</tr>
<tr>
<td></td>
<td>(0.86)</td>
<td>(0.84)</td>
<td>(1.00)</td>
<td>(0.26)</td>
<td>(0.21)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration</td>
<td>-3.4</td>
<td>86.3</td>
<td>53.3</td>
<td>-0.9</td>
<td>49.3</td>
<td>47.2</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.28)</td>
<td>(0.18)</td>
<td>(0.42)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**C. EMDEs**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total sensitivity</td>
<td>-29.1</td>
<td>1070.5</td>
<td>465.6</td>
<td>-21.3</td>
<td>781.6</td>
<td>345.9</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross public debt</td>
<td>-1.0</td>
<td>63.8</td>
<td>28.6</td>
<td>-6.4</td>
<td>349.5</td>
<td>50.3</td>
<td>(0.16)</td>
<td>(0.00)***</td>
</tr>
<tr>
<td></td>
<td>(0.16)</td>
<td>(0.04)**</td>
<td>(0.98)</td>
<td>(0.00)***</td>
<td>(0.00)***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Penetration</td>
<td>1.0</td>
<td>48.2</td>
<td>60.5</td>
<td>0.1</td>
<td>43.9</td>
<td>43.8</td>
<td>(0.85)</td>
<td>(0.38)</td>
</tr>
<tr>
<td></td>
<td>(0.85)</td>
<td>(0.38)</td>
<td>(0.07)*</td>
<td>(0.53)</td>
<td>(0.56)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: P-values in parentheses. The null hypothesis of a unit root is rejected at significance levels of *** p<0.01, ** p<0.05, * p<0.1.
A. Results for the full sample of 47 countries, using data for 1995-2016.
B. Results for 24 advanced economies, using data for 1995-2016.
C. Results for 23 EMDEs, using data for 1995-2016.
### TABLE A.4.4.3 Panel cointegration tests

#### Intercept and trend

<table>
<thead>
<tr>
<th></th>
<th>All countries</th>
<th>Advanced economies</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>p-value</td>
<td>Statistic</td>
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<tr>
<td>Panel v-statistic</td>
<td>-1.7</td>
<td>0.96</td>
<td>2.0</td>
</tr>
<tr>
<td>Panel ρ-statistic</td>
<td>-9.7</td>
<td><strong>0.00</strong>*</td>
<td>1.0</td>
</tr>
<tr>
<td>Panel PP-statistic</td>
<td>-27.8</td>
<td><strong>0.00</strong>*</td>
<td>-3.0</td>
</tr>
<tr>
<td>Panel ADF-statistic</td>
<td>-22.4</td>
<td><strong>0.00</strong>*</td>
<td>-3.8</td>
</tr>
<tr>
<td>Group ρ-statistic</td>
<td>0.3</td>
<td>0.60</td>
<td>3.1</td>
</tr>
<tr>
<td>Group PP-statistic</td>
<td>-13.9</td>
<td><strong>0.00</strong>*</td>
<td>-0.9</td>
</tr>
<tr>
<td>Group ADF-statistic</td>
<td>-11.7</td>
<td><strong>0.00</strong>*</td>
<td>-2.7</td>
</tr>
</tbody>
</table>

#### Intercept

<table>
<thead>
<tr>
<th></th>
<th>All countries</th>
<th>Advanced economies</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>p-value</td>
<td>Statistic</td>
</tr>
<tr>
<td>Panel v-statistic</td>
<td>2.4</td>
<td>0.01***</td>
<td>-0.5</td>
</tr>
<tr>
<td>Panel ρ-statistic</td>
<td>-11.5</td>
<td><strong>0.00</strong>*</td>
<td>-0.2</td>
</tr>
<tr>
<td>Panel PP-statistic</td>
<td>-19.4</td>
<td><strong>0.00</strong>*</td>
<td>-2.8</td>
</tr>
<tr>
<td>Panel ADF-statistic</td>
<td>-15.2</td>
<td><strong>0.00</strong>*</td>
<td>-2.7</td>
</tr>
<tr>
<td>Group ρ-statistic</td>
<td>-1.3</td>
<td>0.09*</td>
<td>1.9</td>
</tr>
<tr>
<td>Group PP-statistic</td>
<td>-10.0</td>
<td><strong>0.00</strong>*</td>
<td>-1.6</td>
</tr>
<tr>
<td>Group ADF-statistic</td>
<td>-9.5</td>
<td><strong>0.00</strong>*</td>
<td>-2.9</td>
</tr>
</tbody>
</table>

Note: Results for the full sample of 47 economies, 24 advanced economies, and 23 EMDEs, all using data for 1995-2016. The null hypothesis of no cointegration is rejected at significance levels of *** p<0.01, ** p<0.05, * p<0.1.
### TABLE A.4.4.4 Determinants of sensitivity of inflation expectations

#### A. Panel regressions

<table>
<thead>
<tr>
<th>Model</th>
<th>Dependent variable: Estimated sensitivity</th>
<th>All countries</th>
<th>All countries</th>
<th>Advanced economies</th>
<th>Advanced economies</th>
<th>EMDEs</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td>FE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation targeting</td>
<td></td>
<td>-0.390***</td>
<td>-0.222***</td>
<td>-0.498***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.094)</td>
<td>(0.053)</td>
<td>(0.165)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central bank transparency</td>
<td></td>
<td>-0.414**</td>
<td>0.040</td>
<td></td>
<td>-0.724*</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.204)</td>
<td>(0.108)</td>
<td></td>
<td>(0.377)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exchange-rate regime</td>
<td>0.306**</td>
<td>0.307**</td>
<td>0.255</td>
<td>0.012</td>
<td>0.060</td>
<td>0.079</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.147)</td>
<td>(0.149)</td>
<td>(0.395)</td>
<td>(0.405)</td>
<td>(0.222)</td>
<td>(0.224)</td>
<td></td>
</tr>
<tr>
<td>Financial openness</td>
<td>0.141</td>
<td>0.046</td>
<td>0.032</td>
<td>-0.094</td>
<td>-0.059</td>
<td>-0.186</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.178)</td>
<td>(0.177)</td>
<td>(0.121)</td>
<td>(0.125)</td>
<td>(0.289)</td>
<td>(0.286)</td>
<td></td>
</tr>
<tr>
<td>Exchange-rate regime x financial openness</td>
<td>0.070</td>
<td>-0.046</td>
<td>-0.343</td>
<td>-0.069</td>
<td>1.037**</td>
<td>1.001**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.222)</td>
<td>(0.225)</td>
<td>(0.400)</td>
<td>(0.410)</td>
<td>(0.490)</td>
<td>(0.493)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,034</td>
<td>1,034</td>
<td>528</td>
<td>528</td>
<td>506</td>
<td>506</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.067</td>
<td>0.055</td>
<td>0.203</td>
<td>0.178</td>
<td>0.078</td>
<td>0.067</td>
<td></td>
</tr>
</tbody>
</table>

Note: Results of panel regressions for the full sample of 47 countries, 24 advanced economies, and 23 EMDEs with country and time fixed effects, using data for 1995-2016. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

#### B. Panel cointegration regressions (fully modified OLS and dynamic OLS)

<table>
<thead>
<tr>
<th>Model</th>
<th>Dependent variable: Residual from the first regression</th>
<th>All countries</th>
<th>All countries</th>
<th>Advanced economies</th>
<th>Advanced economies</th>
<th>EMDEs</th>
<th>EMDEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FMOLS</td>
<td>DOLS</td>
<td>FMOLS</td>
<td>DOLS</td>
<td>FMOLS</td>
<td>DOLS</td>
<td></td>
</tr>
<tr>
<td>Penetration</td>
<td>-0.004</td>
<td>-0.010</td>
<td>0.012</td>
<td>0.010</td>
<td>-0.015</td>
<td>-0.021</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.010)</td>
<td>(0.003)**</td>
<td>(0.006)*</td>
<td>(0.008)**</td>
<td>(0.011)*</td>
<td></td>
</tr>
<tr>
<td>Gross public debt</td>
<td>0.008</td>
<td>0.009</td>
<td>-0.002</td>
<td>-0.001</td>
<td>0.018</td>
<td>0.020</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.002)**</td>
<td>(0.003)**</td>
<td>(0.001)**</td>
<td>(0.001)</td>
<td>(0.005)**</td>
<td>(0.006)**</td>
<td></td>
</tr>
</tbody>
</table>

Note: Results of group mean panel fully modified ordinary least squares regressions (FMOLS) and group mean dynamic ordinary least squares regressions (DOLS) the full sample 47 countries, 24 advanced economies, and 23 EMDEs. Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
ANNEX 4.5 Inflation Targeting: Country Experiences

Inflation targeting in Brazil

Rationale. Brazil adopted inflation targeting in July 1999 after it became clear that five years of exchange-rate targeting had failed. Despite the success of the Central Bank of Brazil (BCB) in reducing historically high inflation through exchange-rate stabilization measures that began in 1994, a lack of fiscal discipline resulted in a gradual buildup of government debt that in turn made the Brazilian real vulnerable to speculative attacks (Mishkin and Savastano 2002). Amid a severe currency crisis that began in early 1999, Brazil shifted to an inflation-targeting regime to “coordinate market expectations and control inflation” (Barbosa-Filho 2008).

Process. The inflation-targeting framework, adopted by presidential decree, established that the National Monetary Council would set inflation targets no later than two years in advance, following a transition period concluding in 2002. The BCB was granted instrument independence to this end (Bognanski, Tombini, and Werlang 2000). If end-year annual inflation is out of the established tolerance range, which has been changed over time, the governor of the BCB is required to provide an open (public) letter to the minister of finance explaining why the target was not met and what actions will be taken to return inflation to the target range. The framework also required the BCB to issue a quarterly inflation report detailing the results of its recent monetary policy actions and its projections for inflation.

Several aspects of Brazil’s inflation-targeting framework are distinctive. For one, the BCB is not solely responsible for setting the inflation target range. The entity that establishes the targets, the National Monetary Council, is composed of the governor of the BCB, the minister of finance, and the minister of planning, development, and management. In addition, Brazil’s target band was for a long time quite wide compared to that in other inflation-targeting countries (IMF 2015).\(^1\) Official assessment of whether the annual target has been met is based only on the December/December change in CPI. Furthermore, although Brazil has maintained a de jure flexible exchange rate under its inflation-targeting regime, the BCB has at times intervened in foreign exchange markets to manage excess volatility of the currency.

\(^1\) However, after the target was held at 4.5 percent and the tolerance band at 2.5-6.5 percent since 2006, the band was narrowed to 3-6 percent in 2018. From 2019-21 the target and tolerance band will both be incrementally lowered on an annual basis, to a target of 3.75 percent within a band of 2.25-5.25 percent in 2021.
When inflation targeting was adopted in 1999, Brazil had a sound banking system and was in the process of strengthening its fiscal profile. The banking system had been restructured after a crisis in the early 1990s. Although government debt was still rising in 1999, fiscal adjustment was underway. A series of debt-restructuring agreements between individual states and the federal government had been negotiated a few years prior. Fiscal discipline improved with the passing of the Fiscal Responsibility Law in 2000 (López Vicente and Serena 2014).

**Results.** Brazil’s inflation-targeting regime was successful in the first years after its inception. Inflation was within the target range in 1999 and 2000, and BCB transparency improved markedly (Figure A.4.5.1). A major challenge developed in 2001, however, when a combination of shocks—a severe drought and energy crisis, slowing global growth, and contagion from a financial crisis in Argentina—led to another bout of currency depreciation (Minella et al. 2003). The currency pressure was exacerbated in 2002 by a sharp rise in bond spreads, a weak external position (Brazil had insufficient capital inflows to finance its current account deficit and foreign exchange reserves were low), and uncertainty about macroeconomic policy during the presidential election cycle. As the real depreciated, inflation spiked to more than 17 percent in May 2003, and concerns about debt sustainability rose (at the time, half of Brazil’s public debt was denominated in or indexed to the U.S. dollar). Inflation far exceeded the upper bound of the target band for three consecutive years to 2003, and three-year-ahead inflation expectations were around the upper limit of the target inflation band in 2002 and 2003. Five-year-ahead expectations, however, remained better anchored and within the band, reaching a maximum of 5.2 percent in the first half of 2003, below the 6.5 percent upper limit at the time.

The deviations from the target in 2001-03 were followed by a long period of better performance. Although headline inflation remained above the upper limit of the target band through mid-2005, five-year-ahead inflation expectations for Brazil declined toward the middle of the band. Disinflation during these years, however, occurred in large part due to exchange-rate appreciation, which resulted from a combination of relatively high domestic policy interest rates and a supportive global trade and financing environment (Barbosa-Filho 2008; Arestis 2011).

Brazil managed to keep inflation within the target band during the global financial crisis. Headline inflation rose in the leadup to the global financial crisis in response to rising oil prices, strong capital inflows, and growing domestic demand, but was still within the target band as Lehman Brothers collapsed. Inflation expectations increased in 2007 and 2008, but not sharply, providing evidence that expectations had become better anchored under the inflation-
targeting regime. As the crisis deepened and capital inflows dropped sharply, the BCB prioritized stabilizing the exchange rate and maintaining adequate liquidity, in part through foreign exchange market interventions and reducing reserve requirements (Céspedes, Chang, and Velasco 2014).

From 2011 to mid-2014, headline inflation in Brazil was near or slightly above the upper limit of the target band, reflecting currency depreciation; rising wage costs; continued price indexation; and, in the latter part of this period, drought conditions in parts of the country that were aggravated by the onset of the El
Niño weather phenomena (IMF 2015). In response, the BCB began raising interest rates in mid-2013. Yet inflationary pressures intensified after an increase in regulated gasoline and diesel prices in late 2014 and electricity tariffs in early 2015. From mid-2014 through late 2016, headline inflation was persistently above the upper bound of the target range, and was more than 4 percentage points above the upper bound of 6.5 percent over the 12 months ending December 2015. Moreover, the government’s primary balance deteriorated sharply, raising the public debt-to-GDP ratio. However, despite rapidly rising inflation, five-year-ahead inflation expectations remained firmly in the middle of the band, suggesting that the inflation-targeting regime retained credibility.

After peaking in early 2016 following the realignment of administered prices, inflation gradually moderated, and the BCB began an extended period of interest rate easing late in the year. By end-2017, inflation was slightly below the 3 percent lower bound of the target band, largely due to food price deflation that in turn reflected very strong agricultural production. Five-year-ahead inflation expectations continued to moderate during this period.

The behavior of inflation expectations in Brazil has been broadly consistent with the estimated sensitivity of long-term inflation expectations to shocks. Following a large initial drop in the sensitivity of expectations to shocks after the introduction of the inflation-targeting regime in 1999, sensitivity has been more or less constant, suggesting that the inflation-targeting regime has been successful in anchoring expectations. Yet the sensitivity to shocks is still higher than in some other inflation-targeting EMDEs. A deterioration of fiscal balances could have impeded the anchoring of inflation expectations (Cerisola and Gelos 2009; de Mendonça and Veiga 2014). An additional factor may have been that BCB independence was less well established in Brazil than in other countries (Cortes and Paiva 2017; Minella et al. 2003).

**Lessons learned.** Brazil’s experience with inflation targeting offers two key lessons. First, long-term inflation expectations can remain stable during sharp fluctuations in actual inflation even in the absence of typical elements of inflation-targeting regimes elsewhere (e.g., the central bank having sole power to set inflation targets, fixed-term appointment of central bank governors, and use of a narrow inflation target band). Further, inflation expectations in Brazil have been stable despite periodic questions about the credibility of the inflation-targeting regime arising from its unique institutional arrangements (IMF 2015). However, some of the specifics of the regime (i.e., wide target band, use of only December data for measuring results) have arguably made formal compliance with targets easier than in most other inflation-targeting countries.
Second, fiscal policy can be a key factor in determining the outcome of inflation targeting and controlling inflation expectations (Cerisola and Gelos 2009; de Mendonça and Veiga 2014). For instance, during the 2001-03 currency crisis, Brazil avoided a prolonged growth contraction thanks to the fiscal adjustments put in place in the late 1990s. These measures lent support to the inflation targets and the BCB’s well-articulated strategy for reverting inflation to target levels (Giavazzi, Goldfajn, and Herrera 2005). At the same time, the structure of public debt in Brazil at the time—a large share of debt was short term or denominated in foreign currency—was a constraint on the central bank’s ability to freely target inflation, since interest rate hikes abroad had a significant adverse impact on debt service obligations. Similarly, the high level of foreign currency-denominated debt may have also dissuaded the central bank from allowing the exchange rate to float freely, despite the stated commitment to floating (López Vicente and Serena 2014). Over time, the structure of public debt has changed, and the vast majority domestic debt is now issued domestically. However, the stock of debt has risen rapidly in recent years.

Inflation targeting in Chile

**Rationale.** Expansionary macroeconomic policies in Chile in the late 1980s, together with the oil price spike that accompanied the Gulf War in the early 1990s, resulted in a sharp increase in inflation, to a peak of 30 percent in October 1990. These factors triggered the decision to adopt inflation targeting (Morandé 2002). Policymakers recognized that the fundamental historical driver of the inflation trends was excessive credit expansion by the Central Bank of Chile (BCC; Corbo 2005). To better discipline monetary policy, the BCC first announced a numerical target for inflation in 1990. Since the target was set for just one year ahead, it did not amount to the complete adoption of inflation targeting. But it was the first step in the transition toward such a regime.

**Process.** Gradual implementation, a hallmark of Chile’s inflation targeting experience, allowed the BCC to build credibility. Legislation passed in 1989 made the BCC fully independent and declared price stability to be the primary monetary policy objective. The BCC was given authority to define this objective (i.e., goal independence) and to control of the instruments of monetary policy (i.e., instrument independence). A new framework of banking sector regulation and supervision was among the strongest across all emerging markets (Mishkin 2004).

Starting in 1991, the BCC adopted a partial inflation-targeting regime. Under this arrangement, it announced a headline target for annual inflation in December of each year, gradually reducing the level of the target, but continued
to also target an exchange-rate band and retained the right to use short-term capital controls if needed.\(^2\) In fact, Chile used unremunerated (non-interest bearing) reserve requirements on selective capital inflows through most of the 1990s to discourage build-ups of short-term liabilities, favored a weaker exchange rate, and provided more operating space for monetary policy (De Gregorio, Tokman, and Valdés 2005). The exchange-rate band was widened during the decade, allowing more flexible adjustment to external shocks (Bordo and Siklos 2014).

In September 1999, Chile shifted to a floating exchange-rate regime and formally adopted a flexible inflation-targeting framework that recognized the lag effect in monetary policy and the short-run trade-off with output. Key components of the framework included bolstering the statistical and analytical capacity of the BCC, publication of a monetary policy report (initially three issued per year, and four per year since 2009), and the release of minutes of monetary policy meetings with a short lag. In addition, the BCC announced its intent to deepen the foreign exchange derivatives market, and to intervene in the foreign exchange market only in extraordinary circumstances (Valdés 2007).

Over time, Chile’s inflation target has been fine-tuned. In 1999, the BCC set the target band for annual inflation at 2-4 percent (to be achieved in 2001), and later extended this target indefinitely. In 2001, the target was redefined as 3 percent with at +/- 1 percentage point tolerance range, while the horizon for achieving the 3 percent target, from any current deviation, was lengthened from 12-24 months to 24 months to more realistically account for the lag in the monetary transmission mechanism.

In 2001, the government adopted a balanced budget rule that constrained public expenditures to ensure that the structural balance, measured as a share of GDP, met a specific target or range (De Gregorio 2009b; Llédo et al. 2017). The fiscal targets are were then regularly adjusted in line with changes in potential growth and forecasts of long-term copper prices.\(^3\) Two independent committees, one focused on potential output and the other on copper prices, advise on the practical calculation of the structural balance.

**Results.** Despite some large fluctuations of inflation around the target range, long-term inflation expectations in Chile have been remarkably well anchored since the adoption of inflation targeting, and the sensitivity of inflation expectations to shocks are among the lowest in EMDEs. During the early years

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\(^2\) The new framework also included current account deficit targets (Céspedes and Soto 2005).

\(^3\) Prior to 2015, long-term molybdenum prices were also considered in setting structural balance targets. Llédo et al. (2017) provide additional details.
of the inflation targeting regime, inflation fell and became less volatile. Even under the partial inflation-targeting regime, there was a sustained decline in headline inflation and in inflation expectations (Figure A.4.5.2). Average inflation fell from 15.5 percent in 1991-94 to 5.7 percent from 1995-98. Moreover, the exchange rate pass-through to inflation dropped significantly starting in the mid-1990s and continued after the adoption of formal inflation targeting in 1999 (Schmidt-Hebbel and Tapia 2002).
A period of low inflation in 2003 and 2004 challenged the credibility of Chile’s inflation target. In the second half of 2003, Chile experienced a significant and unexpected deceleration in inflation as the peso appreciated and competition in the retail sector intensified (Central Bank of Chile 2004). While survey-based inflation expectations remained close to the target of 3 percent (i.e., well anchored), five-year-ahead market-based inflation expectations declined significantly.

Long-term inflation expectations varied only slightly during the global financial crisis, despite large gyrations in actual inflation. From mid-2007 to late 2008, headline inflation in Chile experienced upward pressure from international factors—namely, rising food and energy prices. Headline inflation peaked at 9.9 percent (year-on-year) in October 2008. Although short-term expectations increased significantly as inflation rose, the reaction of five-year-ahead expectations was much more muted, reaching a high of 3.2 percent in the second half of 2008. Thereafter, as the global financial crisis deepened, and global activity slowed, inflation in Chile rapidly became negative, prompting a 775 basis-point reduction in the policy interest rate in the seven months to July 2009 and the introduction of several liquidity support measures. Yet five-year-ahead inflation expectations dropped only slightly, to 2.9 percent in the second half of 2009, suggesting that expectations were by that point very well anchored.

Inflation rose well above the target band in 2014-16, due to peso depreciation following the slump in copper prices. Excess capacity in the economy and a cautious monetary policy stance, however, helped reduce inflationary pressure, and by mid-2017, inflation began to slightly undershoot the target band. Food price deceleration and, initially, peso appreciation, contributed to the undershooting. Through these fluctuations, long-term inflation expectations were impressively stable.

Indeed, inflation expectations at the three-year-ahead and five-year-ahead horizons have been stable at around 3 percent since 1999. At the same time, the sensitivity of long-term inflation expectations to revisions in the short-term inflation forecast and other factors steadily declined during the decade after the adoption of full-fledged inflation targeting. Since 2009, the sensitivity of long-term expectations to shocks has been close to zero, consistent with findings by De Pooter et al. (2014) that inflation expectations have become better anchored in Chile over time.

**Lessons learned.** Chile’s experience with inflation targeting offers three key lessons. First, gradual and successful implementation of the regime can have a lasting impact on inflation expectations. Second, deviations of actual inflation from the target, although substantial at times in Chile’s case, need not weaken the credibility of the central bank. A clear strategy for returning inflation to
target during the medium term, taking into account the lagged effect of monetary policy and the short-run trade-off between output and inflation, is more important than precise targeting from one year to the next. Third, a comprehensive, credible macroeconomic policy framework has yielded positive returns in Chile. A credible fiscal rule, strong financial sector regulation and supervision, and well-functioning capital markets—as well as the monetary policy regime of inflation targeting with a flexible exchange rate—have all helped generate favorable macroeconomic outcomes (De Gregorio, Tokman, and Valdés 2005; Valdés 2007).

Inflation targeting in Poland

Rationale. During the 1990s, monetary policy in Poland embodied two intermediate strategies: maintaining a stable exchange rate and controlling money supply growth (NBP 1998). Amid the challenges related to the transition to a market economy, inflation was reduced from an extremely high level in 1990 to around 10 percent by the end of the decade. But the two strategies also generated tension in the conduct of monetary policy. Inflation stabilization stalled, while episodes of excessive capital inflows as Poland integrated more deeply into global markets stoked fears of inflation persistence. Growing current account deficits highlighted a primary disadvantage of exchange-rate targeting, since a flexible rate offers a key adjustment mechanism for balance of payments disequilibria. This, coupled with the need to meet certain price stability and exchange-rate criteria as Poland began accession discussions with the EU, triggered the announcement by the National Bank of Poland (NBP) in 1998 that it would adopt an inflation target beginning in 1999 (Gottschalk and Moore 2001; Jonas and Mishkin 2003).

Process. Major legislative changes in the late 1990s paved the way for the adoption of inflation targeting. A new Constitution in early 1997, together with the Act on the National Bank of Poland passed later the same year, established both goal and instrument independence for the NBP (Polański 2004). Monetary policy would henceforth be conducted by a Monetary Policy Council (MPC) composed of 10 members serving fixed-duration terms. The new Constitution also enshrined two Maastricht Treaty fiscal requirements into law: it barred direct NBP financing of government deficits and imposed a public debt ceiling of 60 percent of GDP. These legislative changes followed the development of indirect instruments of monetary policy in the early 1990s, including treasury bills and bonds, which allowed the NBP to begin to conduct open market operations.

\[4\) However, the risk of fiscal dominance over monetary policy was perceived to be already low at the time (Gottschalk and Moore 2001).]
Introducing the medium-term strategy for inflation targeting, the MPC committed to achieving inflation-reduction targets and to publishing a semiannual inflation report (NBP 1998). The medium-term target for CPI inflation was defined as below 4 percent by 2003. By end-2002, inflation was less than 2 percent, well below the target ceiling. Poland took a cautious approach to liberalizing its exchange rate, indicating that the date of floating would depend on foreign exchange market developments and on the pace of capital account liberalization. The eventual flotation of the zloty in April 2000 was smooth, however, with no speculative attack despite a large current account deficit.

Over time, Poland’s inflation-targeting regime has been fine-tuned. In 2003, the NBP redefined the target to be 2.5 percent, within a band of +/- 1 percentage point (NBP 2003).

Results. When inflation targeting was announced in 1998, inflation was falling. Yet the short-term inflation target was still overshot in 1999-2001, even after the target band was raised and widened in 2001 (Figure A.4.5.3). This was followed by four years of below-target inflation. Several factors may explain the undershooting of inflation relative to target. First, the immature domestic bond market limited the ability of the NBP to estimate the transmission of monetary policy to inflation (Christoffersen, Slok, and Wescott 2001; Polański 2004). Second, deficiencies in data availability and quality prevented timely identification of inflation pressures, and excess liquidity produced by foreign exchange intervention and institutional issues in the banking sector distorted monetary policy transmission (Schaechter, Stone, and Zelmer 2000). Despite the misses, the NBP communicated the deviations sufficiently far in advance that the public was not surprised by them (Buliř et al. 2008). The avoidance of surprises helped build the credibility of inflation targeting.

Inflation overshot the target band during and after the global financial crisis but persistently undershot it in 2013-16. In 2013, the slowdown of the Euro Area led to region-wide disinflation, including in Poland, where inflation fell below target. The plunge in oil prices that began in mid-2014 accelerated the deflationary trend, contributing to negative inflation during 2014-16. However, the impact of low inflation in the Euro Area on the Polish economy was smaller than in economies with more rigid exchange-rate regimes (Iossifov and Podpiera 2014). During the period of undershooting, the NBP kept its policy rate at 1.5 percent amid concerns about macroeconomic stability (NBP 2016). Inflation recovered to the target range in 2017 as oil prices rose and the Euro Area economy strengthened.
FIGURE A.4.5.3 Inflation targeting in Poland

Inflation converged toward the target range after the introduction of inflation targeting in Poland, while long-term inflation expectations became better anchored and a measure of central bank transparency improved markedly. Over time, the sensitivity of inflation expectations to shocks has declined.

A. Inflation and inflation expectations

B. Central bank transparency

C. General government primary balance and debt

D. Sensitivity of inflation expectations to shocks

Sources: Consensus Economics, Dincer and Eichengreen (2014), Haver Analytics, International Monetary Fund, World Bank.

A-D. The start of the inflation-targeting regime is shaded in gray.

B. Transparency is based on information from the National Bank of Poland’s website, statutes, annual reports, and other published documents, as calculated by Dincer and Eichengreen (2014).

C. The primary balance is net government lending and borrowing, excluding net interest payments.

D. Time-varying sensitivity is estimated by regressing long-term inflation forecast revisions on inflation shocks. Dotted lines denote 68 percent confidence interval. Annex 4.3 provides details on the methodology.

Click here to download data and charts.

Measures of long-term inflation expectations in Poland have stabilized under the inflation targeting regime, mostly fluctuating within the target band. Five-year-ahead inflation expectations stabilized immediately after the shift to inflation targeting—initially, to a level well below the target band. Since 2003, the year the short- and medium-term targets were merged, five-year-ahead expectations have been firmly anchored at about 3 percent. This is consistent with the low, and steadily moderating, sensitivity of inflation expectations to shocks and an improvement in monetary policy credibility (NBP 2003).
Lessons learned. Poland’s experience with inflation targeting offers two key lessons. First, it is possible to control inflation, despite limitations on the relevant data and the presence of much uncertainty about monetary policy transmission. When inflation targeting was adopted in 1999, domestic financial markets in Poland were still developing, and the transmission of monetary policy in the emerging market economy was untested. Although these conditions limited the NBP’s ability to respond to shocks in a timely manner, the NBP succeeded in bringing down the inflation rate, broadly in line with the medium-term targets. Inflation volatility, as well, fell significantly after the introduction of inflation targeting.

Second, the combination of inflation targeting and a flexible exchange rate seems to have reduced spillovers from external shocks, in line with results in the literature on macroeconomic adjustment (e.g., Georgiadis 2016). Real exchange-rate depreciation supported Poland’s growth during the global financial crisis, even as other European economies experienced a sharp slowdown in activity (Andrle, Garcia-Saltos, and Ho 2014). Moreover, spillovers to Poland from the recent period of ultra-low inflation in the Euro Area were lower than in other EU countries with lower exchange-rate flexibility (e.g., Bulgaria, Croatia; Iossifov and Podpiera 2014).
References


The degree to which domestic prices adjust to exchange rate movements is key to understanding inflation dynamics, and hence to guiding monetary policy decisions. However, the exchange rate pass-through to inflation varies considerably across countries and over time. This chapter brings to light two fundamental factors accounting for these variations: the nature of the shock triggering currency movements and country-specific characteristics. First, an empirical investigation demonstrates that different domestic and global shocks can be associated with widely different pass-through ratios. This underscores the need to consider the underlying causes of currency movements before evaluating their impact on inflation. Second, country characteristics matter, including policy frameworks that govern monetary policy responses, as well as other structural features that affect an economy’s sensitivity to currency fluctuations. Pass-through ratios tend to be lower in countries combining flexible exchange rate regimes and credible inflation targets. Empirical results also suggest that central bank independence can greatly facilitate the task of stabilizing inflation following large currency movements and allows fuller use of the exchange rate as a buffer against external shocks.

Introduction

Exchange rate fluctuations are an important driver of inflation and could therefore have significant implications for the formulation of monetary policy (Fischer 2015; Forbes 2015; Mishkin 2008). The expected impact of currency movements on consumer prices will determine how the central bank should react to them. In particular, monetary authorities might look beyond the price-level effect of an exchange rate movement, but may choose to respond if the impact on inflation is persistent. The risk of policy missteps if the pass-through is not properly evaluated is particularly elevated in emerging market and developing economies (EMDEs), where large currency movements are more frequent and where central banks have a greater propensity to respond to them (Calvo and Reinhart 2002; Ball and Reyes 2008). This highlights the importance of correctly assessing the exchange rate pass-through ratio (ERPTR) to inflation—defined in this chapter as the percent increase in consumer prices associated with a 1 percent depreciation of the effective exchange rate after one year.

Notes: This chapter was prepared by Jongrim Ha, Marc Stocker, and Hakan Yilmazkuday. Background materials were provided by Sergiy Kasyanenko.
A rich literature has demonstrated that currency movements are only partially transmitted to domestic prices, with effects dissipating through the production chain. The pass-through to consumer prices goes through various channels, from direct effects through energy and other commodity prices, to indirect effects through import prices, wage formation and profit markups (Bacchetta and van Wincoop 2003; Burstein and Gopinath 2014; Ito and Sato 2008; McCarthy 2000). Even in the case of internationally traded goods, different forms of market segmentation and/or nominal rigidities may explain an incomplete pass-through (see Box 5.1 for a literature review).

Many structural factors have been associated with a lower sensitivity of domestic prices to exchange rate movements, including: the degree of competition among importing and exporting firms (Amiti, Itskhoki, and Konings 2016), the frequency of price adjustments (Devereux and Yetman 2003; Corsetti, Dedola, and Leduc 2008; Gopinath and Itskhoki 2010), the composition of trade (Campa and Goldberg 2010), the level of participation in global value chains (Georgiadis, Gräb, and Khalil 2017), the share of trade invoiced in foreign currencies (Casas et al. 2017; Gopinath 2015), and the use of currency hedging instruments (Amiti, Itskhoki, and Konings 2014). A credible monetary policy framework that supports well-anchored inflation expectations has also been viewed as an effective way to reduce the pass-through to consumer prices (Carriere-Swallow et al. 2016; Gagnon and Ihrig 2004; Reyes 2004; Schmidt-Hebbel and Tapia 2002; Taylor 2000).

Beyond structural factors and country characteristics, the nature of the macroeconomic shock that triggers an exchange rate movement plays a key role in determining the size of the associated pass-through (Comunale and Kunovac 2017; Forbes, Hjortsoe, and Nenova 2017; Shambaugh 2008). This reflects the fact that shocks impacting the exchange rate concurrently affect activity, mark-ups, productivity, and a number of other factors that influence price formation and inflation expectations. It is thus likely that the extent of estimated ERPTRs will vary widely depending on the shock that triggers them—a possibility that most empirical studies have not taken into account.

This chapter contributes to a recent strand of the literature that emphasizes the importance of identifying underlying shocks to assess the transmission of exchange rate movements to inflation, and therefore to formulate the correct monetary policy response. For instance, if the ERPTR associated with monetary policy changes is higher than the one associated with other types of shocks, there is a risk that a central bank might underestimate the exchange rate channel of its actions and maintain an excessively tight (or loose) monetary policy stance relative to what is actually needed to stabilize inflation and output. This may lead to unnecessary fluctuations in activity and make the anchoring of inflation expectations more difficult to achieve over time.
Many studies have estimated the exchange rate pass-through to inflation, producing a wide range of estimates depending on country characteristics, as well as the type of shocks that trigger the exchange rate changes.

Properly measuring the exchange rate pass-through is important for forecasting inflation and for setting monetary policy. Earlier studies generally estimated the exchange rate pass-through ratio (ERPTR) in a reduced-form framework, treating exchange rate movements as exogenous rather than considering underlying shocks behind such movements.

A group of recent studies, however, has emphasized that different shocks can be associated with widely different ERPTRs. These studies usually identify underlying shocks in structural vector-autoregressive (SVAR) models, highlighting heterogeneity in both the direction and magnitude of ERPTRs, depending on the nature of the shocks and country characteristics (Shambaugh 2008; Forbes, Hjortsoe, and Nenova 2017).

Explanatory factors include monetary policy regimes, the level of central bank credibility, trade and financial market openness, the degree of participation in global value chains, and structural features of product and labor markets.

Against this background, this box addresses the following questions:

- **What are the theoretical underpinnings of partial exchange rate pass-throughs to inflation?**
- **How do pass-throughs vary depending on the source of shocks?**
- **What are the key country characteristics affecting pass-throughs?**

**What are the theoretical underpinnings of partial exchange rate pass-throughs to inflation?**

An incomplete adjustment of prices to exchange rate movements can arise in the presence of international market segmentation for traded goods, either because of various trade frictions or because of firms’ ability to practice price discrimination across international locations. Nominal rigidities may also help explain the persistence of such deviations over time, and lead to a declining ERPTR across the production chain.
Price discrimination by firms. Producers’ ability to have different pricing strategies across different segments of international markets is a key feature of most theoretical models of partial ERPTRs. In particular, the pricing-to-market literature (originally developed by Krugman 1987 and Dornbusch 1987) places monopolistic firms at the center of international price discrimination. Exporters can adjust their mark-ups over marginal cost across different destinations to take account of demand conditions and price elasticities encountered in each market (Froot and Klemperer 1989; Auer and Chaney 2009). In general, models with heterogeneous consumers give rise to more flexible demand systems that allow for “optimal” international price discrimination with incomplete ERPTRe (Goldberg and Hellerstein 2008; Hellerstein 2008; Goldberg and Verboven 2001; Nakamura and Zerom 2010).

Endogenous firm selection. International trade models of cross-border production networks have provided further rationale for partial ERPTRe. In these models, macroeconomic shocks produce a new endogenously determined distribution of firms, impacting pricing strategies and aggregate ERPTRe (Bernard et al. 2003; Chaney 2008; Eaton, Kortum, and Kramarz 2011; Mayer, Melitz, and Ottaviano 2014; Melitz and Ottaviano 2008; Rodriguez-Lopez 2011). More competitive and productive firms, which also tend to source more of their inputs internationally, have a larger market share, which lowers average pass-throughs and deepens global value chain integration (Amiti, Itskhoki, and Konings 2014; de Soyres et al. 2018; Gopinath and Neiman 2014).

Nominal rigidities. Nominal rigidities in local currency pricing can account for a less than full pass-through, even when mark-ups are constant. In particular, when prices are sticky, the currency of invoices will determine the rate of pass-through (Choudhri and Hakura 2015; Devereux, Engel, and Storgaard 2004; Bacchetta and van Wincoop 2005; Gopinath and Itskhoki 2010; Floden and Wilander 2006). In models with nominal price rigidities, producers opt to invoice in the currency of either the origin or the destination depending on the desired ERPTRe. Exporters facing stronger competition in the destination markets may choose to invoice in local currencies to keep prices stable relative to competitors, thus reducing the overall exchange rate pass-through.

Non-tradable input costs. Local non-tradable inputs are relatively immune to exchange rate movements, which tend to lower the exchange
rate pass-through to consumer prices. In particular, distribution costs drive a significant wedge between producer and retail prices (Burstein, Neves, and Rebelo 2003; Corsetti and Dedola 2005; Berger et al. 2012). Models with consumer search (Alessandria 2009; Alessandria and Kaboski 2011) and inventories (Alessandria et al. 2010) work in a broadly similar fashion by creating a disconnect between the border and consumer prices of imported goods.

How do pass-throughs vary depending on the source of shocks?

While structural features play an important role in determining ERPTRs, the nature of the macroeconomic shocks behind the exchange rate movements has been increasingly emphasized as a determining factor (Forbes, Hjortsoe, and Nenova 2017). Shocks can act concurrently on inflation and exchange rates, with varying implications for ERPTRs. In a literature review, Goldberg and Knetter (1997) already documented that estimated exchange rate pass-throughs depend critically on how well identified the sources of the exchange rate movements were.

Shambaugh (2008) took this argument one step further by systematically categorizing exchange rate pass-throughs by types of shock. He estimated a vector-autoregressive (VAR) model with long-run identifying restrictions on industrial production, the real exchange rate, consumer prices, the nominal exchange rate, and import prices for 11 mostly advanced economies. ERPTRs after 1 year are estimated for shocks to domestic supply, domestic demand, domestic prices, foreign prices, and import prices. A foreign price shock has a smaller pass-through rate, close to 0.5, as does a domestic demand shock, at around 0.4.

Forbes, Hjortsoe, and Nenova (2017 and 2018) apply a five-variable SVAR with short- and long-term identifying restrictions to the United Kingdom and 26 small open economies with de facto floating exchange rates during 1990-2015. They estimate sizable ERPTRs in responses to domestic monetary policy shocks, but modest ones in response to domestic demand shocks. Their estimates of ERPTRs following global shocks (both permanent and transitory) are quite heterogeneous across countries (Figure 5.1.1). Borensztein and Queijo (2016) follow a broadly similar approach for a group of South American countries; Comunale and Kunovac (2017)
for euro area countries; Cunningham et al. (2017) for a sample of advanced economies; and Ca’Zorzi, Hahn, and Sanchez (2007) for 12 EMDEs. While ERPTRs were historically larger in EMDEs, with currency depreciations often associated with inflation crises and subsequent sharp recessions (Frankel and Rose 1996; Reinhart and Rogoff 2008), they have recently declined in many countries, reflecting the shifting nature of shocks and institutional change (Carriere-Swallow et al. 2016; Forbes, Hjortsoe, and Nenova 2017; Tunc 2017).

What are the key country characteristics affecting pass-throughs?

Many empirical studies have focused on the relationship between estimated ERPTRs and country characteristics. In general, greater openness to trade and financial transactions, less credible central banks, more volatile inflation and exchange rates, and lower levels of market competition are associated with higher ERPTRs.

Various studies have emphasized trade openness and the composition of imported goods (Campa and Goldberg 2005 and 2010), central bank credibility (Taylor 2000; Gagnon and Ihrig 2004; Choudri and Hakura 2006; Mishkin and Schmidt-Hebbel 2007; Coulibaly and Kempf 2010; Caselli and Roitman 2016; Carriere-Swallow et al. 2016; Caselli and Roitman 2016), the degree of competition in product markets (Devereux, Tomlin, and Dong 2015; Amiti, Itskhoki, and Konings 2016), inflation volatility (Ca’Zorzi, Hahn, and Sanchez 2007; Forbes, Hjortsoe, and...
Chapter 5

Inflation: Evolution, Drivers, and Policies

Against this background, this chapter examines the following questions:

- How have exchange rate movements impacted inflation over time?
- How does the pass-through to inflation depend on the underlying shock triggering the exchange-rate movement?
- What country characteristics are associated with lower pass-throughs?

To answer these questions, this chapter first examines the extent of the comovement between inflation and exchange rates across 34 advanced economies and 138 EMDEs, including event studies of significant depreciation and appreciation episodes. Second, it estimates from a series of factor-augmented vector-autoregressive (FAVAR) models the impact of various global and domestic shocks on exchange rates and inflation, deriving shock-specific

Box 5.1 Exchange rate pass-through: A review (continued)

Nenova 2017), and exchange-rate volatility (Campa and Goldberg 2005). Other studies focus on microeconomic aspects of price-setting: nominal rigidities (Devereux and Yetman 2003; Corsetti, Dedola, and Leduc 2008), the role of foreign currency pricing, especially in invoicing (Gopinath, Itskhoki, and Rigobon 2010; Gopinath 2015; Devereux, Tomlin, and Dong 2015), the dispersion of price changes (Berger and Vavra 2015), and the frequency of price adjustments (Gopinath and Itskhoki 2010). Korhonen and Wachtel (2006) found that high degrees of dollarization and import penetration accelerated the speed of pass-through in Commonwealth of Independent States (CIS) countries relative to other emerging markets.

Other research indicates that exchange rate pass-through varies over time and may be subject to regime-switching and structural breaks (Ozkan and Erden 2015; Campa and Goldberg 2005; Cunningham et al., 2017; Donayre and Panovska 2016; Khalaf and Kichian 2005). Some studies link this time-varying exchange rate pass-through to the role of domestic factors, such as the changing composition of imports and shifts in monetary policy frameworks, or to external factors, such as the increasing role of China in the global economy (Marazzi et al. 2005; Gust, Leduc, and Vigfusson 2010).
pass-through ratios. The models are estimated from a subsample of 55 countries, including 26 EMDEs. Third, it investigates how country characteristics affect pass-through ratios, paying a particular attention to monetary policy frameworks, participation in global value chains, and foreign-currency invoicing.

The main conclusions are as follows:

- Large depreciation episodes continue to be associated, on average, with more significant increases in consumer price inflation in EMDEs than in advanced economies. Unconditional pass-throughs tend to increase with the size of the depreciation in both country groups.

- The relationship between inflation and currency movements depends on the nature of the underlying shock. Monetary policy shocks are associated with a higher exchange rate pass-through compared to other domestic shocks, while global shocks have widely different effects.

- Pass-throughs are generally lower in countries with more flexible exchange rate regimes and a credible commitment to an inflation target. This, in turn, facilitates the central bank’s task of stabilizing inflation and makes exchange rate movements a more effective buffer against external shocks.

The contribution of this chapter to the literature is threefold. First, it utilizes a rich set of results to shed new light on the heterogeneity of pass-through estimates across countries and over time.

Second, it supplements a burgeoning empirical literature linking exchange rate pass-through to underlying shocks in a structural vector-autoregressive model framework. This contrasts with traditional reduced-form approaches that estimate “average” pass-throughs based on conditioning variables. The estimation of shock-specific pass-throughs refines the analysis of factors affecting the link between exchange rate movements and inflation.

Third, compared to the few preceding studies that have derived state-dependent estimates of ERPTRs (Forbes, Hjortsoe, and Nenova 2017, 2018; Shambaugh 2008), this chapter investigates additional shocks and uses a larger sample of countries. It looks at the impact of three domestic shocks (monetary policy,

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1 Defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change to three domestic shocks (monetary policy, domestic demand, and domestic supply), three global shocks (global demand, global supply, and oil prices), and one residual shock (risk premium).
demand, and supply), three global shocks (demand, supply, and oil price), and a residual shock capturing, among other factors, changing risk premiums. A unique FAVAR framework combining global and domestic developments allows identification of these different shocks in a unified set-up. Moreover, the identification strategy uses an efficient algorithm to combine sign and zero restrictions, preserving a certain level of agnosticism (Arias, Rubio-Ramirez, and Waggoner 2014). Finally, compared to previous studies, this chapter is more focused on EMDE-specific characteristics, including monetary policy frameworks, participation in global value chains, and foreign currency invoicing.

The next sections offer key stylized facts about the link between inflation and exchange rate movements, present estimates of shock-specific exchange rate pass-through ratios, and demonstrate the importance of structural factors and country-specific characteristics. The conclusion discusses policy implications and suggests avenues for future research.

**Exchange rate movements and inflation**

This section examines the historical relationship between changes in the nominal effective (trade-weighted) exchange rate and consumer price inflation. A depreciation (decline in the effective exchange rate) is expected to cause the domestic price of imports to rise and, depending on a host of factors, higher consumer prices (i.e., a positive pass-through). The first step in this descriptive analysis examines the impact of large currency movements on consumer price inflation in cross-country event studies. The second step examines the stability of the relationship between inflation and currency movements over time.

**Inflation and exchange rate movements: Event study**

The event study presented in this section explores episodes of large exchange rate fluctuations, defined as quarterly movements in excess of 5 percent across 34 advanced economies and 138 EMDEs. The rationale for focusing on large currency fluctuations is twofold. First, such episodes are more likely to induce detectable changes in prices throughout the entire production chain. This helps trace factors influencing the exchange rate pass-through across countries. Second, such an event study allows the estimation of the pass-through conditional on the size and direction of the exchange rate movement. A common assumption in the literature is that the relationship between exchange rate movements and inflation is both linear and symmetric. However, prices may respond differently to large changes in the exchange rate, and depreciations may generate an asymmetric reaction relative to appreciations. Computing unconditional pass-throughs associated with different types of exchange rate movements can help disentangle these effects.
Overall, depreciations of between 5 and 10 percent per quarter have been associated with a low unconditional pass-through over the last two decades (Figure 5.1). Median estimates of the same quarter pass-through are close to zero in advanced economies, and around +0.1 for EMDEs (i.e., a 10 percent depreciation in the median EMDE triggers a 1 percent increase in consumer prices after one quarter). Depreciations of between 10 and 20 percent in a given quarter were generally accompanied by a higher pass-through, with median values of +0.1 for advanced economies and +0.2 for EMDEs. Depreciations in excess of 20 percent were associated with pass-throughs of around +0.4 in both groups of countries, but these events have been far less common recently, which reduces the reliability of estimated pass-throughs.

The event study also confirms a broad-based decline in the pass-through among EMDEs over the last two decades. For depreciations of between 5 and 10 percent, the median pass-through in EMDEs fell by a factor of three from 1980-98 to 1998-2017. This decline came together with a reduction in the frequency and severity of currency depreciations. Prior to 1998, large depreciation episodes in EMDEs clustered around periods of U.S. dollar appreciation, often associated with a tightening of U.S. monetary policy. In some cases, these led to full-blown currency or debt crises, particularly in Latin America during the 1980s and the early- to mid-1990s, and in Asia during the second half of the 1990s. The reduced frequency of large depreciations and lower unconditional pass-throughs over the last two decades may have common causes: enhanced monetary and fiscal policy frameworks, more flexible exchange rate regimes, the accumulations of foreign exchange reserves, lower current account deficits, and better external debt management (Frankel, Parsley, and Wei 2005). Unconditional pass-throughs remained higher among EMDEs with less flexible exchange rate regimes (i.e., those devaluing from currency pegs or other forms of currency arrangements), and those without inflation-targeting central banks.

Appreciation episodes are generally associated with positive but lower pass-throughs compared to depreciations of the same magnitude, with median values of +0.02 for both advanced economies and EMDEs for appreciations of between 5 and 10 percent, and only slightly higher for appreciations of between 10 and 20 percent (Figure 5.2). These results may indicate that currency appreciations induce a weaker response from import and consumer prices compared to similar size depreciations (Brun-Aguerre, Fuertes, and Greenwood-Nimmo 2017). However, large currency appreciations are also rare events, making rigorous conclusions about asymmetric effects difficult to establish in this context. Overall, the results appear to point to the presence of non-linearities in the relationship between exchange rate movements and inflation, including in EMDEs (Caselli and Roitman 2016).
**FIGURE 5.1 Pass-through during significant currency depreciations**

The median pass-through associated with large currency depreciations declined in EMDEs over the last two decades but remains higher among countries with less flexible exchange rate regimes and without inflation-targeting central banks. The frequency and severity of depreciation episodes dropped as well.

A. Unconditional pass-through from depreciations of 5 to 10 percent

B. Unconditional pass-through from different depreciation episodes, 1998-2017

C. EMDEs: Unconditional pass-through from depreciations of 5 to 10 percent, 1998-2017

D. EMDEs: Unconditional pass-through from different depreciation episodes, 1998-2017

E. Frequency of significant exchange rate depreciations: Advanced economies

F. Frequency of significant exchange rate depreciations: EMDEs


Notes: Depreciations are defined as negative quarterly changes in the nominal effective exchange rate. The sample comprises 34 advanced economies and 138 EMDEs.

A.-D. Pass-throughs are defined as the change in consumer prices after one quarter divided by the depreciation of the nominal effective exchange rate. The markers refer to the median pass-through. A.C. The bars show the interquartile range of pass-throughs. C.D. Countries with "high" trade openness are defined as those with above median trade-to-GDP ratios, all others are considered to have "low" trade openness. Exchange rate and inflation-targeting (IT) regimes are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

[Click here to download data and charts.]
Inflation and exchange rate correlation: Evolution over time

While the declining sensitivity of inflation to exchange rate movements has been extensively documented, this relationship is generally assumed to be stable in the short-term. However, there is growing evidence that pass-throughs can vary considerably even over short periods of time, making inference from average values unreliable and potentially misleading for policy evaluation and forecasting purposes.

This instability in pass-through rates can be illustrated by plotting rolling correlation rates between exchange rate movements and consumer price
inflation over time (Figure 5.3). For advanced economies, the median correlation rate became increasingly positive during the late 1990s (+0.4 in 2000); during the mid-2000s (+0.2 in 2007); and again during the mid-2010s (+0.5 in 2014). These were periods marked by unusually large monetary policy shocks or heightened uncertainty over policy actions, providing some evidence of stronger exchange rate pass-through to inflation during such episodes. In contrast, correlation rates were close to zero during the recovery in the early

Using a three-year window of the bivariate correlation between nominal effective exchange rate depreciation rate in one quarter and the inflation rate in the next quarter. For both advanced economies and EMDEs, correlation rates tend to peak after one quarter, indicating that exchange rate movements have the strongest impact on inflation with a one-quarter lag.
2000s and turned significantly negative during the global financial crisis (-0.5 in 2008-09). They were also close to zero during the latest synchronized upturn in 2017-18. These were periods dominated by shifts in either domestic or global demand conditions, which appear to be associated with a lower sensitivity of inflation to exchange rate movements. These trends were largely shared across countries, as reflected in similar swings in the upper and lower bands of the interquartile range of country estimates.

Among EMDEs, the median correlation also moved close to zero during the economic recovery of the early 2000s and during the global financial crisis, but became increasingly positive after 2010 amid deteriorating supply-side conditions in many countries, including commodity exporters facing the end of the commodity super-cycle (Baffes et al. 2015).

A wide range of cross-country and time variation in the correlation between exchange rates and inflation is consistent with the notion that different shocks as well as country-specific characteristics can shape the response of inflation to currency movements. These two factors—the source of shocks and country characteristics—are discussed in the next two sections.

**Pass-through to inflation and underlying shocks**

A recent strand of the literature on the exchange rate pass-through has emphasized the importance of identifying the underlying cause of currency movements (Comunale and Kunovac 2017; Forbes, Hjortsoe, and Nenova 2017 and 2018; Shambaugh 2008). For example, a depreciation driven by monetary policy easing could be accompanied by larger increases in inflation, as it raises import prices in the short term and is associated with stronger aggregate demand (and, consequently, an increase in overall pricing pressures) over the medium term. In this case, the pass-through should be expected to be positive and large as both domestic and external forces contribute to higher inflation. In contrast, a depreciation associated with weaker domestic demand could be accompanied by lower inflation over time, as the impact of rising economic slack on domestic prices could outweigh that of higher import prices. In this case, the shock-specific pass-through could be negative. The sensitivity of inflation to exchange rate movements can, therefore, vary considerably depending on the macroeconomic environment and the source of the shocks. This section quantifies differences in pass-through ratios associated with various global and domestic shocks.

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3 Sharp movements in oil prices around the global financial crisis also impacted the correlation between exchange rate movement and domestic inflation trends around that period.
4 Range between the 25th and 75th percentile of country estimates.
Methodology. For this empirical investigation, country-specific factor-augmented vector-autoregressive (FAVAR) models were estimated for 29 advanced economies and 26 EMDEs, using quarterly data over the period between 1971 and 2017. The model provides a multivariate open-economy framework that maps domestic and foreign drivers of inflation and the nominal effective exchange rate. The identification strategy is based on the following assumptions, combining both sign and short-term restrictions:

- A positive domestic demand shock is assumed to raise domestic output growth and inflation.\(^5\)
- A positive (contractionary) monetary policy shock is assumed to cause an exchange rate appreciation, decrease domestic output growth, and reduce inflation.
- A positive supply shock is assumed to raise output growth, but to lower inflation.
- A positive global demand shock triggers a simultaneous upswing in global output growth, global inflation, and oil prices.\(^7\)
- A positive global supply shock leads to higher global output growth and oil prices, but lower global inflation.
- A positive oil price shock induces an increase in oil prices and global inflation, but a drop in global output growth.
- Global shocks can have contemporaneous effects on domestic variables, but domestic shocks can only influence global variables with a lag.

A two-step procedure is applied to measure shock-specific exchange rate pass-throughs. First, the exchange rate and inflation responses to these shocks are mapped separately from impulse response functions. Second—as in Shambaugh (2008) and Forbes, Hjortsoe, and Nenova (2017 and 2018)—the pass-through is defined as the cumulative impulse response of consumer price inflation relative to the impulse response of the effective exchange rate over the same period. The pass-through is measured one year after the initial shock, as in Shambaugh (2008).

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5 Details of the modeling approach are provided in Annex 5.1.
6 An alternative specification also assumes that positive domestic demand shocks lead to a contemporaneous increase in domestic interest rates. See Annex 5.1 for robustness results.
7 Global shocks are derived from a separate tri-dimensional vector-autoregressive model, which incorporates global output growth, global inflation, and oil price changes, following the approach of Charnovski and Dolado (2014), and Uhlig (2005). See Chapter 3 for details.
A positive pass-through indicates that a shock triggering a currency depreciation is followed by an increase in consumer prices, as generally expected, while a negative value means that a shock triggering a currency depreciation is followed by a decline in consumer prices.

**Exchange rate responses**

Since pass-through ratios are defined in this framework as the relative response of consumer prices and the exchange rate to different global and domestic shocks, it is important to first investigate the estimated impact of these shocks on the exchange rate. Empirical studies have shown that fundamentals have some, albeit limited, predictive power over exchange rate movements. These fundamentals include changes in relative business cycle positions, monetary policy stances, risk premiums, and terms of trade (Ca’Zorzi and Rubaszek 2018; Cheung et al. 2017). In particular, periods of domestic output or investment contraction are often associated with currency depreciations (Cordella and Gupta 2015; Landon and Smith 2009; Campa and Goldberg 1999). Monetary policy easing can also lead to currency depreciations, as a declining interest rate differential with the rest of the world tends to put downward pressure on the domestic currency (Chinn and Meredith 2005; Engel 2016). Rising risk premiums and heightened sovereign default risks can also trigger such downward pressures (Foroni, Ravazzolo, and Sadaba 2018). Finally, nominal exchange rates can respond to terms of trade shocks, particularly in commodity exporters with flexible currency regimes (Aizenman, Edwards, Riera-Crichton 2012; Schmitt-Grohé and Uribe 2018).

Impulse responses from the FAVAR model provide a basis for disentangling the impact of different types of domestic and global shocks on the exchange rate. The results described below are based on a one-year response of nominal effective exchange rate to one standard-deviation shocks. Median and interquartile ranges of country-specific estimates are reported for different groups.\(^8\)

**Domestic shocks.** Monetary policy tightening leads to currency appreciations in all advanced economies and EMDEs (Figure 5.4). Interest-rate-driven appreciations are estimated to be larger in EMDEs, particularly among countries with inflation-targeting central banks and in some commodity exporters (Brazil, Colombia, South Africa). Stronger domestic demand causes currency appreciations as well, but the impact is statistically insignificant after one year in

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\(^8\) An interquartile range is a range between the 25th to the 75th percentile of country estimates within each country group.
most cases. Meanwhile, changes in domestic supply conditions have mixed effects. This is consistent with the literature arguing that productivity shocks have uncertain implications for currency movements (Alfaro et al. 2018; Corsetti, Dedola, and Leduc 2008).

**Global shocks.** The median impact of global shocks on the exchange rate is close to zero across countries (Figure 5.5). Obviously, this result is not surprising because one country’s currency depreciation is, by definition, another’s appreciation. Still, domestic currency appreciations are more likely to happen in the wake of a positive global demand shock, particularly among EMDEs. This could reflect the fact that the U.S. dollar, which remains the global currency of exchange, generally depreciates during global upturns. A weaker U.S. dollar, in turn, typically supports capital inflows and amplifies appreciations in EMDEs, particularly among countries with current account deficits (Avdjiev et al. 2018). A positive global supply-side shock has mixed effects, with currency depreciations observed among some EMDEs that run current account surpluses (e.g., China) and appreciations among some commodity exporters (e.g., Brazil, Colombia, Malaysia, South Africa). Rising oil prices also tend to be associated with currency appreciations in oil-exporting economies, and with depreciations in some oil-importers.

**Relative contributions of global and domestic shocks.** On balance, domestic factors are dominant drivers of exchange rate fluctuations, accounting for about two-thirds of currency movements in advanced economies, and more than one-half in EMDEs (Figure 5.6). Although the direction and magnitude of the impact of global shocks varies substantially across countries, these shocks still explain around 7 percent of the variance of currency movements in the median advanced economy, and up to 16 percent in the median EMDE. Forbes, Hjortsoe, and Nenova (2017) present similar results, but they attribute a larger share of currency movements to global shocks. About 25 percent of currency movements are accounted for by other shocks, which encompass changes in sovereign and private-sector risk premiums. Indeed, shifting expectations about sovereign default risks can have a significant impact on exchange rate dynamics (Alvarez, Atkeson, and Kehoe 2009; Foroni, Ravazzolo, and Sadaba 2018).

**Estimated pass-through**

Shock-specific ERPTRs are calculated from country-specific FAVAR models as the ratio between the impulse response of inflation and the impulse response of the exchange rate to different shocks after one year. These conditional pass-

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9 In this chapter, statistical inferences are based on 68 percent confidence intervals.
10 At around 30 percent, on average.
FIGURE 5.4 Exchange rate responses to domestic shocks

Monetary policy tightening and, to a lesser degree, positive domestic demand shocks are accompanied by currency appreciations, particularly among EMDEs that are more open to trade, have more flexible exchange rate regimes, and have inflation-targeting central banks.

A. Monetary policy shocks

B. EMDEs: Monetary policy shocks

C. Domestic demand shocks

D. EMDEs: Domestic demand shocks

E. Domestic supply shocks

F. EMDEs: Domestic supply shocks


Notes: One-year impulse responses of the exchange rate to domestic shocks (monetary policy, domestic demand, and domestic supply) from country-specific FAVAR models estimated for 29 advanced economies and 26 EMDEs over the period 1998-2017. Bars show the interquartile range and markers represent the median across countries. A positive number indicates an appreciation.

B.D.F. Countries with “high” trade openness are defined as those with above median trade-to-GDP ratios, all others are considered to have “low” trade openness. Exchange rate and inflation-targeting (IT) regimes are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

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FIGURE 5.5 Exchange rate responses to global shocks

The effect of global shocks on exchange rates has varied considerably across countries. However, strengthening global demand is more often followed by domestic currency appreciations, particularly among EMDEs with floating exchange rate regimes and inflation-targeting central banks. Oil price shocks have opposite effects on the exchange rates of energy exporters and energy importers.

A. Global demand shocks

B. EMDEs: Global demand shocks

C. Global supply shocks

D. EMDEs: Global supply shocks

E. Oil price shocks

F. EMDEs: Oil price shocks

Notes: One-year impulse response of the exchange rate to global shocks (demand, supply, and oil prices) from country-specific FAVAR models estimated for 29 advanced economies and 26 EMDEs over the period 1998-2017. Bars show the interquartile range and markers represent the median across countries. A positive number indicates an appreciation.

B.D.F. Countries with "high" trade openness are defined as those with above median trade-to-GDP ratios, all others are considered to have "low" trade openness. Exchange rate and inflation-targeting (IT) regimes are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

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through ratios can help establish a link between cross-country and time variations in the average ERPTRs, and various factors such as different sensitivities to shocks, changes in the prevalence of some shocks, improved policy frameworks, or other structural factors.

Median estimates of pass-through ratios are reported across different country groups, as well as interquartile ranges across these country groups.

**Domestic shocks.** Domestic shocks account for over half of the variance of both inflation and exchange rates in most countries, but are associated with different ERPTRs depending on their source.

*Domestic monetary policy* shocks are generally associated with large positive ERPTRs (e.g., currency depreciations combined with monetary policy easing are accompanied by significant increases in inflation). Median values since 1998 are estimated to be +0.2 in advanced economies and +0.3 in EMDEs (Figure 5.7).
Pass-through ratios are generally higher in small open EMDEs that have less flexible exchange rate regimes or do not have inflation-targeting central banks (e.g., Macedonia FYR, Morocco, Azerbaijan, Jordan, Honduras, Botswana). The finding that EMDEs with inflation-targeting central banks tend to have lower-than-average ERPTRs provides preliminary evidence that a credible commitment to price stability helps weaken the responsiveness of inflation to exchange rate movements.

In a sharp contrast with monetary policy shocks, domestic demand shocks are associated with small negative ERPTRs for most countries (e.g., a negative domestic demand shock tends to be associated with both currency depreciation and declining inflation). Median values at around -0.07 are similar for both advanced economies and EMDEs. Among EMDEs, the ERPTR is generally more negative in countries with less flexible exchange rate regimes and without inflation-targeting central banks.

Domestic supply-side shocks are associated with positive ERPTRs, but with lower median values compared to monetary policy shocks (less than +0.1 in both advanced economies and EMDEs). However, most of these estimates are insignificant, with wide variations across country groups.

Global shocks. Global shocks account for smaller proportion of the variance of exchange rate movements, and are associated with more variations in estimated ERPTRs.

ERPTRs associated with global demand shocks tend to be positive among EMDEs (e.g., currency depreciation coupled with higher inflation), particularly in economies with less flexible exchange rate regimes and without inflation-targeting central banks (Figure 5.8). However, in several EMDEs, ERPTRs are estimated to be negative (i.e., currency depreciation coupled with lower inflation), including among some energy exporters (e.g., Azerbaijan, Colombia). Estimated ERPTRs are statistically insignificant in over one-fifth of advanced economies and one-third of EMDEs.

Oil price shocks tend to be associated with widely different ERPTRs. The median ERPTR is positive for many energy exporters (e.g., Azerbaijan, Colombia, Malaysia), but negative in advanced economies, except for the United States (partly due to the negative correlation between the U.S. dollar and oil prices). Estimates are insignificant in over one-half of advanced economies and almost two thirds of EMDEs.

Global supply shocks tend to generate large variations in ERPTRs as well, with a negative median estimate for advanced economies and a positive one for EMDEs. However, estimates are insignificant in nearly three-quarters of advanced economies and about two-thirds of EMDEs.
FIGURE 5.7 Pass-through associated with domestic shocks

The exchange rate pass-through is large and positive when currency movements are associated with monetary policy changes. It is smaller when associated with changes in domestic supply conditions, and negative when associated with changes in domestic demand conditions. Among EMDEs, the pass-through is generally lower among countries with more flexible exchange rate regimes and inflation-targeting central banks.

A. Monetary policy shocks

B. EMDEs: Monetary policy shocks

C. Domestic demand shocks

D. EMDEs: Domestic demand shocks

E. Domestic supply shocks

F. EMDEs: Domestic supply shocks


Notes: Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change estimated from FAVAR models for 29 advanced economies and 26 EMDEs over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries.

B.D.F. Countries with "high" trade openness are defined as those with above median trade-to-GDP ratios, all others are considered to have "low" trade openness. Exchange rate and inflation-targeting regimes (IT) are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

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FIGURE 5.8 Pass-through associated with global shocks

Exchange rate pass-throughs vary widely, depending on the source of the global shock and country characteristics. For EMDEs, the pass-through is generally the lowest among countries that are less open to trade, have more flexible exchange rate regimes, and have inflation-targeting central banks.

A. Global demand shocks

B. EMDEs: Global demand shocks

C. Global supply shocks

D. EMDEs: Global supply shocks

E. Oil price shocks

F. EMDEs: Oil price shocks


Notes: Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change estimated from FAVAR models for 29 advanced economies and 26 EMDEs over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries.

B.D.F. Countries with “high” trade openness are defined as those with above median trade-to-GDP ratios, all others are considered to have “low” trade openness. Exchange rate and inflation-targeting (IT) regimes are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

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CHAPTER 5 INFLATION: EVOLUTION, DRIVERS, AND POLICIES

FIGURE 5.9 Pass-through associated with exchange rate shocks

The exchange rate pass-through is close to zero when currency movements are associated with residual exchange rate shocks (i.e., not defined as domestic or global shocks).

A. Exchange rate shocks

B. EMDEs: Exchange rate shocks


Notes: Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change estimated from FAVAR models for 29 advanced economies and 26 EMDEs over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries.

B. Countries with “high” trade openness is defined as those with above median trade-to-GDP ratios, all others are considered to have “low” trade openness. Exchange rate and inflation-targeting (IT) regimes are based on IMF classifications (see Database Annex for details). Energy exporters are defined as in World Bank (2018), all other countries are considered energy importers. Countries with current account deficits are those with a negative average current account balance over the period 1998-2017.

Other shocks. The FAVAR models attribute nearly a quarter of currency movements to residual shocks that may be linked to shifting risk premiums and other unmeasured factors. The median ERPTR associated with such shocks is close to zero in both advanced economies and EMDEs (Figure 5.9). However, it tends to be negative in EMDEs with less flexible exchange rate regimes, indicating that the direct effect of exchange rate changes on import prices is more than offset by other factors in those countries.

Past empirical studies disentangling the impact of different types of shocks on exchange rates and inflation have reached broadly similar conclusions (Box 5.1). For instance, Forbes, Hjortsoe, and Nenova (2017) estimate a five-variable structural vector-autoregressive (SVAR) model with short- and long-term identifying restrictions using a sample of 26 small open economies with de facto floating exchange rates. They report relatively large positive ERPTRs in responses to domestic monetary policy shocks, but modest ones for responses to domestic supply shocks, and negative EPRTRs for domestic demand shocks. They also find that pass-throughs associated with global shocks vary considerably in magnitude and direction. Shambaugh (2008) tests for cross-country differences in shock-specific ERPTRs and concludes that domestic demand shocks have a smaller pass-through relative to other types of shocks.
Average pass-through. To facilitate a comparison with other empirical studies, a weighted average of shock-specific pass-through ratios is computed, using shares of currency movements accounted for by each type of shock as weights. This summary measure reflects the average sensitivity of inflation to exchange rate movements over the entire estimation period.

Overall, average ERPTRs are estimated to have declined in both advanced economies and EMDEs in recent decades. The median estimate for advanced economies averaged +0.08 since 1970 but was close to zero over 1998-2017 (Figure 5.10). For EMDEs, the median value averaged +0.15 since 1970, but declined to +0.08 over 1998-2017.

Among larger EMDEs, the average ERPTR in China is estimated at +0.08 since 1998, somewhat below previously reported estimates (Jiang and Kim 2013; Shu and Su 2009; Wang and Li 2010). For India, the average ERPTR is estimated at +0.14, broadly in line with previous studies (Bhattacharya, Patnaik, and Shah 2008; Forbes, Hjortsoe, and Nenova 2017; Kapur and Behera 2012). For the Russian Federation, it is measured at +0.11, consistent with findings of the Central Bank of the Russian Federation (2014). For Brazil, the average ERPTR is estimated at +0.06 since 1998, towards the lower end of other studies (Forbes, Hjortsoe, and Nenova 2017; Ghosh 2013; Nogueira and Leon-Ledesma 2009). For South Africa, the ERPTR is estimated at +0.07, broadly in line with the evidence presented in Kabundi and Mbelu (2018).
Pass-through to inflation and structural factors

The findings of this chapter confirm that the nature of the shocks behind exchange rate movements plays a critical role in determining both the direction and the magnitude of the exchange rate pass-through to inflation. Country characteristics matter as well. Monetary policy frameworks and structural factors, such as the degree of international trade integration and foreign currency invoicing can make domestic prices more or less sensitive to exchange rate fluctuations. In EMDEs, improvements in monetary policy frameworks are credited for being a major force in pushing average ERPTRs down over the last two decades.

Monetary policy framework and credibility. The empirical literature has generally found ERPTRs to be smaller among advanced economies and in EMDEs with inflation-targeting or more credible central banks (Carriere-Swallow et al. 2016; Gagnon and Ihrig 2004; Reyes 2004; Schmidt-Hebbel and Tapia 2002). Over the past two decades, an increasing number of central banks have adopted inflation targets and enhanced their credibility, which has helped reduce ERPTRs (Mishkin and Schmidt-Hebbel 2007; Coulibaly and Kempf 2010). This tendency has been observed across EMDEs, including in many economies in Asia (Prasertnukul, Kim, and Kakinaka 2010), Latin America (Ghosh 2013), and Eastern Europe and Central Asia (Maria-Dolores 2010; Yüncüler 2011). More generally, countries with lower inflation and less volatile exchange rates have been found to have lower average pass-throughs as well (Forbes, Hjortsoe, and Nenova 2017).

The consequences of inflation-targeting frameworks and greater central bank credibility and independence are discernible in estimated ERPTRs for both domestic and global shocks. In particular, the ERPTR associated with *domestic monetary policy* shocks is significantly smaller in EMDEs with more independent central banks (Figure 5.11). An improvement of the central bank independence index from one-standard-deviation below the sample mean to one-standard-deviation above it can reduce the pass-through ratio associated with monetary policy shock by half. In countries with more independent central banks, inflation responds less to exchange rate movements triggered by *global demand* and *oil price* shocks as well. This implies that countries with flexible exchange rates can better absorb external shocks through currency adjustments without threatening price stability.

Trade openness and participation in global value chains. The feedback between trade openness and exchange rate pass-through is multifaceted. A larger share of foreign products in domestic markets implies a potentially larger role for exchange rate movements in driving aggregate inflation (Benigno and Faia 2016; Soto and Selaive 2003). This would be consistent with a higher average ERPTR
in more open economies. However, increased foreign competition in domestic markets will tend to reduce the pricing power of domestic firms, which will tend to reduce the ERPTR (Auer 2015; Berman, Martin, and Mayer 2012; Gust, Leduc, and Vigfusson 2010). More competitive or productive firms also tend to have larger market shares and source more of their inputs internationally (Gopinath and Neiman 2014), further contributing to a decrease in the ERPTR (Amiti et al. 2014).

The degree of global value chain (GVC) integration could play an important role as well. By fragmenting production and increasing the share of intermediate goods in total trade, a higher GVC integration could weaken the response of both import and export prices to exchange rate movements. Such an effect has been identified in both advanced economies and EMDEs (Amiti et al. 2014; de Soyres et al. 2018; Georgiadis, Gräb, and Khalil 2017).

A number of economies in East Asia Pacific and Eastern Europe and Central Asia have both high GVC integration and low average pass-throughs; however, a clear link between the GVC integration and pass-throughs could not be established, partly reflecting the correlation between GVC participation and other variables associated with trade openness (Figure 5.12; Chinn 2014).

**Foreign currency invoicing.** Having a large share of imports invoiced in a foreign currency could amplify the sensitivity of import and export prices to exchange rate movements (Devereux, Tomlin, and Dong 2015; Gopinath 2015). The ERPTR to import and export prices has been found to be particularly elevated for countries with a high share of imports priced in U.S. dollars (Casas et al. 2017; Korhonen and Wachtel 2006). More generally, domestic prices in highly dollarized economies tend to react more to currency movements relative to other countries, since both tradable and non-tradable goods are priced in a foreign currency (Carranza, Galdon-Sanchez, and Gomez-Biscarri 2009; Reinhart, Rogoff, and Savastano 2014; Sadeghi et al. 2015). However, the selection of the pricing currency could itself depend on the desired level of the exchange rate pass-through, preserving the causal relationship (Gopinath, Itskhoki, and Rigobon 2010).

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11 For instance, using a structural two-country model, Georgiadis, Gräb, and Khalil (2017) show that the sensitivity of an economy’s local currency production costs to exchange rate changes rises as it participates more in global value chains by importing a larger share of its intermediate inputs. The increased sensitivity of the economy’s local-currency production costs to exchange rate changes translates into a lower sensitivity of its foreign-currency export prices to exchange rate changes. As the economy’s foreign-currency export price equals its trading partner’s local-currency import price, an increase in the economy’s global value chain participation implies a fall in its trading partner’s exchange rate pass-through to local-currency import prices.
A significantly larger share of foreign currency (and U.S. dollar) invoicing in most EMDEs relative to advanced economies could partly help explain a difference in average ERPTRs across these two groups. However, the relationship between the size of the pass-through and the share of imports invoiced in foreign currencies appears to be tenuous (Figure 5.13). For instance, EMDEs with a higher share of foreign currency invoicing and more elevated
ERPTRs are also characterized by less flexible currency regimes, and the absence of an inflation-targeting central bank. Overall, the share of foreign currency invoicing is merely a secondary factor explaining cross-country differences in estimated ERPTRs.

FIGURE 5.12 Global value chain participation and pass-through

Higher global value chain participation is associated with lower pass-throughs in some EMDEs, but the relationship is tenuous across the full sample.
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FIGURE 5.13 Foreign currency import invoicing and pass-through

The share of foreign currency invoicing does not seem to account for cross-country variations in ERPTRs in EMDEs.

A. Share of imports invoiced in foreign currency

B. Share of foreign currency invoicing and pass-through from monetary policy shocks

C. Share of foreign currency invoicing and pass-through from monetary policy shocks in EMDEs

D. Share of foreign currency invoicing and average exchange rate pass-through in EMDEs

Sources: Gopinath (2015), World Bank.
Notes: Share of imports invoiced in foreign currency based on data for 50 countries calculated by Gopinath (2015). Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change estimated from FAVAR models for 29 advanced economies and 26 EMDEs over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries. B. Low and high share of foreign currency invoicing are defined as below or above the sample average. C.D. The sample only includes EMDEs with floating exchange rate regimes according to IMF classification (see Database Annex for details). D. Shock-specific pass-throughs are aggregated using shares of currency movements accounted for by each type of shock as weights.

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Conclusion

Monetary authorities in EMDEs have long been worried that significant exchange rate fluctuations could jeopardize price stability and force disruptive monetary policy responses. To alleviate these concerns, some countries adopted managed currency arrangements or leaned against undesirable currency movements with aggressive policy changes—a practice that has been dubbed, “fear of floating” (Calvo and Reinhart 2002; Ball and Reyes 2008). However, a lack of exchange rate flexibility can amplify global shocks, encourage speculative attacks, and make it more difficult to credibly anchor inflation expectations.
This in turn tends to increase the sensitivity of inflation to exchange rate movements, constraining the effectiveness of monetary policy, and, as a result, limiting the adjustment of relative prices and the efficacy of expenditure-switching mechanisms as a buffer against global shocks.

This underscores the importance of properly evaluating the exchange rate pass-through to inflation under various circumstances and identifying the factors affecting it. Such an evaluation is of fundamental importance to formulate the appropriate and proportionate monetary policy response to currency movements.

This chapter investigated the relationship between inflation and exchange rate movements, contingent on the nature of the underlying shocks. Using factor-augmented vector-autoregressive (FAVAR) models, seven shock-specific pass-through ratios were computed for each country. These ratios were then grouped and aggregated to identify common patterns.

Overall, domestic shocks were found to be a dominant driver of exchange rate fluctuations across most countries but were associated with significantly different pass-throughs to inflation, depending on their characteristics. In particular, domestic monetary shocks were generally accompanied with higher than average pass-throughs, particularly in countries with less flexible exchange rate regimes and without inflation-targeting central banks. In contrast, domestic demand shocks were typically associated with negative and mostly insignificant pass-through ratios, due to the offsetting effects of growth and exchange rate channels (e.g., weakening domestic demand giving rise to both currency depreciation and declining inflation). Global shocks accounted for a smaller proportion of exchange rate movements and were associated with a considerable heterogeneity of estimated ERPTRs depending on country characteristics and the source of the shock.

Differences in shock-specific ERPTRs could have important implications for monetary policy. For example, the exchange rate pass-through during an initial economic recovery phase could be low reflecting the predominance of domestic demand shocks. However, appreciation caused by unexpected monetary policy tightening could be associated with a significantly larger degree of pass-through. Failing to take these factors into account may lead central banks to tighten policy more than needed to stabilize inflation, creating unnecessary fluctuations in activity.

Monetary policy frameworks and other country-specific characteristics affecting the sensitivity of domestic prices to currency fluctuations matter as well. In particular, a credible commitment to maintain low and stable inflation has been one the key factors behind a weak pass-through of even sizeable depreciations to
inflation in both advanced economies and EMDEs over the last two decades. Looking at the cross-section of ERPTR estimates in EMDEs, an improvement of the central bank independence index from one-standard-deviation below the sample mean to one-standard-deviation above the sample mean could potentially reduce the pass-through ratio associated with domestic monetary policy shock by half. This highlights a self-reinforcing feedback between central bank credibility and price stability. Similarly, currency movements triggered by global demand and oil price shocks also have more limited effects on inflation when central banks are credibly committed to an inflation target. This speeds up relative price adjustments and reinforces the benefit of flexible currency regimes.

Overall, the downward trend in exchange rate pass-through presented in this chapter can be connected to an improvement central bank policies and a more solid anchoring of inflation expectations. Other structural factors, including growing integration in global value chains, could have played a role as well, but are not able to account for cross-country differences in pass-through ratios.

Future research could investigate more formally the relationship between estimated ERPTRs and structural factors such as the degree of value chain participation and foreign currency invoicing practices in EMDEs. This could take the form of event studies around significant policy or other structural changes. The analysis of shock-specific pass-through could also be extended to different inflation measures, for example import prices, PPI, GDP deflator, and core CPI inflation. This could shed more light on the source of incomplete pass-through to consumer price inflation, and help guide monetary policy decisions. Finally, non-linearities in the exchange rate pass-through could be further investigated, looking at both the direction and size of the various shocks under consideration.
ANNEX 5.1 Methodology and database

Estimation Methodology

The analysis rests on country-specific factor-augmented vector-autoregressive (FAVAR) models, consisting of global and domestic variables. The global block includes three variables: global inflation, global output growth, and oil price growth. The domestic block includes four country-specific variables: inflation, output growth, changes in nominal effective exchange rates, and monetary policy (or equivalent short-term) nominal interest rates (for precise variable definitions, please see the last section in this Annex).

In its structural form, the FAVAR model is represented by:

$$B_0 y_t = \alpha + \sum_{i=1}^L B_i y_{t-i} + \varepsilon_t$$

where $\varepsilon_t$ is a vector of orthogonal structural innovations, and $y_t$ consists of global inflation ($f_t, \pi_{global}$), global output growth ($f_t^y, global$), oil price growth ($\Delta OP$), country-specific inflation ($\pi_t^i$), country-specific output growth ($Y_t^i$), country-specific changes in nominal effective exchange rates ($XR_t^i$), and country-specific monetary policy (or equivalent short-term) nominal interest rates ($I_t^i$). The vector $\varepsilon_t$ consists of seven global and domestic structural shocks (to be defined below). Postulating that $B_0^i$ in our econometric model has a recursive structure such that the reduced form errors ($u_t$) can be decomposed according to $u_t = B_0^i \varepsilon_t$, similar to Charnavoki and Dolado (2014) and Forbes, Hjortsoe, and Nenova (2017; 2018), the imposed sign and short-term restrictions can be written as follows:

$$
\begin{bmatrix}
\varepsilon_t^{GlobalDemand} \\
\varepsilon_t^{OilPrice} \\
\varepsilon_t^{GlobalSupply} \\
\varepsilon_t^{DomesticDemand} \\
\varepsilon_t^{DomesticSupply} \\
\varepsilon_t^{MonetaryPolicy} \\
\varepsilon_t^{ExchangeRate}
\end{bmatrix} =
\begin{bmatrix}
+ & - & + & 0 & 0 & 0 & 0 \\
+ & + & + & 0 & 0 & 0 & 0 \\
+ & + & - & 0 & 0 & 0 & 0 \\
* & * & * & + & + & - & * \\
* & * & * & + & - & - & * \\
* & * & * & * & + & + & * \\
* & * & * & * & + & + & *
\end{bmatrix}
$$

where * stands for an unrestricted initial response. While country-specific shocks do not affect global variables in the first four quarters, global shocks can affect
country-specific variables (without any sign or zero restrictions). A positive country-specific supply or a positive country-specific demand shock increases country-specific output growth. Furthermore, a country-specific supply shock reduces domestic inflation whereas a country-specific demand shock increases domestic inflation. A positive exchange rate shock (corresponding to an appreciation of the domestic currency) is assumed to increase the exchange rate, but its impact on other domestic variables is left unrestricted. Finally, a positive interest rate shock (corresponding to a contractionary monetary policy) initially increases the domestic interest rate and results in an appreciation of the domestic currency, while it decreases domestic output growth and inflation. All country-specific shocks are assumed to affect country-specific variables on impact through the corresponding sign restrictions, although our robustness checks (below) also consider such restrictions lasting for an alternative number of periods.

The system is estimated on a country-by-country basis using quarterly data with two lags as in Charnavoki and Dolado (2014). The Bayesian estimation used searches for 1,000 successful draws out of at least 2,000 iterations with 1,000 burn-ins. The results shown in the Chapter are based on the median of these 1,000 successful draws and 68 percent confidence sets at the country level, although alternative presentation methodologies (e.g., the median target as in Fry and Pagan 2011) are considered as a robustness check below. In the Bayesian estimation, Minnesota priors proposed by Litterman (1986) are used; since the Minnesota prior assumes that the variance-covariance matrix of residuals is known, we use the entire variance-covariance matrix of the VAR estimated by OLS. For the actual estimation, the identification strategy through the algorithm introduced by Arias et al. (2014) is used, where the standard Cholesky-decomposition is employed together with an additional orthogonalization step that is necessary to produce a posterior draw from the correct distribution for SVAR coefficients.

Results for the role of global and domestic shocks in domestic inflation are presented as median point estimates across countries. Interquartile ranges indicate the range from the 25th and 75th quartile of country-specific estimates (e.g., Forbes, Hjortsoe, and Nenova 2017). For presentational clarity, and consistent with other studies in the literature, the country-specific confidence sets are calculated but not presented.

**Exchange rate pass-through**

Following Shambaugh (2008) and Forbes, Hjortsoe and Nenova (2017), for each country, the exchange rate pass-through ratio (ERPTR) is defined as the ratio of the response of country-specific inflation to the response of the nominal
exchange rate changes following a given shock. The sign of the ratio is inverted, so that a positive ERPTR denotes a situation where a currency depreciation is accompanied by rising inflation:

\[
\text{ERPTR} = - \frac{\text{Response of country-specific inflation}}{\text{Response of country-specific nominal exchange-rate change}}
\]

As in Forbes, Hjortsoe and Nenova (2017) and others, the ERPTR is calculated based on one-year cumulative impulse response functions of the endogenous variables. Since the Bayesian estimation results are based on 1,000 successful draws satisfying the sign restrictions, the country-specific ERPTRs are represented as the median (and 68 percent confidence sets) of successful-draw-specific ERPTRs (i.e., ERPTRs are calculated for each successful draw individually before being used to have a country-specific statistic).

Robustness Checks

Several robustness checks are performed:

- An alternative number of periods (i.e., two-quarters) has been considered in imposing sign restrictions in identifying country-specific structural shocks. Resulting pass-through ratios are largely comparable to the benchmark estimates (Figure A.5.1.1).

- An alternative specification of sign restrictions has been considered where positive domestic demand shocks lead to a contemporaneous increase in country-specific interest rates. Pass-through ratios associated with domestic demand and monetary policy shocks in this specification are very similar to the benchmark estimates (Figure A.5.1.2).

- Alternative presentations of 1,000 successful draws have been considered following Fry and Pagan (2011), where rather than presenting the median across 1,000 successful draws, the draw that is closest to the median across 1,000 successful draws (i.e., the median target) has been used. The same strategy has been applied to calculate the corresponding 68 percent confidence sets, again by following Fry and Pagan (2011).

Data

The sample includes 29 advanced economies and 26 EMDEs with at least 10 years (40 quarters) of continuous data for the variables in the domestic block but the sample period differs across countries. Long-term trends of the variables are eliminated using the local mean method as in Stock and Watson (2012). The
FIGURE A.5.1.1 Pass-through: One versus two quarters sign restrictions

**A. Monetary policy shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs

**B. Global demand shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs

**C. Domestic demand shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs

**D. Global supply shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs

**E. Domestic supply shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs

**F. Oil price shocks**

- Benchmark
- Two-quarters sign rest.
- All
- Advanced economies
- EMDEs


Notes: Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change to shocks from country-specific FAVAR models estimated for 51 economies (29 advanced economies and 22 EMDEs) over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries. In the alternative specification, sign restrictions are applied to both current and next quarter.

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FIGURE A.5.1.2 Pass-through: Additional sign restriction to identify domestic demand shocks

A. Monetary policy shocks

B. Global demand shocks

C. Domestic demand shocks

D. Global supply shocks

E. Domestic supply shocks

F. Oil price shocks


Notes: Pass-throughs are defined as the ratio between the one-year cumulative impulse response of consumer price inflation and the one-year cumulative impulse response of the exchange rate change to shocks from country-specific FAVAR models estimated for 51 economies (29 advanced economies and 22 EMDEs) over the period 1998-2017. A positive pass-through means that a currency depreciation is associated with higher inflation. Bars show the interquartile range and markers represent the median across countries. In the alternative specification, an additional sign restriction was imposed, assuming that a positive domestic demand shock leads to a contemporaneous increase in domestic interest rates.

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following variable definitions are used as inputs into the FAVAR estimation.

- Global output growth is the global common factor of quarter-on-quarter, seasonally adjusted real GDP growth in a sample of 29 countries for 1971Q1-2017Q4.1

- Global inflation is the global common factor of quarter-on-quarter headline CPI inflation (seasonally adjusted) in a sample of 47 advanced economies and EMDEs.2

- Oil price growth is the quarter-on-quarter growth rate of nominal oil prices (average of Dubai, WTI, and Brent).

- Country-specific inflation is quarter-on-quarter, seasonally adjusted headline CPI inflation.

- Country-specific output growth is quarter-on-quarter, seasonally adjusted real GDP growth.

- Domestic interest rates are annualized 3-month treasury-bill rates or monetary policy rates.

- Nominal effective exchange rate changes are the quarter-on-quarter changes in the trade-weighted nominal exchange rates against 52 currencies, as provided by the Bank for International Settlements.

Global output growth and global inflation are estimated using the following two single-factor dynamic factor models:

\[
Y_t^i = \beta^{Y,i}_{\text{global}} f^Y_{t,\text{global}} + e_t^{Y,i}
\]

\[
\pi_t^i = \beta^{\pi,i}_{\text{global}} f^\pi_{t,\text{global}} + e_t^{\pi,i}
\]

where \( \pi_t^i \) and \( Y_t^i \) are inflation and output growth in country \( i \) in quarter \( t \), respectively, while \( (f^Y_{t,\text{global}}) \) and \( (f^\pi_{t,\text{global}}) \) are the global common factors for inflation and output growth in quarter \( t \), respectively. Details on the estimation of the global factors including the evolution of factor estimates and variance decompositions are presented in Chapter 3.

---

1The dynamic factor estimation of the global GDP factor requires a balanced panel throughout the full sample period. Thus, only a subset of countries is employed for this estimation.

2The number of countries in the estimation of the global output and inflation factors is based on the data availability. As explained in Chapter 3, the estimates of global inflation and output factors do not change much when the same group of countries are employed.
### TABLE A.5.1.1 List of countries and sample periods

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample Period</th>
<th>Country</th>
<th>Sample Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iceland</td>
<td>1988:3 - 2017:4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Countries with at least 40-quarters of data have been included.
References


Global developments—perhaps technological in nature, such as the tremendous growth of online shopping—could be helping to hold down inflation in a persistent way in many countries.

Janet L. Yellen (2017)

Increased competition and changes in technology are driving down the prices of many of the things we buy…. A question we are grappling with here is how much further this process has to run.

Philip Lowe (2017)

There are reasons why low inflation is a phenomenon, and they should be set out clearly. However, there is no reason to assume that inflation will no longer rise. If the central banks aren’t careful, we could very quickly end up with higher inflation rates again…. It would be totally irresponsible to declare that inflation has been conquered for once and for all.

Agustín Carstens (2018)
PART C

INFLATION

Low-Income Country Considerations
Most of the variation in inflation among low-income countries (LICs) over the past decades is accounted for by external shocks. More than half of the variation in core inflation rates among LICs is due to global core-price shocks, compared with one-eighth in advanced economies. Global food and energy price shocks account for another 13 percent of core inflation variation in LICs—half more than in advanced economies and one-fifth more than in non-LIC EMDEs. This points to challenges in anchoring domestic inflation expectations, which have been most evident among LICs with floating exchange rates, especially in those cases where central banks’ independence has been weak.

Introduction

Low and stable inflation helps promote long-term economic growth, and it has become the primary objective of the monetary policies of central banks around the world (Chapter 1). One of the key factors that determine the ability of central banks to achieve this objective is the degree to which inflation expectations are well anchored (Blinder et al. 2008). In order to steer inflation expectations, central banks typically establish a nominal policy anchor, which can either be quantity-based (e.g., broad money supply or M2), price-based (e.g., exchange rate) or a target for inflation itself.

Inflation expectations are shaped by many factors, including the history of inflation and the degree of credibility of the central bank (Chapter 4). If the central bank’s commitment to its nominal anchor has high credibility, temporary inflation shocks—for example due to commodity price shocks—will not set inflation expectations adrift. A central bank’s credibility, in turn, depends on whether it is (i) committed to achieving its objective of low and stable inflation, (ii) has sufficient institutional capability to deliver on its commitment, and (iii) has a track record of achieving its objective.

Note: This chapter was prepared by Jongrim Ha, Anna Ivanova, Peter Montiel and Peter Pedroni.

1 Central banks are responsible for maintaining not only price stability (low and stable inflation) but also (especially more recently) financial stability (the soundness of the domestic financial system). The instruments of monetary policy are generally used mainly for the former objective; a different set of instruments is generally used for the latter (Taylor 2005; Hammond, Kanbur, and Prasad 2009).

2 The use of targets for the growth of monetary aggregates has generally fallen out of favor since the 1980s, at least in advanced economies, because of such problems as instability in relationships between monetary growth and inflation and the divergent behavior of different aggregates.
Ensuring monetary policy credibility is particularly important for LICs, which have historically had to cope with frequent domestic supply shocks, especially weather-related shocks to agricultural production that feed through to food prices (Frankel 2011). Moreover, LIC central banks face a number of other impediments to their ability to anchor inflation expectations. First, they are likely to face a broader set of objectives, compared with those in advanced economies and other EMDEs; for example, the exchange rate is more likely to be a separate and important policy objective (Rodrik 2007; Berg and Miao 2010). Second, weak institutional capacity of central banks in LICs may complicate monetary policy management. Third, central banks in LICs generally lack a track record of low inflation. Finally, globalization has increased LICs’ exposure to external price shocks.

While LICs have achieved significant progress in reducing inflation over the past two decades, they have done so in an international environment characterized by significantly lower worldwide inflation. How much of LICs’ progress represents home-grown gains in central bank credibility, and how much is simply the result of a more favorable global environment? This chapter attempts to shed some light on this issue.

More specifically, this chapter addresses the following questions.

• How has inflation in LICs evolved?

• How well anchored are inflation expectations in LICs?

• What country characteristics have been associated with stronger anchoring?

In this chapter, the question of the degree of anchoring of medium-term inflation expectations in LICs is tackled by estimating a novel heterogeneous...
The model examines the extent to which core inflation in LICs has remained stable in the face of a variety of external shocks, including shocks to global core, energy and food price inflation, and other shocks transmitted to the domestic economy through exchange rate fluctuations. The assessment is made based on the degree of sensitivity of the domestic core inflation, which is determined by the degree of anchoring of inflation expectations, to external shocks. The estimation is based on a monthly panel dataset that covers 104 countries (25 advanced economies, 79 EMDEs including 18 LICs) for the period 1970M2-2016M12. This dataset contains at least 36 months of continuous data for each country, for six variables—headline CPI, food CPI, energy CPI, core CPI, nominal effective exchange rate (NEER), and rainfall. Differences across income groups and subgroups in LICs in the extent to which domestic core inflation performance has been insulated from international factors are analyzed in terms of country characteristics, institutional factors, and policy regimes under a simple ordinary least squares (OLS) regression framework.

The chapter’s principal conclusions are as follows.

LICs, like other EMDEs, have experienced higher average levels and volatility of headline inflation than advanced economies. However, both the level and volatility of headline inflation has declined in all three country groups over the past two decades. The fall in inflation volatility in LICs is largely accounted for by declines in the volatility of core and energy price inflation. Food price inflation volatility has remained elevated.

Among LICs, core inflation has tended to be lower in countries with lower public debt ratios, fixed exchange rates, and higher degree of capital account openness and greater central bank transparency. Although these results are largely consistent with those for advanced economies and other EMDEs, the effects of these characteristics seem to be more prominent for LICs.

Core inflation in LICs was more susceptible to external disturbances than in the other country groups. Around three quarters of the variation in domestic core inflation rates among LICs was accounted for by external inflationary shocks, and very little by shocks to domestic core inflation, a result exactly opposite to

---

6 In particular, the heterogeneous panel SVAR methodology, which is a variant of the Pedroni (2013) methodology, allows analyzing the consequences of various unanticipated global and domestic inflation shocks on the domestic core CPI. Rather than using pooled estimation, the approach incorporates group mean panel estimation methods to avoid inconsistent estimation that can occur under pooled methods when the dynamics associated with endogenous variables are heterogeneous. See Annex 6.2 for details.
that of advanced economies where only a quarter of the variation in domestic core inflation is explained by global inflation shocks.

Consistent with the findings in the other chapters in this report, domestic characteristics appear to matter not just for the level of domestic core inflation, but also for determining the susceptibility of core inflation to external shocks though further research is needed to solidify this evidence.

Importantly, however, the results indicate that what sets LICs apart may be not so much that they differ from the other country groups in terms of these characteristics as that these characteristics appear to operate differently in the LIC environment. Notably, although LICs that fix their exchange rates seem to succeed in anchoring inflation expectations about as well as other economies, those that float have had a much more difficult time in anchoring inflation expectations, suggesting that LICs may have in essence imported their anti-inflation credibility.

This chapter presents the results of what is the first investigation reported in the literature of the effects of various inflation shocks, both domestic and global, on core inflation in a large group of countries, with a specific focus on LICs. The study takes advantage of the flexibility of a heterogeneous panel SVAR framework and a large dataset including core inflation series for 18 LICs and 61 other EMDEs. The empirical framework makes possible the analysis of the impact of global and domestic shocks on core inflation in different groups of countries in a unified framework. Moreover, it helps identify the global component of core inflation endogenously and produces a parsimonious representation of the common and idiosyncratic components of core inflation in the countries within the sample. To help identify the exogenous component of domestic agricultural supply shocks, typically associated with food price inflation, the study uses rainfall data as an exogenous instrument. Finally, this chapter also contributes to the literature by analyzing the country characteristics that help explain differences in core inflation responses to shocks between LICs and other country groups.

The next section documents the evolution of inflation over time and across countries, with special focus on LICs. The following section examines the impact of global and domestic inflation shocks on core inflation in LICs using a heterogenous panel SVAR model. The subsequent section distills the country characteristics associated with a larger role of global shocks. The final section concludes with a discussion of policy implications for LICs’ control of inflation.

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7 The relevance of the instrumental variable is tested using statistical methods and it is significant at 5 percent level. Refer to Annex 6.2 for the details on the test results.
Evolution of inflation in LICs

Data for two periods are examined: 1980-99 and 2000-16. In both periods, LICs, like other EMDEs, generally experienced higher levels and volatility of consumer price inflation than advanced economies (Figure 6.1). This is true of headline, core, food, and energy price inflation. Both the level and volatility of inflation declined between the two periods in each of the three groups, but the level and volatility of headline and core inflation in LICs still remained generally higher than in advanced economies. Median headline inflation in LICs was around 6 percent in 2000-16, three times median inflation in advanced economies. As Chapter 1 demonstrates, inflation performance in LICs has improved markedly over the past three decades but the decline happened later (starting in the 90s) than in advanced economies (starting in the late 70s).

Inflation volatility in LICs has also declined in recent decades (with the exception of food price inflation). This decline in volatility is not simply the result of the decline in median inflation among LICs: the cross-country correlation between the level of inflation and its volatility has tended to be much lower in LICs than in other country groups.\(^8\) The higher volatility of inflation in LICs suggests that these countries may either have experienced more frequent and/or larger shocks that tended to destabilize the inflation rate, or that their inflation rates have been more susceptible to shocks.

Food and energy prices, like other primary commodity prices, are known to be more volatile than the prices of services and manufactured goods. The historically-high volatility and the lower correlation between inflation levels and inflation volatility in these countries, may therefore be the result of greater sensitivity of inflation in LICs to global commodity prices. Simple correlations do indeed reveal that food inflation, but not energy inflation, has been a more important driver of fluctuations in headline inflation in LICs and other EMDEs than in advanced economies (Figure 6.1). For core inflation, however, the evidence is more mixed: its correlation with food and energy inflation has not been clearly higher in LICs than in the other two country groups. The food and energy components of the CPI have historically been more volatile in LICs and other EMDEs than in advanced economies, reflecting the closer link of consumer prices with primary commodity prices in the former groups of countries, where food and energy embed smaller services component than in advanced economies. Combined with the greater importance of food in LIC

\(^8\)The correlation coefficient between the level and volatility of headline inflation (median across countries) is around zero in LICs for the period 1980-2016, while the coefficients for other EMDEs and advanced economies are 0.48 and 0.50, respectively.
FIGURE 6.1 Inflation levels and volatility, by country group

Headline, food, energy, and core consumer price inflation in LICs and other EMDEs have typically been higher and more volatile than in advanced economies. Both inflation and its volatility have declined across all country groups in the past two decades, with a particularly pronounced fall in inflation volatility in LICs (except for food). Nonetheless, headline and core inflation in LICs, and their volatility, have remained generally higher than in advanced economies. Food inflation has been a more important driver of fluctuations in headline inflation in LICs and other EMDEs than in advanced economies.

A. Median inflation

B. Inflation volatility

C. Correlation of headline and food inflation

D. Correlation of headline and energy inflation

E. Correlation of core and food inflation

F. Correlation of core and energy inflation

Sources: Haver Analytics, IFS, World Bank.
Notes: All inflation rates are annual. Headline inflation uses a balanced panel for 1980-2016, including 154 countries (29 advanced economies, 98 EMDEs, and 27 LICs). Core inflation uses a balanced panel for 1980-2016, including 54 countries (27 advanced economies, 24 EMDEs, and 3 LICs). Food inflation uses a balanced panel for 1980-2016, including 104 countries (29 advanced economies, 61 EMDEs, and 14 LICs). Energy inflation uses a balanced panel for 1980-2016, including 55 countries (27 advanced economies, 25 EMDEs, and 3 LICs). EMDEs here exclude LICs. "AEs" stands for advanced economies.
A.B. Simple averages of median annual inflation or inflation volatility.
B. Inflation volatility is measured as standard deviation of annual inflation rates for the past ten years.
C.-F. Non-stationary part of each series is eliminated using the methodology by Stock and Watson (2012).
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consumption baskets, it is expected that movements in global food price inflation have played a relatively more important role in inflation variation in LICs.

Median core inflation has tended to be lower in LICs with the following features: greater capital account openness; lower public debt ratios; fixed exchange rate regimes; higher degrees of central bank independence and transparency; higher degrees of participation in global value chains; and, to a lesser extent, higher degrees of trade openness (Figure 6.2). The findings for advanced economies and other EMDEs are similar to those for LICs, except that advanced economies with relatively high public debt have tended to have lower core inflation. Higher degrees of capital account openness, fixed exchange rate regimes, and greater central bank transparency are associated with more pronounced differences in core inflation in LICs than in advanced economies and other EMDEs.

While greater reliance on exports of primary commodities and less financial openness than in other country groups have continued to characterize LICs in recent years, structural changes, including changes in macroeconomic institutions and policy regimes, may have helped reduce inflation and its volatility in these countries (Chapter 1). In broad terms:

- Trade openness has increased for all country groups since the early 1990s, with both the degree of openness as well as its evolution over time being similar in advanced economies and EMDEs (including LICs). While capital account openness has also increased for all groups since the early 1990s, it remains much lower in EMDEs than in advanced economies, and has increased at a much slower pace.

- The proportion of EMDEs with pegged exchange rates fell sharply after the collapse of the Bretton Woods system in the early 1970s, but stabilized in the mid-1990s and has been stable since then.

- An index of central bank independence and transparency is markedly lower in LICs and other EMDEs than in advanced economies, though it underwent a notable increase between 1991 and 2016.

**Transmission of shocks into core price inflation**

**Methodology.** To examine how well anchored core inflation is in LICs, a heterogeneous panel SVAR methodology is adopted to identify the effects of various global and domestic inflation shocks on the domestic core CPI inflation.
FIGURE 6.2 Median core inflation, by country characteristics

Core inflation has tended to be relatively low in LICs, other EMDEs, and advanced economies with greater capital account openness, lower public debt ratios (except in advanced economies), fixed exchange rates, higher central bank transparency, greater participation in global value chains, and, to a lesser extent, greater trade openness.

A. By trade openness

B. By capital account openness

C. By public debt ratio

D. By exchange rate regime

E. By central bank transparency

F. By participation in the global value chain


Notes: A.-F. Based on median annual core inflation across 145 countries (34 advanced economies, 91 EMDEs, and 20 LICs) from 1980 to 2016. Countries with “high” defined as those with value above median, all others are considered to have “low.” EMDEs here exclude LICs. “AEs” stands for advanced economies.

A.-B. Trade and capital account openness are based on trade-to-GDP (percent) and Chinn and Ito (2018) index, respectively.

C. Percent of GDP.

D. Exchange rate regime is based on the classification by Shambaugh (2004).

E. Based on the central bank transparency index by Dincer and Eichengreen (2014). The higher the index is, the more transparent and independent central bank is.

F. A country is classified as well-integrated into the global value chain if one of the two conditions is met: the sum of Backward and Forward participation in GVCs is greater than the median of the sample in a particular year, or the sum of intermediate exports and imports as percent of GDP is greater than the median of the sample in a particular year. All other countries are defined as “low” GVC participation.

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in an orthogonalized reduced form setting.\textsuperscript{9} In particular, the panel SVAR structure includes a 3 x 3 block of global variables, namely global energy, global food, and global core price inflation obtained by the cross-sectional average of individual country inflation rates, with the three variables arranged in this order.\textsuperscript{10} It also includes a 3 x 3 block of panel variables, composed of individual country food inflation, core inflation and NEER, with the three panel variables arranged in this order. Each block is then orthogonalized via a standard Cholesky decomposition, and additional restrictions are imposed such that the domestic variables do not have an impact on the global variables, while the global variables are permitted to have an impact on the country-specific variables.\textsuperscript{11} An important issue is that identified domestic food-price shocks can be endogenous to domestic core inflation in the case that both variables are significantly influenced by common components, presumably domestic demand shocks. To avoid this, domestic food inflation is instrumented by external variables, rainfall and the square of rainfall, which reflect exogenous shocks such as weather events.\textsuperscript{12} Finally, all dynamics are permitted to be heterogeneous across countries, so that the distribution of country-specific impulse response functions (IRFs) can be estimated (Annex 6.2).

- The cumulative response of domestic core inflation to unanticipated innovations in the three global inflation measures is computed as the response to a standardized one-percentage-point increase in the relevant global inflation rate. A muted response of domestic core inflation is interpreted as weaker transmission of the global shocks into domestic core inflation.

- Next, variance decompositions for domestic core inflation are computed, which supplement the information contained in the IRFs by providing

\textsuperscript{9} The approach can be thought of as an adaptation of the Pedroni (2013) methodology that relaxes the diagonality of the loading matrix for the common versus idiosyncratic orthogonalized shocks in a way that is particularly well suited for reduced form Cholesky analysis through the use of global versus domestic block Granger causality restrictions in the panel. See Annex 6.2 for details.

\textsuperscript{10} One could also consider using principal component or dynamic factor estimates in place of the global variables. However, a combination of observed global variables and cross-section averages is used in this chapter for three reasons: (1) cross sectional averages tend to be close proxies for the first principal component (Pesaran 2006), (2) even if they differ slightly, asymptotically as the number of countries gets large, which one is used should not matter for the panel VAR method in terms of orthogonalizing global core shocks from domestic shocks, (3) the dataset is unbalanced which makes the estimation of the dynamic factors more cumbersome.

\textsuperscript{11} In other words, this chapter takes a two-step estimation process. First, the global block is estimated and fixed. Second, the global block is used to help in the selection of parameters for the domestic block, but not vice versa (see Annex 6.2 for details).

\textsuperscript{12} More specifically, the predicted value of domestic food inflation from a regression of food inflation rates on rainfall and rainfall squared is used as a proxy for the domestic food inflation net of demand-side effects. This proxy is included as one of the endogenous variables in the VAR framework.
estimates of the portion of variation in domestic core inflation that is explained by global shocks. It is expected that if inflation expectations are well-anchored, then the variance of domestic core inflation is more likely to be explained primarily by its own domestic core-price shocks, and that relative price shocks (global or domestic) will have more modest effects.

- The values of the IRFs and variance decompositions are then projected on institutional and policy characteristics of each country. This allows us to determine the characteristics associated with relatively high versus low response rates of the domestic core inflation to various global inflation innovations, and to assess which characteristics are more closely associated with well-anchored inflation expectations in low-income countries.

**Impact of global shocks.** Medians and inter-quartile ranges of the cumulative IRFs of domestic core inflation (which are equivalent to responses of the level of the log CPI) in advanced economies, non-LIC EMDEs and LICs are shown in Figure 6.3, for both the 6 and the 18 months after the shock, to illustrate the persistence of the impact. During the sample period, 1970-2016, core inflation responded very differently in LICs, compared with advanced economies and other EMDEs, to global core-price shocks: A one-percentage-point increase in global core inflation increased median core inflation in LICs by close to 0.6 percentage point after 18 months, compared with less than 0.2 percentage point in advanced economies and other EMDEs. Thus, LICs appear to import more of the fluctuations in core global inflation than the other country groups. Next, the effects on domestic core inflation of international relative price changes is considered, in the form of separate shocks to global food and energy inflation, holding global core inflation constant. Shocks to global food inflation have more notable consequences for the domestic core inflation in LICs: A one-percentage-point increase in global food inflation raised median core inflation in LICs by around 0.1 percentage point (and by up to 0.3 percentage points) within 6 months, larger than the effects in advanced economies and other EMDEs. With respect to shocks to global energy inflation, median core inflation in LICs responded more sharply and quickly than that in advanced economies and other EMDEs, though with more heterogeneous responses across countries.

These results likely reflect the relatively large weight of food more generally as well as the relatively large weights of imported food and energy, in headline CPI of LICs, and the weaker response of many LIC central banks to the “second-round” effects of these shocks that allow them to be transmitted to the core prices. Alternatively, it could also be the case that labor is able to shift its wages in response to these shocks in these countries. Shocks to global core, food, and energy prices all tend to create increases in domestic core inflation in LICs. However, core inflation in LICs appears to be more sensitive to global core
inflation than to changes in international relative prices of food and energy. By contrast, other EMDEs show limited sensitivity to global core-price shocks, but more closely resemble LICs in their response to international prices of food and energy. Core inflation in advanced economies displays minimal sensitivity to changes in both global core inflation and the international energy inflation, but some sensitivity to changes in the international price of food, though less than that of LICs.

Impact of domestic food-price shocks. Next, the dynamic response of core inflation to domestic food-price shocks is examined (Figure 6.4). Such shocks are likely to contain a strong endogenous component—they are likely, in part, to be responses to variables that similarly affect domestic core inflation. The estimation therefore uses rainfall measures (rainfall and rainfall squared) to isolate domestic food supply shocks. Since consumer prices in LICs contain relatively large food components, and since much of the food consumed in these countries is produced in large domestic agricultural sectors, the expectation was that supply shocks to domestic food prices would tend to destabilize core inflation in LICs, with smaller effects on core inflation in other EMDEs and

FIGURE 6.3 Response of core inflation to global price shocks

The median response of domestic core inflation to global core price shocks is relatively large for LICs, compared to other EMDEs and advanced economies, both 6 and 18 months after the shocks, though with significant variation in responses among LICs. There is long-lasting impact with some delay in LICs, hinting at the possibility of spillovers from advanced economies. The median response to global energy price shocks is relatively small, with no large differences across country groups. The response to global food price shocks is larger in LICs than in advanced economies and other EMDEs, and there is also substantial variation in responses across LICs.

A. Response to global core price shocks

B. Response to global food and energy price shocks


Notes: Cumulative impulse response functions (IRFs) after 6 and 18 months, respectively, of domestic core inflation following a one-percentage-point increase in inflation measures. Medians and inter-quantile ranges (25th and 75th percentiles) of IRF distributions are shown for each country group. The results are based on a heterogeneous panel SVAR model with 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs) between 1970m2 and 2016m12. EMDEs here exclude LICs. “AEs” stands for advanced economies. See Annex 6.2 for details.
advanced economies. Indeed, the results find that a supply-driven domestic food price shock tended to raise median core inflation in LICs, and to have a negligible effect on core inflation in advanced economies and other EMDEs (Figure 6.4). However, the effect in LICs is short-lived, fading within six months of the shock.\footnote{Three possible interpretations of this finding may be mentioned. First, food price inflation seems more volatile and less persistent in LICs than in other countries (Figure 6.1), so that while domestic supply shocks may be both more frequent and larger than in the other country groups, they may also be rapidly reversed, suggesting that, if the core price level is itself more flexible in LICs, the effects of domestic food price shocks in those countries may be short-lived. Second, food price subsidies tend to be used more commonly and more intensively in LICs than in the other country groups. To the extent that these keep the price paid by consumers below producer prices, increases in prices received by domestic producers may have a muted effect on consumer prices. Third, assuming that imported food cannot be easily substituted with the domestically-produced food, the adjustment to international food price shocks through, for example, government subsidies may be costlier than the adjustment to the domestic food price shocks, which can eventually be mitigated with the adjustment in domestic food production.}

**Impact of exchange rate shocks.** Finally, the NEER shock, which is the last variable in the Cholesky ordering, effectively picks up all shocks that move the NEER and that are not covered by the first five shocks. Accordingly, the response of domestic core inflation to these NEER disturbances indicates the extent of the exchange rate pass-through to core inflation, irrespective of the underlying shock to the NEER. The estimated pass-through is more pronounced in LICs than in either advanced economies or other EMDEs (Figure 6.4).\footnote{This finding is overall consistent with the findings in Chapter 5 where the estimates of pass-through ratio are on average greater in EMDEs than in advanced economies, although the country group in the chapter includes few low-income countries.} This may again reflect a weaker anchoring of inflation expectations in LICs than in the other country groups, due to weaker commitment to medium-term inflation objectives on the part of LIC central banks, and greater challenges to that commitment posed by larger imported components of the headline CPI.

**Impact of the shocks by exchange rate regime.** To shed more light on the differences between LICs and other country groups in the transmission of global and domestic shocks into domestic core inflation, IRFs were estimated separately for countries with fixed and flexible exchange rate regimes (Figure 6.5). For advanced economies and other EMDEs, the response of domestic core inflation to global core-price shocks was larger in countries with fixed exchange rate regimes. However, the opposite is true for LICs: the response to global core inflation was found to be less pronounced for LICs with fixed exchange rate regimes. One interpretation could be that LICs with fixed exchange rates are more successful in anchoring inflation expectations than those with flexible exchange rates. This may be because weak institutions make a credible
commitment to a price stability difficult without a credible anchor in the form of a fixed exchange rate.

Contribution of the shocks to core inflation variation. Variance decompositions of core inflation were examined for the three country groups, using within-group medians (Figure 6.6). The key differences were found between advanced economies, on the one hand, and LICs and other EMDEs on the other. Consistent with a substantially stronger anchoring of domestic inflation expectations in advanced economies, more than three quarters of the variance of core CPI inflation rates in these economies explained by shocks to core inflation itself. In LICs and other EMDEs, on the other hand, domestic core inflation is overwhelmingly explained by shocks to global core inflation. The variance share of global core-price shocks in the total variation of domestic core inflation is around 60 percent for both of these income groups. The contribution of shocks to the domestic core, by contrast, is much smaller. The share of domestic core inflation explained by global food and energy shocks is moderately larger for LICs than for advanced economies and other EMDEs. In particular, in LICs, global food and energy price shocks account for 12 percent of core inflation variation—half more than in advanced economies and one-fifth
more than in non-LIC EMDEs. In line with the results from the IRFs, this result may suggest that central banks in LICs have not succeeded in anchoring inflation expectations in the face of shocks to inflation rates, and that much of LIC inflation seems to have been driven by spillovers from advanced economies and other EMDEs. This is discussed in more detail in the next section.

Country characteristics and the roles of shocks

Decomposition of core inflation variation by country group. Differences in structural characteristics, in institutions, and in policy regimes might explain the differences in the inflation process among LICs. To shed light on the contribution of these factors, variance decompositions are compared for the estimated response of core inflation 18 months after a shock across country groups, using group medians. The country characteristics are central bank transparency and independence, the public sector debt-to-GDP ratio (an indicator of potential fiscal dominance), the exchange rate regime, and the degrees of international trade and financial integration. For each characteristic, two sub-groups are distinguished in each of the three main country groups: one consisting of countries with “high” values of the relevant characteristic and the other comprising countries with “low” values. The extent to which inflation performance has been home-grown is inferred from the share of the variance of domestic core inflation that is accounted for by domestic core inflation itself, rather than by external or domestic food-price shocks.15

- **Central bank transparency and independence.** For each country group, the differences between the two sub-groups are quite pronounced: in countries with high level of central bank transparency, external shocks play a less important role than in those with low degree of central bank transparency (Figure 6.6). This suggests that inflation expectations are better anchored in the former than in the latter. However, while central bank transparency seems to matter for all country groups, it seems to play a greater role among the LICs and other EMDEs in insulating them from external shocks than in advanced economies. Thus, there appears to be EMDE-specific and LIC-specific factors at play.

- **Public debt.** Even independent and transparent central banks may be unable to resist pressures to provide financing to the fiscal authorities when public debt is high. For each country group, the differences between the two sub-groups are quite pronounced: in countries with high level of central bank transparency, external shocks play a less important role than in those with low degree of central bank transparency (Figure 6.6). This suggests that inflation expectations are better anchored in the former than in the latter. However, while central bank transparency seems to matter for all country groups, it seems to play a greater role among the LICs and other EMDEs in insulating them from external shocks than in advanced economies. Thus, there appears to be EMDE-specific and LIC-specific factors at play.

15 The differences in IRFs between LIC sub-groups are quite similar to the differences in variance decompositions. Higher public debt, lower central bank transparency, and lower capital account openness, which all may capture weaker monetary policy credibility, are associated in LICs with stronger responsiveness of domestic core inflation to global core-price shocks. Trade openness does not appear to make an important difference for LICs’ response to the global core.
LICs with fixed exchange rates are better able than floaters to insulate their domestic core inflation from global core and food price shocks. LIC-floaters, however, fare better at managing global energy price shocks. In contrast, core inflation in advanced economies with floating exchange rates is generally less sensitive to global price shocks while the results for other EMDEs are mixed.

Sources: Shambaugh (2004), World Bank.
Notes: Cumulative impulse response functions (IRFs) after 6 and 18 months, respectively, of domestic core inflation following a one-percentage-point increase in inflation measures. Medians and inter-quartile ranges (25th and 75th percentiles) of IRF distributions are shown for each country group. The results are based on a heterogeneous panel SVAR model with 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). Exchange rate regimes are based on the classification by Shambaugh (2004) between 1970m2 and 2016m12. EMDEs here exclude LICs. “AEs” stands for advanced economies.

sector debt is very high, such that monetary restraint might trigger a solvency crisis for the government. Empirically, across all the country groups, economies with relatively high public-sector debt-to-GDP ratios do exhibit a larger role for external shocks in explaining the variance of core inflation, and this effect is particularly pronounced for LICs (Figure 6.6). Moreover, external shocks explain a larger share of the variance in core inflation in LICs with higher public sector debt ratios than in any of the other subgroups. A somewhat surprising result among advanced economies is that high debt ratios appear to be associated with low inflation (Figure 6.2). This result may reflect the fact that once monetary policy credibility is
FIGURE 6.6 Contribution of inflation shocks to core inflation variation

In advanced economies, variations in core inflation are largely explained by domestic core-price shocks; in LICs and other EMDEs, they are mostly explained by global core-price shocks, possibly reflecting spillovers from advanced economies. The share of core inflation explained by global food and energy shocks is largest in LICs. In both advanced economies and other EMDEs, the response to global core-price shocks is larger in countries with fixed exchange rates whereas the opposite is true for LICs. Higher public debt, less central bank transparency and less capital account openness have been associated with stronger responses of core inflation in LICs to global core-price shocks.

A. Income group

B. Central bank transparency

C. Public debt

D. Trade openness

E. Capital account openness

F. Exchange rate regime


Notes: Forecast error variance decompositions (forecasting horizon: 18 months) based on medians across countries within each group. The results are based on a heterogeneous panel SVAR model with 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. “AEs” stands for advanced economies.

B.-E. Countries with “high” characteristics are defined as those with values above the median, all others are considered to be “low.”

B. Based on central bank transparency index by Dincer and Eichengreen (2014).

C. Classification of countries is “high” and “low” based on government debt in percent of GDP.

D.E. Measures of trade and capital account openness are based on trade (exports plus imports)-to-GDP ratios and the Chinn and Ito (2018) index, respectively.

F. Exchange rate regime is based on Shambaugh (2004).

Click here to download data and charts.
established, as is the case in many advanced economies, countries may afford to accumulate higher debt without destabilizing expectations.\footnote{It may also capture low-inflation, high-debt outcomes in advanced economies in the wake of the global financial crisis or the role of a few advanced economies (such as Italy and Japan) where high levels of public debt have gone together with low inflation for reasons not considered here.}

- **Financial and trade openness.** Figure 6.6 (panels D and E) compares variance decompositions across countries with different degrees of international trade and financial openness. If international financial integration, which brings the possibility of abrupt reversal in capital flows, imposes more discipline on the monetary policy makers and helps anchoring inflation expectations over time, this could help explain why advanced economies, which are generally more financially open, exhibit relatively low sensitivity to external inflationary shocks, with the lowest sensitivity of all in their highly open sub-group. A similar relationship is exhibited by LICs: for countries with higher capital account openness, the variance share of global shocks is about one half, while for countries with lower capital account openness the share is greater than 80 percent. In fact, the difference between the more and less integrated sub-groups of LICs is larger than in the other country groups. Trade openness, which may also serve a disciplining device, does not seem to play an important role in the sensitivity of domestic core inflation to global core shocks in LICs, although LICs with higher trade openness show smaller variance shares for global food and energy shocks. In the other country groups, higher trade openness has tended to be associated with higher variance shares for external factors. The latter could reflect the fact that higher trade openness may be associated with higher exposure to global shocks.

- **Exchange rate regime.** As is discussed above, the effects of exchange rate regimes differ between advanced economies and non-LIC EMDEs, on the one hand, and LICs on the other (Figure 6.6). Ex ante, one might expect fixed exchange rate regimes to be associated with stronger transmission from external inflationary shocks to domestic core inflation, because small countries that fix will tend to import inflation performance of their trading partners, whereas those that float can, in principle, control their domestic inflation rates independently. This indeed seems to be what is observed in the case of advanced economies, and to a lesser extent, non-LIC EMDEs: shocks to global core inflation account for a much larger fraction of the variance of domestic core inflation in fixed regimes than in floating regimes. For LICs, however, these findings are reversed: core inflation in floaters is less robust in the face of external shocks than in countries that fix. This may reflect the particular challenges faced by LIC central banks. Because their
domestic inflation rates are determined largely by those of their trading partners, LICs with credibly fixed exchange rates may be characterized by inflation expectations that tend to be anchored to the “normal” inflation experience of their trading partners and not be disrupted by transitory external inflationary shocks. By contrast, LICs with floating regimes can avail themselves of no such external anchor; their anchor for inflation expectations has to be home-grown. In the face of the challenges LIC central banks may find it difficult to provide such an anchor, and in its absence transitory external inflationary shocks may create inflation expectations, which become self-fulfilling (discussed more fully in Annex 6.1).

Correlates of the impact of shocks on core inflation

The discussion above is suggestive and intuitive, but does not quantify the implications of changes in the country characteristics. To investigate more comprehensively the implications of marginal variations in a wide set of country characteristics, all possible bivariate relationships between the country characteristics and the estimated responses (and variance shares) 6 months and 18 months after the shocks were systematically explored.

Methodology. Three conceptually distinct types of investigation were conducted.

- First, the country characteristics most likely to be important in explaining the differences in the magnitudes of the cumulative IRFs, and variance decompositions between LICs and the other country groups were examined. This was done by first exploring whether a LIC dummy for the response was significant in a regression that also included only an EMDE (non-LIC) dummy and a constant, and then checking whether an addition of any country characteristics into the regression rendered the LIC dummy insignificant.

- Next, policies that would allow LICs to reduce the transmission of global food, energy, and core price shocks to domestic core inflation were explored using two different approaches: by studying the marginal association of country characteristics attributable to policies with the cumulative IRFs of domestic core inflation to global shocks and by studying the marginal association of similar characteristics with the variance contributions of global shocks to domestic core inflation variation.

- Third, the existence of a “LIC effect” was tested further by examining whether responses of the dependent variables to country characteristics differed systematically between LICs and the other country groups. To this
end, a series of cross-section estimations were conducted using the entire sample of 104 countries, in an attempt to isolate the influence of individual country characteristics on the effects of external inflationary shocks on the variance of domestic core inflation.

**What is the LIC effect?** The results of the first investigation are presented in Table 6.1 for equations where cumulative IRFs were the dependent variable and in Table 6.2 for equations where the variance decomposition estimates were the dependent variable. The first row of each table indicates the coefficient estimates and significance levels (shown by asterisks) of the LIC dummy when it is included in a regression with a constant and an EMDE (non-LIC) dummy only. The subsequent rows show results of regressions where additional variables are included individually. Specifically, each row corresponds to a different regression, which includes not only a LIC dummy, an EMDE dummy, and a constant, but also the variable indicated in the row label. It is important to note that the numeric values and significance levels shown in the table are not those of the additional included variable, but rather of the LIC dummy. Thus, it is for cases where row 1 shows statistical significance, and some other row in the table shows insignificance that it can be inferred that a country characteristic renders an otherwise significant LIC dummy insignificant when included in the regression.

The response of core inflation in LICs to global shocks is only statistically elevated in the case of global food-price shocks (Table 6.1). However, global core-price shocks explain 37-39 percentage points more of LIC core inflation variation than in other regions (Table 6.2). The latter set of results is consistent with what was noted earlier, in that global inflation shocks appear to have larger contribution to the variation in domestic inflation in LICs than in other EMDEs or advanced economies.

For the transmission of global food-price shocks, several structural characteristics appear to be important, including dependence on commodity imports, the labor market (or demographic) variables, capital account openness, and trade openness. Also, the variable indicating the degree of central bank transparency and independence appears to play a role. By contrast, for the transmission of global core-price shocks, it was difficult to identify country characteristics that could explain the LIC dummy. To some extent, the degree of LIC effect is influenced by central bank transparency, trade openness, and population growth since the inclusion of these variables substantially changed the magnitude of the regression coefficients though it did not render the coefficient on the LIC dummy insignificant. While these results are not formal tests of causation, they suggest that the degree of central bank transparency, trade and capital account openness, as well as demographic variables are most likely associated with the
**TABLE 6.1 Regression of response of core inflation**

<table>
<thead>
<tr>
<th>Response of domestic core to</th>
<th>Global energy</th>
<th>Global food</th>
<th>Global core</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time horizon (month)</td>
<td>6</td>
<td>18</td>
<td>6</td>
</tr>
<tr>
<td>LIC dummy</td>
<td>0.01 [0.65]</td>
<td>0.02 [0.48]</td>
<td>0.08** [2.21]</td>
</tr>
<tr>
<td>Level of headline inflation (LIC dummy in the inclusion of each level of headline inflation variable)</td>
<td>0.00 [0.14]</td>
<td>0.01 [0.25]</td>
<td>0.07** [1.85]</td>
</tr>
<tr>
<td>Commodity importer</td>
<td>0.05** [2.30]</td>
<td>0.09** [2.34]</td>
<td>0.06 [1.38]</td>
</tr>
<tr>
<td>GDP</td>
<td>0.00 [0.01]</td>
<td>0.01 [0.14]</td>
<td>0.07* [1.75]</td>
</tr>
<tr>
<td>Inflation target</td>
<td>0.00 [-0.1]</td>
<td>0.00 [0.09]</td>
<td>0.07* [1.86]</td>
</tr>
<tr>
<td>Pegged exchange rate regime</td>
<td>0.00 [0.00]</td>
<td>0.00 [0.12]</td>
<td>0.066* [1.76]</td>
</tr>
<tr>
<td>Central bank transparency</td>
<td>0.01 [0.66]</td>
<td>0.02 [0.44]</td>
<td>0.05 [1.13]</td>
</tr>
<tr>
<td>Public debt</td>
<td>0.00 [0.00]</td>
<td>0.00 [0.12]</td>
<td>0.07* [1.91]</td>
</tr>
<tr>
<td>Population growth</td>
<td>0.02 [0.77]</td>
<td>0.02 [0.58]</td>
<td>0.04 [0.89]</td>
</tr>
<tr>
<td>Labor market flexibility</td>
<td>0.01 [0.51]</td>
<td>0.02 [0.51]</td>
<td>0.06 [1.61]</td>
</tr>
<tr>
<td>Capital account openness</td>
<td>0.01 [0.36]</td>
<td>0.01 [0.31]</td>
<td>0.04 [-0.59]</td>
</tr>
<tr>
<td>Trade openness</td>
<td>0.01 [0.3]</td>
<td>0.01 [0.25]</td>
<td>0.06 [1.63]</td>
</tr>
</tbody>
</table>

Sources: Chinn and Ito (2018), Dincör and Eichengreen (2014), International Monetary Fund, World Bank.

Notes: Each row corresponds to a different regression, where the coefficients and significances (t-values) are those of the variable indicated in the row title. The dependent variables are based on a country-specific heterogeneous panel SVAR estimation for 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. Asterisks denote significance levels (*** p<0.01, ** p<0.05, *p<0.1). The numbers in bracket refer to t-statistics. "GDP" refers to national GDP measured in U.S. dollars using PPP (not market) exchange rates. Inflation targeting regimes (IT) are defined as in IMF (2016). Central bank transparency data are based on Dincer and Eichengreen (2014). Exchange rate regimes are based on Shambaugh (2004). "Labor market flexibility" is based on the estimates compiled by the Fraser institute, with a higher value representing a more flexible labor market. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2018). Dependent variables are based on mean values over the country-specific sample periods.
## Table 6.2 Regression of variance decompositions of core inflation

<table>
<thead>
<tr>
<th>Variance share for domestic core</th>
<th>Global energy</th>
<th>Global food</th>
<th>Global core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forecasting horizon (month)</strong></td>
<td>6 18</td>
<td>6 18</td>
<td>6 18</td>
</tr>
<tr>
<td>LIC dummy</td>
<td>0.01</td>
<td>0.03</td>
<td>0.03**</td>
</tr>
<tr>
<td></td>
<td>[0.36]</td>
<td>[1.40]</td>
<td>[2.04]</td>
</tr>
<tr>
<td>Level of headline inflation</td>
<td>0.00</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.2]</td>
<td>[1.21]</td>
<td>[1.88]</td>
</tr>
<tr>
<td>in the inclusion of each level</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td>of headline inflation variable</td>
<td>[0.56]</td>
<td>[1.03]</td>
<td>[0.81]</td>
</tr>
<tr>
<td>Commodity importer</td>
<td>0.00</td>
<td>0.02</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>[0.05]</td>
<td>[1.01]</td>
<td>[1.83]</td>
</tr>
<tr>
<td>GDP</td>
<td>0.00</td>
<td>0.02</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>[0.42]</td>
<td>[1.33]</td>
<td>[1.74]</td>
</tr>
<tr>
<td>Inflation target</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.29]</td>
<td>[1.21]</td>
<td>[1.65]</td>
</tr>
<tr>
<td>Pegged exchange rate regime</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.29]</td>
<td>[1.3]</td>
<td>[1.42]</td>
</tr>
<tr>
<td>Central bank transparency</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02*</td>
</tr>
<tr>
<td></td>
<td>[0.5]</td>
<td>[1.5]</td>
<td>[1.74]</td>
</tr>
<tr>
<td>Public debt</td>
<td>0.02</td>
<td>0.04*</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.87]</td>
<td>[1.82]</td>
<td>[1.53]</td>
</tr>
<tr>
<td>Population growth</td>
<td>0.01</td>
<td>0.03</td>
<td>0.03***</td>
</tr>
<tr>
<td></td>
<td>[0.5]</td>
<td>[1.58]</td>
<td>[2.23]</td>
</tr>
<tr>
<td>Labor market flexibility</td>
<td>-0.01</td>
<td>0.02</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>[-0.28]</td>
<td>[0.85]</td>
<td>[0.32]</td>
</tr>
<tr>
<td>Capital account openness</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.55]</td>
<td>[1.46]</td>
<td>[1.33]</td>
</tr>
<tr>
<td>Trade openness</td>
<td>0.01</td>
<td>0.03</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>[0.55]</td>
<td>[1.46]</td>
<td>[1.33]</td>
</tr>
</tbody>
</table>


Notes: Each row corresponds to a different regression, where the regression includes a LIC dummy, an EMDE dummy, a constant and the variable indicated in the row label. The numeric values and significance levels (t-values) are not those of the additional included variable, but rather those of the LIC dummy when the variable indicated in the row label was included in the regression. Thus, it is cases where row 1 shows significance, and some other row in the table shows insignificance, that are indicative of a country characteristic that rendered an otherwise significant LIC dummy insignificant through its inclusion in the regression. The dependent variables are based on country-specific heterogeneous panel SVAR estimations for 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. Asterisks denote significance levels (** p<0.01, * p<0.05, *p<0.1). The LIC dummy is equal to 1 for any LIC, and 0 for any other country. “GDP” refers to national GDP measured in U.S. dollars using PPP (not market) exchange rates. Inflation targeting regimes (IT) are defined as in IMF (2016). Central bank transparency data are based on Dincer and Eichengreen (2014). Exchange rate regimes are based on Shambaugh (2004). “Labor market flexibility” is based on the estimates compiled by the Fraser Institute, with a higher value representing a more flexible labor market. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2018). Dependent variables are based on mean values over the country-specific sample periods. The numbers in bracket refer to t-statistics.
higher contribution of global inflation shocks to variations in domestic core inflation in LICs. Further empirical investigation of the LIC effect is needed to identify the factors that could render the LIC dummy insignificant. Perhaps, additional structural characteristics of the economy (e.g., industry structure) could help explain the LIC effect.

**How can LICs reduce their vulnerability to global inflation shocks?** To examine how LIC inflation rates respond to global shocks, the previous links are recomputed for LICs only, and thus without a LIC dummy. The results for IRFs of domestic core inflation as the dependent variable 1 month, 6 months, and 18 months after the original shock are shown in Table 6.3 and for variance decompositions as the dependent variable are shown in Table 6.4. The coefficients and significance levels shown are now those of the variables indicated in the row title.

The strength of the energy and food price shock transmission are inversely associated with both increased trade and financial openness as well as increased central bank transparency. Similarly, the results suggest that the magnitude of transmission of the global core shock is negatively associated with increased central bank transparency.\(^{17}\) Although less statistically significant, the results indicate that higher financial and trade openness is associated with an increased strength in the transmission of global core shocks into core inflation in LICs.

Therefore, openness measures appear to play different roles for the cumulative IRFs and variance decompositions of the domestic core inflation to global relative price shocks versus global core-price shocks in LICs. It could be that relative price shocks (e.g., shocks in energy and food prices) are mostly driven by supply shocks, while shocks to the global core inflation are largely demand shocks. Thus, the differential consequences of openness for the transmission of these shocks into the domestic core inflation reflect different channels through which demand and supply shocks are transmitted. Alternatively, it could also be the case that global relative price shocks are less destabilizing for domestic inflation expectations because opening of trade and of domestic financial market to global markets contribute to the anchoring of inflation expectations as a disciplining device. It is also possible that the global core-price shocks could have different consequences for domestic core inflation in different groups of

\(^{17}\) Note that the results do not necessarily imply a causal relation from greater central bank transparency to better anchored domestic core inflation in LICs. Central bank transparency may simply be a proxy for a whole constellation of institutional factors that may be conducive to a better anchoring of core inflation expectations in LICs (See, for instance, Bordo and Siklos 2017). The important point is that the usual policy suspects—such as central-bank transparency—appear to have the type of association with the anchoring of core inflation expectations that might be expected, but of course these results are at best suggestive.
### TABLE 6.3 LICs: Regression of response of core inflation on country characteristics

<table>
<thead>
<tr>
<th>Response of domestic core to</th>
<th>Global energy</th>
<th></th>
<th></th>
<th>Global food</th>
<th></th>
<th></th>
<th></th>
<th>Global core</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time horizon (month)</td>
<td>1</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>6</td>
<td>18</td>
<td>1</td>
<td>6</td>
<td>1</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Level of headline inflation</td>
<td>0.00</td>
<td>0.01</td>
<td>0.03</td>
<td>0.00</td>
<td>0.01</td>
<td>0.04</td>
<td>-0.02</td>
<td>-0.37</td>
<td>-0.46</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>-0.05</td>
<td>-0.06</td>
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<td>0.01</td>
<td>-0.01</td>
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<td>2.23**</td>
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<tr>
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<td>0.00</td>
<td>0.01</td>
<td>0.00</td>
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<td>0.04*</td>
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<tr>
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<td>[2.42]</td>
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<td>[1.65]</td>
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<tr>
<td>Pegged exchange rate regime</td>
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<td>0.00</td>
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<td>-0.01</td>
<td>-0.06</td>
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<tr>
<td></td>
<td>[-0.89]</td>
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<td>[-0.79]</td>
<td>[-0.07]</td>
<td>[-0.14]</td>
<td>[-0.35]</td>
<td>[1.05]</td>
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<tr>
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<td>[0.95]</td>
<td>[-0.05]</td>
<td>[-0.27]</td>
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</tr>
<tr>
<td>Public debt</td>
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<td>0.00</td>
<td>-0.05</td>
<td>-0.01</td>
<td>0.01</td>
<td>-0.06</td>
<td>0.03</td>
<td>0.84</td>
<td>0.26</td>
<td></td>
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</tr>
<tr>
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<td>[0.34]</td>
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</tr>
<tr>
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<td>-0.01</td>
<td>0.01</td>
<td>0.09</td>
<td>0.09</td>
<td>0.01</td>
<td>0.51</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[1.07]</td>
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<td>[-0.09]</td>
<td>[0.75]</td>
<td>[0.79]</td>
<td>[0.44]</td>
<td>[0.23]</td>
<td>[0.56]</td>
<td>[0.68]</td>
<td></td>
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</tr>
<tr>
<td>Labor market flexibility</td>
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<td>0.01</td>
<td>0.08</td>
<td>0.01</td>
<td>-0.08</td>
<td>-0.15</td>
<td>-0.05</td>
<td>1.26**</td>
<td>2.39***</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.59]</td>
<td>[0.35]</td>
<td>[1.41]</td>
<td>[0.35]</td>
<td>[-0.66]</td>
<td>[-0.68]</td>
<td>[-1.03]</td>
<td>[1.72]</td>
<td>[3.02]</td>
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</tr>
<tr>
<td>Capital account openness</td>
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<td>0.06</td>
<td>-0.02</td>
<td>0.00</td>
<td>-0.31*</td>
<td>-0.68**</td>
<td>-0.01</td>
<td>1.42</td>
<td>0.48</td>
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<tr>
<td></td>
<td>[0.38]</td>
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<td>[-0.18]</td>
<td>[-0.03]</td>
<td>[-1.82]</td>
<td>[-2.2]</td>
<td>[-0.17]</td>
<td>[0.92]</td>
<td>[0.25]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trade openness</td>
<td>-0.01</td>
<td>0.01</td>
<td>-0.09**</td>
<td>-0.02</td>
<td>-0.10</td>
<td>-0.25</td>
<td>0.06*</td>
<td>0.72</td>
<td>-0.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[-0.94]</td>
<td>[0.21]</td>
<td>[-2.1]</td>
<td>[-1.08]</td>
<td>[-1.14]</td>
<td>[-1.63]</td>
<td>[1.83]</td>
<td>[1.02]</td>
<td>[-0.2]</td>
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<td></td>
</tr>
</tbody>
</table>


Notes: Each row corresponds to a different regression, where the coefficients and significances (t-values) are those of the variable indicated in the row title. The dependent variables are based on a country-specific heterogeneous panel SVAR estimation for 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. Asterisks denote significance levels (** p<0.01, *** p<0.05, * p<0.1). The numbers in bracket refer to t-statistics. “GDP” refers to national GDP measured in U.S. dollars using PPP (not market) exchange rates. Inflation targeting regimes (IT) are defined as in IMF (2016). Central bank transparency data are based on Dincer and Eichengreen (2014). Exchange rate regimes are based on Shambaugh (2004). “Labor market flexibility” is based on the estimates compiled by the Fraser Institute, with a higher value representing a more flexible labor market. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2018). Dependent variables are based on mean values over the country-specific sample periods. The numbers in bracket refer to t-statistics.
### TABLE 6.4 LICs: Regression of variance decompositions of core inflation on country characteristics

<table>
<thead>
<tr>
<th>Variance share of</th>
<th>Global energy</th>
<th>Global food</th>
<th>Global core</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Forecasting horizon (month)</strong></td>
<td>1</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Level of headline inflation</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[0.99]</td>
<td>[0.35]</td>
<td>[-0.46]</td>
</tr>
<tr>
<td>Commodity importer</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[-0.71]</td>
<td>[-0.06]</td>
<td>[0.15]</td>
</tr>
<tr>
<td>GDP</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[1.08]</td>
<td>[0.50]</td>
<td>[0.72]</td>
</tr>
<tr>
<td>Pegged exchange rate regime</td>
<td>-0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[-0.89]</td>
<td>[-0.17]</td>
<td>[0.11]</td>
</tr>
<tr>
<td>Central bank transparency</td>
<td>-0.006**</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[-1.98]</td>
<td>[-0.06]</td>
<td>[-0.78]</td>
</tr>
<tr>
<td>Public debt</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[-0.63]</td>
<td>[-1.3]</td>
<td>[-1.44]</td>
</tr>
<tr>
<td>Population growth</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[1.07]</td>
<td>[-0.19]</td>
<td>[-1.09]</td>
</tr>
<tr>
<td>Labor market flexibility</td>
<td>0.00</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>[0.58]</td>
<td>[-0.86]</td>
<td>[0.23]</td>
</tr>
<tr>
<td>Capital account openness</td>
<td>0.00</td>
<td>-0.06***</td>
<td>-0.01**</td>
</tr>
<tr>
<td></td>
<td>[0.37]</td>
<td>[-3.59]</td>
<td>[-2.04]</td>
</tr>
<tr>
<td>Trade openness</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.01**</td>
</tr>
<tr>
<td></td>
<td>[-0.92]</td>
<td>[-1.31]</td>
<td>[-2.23]</td>
</tr>
</tbody>
</table>


Notes: Each row corresponds to a different regression, where the coefficients and significances (t-values) are those of the variable indicated in the row title. The dependent variables are based on a country-specific heterogeneous panel SVAR estimation for 104 countries (25 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. Asterisks denote significance levels (** p<0.01, * p<0.05, ** p<0.1). “GDP” refers to national GDP measured in U.S. dollars using PPP (not market) exchange rates. Inflation targeting regimes (IT) are defined as in IMF (2016). Central bank transparency data are based on Dincer and Eichengreen (2014). Exchange rate regimes are based on Shambaugh (2004). “Labor market flexibility” is based on the estimates compiled by the Fraser Institute, with a higher value representing a more flexible labor market. The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2018). Dependent variables are based on mean values over the country-specific sample periods. The numbers in bracket refer to t-statistics.
LICs, by interacting with other structural features, for example exchange rate regimes.\(^\text{18}\)

In sum, from the two types of regression analysis, it seems that the policy reactions for the LIC effect need not be the same as the causes of the LIC effect, especially for global core-price shocks, which explain the largest portion of variation in LICs’ core inflation. The exceptions to this might be the degree of openness and the degree of central bank independence, for the transmission of global energy and food price shocks. The above results point toward individual country characteristics that may be significant either in helping to account for differences in the transmission of global shocks to domestic core inflation in LICs, or in helping to identify which policies might help reduce the magnitude and variance contribution of these transmissions. The next step is to use these results as a basis for investigating possible multivariate relationships especially interaction effects that help identify policies that may be particularly effective in anchoring inflation expectations in LICs.

**How do the effects of country characteristics differ in LICs from other country groups?** The presence of a “LIC effect” was explored further by using data for all country groups to examine whether values of the dependent variable differ systematically for LICs. The results indicate that for both LICs and other EMDEs, the share of the 18-month variance in domestic core inflation explained by global core inflation is much higher than for advanced economies, although not greatly different between these two groups (Table 6.5).

Next, the robustness of these differences to the inclusion of other variables was examined. Initial results suggested that the various cross-country differences could affect the transmission of global core inflation to domestic core inflation. Accordingly, variables capturing trade and financial openness, exchange rate regime, and central bank transparency were included in the regressions, one at a time (columns 2 through 4). However, none of these variables made a significant difference. The coefficients on the EMDE (non-LIC) and LIC dummies were essentially unaffected, and none of the additional variables were statistically significant (to save space, these results are not reported). Instead, in column 5 all the variables were included together. Again, none was statistically significant and the coefficients on the dummies were unaffected. These results suggest that the differences between LICs and other EMDEs, on the one hand, and advanced economies on the other, are not due to systematic differences among these sets of countries with respect to the characteristics most naturally suggested by theory.

\(^\text{18}\) This would be analogous to the observation in Figure 6.5 that shows that different types of shocks have different consequences on advanced economies and EMDEs depending on exchange rate regimes.
The next question considered was whether the different inflation performance of LICs and other EMDEs, relative to advanced economies, is attributable to differences in the effects of the relevant characteristics on the transmission from global to domestic core inflation between LICs and other EMDEs, on the one hand, and advanced economies on the other. This question was explored by interacting these characteristics with the EMDE and LIC dummies, one at a time. If the interaction term is statistically significant, the implication would be that the EMDE or LIC context makes a difference in the role of the relevant characteristics. This was not the case for either of the openness variables (the results are not reported here). However, the exchange rate regime did make a substantial difference, as shown in columns 6 and 7 of Table 6.5. The interaction of the pegged exchange rate regime variable, pegged XR, with both the EMDE and LIC dummies proved highly significant in both cases, but with opposite signs. Fixed exchange rates thus had a substantial negative effect on transmission from the global to the domestic core in LICs, but a modest positive effect in other EMDEs.

The implications are that both the “EMDE effect” and the “LIC effect” are regime-specific. For illustrative purposes, setting Pegged XR = 0 for countries with floating rates and Pegged XR = 1 for countries with fixed rates, the EMDE effect (column 6 of Table 6.5) would be 0.39 for floating regime countries and 0.59 for fixed regime countries, while for LICs the corresponding values are 0.67 and 0.04. Focusing specifically on the LIC results, the upshot is that LICs that fix their exchange rates seem to be able to anchor inflation expectations about as well as advanced economies, while those that float are not able to do so. This result is consistent with the view that LICs have found it difficult to generate home-grown anchors for the domestic core.

To investigate this issue, the possible role of central bank independence in anchoring inflation expectations among LIC floating regime countries was considered. This was done by interacting a measure of central bank independence, central bank turnover, with exchange rate flexibility (1 – Pegged XR) in LICs. The results are reported in column 7 of Table 6.5. The interaction term is not significant at conventional levels, but in view of the small number of floating regimes among the LICs in the sample, the p-value of 0.27 makes the negative coefficient at least suggestive: LICs that float may be more successful at anchoring inflation expectations in the face of shocks to the global core inflation when their central banks are more independent.

---

19 The central bank turnover measures central bank turn-over rates, the number of changes in central bank heads before the end of legal terms of office, as in Dreher, Sturm, and de Haan (2010). This variable is here used instead of the central bank transparency and independence for wider country coverage of the data.
TABLE 6.5 Regression of variance of core inflation explained by global core price shock on country characteristics

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
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<td>0.50***</td>
<td>0.49***</td>
<td>0.49***</td>
<td>0.49***</td>
<td>0.39***</td>
<td>0.39***</td>
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<tr>
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<td>[0.00]</td>
<td>[0.00]</td>
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<td>[0.00]</td>
<td>[0.00]</td>
<td>[0.00]</td>
</tr>
<tr>
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<td>0.38***</td>
<td>0.38***</td>
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<tr>
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<td>0.001</td>
<td>0.0002</td>
<td>0.0001</td>
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<td></td>
</tr>
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<td>[0.73]</td>
<td>[0.86]</td>
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</tr>
<tr>
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<td></td>
<td>[0.97]</td>
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<td>[0.47]</td>
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<td></td>
</tr>
<tr>
<td>regime (Pegged XR)</td>
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<td>[0.71]</td>
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<tr>
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<td>0.20***</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[0.04]</td>
<td>[0.04]</td>
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</tr>
<tr>
<td>Pegged XR*LIC</td>
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<td>-0.76***</td>
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<td></td>
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<td></td>
</tr>
<tr>
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<td>[0.00]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CB turnover*</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(1-Pegged XR)*LIC</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
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<td>0.36</td>
<td>0.36</td>
<td>0.37</td>
<td>0.46</td>
<td>0.46</td>
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</tbody>
</table>


Notes: Each column corresponds to a different regression. The dependent variables (the variance share of global core shocks for domestic core inflation at the 18-month forecasting horizon) are based on a country-specific heterogeneous panel SVAR estimation for 104 countries (24 advanced economies, 61 EMDEs, and 18 LICs). EMDEs here exclude LICs. Asterisks denote significance levels (*** p<0.01, ** p<0.05, *p<0.1). The LIC dummy equals 1 for any LIC and 0 for any other country. The EMDE dummy equals 1 for any EMDE and 0 for any other country. ‘CB turnover’ refers to the number of changes in the head of a central bank before the end of a legal term of office, based on Dreher, Sturm, and de Haan (2010). Because of the wider availability of data for this variable, it is used instead of central bank transparency. Exchange rate regimes are based on Shambaugh (2004). The measures of trade and capital account openness are, respectively, trade (exports plus imports)-to-GDP ratios (in percent) and the index compiled by Chinn and Ito (2018). Dependent variables are based on mean values over the country-specific sample periods except. The numbers in bracket refer to p-value.

Conclusion

There has been a remarkable degree of convergence of views in academic and policy circles about the principles to which monetary policy should adhere to yield the low and stable medium-term inflation that is conducive to healthy economic growth. However, central banks in LICs face significant challenges in achieving low and stable inflation and in anchoring inflation expectations to such an outcome. Meanwhile, globalization has proceeded apace in LICs as it has elsewhere, affecting, through several channels, the challenges confronted by LICs in achieving this objective.
Nevertheless, inflation rates in LICs over the last two decades have been declining from excessively high levels in many cases, and have converged closer to those of advanced economies and other EMDEs, despite the special challenges faced by these countries. These challenges include sizable domestic shocks, as well as large external shocks which increasing globalization may have amplified. At the same time, inflation has stabilized at a low rate in the large advanced economies. The improvement in LIC inflation performance over the past two decades raises the question of the extent to which it reflects an improved domestic policy environment (i.e., is home-grown) or has effectively been imported. It is hard to take a firm view on this question ex ante, because globalization has been affecting the challenges faced by LIC central banks in complicated ways that do not unambiguously make their anti-inflationary objectives either easier or harder to achieve.

The question must therefore be approached empirically. The heterogeneous panel SVAR technique used for this chapter has allowed us to assess the relative roles of the external inflation environment and domestic factors in driving core inflation in a large group of countries, including both LICs and other country groups. The inclusion of other countries provides better estimates of the influence of relevant global factors and the roles of different country characteristics in explaining the susceptibility of domestic core inflation being dislodged by external shocks. Compared with the existing literature, the results of the analysis in this chapter lead to some new conclusions. In particular:

- LIC core inflation tends to respond more strongly to global core inflation than does core inflation in the other two country groups.

- LIC core inflation responds more strongly to global food inflation than does core inflation in the other two country groups.

- LIC core inflation responds more sharply, although more variably, to global energy inflation than does core inflation in other country groups.

- Exchange rate pass-through to core inflation also appears to be much larger for LICs than for the other groups.

Together, these results suggest that, at least in this sample, core inflation was more susceptible to external disturbances in LICs than in the other country groups. Variance decompositions support this result, indicating that most of the variation in domestic core inflation among LICs was accounted for by external inflationary shocks, and very little by shocks to domestic core inflation, a result exactly opposite to that of advanced economies.
What sets LICs apart is not so much that they differ from advanced economies (and other EMDEs) with regard to characteristics that might be expected to contribute to the importing of global inflation, such as trade or financial openness or the exchange rate regime. Rather, it is that these characteristics appear to operate differently in the LIC environment.

Thus, LICs with floating exchange rates have had a difficult time in stabilizing inflation at a low rate, although they seem to resist external inflationary shocks better when their central banks are more independent. In contrast, LICs that fix their exchange rates seem to be able to succeed in stabilizing core inflation about as well as do advanced economies, suggesting that they might have in essence imported anti-inflation credibility. This latter result reflects the economic principle that a fixed exchange rate against a low-inflation currency is a monetary standard in which the foreign central bank provides the nominal anchor.

A flexible exchange rate regime, in contrast, is on its own monetary standard: a domestic nominal anchor has to stabilize inflation expectations. A popular, and robust, choice for the latter in this century—for many EMDEs as well as advanced economies—is to set an explicit medium- and long-term inflation target for monetary policy (Adrian, Laxton, and Obstfeld 2018). In this regime, the flexible exchange rate provides an important means of adjustment to real sector shocks, which facilitates the robustness of the regime. Fixed exchange rate regimes, in contrast, have often proven fragile, and are prone to collapse. These factors underline the need for a reform agenda to strengthen the anti-inflationary credibility of domestic monetary policy.

The upshot is that LIC central banks do not yet appear to have been sufficiently successful in meeting the challenges posed for them by the environment in which they operate, and have not yet achieved the objective of securing low and stable medium-term inflation rates on a home-grown basis. Instead, the results in this chapter suggest that their much-improved inflation performance might have largely been imported. Consequently, if global inflation were to rise, LICs would likely see their inflation rising in tandem. Hence, the reform agenda for achieving home-grown anti-inflationary credibility in LICs remains unfinished.

The chapter raises questions: The implications for inflationary outcomes of differences in characteristics of LICs and other EMDEs remain to be explored. Of immediate policy relevance are questions related to reforms of LIC central banks to achieve home-grown anti-inflationary credibility. Given the challenging operating environments for LIC central banks, these may well differ from reform priorities elsewhere. Finally, it would be useful to study changes in the transmission of global shocks into LICs.
ANNEX 6.1 Monetary policy challenges in low-income countries

The level and volatility of inflation in LICs has remained higher than in advanced economies and in other EMDEs over the recent two decades. This divergence may partly reflect special monetary policy challenges that arise in LICs from their volatile economies, conflicts among central bank policy objectives, weaknesses in monetary policy transmission, and limited institutional capacity at central banks. There are various ways in which these challenges may be addressed.

Introduction: The role of monetary policy and its recent performance in LICs

Central banks around the world accept that they serve two primary objectives: price stability, meaning low and stable inflation, and financial stability, meaning maintenance of a financial system that is safe and sound (Taylor 2005; Hammond, Kanbur, and Prasad 2009). To achieve their objectives, central banks have two sets of policy instruments. One comprises the instruments of monetary policy, used to exert control over the general level of interest rates, particularly short-term rates, and the supply of credit. The other comprises prudential regulation and supervision, including capital requirements applying to financial institutions and constraints on their lending that are sometimes referred to as macroprudential policies. There is today broad consensus that the instruments of monetary policy are generally best assigned to the objective of price stability, while prudential policies are generally best assigned to the objective of financial stability (Bernanke and Gertler 1999 and many others).

The primary objective of monetary policy is therefore low and stable inflation; this refers more to the medium term rather than the short term, since short-term fluctuations in inflation are unavoidable and of limited importance.

In recent decades there has been substantial progress in many countries, and globally, toward price stability, with inflation having been lowered considerably from the relatively high levels reached in the 1970s and 1980s. Between 2000 and 2016, inflation level more than halved in both advanced economies and EMDEs (excluding LICs), and the inflation volatility has also decreased (Figure 6.1).\(^1\) Despite the global downward trend in level and volatility in inflation, the progress has been less pronounced in LICs. While inflation levels in both headline and core consumer price in LICs are still higher than advanced

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\(^1\) This continues to be so in the recent years. Median consumer price inflation has fallen significantly in EMDEs, to 3.5 percent in 2017 from 5.5 percent a year, on average, in the decade before the global financial crisis. In contrast, median inflation in LICs was 5 percent in 2017, barely changed from the 6 percent average in the years 1999-2008.
inflation in LICs, overall, have not been so successful in recent years with respect to the objective of low and stable inflation, in spite of a global environment conducive to this aim.

This may be due partly to the particular challenges faced by monetary policy in LICs. These are the subject of this annex. It asks two questions:

- What have been the challenges facing monetary policy in LICs?
- How can the challenges be addressed?

**What have been the challenges facing monetary policy in LICs?**

A key factor in determining the ability of central banks to achieve low and stable inflation is their success in anchoring the inflation expectations of wage and price setters. If expectations are well anchored at a low inflation rate, temporary departures of inflation from this level will be less likely to set inflation expectations adrift and have prolonged effects on the inflation rate. Inflation expectations are shaped importantly by the credibility of the central bank, which will depend partly on the clarity of its stated objectives, and partly on its demonstrated commitment to its objectives and ability to achieve them (Blinder et al. 2008, among many others). These considerations point to several particular challenges facing monetary policy in LICs.

One is simply the fact that the history of inflation in LICs is unfavorable to establishing confidence in future price stability. LICs therefore face more of a challenge than advanced economies in establishing a convincing track record of low and stable inflation.

More fundamentally, monetary policy in LICs faces challenges arising from conflicts among policy objectives; difficulties in specifying appropriate policy objectives; weaknesses in the instruments and transmission mechanism of monetary policy; and shortcomings in the analytical capacity of central banks. These are considered in turn.

**Conflicts among policy objectives**

There are several reasons why it may be more challenging in LICs than in advanced economies and in many other EMDEs for central banks to focus their policies on the objective of low and stable inflation.

First, the fact that LICs start with relatively high inflation will make it more difficult for a central bank to make a credible commitment to low and stable inflation, because this will require it to be willing to tolerate relatively weak
activity—negative output gaps—perhaps for an extended period, which will conflict with its secondary objectives (Kasa 2001; Gemayel, Sarwat, and Alexandra 2011).

Second, in LICs there tend to be relatively more frequent supply shocks than in other country groups, arising, for example, from the effects of weather events on agricultural production (Frankel 2011). A poor harvest will tend to increase inflation in the short term while depressing economic activity. Supply shocks thus push inflation and output growth in opposite directions, tending to give rise to a conflict between monetary policy’s primary objective of stabilizing prices and its secondary objectives of supporting growth and maintaining a narrow output gap. Stabilizing inflation in response to supply shocks may thus require the sacrifice of the secondary objectives of monetary policy (Nguyen et al. 2017; Adam 2011; Bashar 2011). This contrasts with demand shocks, relatively less prevalent in LICs than in other country groups, where stabilizing inflation should simultaneously serve the objective of containing output and employment gaps (“divine coincidence”; Blanchard and Galí 2007).

Third, central banks in LICs are more likely to face conflicts between price stability and fiscal considerations, including the demands of the authorities’ fiscal policy (Mas 1995; Prasad 2010). Because they are public sector institutions with the capacity to generate seignorage revenue through the issuance of interest-free liabilities (most notably, currency), central banks can face pressures to provide cheap financing to governments. These pressures will tend to be greater in LICs because systems for raising revenue from taxes are relatively less well developed. In the extreme case of fiscal dominance, in which the central bank is institutionally subservient to the finance ministry, meeting the demands of fiscal policy becomes the bank’s overriding objective, regardless of its adverse consequences for price stability.

Endowing central banks with legal independence has become more prevalent since the early 1990s, partly as a means of allowing central banks to give primacy to price stability over fiscal objectives, and of enhancing their anti-inflationary credibility. However, such de jure independence does not necessarily translate into de facto independence. Researchers have constructed measures of the latter based on various indicators, including for EMDEs (for example, Cukierman 2008, Garriga 2016). One study found that although central bank independence increased around the world with reforms undertaken from the early 1990s, both EMDEs and the sub-group of LICs remained characterized by less independent central banks than advanced economies (Garriga 2016).2

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2 Garriga’s index of independence, which theoretically ranged from 0 (least independence) to 1 (most independence) averaged 0.71 for 34 advanced economies, 0.57 for 110 EMDEs, and 0.62 for 26 LICs.
But even independent central banks may find their commitment to price stability undermined by fiscal constraints. To the extent that a central bank depends on the finance ministry to recapitalize it if it incurs large losses, it may be more receptive to government pressure; and to safeguard its independence in light of this possibility, it may abstain from policies that would require it to incur sustained losses (most notably the sterilization of capital inflows) even if by doing so it endangers price stability. Furthermore, a central bank may find its pursuit of price stability constrained by fiscal considerations even in the absence of concern for its own solvency. For example, when the government’s solvency is itself precarious, the central bank may be reluctant to pursue anti-inflationary policies that would both increase the government’s borrowing costs and reduce tax revenues.

There are therefore several ways in which fiscal considerations can constrain central banks’ policies in pursuit of price stability and undermine their anti-inflationary credibility in LICs.

Fourth, in LICs (as in some other EMDEs) the exchange rate may be a more important policy objective than in advanced economies (Taylor 2001; Mishkin and Savastano 2001; Buffie et al. 2004; IMF 2015). A declared strategy of stabilizing the nominal exchange rate against one or more currencies of trading partners that have a track record of low and stable inflation may well be compatible with the achievement of domestic price stability; indeed, for some LICs it may offer a particularly effective way of achieving this objective. Given the limited international financial integration of many LICs, the adoption of such an exchange rate peg may leave some scope for monetary management directed toward domestic objectives. For many LICs, therefore, monetary and exchange rate policies may remain potentially independent, as noted by Ostry, Ghosh, and Chamon (2012). This contrasts with advanced economies and many EMDEs that are highly integrated with international financial markets, where the open-economy trilemma implies that it would be impossible to maintain independent monetary and exchange rate policies.

Conflicts between monetary and exchange rate policies may, however, arise. Thus an ad hoc assignment of monetary policy to an objective of exchange rate stabilization—motivated, for example, by currency mismatches in balance sheets that mean that depreciation of the domestic currency would increase debt burdens—may be attempted when important pre-conditions (relating, in particular, to international cost competitiveness and inflation differentials) are not met. Such an effort is likely to prove unsustainable and disruptive, and a distraction from monetary stabilization. In such cases, it would be more advisable to address the causes of the balance sheet mismatches, including shortcomings in financial regulation, although constraints on official borrowing
in domestic currency (associated with “original sin”) may be difficult to address in the short term (Calvo and Reinhart 2002, among many others).

There may also be an inclination in LICs, as in other EMDEs, to adopt the real exchange rate as a policy objective. As argued by Rodrik (2007) and Berg and Miao (2010), the real exchange rate may have an important role to play in development policy, through its impact on the traded/non-traded composition of domestic real output and, in particular, as a means of promoting export-led growth. Thus, LIC central banks may be led to include a depreciated real exchange rate target among their objectives. But attempting to use monetary policy to serve this objective will not only distract from the objective of price stability, but be destabilizing for inflation. Thus, a domestic inflationary shock will call for monetary policy to be eased to generate a depreciation of the domestic currency that stabilizes the real exchange rate; but the original inflationary shock will consequently be magnified.

The upshot is that central banks in LICs may be faced with a broader set of objectives than those in advanced economies. Distraction from the primary objective of monetary policy—price stability—either by its secondary aims (supporting employment and growth), or by fiscal considerations, or by an aim of maintaining a depreciated real exchange rate will typically call for more expansionary monetary policies than the central bank would otherwise pursue.

**Difficulties in specifying appropriate policy objectives**

The anchoring of inflation expectations depends on more than the central bank’s commitment to the broad objective of low and stable inflation. It is also likely to require a declared, quantitatively specific inflation objective for the medium term that has public support, and against which the public can judge the central bank’s performance.

However, specification of an inflation objective may prove relatively challenging in LICs. It is unlikely that simply importing the inflation targets of advanced

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3 A recent survey of IMF country desks for 44 LICs and 21 lower middle-income countries (LMICs) found that, while price stability was an important objective of monetary policy in around 80 percent of them, more than two-thirds of the central banks were charged with two or more objectives (IMF 2015). Note that the definition of LICs in the paper differs from the one used in this chapter.

4 In the past, particularly in the 1970s and 1980s, “intermediate targets” for the growth of monetary aggregates were widely used, especially by advanced economies, in attempts to anchor inflation expectations. This strategy encountered a number of difficulties, including significant differences in the behavior of various aggregates; difficulties encountered by central banks in controlling the aggregates; and the instability of relationships between the aggregates and economic developments, including inflation. Monetary aggregates are still monitored by central banks but reliance on them is now limited, and monetary targets play little role.
economies (about 2 per cent a year) would be optimal for LICs. In fact, there are grounds for believing that official inflation objectives in LICs should be somewhat higher than in advanced economies.

First, the weakness of formal tax systems in LICs, and the high collection costs frequently associated with them, point to the case for a larger relative role of seignorage as a source of government revenue, particularly from the relatively large informal sector where tax collection is limited (Huang and Wei 2006; Di Bella et al. 2006). However, the case for a larger role for seignorage revenue, and therefore a higher optimal inflation rate than in advanced economies, depends partly on the productivity of public sector spending. Where there are grounds for believing that public sector spending yields a particularly high marginal social rate of return (for example, in areas such as health and education), the social value of marginal government revenue to finance these outlays will be high, suggesting a greater role for seignorage revenue and therefore a higher optimal inflation rate than in countries where such marginal social returns are lower. This is one reason why appropriate inflation objectives will tend to vary from country to country.

Second, there is empirical evidence that higher inflation begins to exert negative effects on economic growth at significantly higher inflation rates in EMDEs than in advanced economies (e.g., Khan and Senhadji 2001), with significant variation in the effects among individual countries.

These considerations suggest that the challenge is to identify appropriate country-specific inflation objectives. The specification of inflation objectives has indeed proven to be a challenging task for central banks in LICs. The survey of IMF country desk economists reported in IMF (2015) found that most low- and lower-middle income countries (LLMICs) that listed price stability as a central bank objective, but that had not adopted formal inflation targeting, did not have a numerical inflation target, and those that had such a target simply tended to align it with the bank’s inflation forecast.

To the extent that central banks in LICs have objectives in addition to low and stable inflation, such as small output or employment gaps, these will also need to be quantified. This too may pose serious challenges for LICs. Estimation of output and employment gaps, and of appropriate objectives for them, is highly problematic in advanced economies, because of instability in relationships between unemployment and inflation and uncertainty surrounding estimates of potential output. It is likely to be even more so in LICs, for example because of

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5 Again, this is a different set of countries with the group of LICs used in this chapter.
the higher incidence of supply shocks and the greater prevalence and variability of underemployment.

**Weaknesses in the instruments and transmission mechanism of monetary policy**

In advanced economies and many of EMDEs, the key (conventional) monetary policy instrument is a very short-term interest rate, most often an interbank rate such as the federal funds rate in the United States. The central bank can exert close control over the interbank rate through its supply of reserves to the banking system and its administration of standing facilities. In LICs, however, interbank markets are typically absent, as are liquid secondary markets in government securities, which the central bank could seek to influence through open-market operations. The government securities market in LICs tends to be a primary market in which the counterparties to the central bank are commercial banks that adopt a buy-and-hold strategy for such securities. Thus the central bank conducts monetary policy by directly lending to and borrowing from the commercial banking system (e.g., through repo transactions) or by doing so indirectly through the primary market for government securities. These transactions operate by altering the cost of official funds for the banking system.

Thus in LICs, monetary policy heavily depends on the bank-lending channel, typically not activated through an interbank market. Other channels of transmission that are operative in advanced economies, including through interest rates on traded securities, exchange rates, and asset prices, are much weaker in LICs (Mishra, Montiel, and Spilimbergo 2012). This reflects the absence of highly liquid markets for privately issued traded securities; weak links with international financial markets, coupled with relatively inflexible exchange rates; small and illiquid markets for equities; and poorly organized real estate markets.

The strength and reliability of the bank-lending channel are therefore particularly important in LICs. But they tend to be limited by several factors. First, LICs are generally characterized by limited financial inclusion and relatively small formal financial sectors that have only weak links to economic activity in the important informal sectors of the economy. Second, the institutional and legal environment in these economies—including property rights, accounting and disclosure standards, and contract enforcement—tends to be relatively weak (see, for example, Beck, Demirgüç-Kunt, and Ross 2009, on LICs in Sub-Saharan Africa). This makes financial intermediation from private savers to private borrowers costly and risky, inducing banks to limit this activity and to prefer holding safer government securities. Third, productive activity in these economies is often dualistic, characterized by a small number of large, well-established firms and a large number of very small, opaque, and often
unstable ones. The marginal cost of bank lending to large firms tends to be relatively low despite the imperfections in the domestic institutional environment, but the marginal cost of extending credit to small firms is likely to rise steeply, so that the volume of lending to such firms may be very insensitive to fluctuations in bank funding costs induced by monetary policy. In short, Tobin’s description of the effects of easing monetary policy under conditions of high liquidity preference as “pushing on a string” may be an especially apt analogy in the case of LICs, and the effects of tightening policy are also likely to be limited. A survey of studies of the strength and reliability of monetary transmission in LICs by Mishra and Montiel (2013), and the empirical evidence based on a large panel of countries by Mishra et al. (2014) are both consistent with this perspective.

The challenges created for monetary policy by weak monetary transmission could conceivably be overcome if the strength of monetary policy effects on such variables as inflation, real output, and the exchange rate could be reliably estimated, since weak effects could be offset by stronger policy measures. However, the strength of monetary transmission in LICs has proven difficult to estimate because of data limitations (Li et al. 2016). Several investigators have focused more narrowly on the extent of pass-through from policy rates to bank lending rates. Saborowski and Weber (2013), for example, found that while changes in policy rates tended to be transmitted almost one-for-one into retail bank lending rates in advanced economies, pass-through in developing countries, was only in the range of 30-45 percent. Abuka et al. (2015) found similar evidence for Uganda in relation to advanced economies, and that pass-through was particularly weak in less financially developed Ugandan districts. But they did find evidence that increases in policy rates were associated with a reduced supply of bank credit, suggesting that a bank-lending channel was operative in Uganda although it was weaker than in advanced economies.

**Shortcomings in the analytical capacity of central banks**

Because monetary policy affects the economy with lags, an important component of inflation targeting—or, for that matter, any other activist monetary policy regime—is an ability of the central bank to forecast with a modicum of accuracy its target variables on the assumption of unchanged policies as well as to assess the effects on those variables of potential changes in the settings of its instruments. In many advanced economies and non-LIC EMDEs, these tasks are performed using structural macroeconomic models of the economies in question. However, few LIC central banks have such models with proven track records (IMF 2015). Although work on such models is underway at many LIC central banks, the task is formidable, not least because of the lack of relevant historical data, insufficient knowledge about the
The analytical capacity of LIC central banks—even their ability to monitor and assess recent and current economic developments—is generally hampered by serious data deficiencies (Gemayel, Sarwat, and Alexandria 2011; IMF 2015). Thus, data on economic developments in informal sectors, which are often large, are typically absent or grossly inadequate. Official estimates of real GDP are typically available only with annual frequency and often with substantial lags. Labor market data, including for wages and unemployment rates, are generally poor. The absence of a well-defined term structure of yields in financial markets makes it difficult to assess market expectations of future monetary policy actions. Finally, estimates of inflation expectations are generally unavailable because of the absence of both survey evidence and market-based measures derived from differences between yields on comparable indexed and non-indexed securities.

Complications introduced by globalization

Finally, globalization changes the environment in which LIC central banks operate in significant ways, both aggravating and easing the challenges they face in attaining their objectives. Consider four aspects of globalization:

- An increasing size of the domestic traded goods sector.
- For many LICs, an increasing volume of inflows of workers’ remittances.
- Larger presence of foreign-owned banks in the domestic economy.
- Increased (though still limited) integration with the international financial market.

Understood in this way, globalization has several effects on the environment in which LIC central banks operate. First, globalization is likely to alter the stability properties of the domestic economy in complicated ways. It increases the economy’s exposure to external shocks, in the form of exogenous changes in...
the foreign-currency prices of traded goods, of remittance flows, and of capital flows. Larger remittance flows, for instance, simultaneously magnify the channels of transmission from the international real economy to domestic aggregate demand. Second, globalization may alter the tradeoffs that the central bank faces between competing objectives. Although most LICs remain poorly integrated with international financial markets, international financial shocks will increasingly begin to pose challenges for central banks in LIC economies as well, especially in the form of destabilizing central bank objectives such as high levels of economic activity, stable exchange rates, and financial sector robustness, thereby making the potential conflicts between such objectives and the central one of achieving medium-run price stability potentially more acute. Third, globalization may affect the monetary transmission mechanism in several ways (Abuka et al. 2015; Montiel and Pedroni 2018). Much research has found a link between individual bank characteristic and the extent to which those banks tend to pass through changes in policy interest rates to their own retail lending rates. More generally, globalization may also affect the relative merits of alternative exchange rate and monetary policy regimes in LICs. For instance, a larger traded goods sector increases the effectiveness of fixed exchange rates in importing anti-inflationary credibility, because a larger share of the domestic price level is directly affected by international goods arbitrage.

How can these challenges be addressed?

Many of the challenges discussed above are related to the stage of economic and financial development of LICs and should be addressed as part of the broader development process. These include the development of financial markets that may be expected to provide the central bank with more effective policy instruments, the improvement of systems for the compilation of economic statistics, and capacity development in central banks and economic ministries, including the strengthening of economic expertise.

The focus here, however, is on the issue of conflicts among policy objectives—a potentially serious obstacle to a central bank’s success in maintaining price stability and achieving anti-inflationary credibility. How can this be addressed? There are several promising options for LICs.

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7 By estimating a dynamic panel model over the period 1970–2007, Arusha and Debdulal (2013) document that international remittance inflows decrease with home country volatility.

8 For example, Abuka et al. (2015) found that better-capitalized banks in Uganda were less likely to pass through changes in policy rates. Since foreign banks tend to differ from domestic banks along many of the relevant dimensions, the changing composition of the domestic banking system associated with foreign bank penetration is likely to affect aggregate pass-through.
First, the central bank’s need to pay attention to the secondary objectives of its monetary policy—particularly employment and the output gap—could be alleviated by the authorities’ use of other economic policies. These could include the judicious use of budgetary policy when there is fiscal space, and structural reforms that reduce the economy’s vulnerability to shocks, strengthen automatic fiscal stabilizers, increase the flexibility and effectiveness of discretionary fiscal policy, and increase the flexibility of labor markets.

Second, the central bank could develop or strengthen instruments separate from monetary policy to address its objective of financial stability, including capital flow management measures and macroprudential policies.

Third, entrusting a large part of the responsibility for financial stability to a supervisory and regulatory authority, separate from the central bank and associated with a well-capitalized deposit insurance agency, could relieve pressure on the central bank to concern itself with financial stability in the conduct of monetary policy.

Finally, the central bank could strengthen its efforts to convince the public of the primacy it gives to the low-inflation objective, in ways discussed by Mishkin (1997). Declaration of a specific inflation target—the strategy adopted by most advanced economies—could serve this purpose, but this strategy may not yet suit LICs for reasons discussed above, including weak and uncertain monetary transmission, data deficiencies, and limited analytical capacity at central banks. For economies, with weak anti-inflation records and credibility, like many LICs, a more effective option could be to peg the exchange rate to a currency or a basket of currencies of one or more trading partners with well-established records of low inflation. The central bank would then, in effect, be piggybacking on the low-inflation credibility earned by these other countries. This would necessarily be at the cost of a loss of monetary autonomy—the central bank would be “tying its hands”—if the economy is well integrated with international financial markets. This may not be a major concern for many LICs at present, because their financial integration is limited and some monetary autonomy may remain. Sight should not be lost, however, of the significant drawbacks of limited international financial integration, including the weakening of the disciplining mechanism that financial integration may exert on a central bank and contribute to its anti-inflationary credibility. The strategy of an exchange rate peg is less likely to be successful for relatively closed economies where the exchange rate plays little role in domestic price formation. There is also a danger that the exchange rate peg may be unsustainable—for example, if it is initially set at a level that, in real terms, makes the economy uncompetitive, or if the convergence of domestic inflation on inflation rates in the partner countries whose currencies provide the currency peg does not occur rapidly.
ANNEX 6.2 Methodology and Database

Model description

This annex explains the details of the heterogeneous panel SVAR methodology used in this chapter. The technique is an adaptation of the heterogeneous panel SVAR methodology first developed in Pedroni (2013). The method is modified to accommodate some of the specific aspects of the analysis of this chapter.

The most important of these adaptations is to accommodate the details of the reduced form specification used in the estimation and analysis of the inflation dynamics in a way that takes advantage of the relatively abundant data sample. To provide motivation for the adaptation, it is worth noting that the original specification developed in Pedroni (2013) works under any method of orthogonalization of the white noise impulses of a VAR, including the type of Cholesky orthogonalization used in this chapter. The original specification imposes a form of structural discipline on the relationship between the common and idiosyncratic components of these impulses that allows the estimation and inference to be done with very short panels, despite the fact that the dynamics are permitted to be heterogeneous among the countries of the panel. Specifically, the approach envisions that the panel vector of what are referred to as the structural impulses or “shocks” are decomposed into analogous mutually orthogonal vectors of common and idiosyncratic structural shocks such that the loadings on these vectors are diagonal.

To use a concrete example of this form of structure, taken from Pedroni (2013), if such a panel vector is thought as composed of two composite structural shocks, “aggregate supply”, $\epsilon_{it}^{\text{AS}}$, and “aggregate demand”, $\epsilon_{it}^{\text{AD}}$, so that $\epsilon_{it} = (\epsilon_{it}^{\text{AS}}, \epsilon_{it}^{\text{AD}})'$, then the relationship between these composite shocks and the corresponding common shocks $\bar{\epsilon}_t = (\bar{\epsilon}_{it}^{\text{AS}}, \bar{\epsilon}_{it}^{\text{AD}})'$ and the corresponding idiosyncratic shocks $\tilde{\epsilon}_{it} = (\tilde{\epsilon}_{it}^{\text{AS}}, \tilde{\epsilon}_{it}^{\text{AD}})'$, becomes $\epsilon_{it} = \Lambda_i \bar{\epsilon}_t + \tilde{\epsilon}_{it}$ where $\Lambda_i$ is the diagonal loading matrix. To put it simply, aggregate demand shocks load only into composite aggregate demand shocks, and not into composite aggregate supply shocks, and so forth, so that the contributions of idiosyncratic and common demand shocks sum to the contribution of the total composite demand shocks. Once the vectors $\epsilon_{it}$ and $\bar{\epsilon}_t$ have been structurally identified, the diagonality of $\Lambda_i$ on the factor structure for the white noise shocks permits consistent estimation of the loadings by simple computation of the correlation between the corresponding elements of $\epsilon_{it}$ and $\bar{\epsilon}_t$, which allows for good small sample estimation properties even in relatively short panels.

By contrast, when the analysis is based on reduced form impulse shocks, as in the case of this chapter, then it may be desirable to loosen this structural aspect,
since the white noise impulse shocks are themselves unknown linear combinations of any underlying structural shocks. This in turn also allows the shapes of the responses to the reduced form common and idiosyncratic components to differ more substantially from one another, again presumably because the mix of underlying structural shocks is free to differ among the common and idiosyncratic components. The econometric cost to reducing these structural aspects of the estimation is of course an increased need for data, particularly in the time series dimension. But in the application in this chapter, sufficient data were obtained to accomplish this.

Thus, to implement this adaptation, in the absence of diagonality of the loading matrix, one of the simplest and most transparent approaches is to directly exploit the remaining orthogonality between the common and idiosyncratic shocks. This can be done by thinking of the panel SVAR as a common global block and a country-specific domestic block nested within the panel, with the orthogonality between the common and idiosyncratic implemented through a set of Granger non-causal restrictions. In effect, the panel SVAR is estimated recursively in multiple tiers, in this case a global tier and a domestic tier, with the global tier estimated first, and then placed within the domestic tier in a manner such that the domestic tier has no impact on the global tier. The global variables can be represented either by cross sectional averages of the national level variables, as in Pedroni (2013), or by variables reported directly at the global level, or any combination of the two.

To see the details of this adapted approach as it relates to the specific setup, let \( \Delta Z_{it} = \Delta (\text{Energy}_t, \text{Food}_t, \text{Core}_t, \text{food}_{it}, \text{core}_{it}, \text{neer}_{it}) \)' be the data vector, where \( \Delta \text{Energy}_t \) is global energy inflation, \( \Delta \text{Food}_t \) is global food inflation, \( \Delta \text{Core}_t \) is global average core inflation, \( \Delta \text{food}_{it} \) is domestic food inflation instrumented by the rainfall data, \( \Delta \text{core}_{it} \) is domestic core inflation, and \( \Delta \text{neer}_{it} \) is the NEER appreciation rate. In this case, the vector moving average form for the panel can be represented here as \( \Delta Z_{it} = A_i(L)e_{it}, A_i(L) = \Sigma_{j=0}^3 A_{ij} \), with the upper left 3 x 3 block representing the global time series block, the lower right 3 x 3 representing the local domestic block, and the lower left 3 x 3 block representing the interactions running from the global block to the domestic block. In precise terms, the Cholesky orthogonalization of the error terms combined with the remaining orthogonalization into common versus idiosyncratic shocks becomes equivalent to the following set of restrictions in this notational form, namely \( [A (k, \ell)_j] = 0 \) if \( j < k \) and \( \ell \leq 3 \), \( A (k, \ell)_j = 0 \) for \( j = 0 \), \( \forall k < \ell \) when \( k > 3 \).

Notice, however, that these restrictions can be implemented equivalently by implementing a recursive two-tiered estimation algorithm. In particular, the estimation algorithm for this adaptation which implements these restrictions can now be summarized as follows.
1. Construct the global variable block, by estimating cross sectional averages
\[ \Delta \tilde{Z}_t = N_t^{-1} \Sigma_{i=1}^{N_t} \Delta Z_{it}, \]
where the notation \( N_t \) reflects the fact that the panel need not be balanced, or use global variables directly, as desired.

2. Estimate the 3 x 3 global tier VAR \( \tilde{R}(L) \Delta \tilde{Z}_t = \tilde{\mu}(t), \tilde{R}(L) = I - \Sigma_{j=1}^{P} \tilde{R}_j, E[\tilde{\mu}_t \tilde{\mu}_t'] = \tilde{\Omega} \tilde{\mu} \) and fix this block.

3. Estimate 6 x 6 individual VARs as \( R_i(L) \Delta Z_{it} = \mu_{it}, R_i(L) = I - \Sigma_{j=1}^{P} R_{ij}, E[\mu_{it} \mu_{it}'] = \Omega_{i,\mu} \forall i \) with the global tier estimates imposed on the upper left 3 x 3 block and the lower right 3 x 3 block set to zero for all lags.

4. Use the Cholesky factorization \( \Omega_{i,\mu} = A_i(0)A_i(0)' \) to orthogonalize the reduced form shocks such that \( \epsilon_{it} = A_i(0)^{-1}\mu_{it}, \) and compute the corresponding country specific impulse responses and variance decompositions on the basis of \( A_i(L) = R_i(L)^{-1}A_i(0). \)

5. Use the sample distributions for individual country specific impulse responses and variance decompositions to compute the quantile responses among countries if desired.

6. Project the sample distributions for the individual impulse responses and variance decompositions onto the sample distributions of individual country characteristics \( x_i \) to study the country specific characteristics associated with the cross-sectional heterogeneity of the dynamics, such as \( \bar{A}_{i,s}(k, \ell) = \alpha_s + \beta_s' x_i + \eta_{i,s} \forall k, \ell, s, s = 0, \ldots, Q \) forecast horizons.

Data and sources

A monthly panel dataset was used covering 104 countries that include 25 advanced economies, 61 non-LIC EMDEs, and 18 LICs for the period 1970m2-2016m12. The panel dataset is unbalanced with the number of observations varying across countries. Various sources were used to construct the monthly series on headline, food, and energy inflation. The main sources for the headline CPI inflation include Haver Analytics, the IMF’s *International*
Financial Statistics, and OECDstat. Similarly, food and energy inflation data are covered by OECDstat, the Economic and Statistical Observatory for Sub-Saharan Africa, Haver Analytics, and for some countries data are obtained from national sources. The NEER data are obtained from the International Financial Statistics.

Core inflation. This is obtained by subtracting the contributions of volatile components of the CPI such as food and energy inflation. First, a measure of core inflation is obtained by using official core data from OECDstat and Haver Analytics. For the countries for which official core inflation was not available, it was estimated by deducting food and energy inflation multiplied by their corresponding weights from headline CPI inflation and dividing this contribution from the core by the weight of core inflation in the total CPI. Namely, the following formula for calculating core inflation was utilized:

\[
\text{Core inflation} = \frac{\pi - \omega_F \pi_F - \omega_E \pi_E}{1 - \omega_F - \omega_E}
\]

where \(\pi\), \(\pi_F\), and \(\pi_E\) are the current monthly inflation rates for headline, food, and energy, and \(\omega_F\) and \(\omega_E\) are the current weights for food and energy. Weights of the sub-indices in the total index are obtained from the Consumer Price Index database published by the International Monetary Fund as well as OECDstat and Haver Analytics.

Rainfall. This is used as an instrumental variable in identifying supply-driven changes in domestic food prices. Rainfall monthly data come from the World Bank’s Climate Change Knowledge Portal: Historical Data. The dataset is produced by the Climatic Research Unit of University of East Anglia, and reformatted by International Water Management Institute. The monthly mean historical rainfall data can be mapped to show the baseline climate and seasonality by month. Rainfall is measured as millimeters per month for all countries for the period 1970-2016. To test the relevancy of the instruments, panel based Lambda-Pearson Statistics (or Fischer statistics) are used. Specifically, this Lambda-Pearson statistic is constructed as -2.0*\(\Sigma_i\ln P_i\) (where, \(\ln P_i\) is the natural log of the significance level associated with the F-test for significance of the rainfall IV for country \(i\)). Under the null hypothesis of

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4 For most LICs and other EMDEs measures of monthly energy inflation are not available. Instead, for these countries the calculation of core inflation uses the Housing, Water, Electricity, Gas and Other Fuels category of the CPI as a proxy for energy inflation.

5 Constructing the F-statistic for joint significance of all the corresponding members of the panel would not be desirable, because F-statistics are well known to behave poorly as the number of implied restrictions grows large.
significance of the rainfall IV for the panel, this Lambda-Pearson panel statistic will have a Chi-Square distribution with $2*N$ degrees of freedom, where $N$ is the number of countries. The results show that the instrument variables are significant at 5 percent level. (In the case of LICs, they are significant at 1 percent level.)

Country characteristics

To help explain the variation of domestic inflation, a number of potentially important country-specific characteristics were used that may affect a nation’s inflation rate. The characteristics considered are (1) Exchange rate regime by the classification of Shambaugh (2004) (where “1” is assigned to those countries that have pegged or fixed exchange rates and “0” is assigned to those with flexible exchange rates); (2) an indicator of whether a country has an inflation targeting framework; (3) Dincer and Eichengreen (2014)’s central bank transparency index (the higher the index a more transparent and independent central bank; (4) gross public debt as percentage of GDP; (5) trade openness, defined as the sum of exports and imports of goods and services as a share of gross domestic product from the World Bank’s World Development Indicators and the IMF’s World Economic Outlook; (6) indicator of the degree of global value chain (GVC) participation (where “1” is assigned to those countries that are considered to be well-integrated into the GVCs and “0” otherwise); (7) the Chinn and Ito (2018) index of capital account openness; (8) an indicator whether a country is an commodity importer or exporter; and (9) central bank turnover, using data compiled by Dreher, Sturm, and de Haan (2010). For a complete list of the country characteristics, sources, and methods used for construction of the indicators, see Database Annex.
References


In the event of large swings in world food prices, countries often intervene to dampen the impact of international food price spikes on domestic prices and to lessen the burden of adjustment on vulnerable population groups. While individual countries can succeed at insulating their domestic markets from short-term fluctuations in global food prices, the collective intervention of many countries exacerbates the volatility of world prices. Insulating policies introduced during the 2010-11 food price spike accounted for 40 percent of the increase in the world price of wheat and one-quarter of the increase in the world price of maize. Combined with government policy responses, the 2010-11 food price spike increased global poverty by 1 percent or 8.3 million.

Introduction

In August 2011, international food prices hit an all-time high. This followed shortly after the 2007-08 food price spike, which pushed an estimated 105 million people into extreme poverty (Ivanic and Martin 2008). This event also prompted widespread concerns about the food security of the poorest. Although food prices have declined considerably since then, in real terms, they are still significantly above their 2000 lows (Figure 7.1). New evidence points to a rise in world hunger and severe food insecurity between 2014-17, reversing the declining trend observed in the previous decade. In 2017, the number of undernourished people reached 821 million, up by 5 percent since 2014 and a major step backwards in achieving the second Sustainable Development Goal target (SDG2) of hunger eradication by 2030 (FAO et al. 2018). Climate variability and the growing frequency of extreme weather events increase the risk of disruption to food production and are accompanied by food price spikes, setbacks in food availability and access to food.

Food prices are determined by the complex interaction between demand and supply forces. A dramatic increase in demand for feedstock for biofuel production in the early 2000s put considerable pressure on markets for grain and contributed to a rundown in stocks (Akiyama et al. 2001; Wright 2014).

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1 Unless otherwise stated, the concept of food prices as used in this chapter refers to the commodity price of major staple foods such as rice, wheat and maize.
Population growth and urbanization, as well as a shift in diets toward animal-based foods, created demand pressures despite an increase in agricultural productivity in emerging and developing economies (EMDEs; Fukase and Martin 2017). Slowing yield growth and declining availability of agricultural land also constrained food production growth. Extreme climate events (e.g., El Niño, droughts, and natural disasters), particularly when stock levels are low, have also contributed to food price volatility.

Food price increases have important macro- and microeconomic impacts through several channels. At the macroeconomic level, food price increases result in higher inflation, which can significantly affect household real incomes. High food prices can also result in terms of trade shocks, with important implications on growth and government policy space.

The microeconomic impact of food price increases on poverty and inequality depends on the net food seller status of the poorest households. For households that are net sellers of food products (such as farmers, agricultural workers, and small land owners), rising food prices increase real incomes. By contrast, they lower the real incomes of households who are net buyers of food. In low-income countries (LICs), poor urban households spend large shares of their income on food and are likely to feel the effects of such declines in real incomes most severely. On average, sharp increases in food prices raise poverty, reduce nutrition, and curtail the consumption of essential services such as education and healthcare (World Bank 2011). In the longer term, once producers and consumers have adjusted to the increases and wage rates have responded, sustained increases in food prices may lower poverty (Ivanic and Martin 2014a; Gillson and Fouad 2014).

A decline in food prices can also have adverse impacts for net sellers of food, particularly in the short term, when they are highly dependent on revenues from crops. Interest groups often put pressure on governments not to allow food prices to fall too rapidly.

Countries often use policy interventions to dampen the domestic impact of international food price spikes and lessen the burden on vulnerable population groups. For example, during the 2007-08 food price spike, close to three-quarters of EMDEs took policy action to insulate their domestic prices from the sharp increase in international food prices (World Bank 2009). In the event of food price spikes, net importers usually intervene by lowering rates of protection (typically tariffs) on food, while net exporters impose export restrictions or bans. These policies are often complemented with social safety net programs such as cash transfers or school feeding programs that help deal with the income effects of the food price rise without distorting domestic prices.
FIGURE 7.1 Global food prices

In August 2011, shortly after the 2007-08 food price spike, international nominal food prices hit an all-time high. Although food prices have declined considerably since then, in real terms, they are still significantly above their lows in the 2000s.

A. Global food prices

B. Global food price volatility


A. Based on yearly commodity price indexes between 1960-2017. The World Bank manufactures unit value index is used as deflator.


To the extent that policy interventions reduce the transmission of international price spikes to domestic markets, they may appear to be successful for individual countries. However, the combined intervention of many countries raises international prices. These insulating policies tend to encourage consumption and reduce production during price spikes. This, in turn, results in higher import demand and reduced export supply that further drive up global prices. During price plunges, government interventions encourage greater exports and greater global supply that further depresses prices. Only countries that insulate themselves to an above-average degree can reduce price volatility in their domestic markets (Anderson, Martin, and Ivanic 2017).

The international community has recognized the importance of ensuring the stability and availability of food supplies as key to addressing several development objectives. The Sustainable Development Goals (SDGs) give food security a high priority: SDG 2 sets out explicitly the goal to “end hunger, achieve food security and improved nutrition, and promote sustainable agriculture.” Other SDGs are strongly interconnected: food, agriculture and nutrition play an important role in SDG 1 on ending poverty, SDG 12 on sustainable consumption, and production and SDG 13 on climate change adaptation and mitigation.

In this context, this chapter addresses the following questions:

- How do food price shocks affect EMDEs and LICs?
- How do countries intervene to reduce the impact of food price shocks?
What was the impact of the 2010-11 food price shock on poverty?

The chapter presents the following findings:

- At the macroeconomic level, a high share of agriculture and food in total output, consumption, employment, trade, and government revenues heighten countries’ vulnerability to volatility in international food prices. At the microeconomic level, food price spikes are felt most severely by the poorest segments of the population who are net food buyers.

- Governments in EMDEs tend to respond particularly strongly to sharp changes in world prices for staple foods—such as rice, wheat and maize—to smooth volatility. Domestic food prices are considerably less volatile than world food prices in the short run, but over the longer term, there is a tendency for domestic and world prices to return to their original relationship. In the short run, a 1 percent increase in world rice, wheat and maize prices is associated with an increase in domestic prices by 0.6 percent, 0.7 percent, and 0.8 percent, respectively.

- While individual countries can succeed at insulating their domestic markets from short-term fluctuations in global food prices, their combined interventions make global food prices more volatile. Insulating policies introduced during the 2010-11 food price spike accounted for 40 percent of the increase in the world price of wheat and one-quarter of the increase in the world price of maize. In contrast, government interventions in rice markets dampened the degree to which world prices increased by about 50 percent.

- The 2010-11 food price spike increased poverty by 1 percent or 8.3 million, despite widespread government intervention.

The chapter contributes to two strands of literature: the implications of government interventions to insulate domestic grain markets, and the impacts of changes in world food prices on poverty. First, the chapter discusses the features and sources of the 2010-11 food price spike. Second, it quantifies the degree to which countries intervened. Third, the chapter is the first study to quantify the impact of the poverty impact of the 2010-11 food price spike and associated trade policy interventions.

**Food price shocks**

At the macroeconomic level, a high share of agriculture and food in total output, consumption, employment, trade, and government revenues heighten countries’ vulnerability to volatility in international food prices. At the microeconomic
level, a high share of net food buyers among the poorest segments of society heightens the adverse effects of food price spikes on poverty and income distribution.

Macroeconomic channels

Reliance on food imports and production. Agriculture accounts for close to one-third of total value added and two-thirds of total employment in LICs. This is almost three times their shares in the average EMDE (Figure 7.2; Aksoy and Beghin 2004). For example, in Burkina Faso and Burundi, agriculture accounts for more than four-fifths of total employment. In Chad and Sierra Leone, it accounts for more than half of domestic value added. In addition, more than three-quarters of LICs are net food importers compared to only half of EMDEs. In these net food-importing LICs, net food imports amount to 5.4 percent of private consumption. Benin and Gambia are particularly vulnerable to high food prices, with net food imports at more than 10 percent of private consumption.2

Inflation. A surge in food prices increases Consumer Price Index (CPI) inflation. For example, the 2007-08 and 2010-11 surges in international food prices caused substantial inflationary pressures. LIC inflation more than doubled, from 7 to 15 percent during 2007-2008 and from 5 to 11 percent during 2010-2011. The increase in EMDE inflation was less pronounced, from 7 to 11 percent during 2007-2008 and from 5 to 6 percent during 2010-2011. Food prices accounted disproportionately for these increases in inflation—for about two-thirds in LICs and more than half in EMDEs. In vulnerable LICs such as Benin and Niger, where net food imports amount to 15 and 7 percent of household consumption, respectively, inflation surged from 1 percent to 8 percent and 0.2 percent to 11 percent, respectively, during the 2007-08 food price spike.

Terms of trade. Sharp increases in food prices can result in significant adverse terms of trade shocks, especially for countries that are large net importers of food. More than three-quarters of LICs are net food importers. Accordingly, in the median LIC, the terms of trade index declined by 2 percent and 4 percent during the 2007-08 and 2010-11 food price spikes, respectively. In some, the deterioration was much steeper. For example, the terms of trade index of Sierra Leone, an LIC highly reliant on food imports, weakened by 10 percent during each of these food price spike episodes. More broadly, severe terms of trade shocks are considerably more common in LICs than in advanced economies (IMF 2011). In addition, of all possible external shocks, negative terms of trade

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2 Conversely, heavy reliance on food exports heightens vulnerability to food price declines. For example, in Malawi, net food exports amount to 12 percent of total private consumption.
FIGURE 7.2 Macroeconomic channels of transmission

At the macroeconomic level, a high share of agriculture and food in total output, consumption, employment, trade, and government revenues heighten countries’ vulnerability to volatility in international food prices.

A. Share of agriculture in economy

B. Net food importers and exporters

C. Inflation in LICs

D. Contribution of food prices to inflation

E. Terms of trade in LICs

F. Fiscal balance in LICs

A. Based on a sample of 93 EMDEs, and 21 LICs. Averages for 2010-2016.
B. Blue bars show the share of EMDEs or LICs in which food imports exceed food exports (“Net food importers”) or food imports fall short of food exports (“Net food exporters”). Red bars show net food imports relative to consumption in EMDE and LIC food exporters and importers.
C. Average inflation based on a sample of 12 LICs.
D. Share of inflation accounted for by food price inflation. Orange line indicates half.
E. Net barter terms of trade index, 2000=100.
F. Median based on a sample of 26 LICs.

Click here to download data and charts.
shocks tend to have the most severe output cost in low-income countries (Becker and Mauro 2006).

*Fiscal policy constraints.* Heavy reliance on food and agricultural exports exposes many countries to the volatility of international commodity prices. Absent stabilizing fiscal arrangements, this can introduce volatility into public finances and erode fiscal sustainability: rising food prices may increase tax revenues from the agricultural sector and encourage governments to spend. Conversely, when food prices fall, revenue losses in the agricultural sector are exacerbated by political pressures to subsidize food production. Food price spikes may also cause sociopolitical instability, including political unrest and food riots (Barrett 2013). During the sharp rise in food prices in 2007-2008, LICs’ fiscal balances deteriorated, on average, by close to 1 percentage point of GDP, partly due to higher food import bills.

*Monetary policy constraints.* In countries where inflation expectations are not well-anchored and monetary policy frameworks are weak, the increase in inflation caused by rising food prices can compel central banks to tighten policy. In heavy food importers, this can be exacerbated by exchange rate depreciation in response to the deteriorating terms of trade. Indeed, during the 2007-08 food price spike, close to half of EMDE central banks responded to rising inflation and depreciation by tightening monetary policy.³

**Microeconomic channels**

Rising food prices impact households through price and income effects. Rising food prices reduce households’ purchasing power but raise income generated from food production.

Poor households—those with per capita income less than $2.97/day—spend on average more than half of their income on food in EMDEs and close to two-thirds in LICs (Figure 7.3). In countries such as Burundi, Guinea and Honduras, the share of food expenditures is even higher, accounting for more than three-quarters of total consumption of the poorest households. In LICs, more than one-third of the poorest households’ consumption expenditure on food is spent on staple foods such as cereals and vegetables. These staple foods are considerably more exposed to international price volatility than domestically-processed food products (Figure 7.1).

For households that are net sellers of agricultural and food products (e.g., farmers), rising food prices raise incomes. More than one-fifth of households

³ Based on a sample of 54 EMDEs.
around and below the poverty line are net food sellers in the average EMDE and LIC. Households around and below the poverty line in these countries tend to generate about one-quarter of their incomes from food production.

The overall impact depends on the relative magnitude of income and price effects of households in different segments of the income distribution. If the positive income effect outweighs the overall loss of purchasing power, household real incomes rise. In contrast, poor urban households, which are typically net buyers of food that spend a large share of their consumption expenditure on food, are likely to suffer real income losses (Aksoy and Hoekman 2010).

On average, many of the poor in EMDEs and LICs are net buyers of food. As a result, food price spikes tend to raise poverty, reduce nutrition and cut consumption of essential services such as education and healthcare. For example,
the 2007-2008 rise in food prices is estimated to have raised the number of poor by 105 million (Ivanic and Martin 2008). In extreme cases, food price spikes can induce food insecurity and hunger, with severely adverse long-term impacts on human capital.

**Government interventions**

In the event of large swings in global food prices, governments are confronted with difficult policy choices. One option is to allow domestic prices to adjust to world food price changes, exposing domestic consumers and producers to changes in their real incomes. This may, however, raise inflation in the short-run and, in countries where inflation expectations are poorly-anchored, in the medium- to long-run. The decline in real incomes of poor net buyers associated with higher inflation (Easterly and Fischer 2001) would entail welfare losses, especially when net consumers of food are loss- and risk-averse (Gouel and Jean 2015; Freund and Ozden 2008; Giordani, Rocha, and Ruta 2016). Meanwhile, net sellers of food may gain.

Alternatively, governments can spare consumers or producers from these losses by reducing the transmission of international food price shocks to domestic markets. As measured in this chapter, policy intervention is reflected in the ratio of domestic to world prices—the “protection rate.” If, during a period of rising world prices, the rate of protection declines, a country is seeking to insulate its domestic markets from the increase in prices. If the protection rate rises, policy makers are compounding the increase in world prices. This may occur with the objective of correcting past “errors,” either because domestic prices fell below policy makers’ desired long-run level, or because policy has insulated the market from world markets and an exogenous shock, such as a harvest shortfall, has caused the domestic price to rise relative to the world price.

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4 A sizable non-tradeable service component in the cost of providing consumers with food (transportation, storage, retail, etc.) dampens the pass through of changes in world food prices into domestic markets.

5 In principle, monetary policy tightening can also offset inflationary effects from rising global food prices to ensure that rising food prices remain a purely relative price change and do not become entrenched in higher inflation. However, this would come at the cost of reduced economic activity (Lustig 2009). Among LICs, only Uganda is formally committed to an inflation-targeting regime, which aims to keep average annual core inflation at 5 percent +/- 2 percent.

6 Policy makers may also have a longer-term goal to protect (or to tax) domestic agents (Grossman and Helpman 1994). In empirical work based on political economy models, protection rates vary to reduce both the costs associated with adjusting prices and the costs of providing a rate of protection that differs from the long-run political equilibrium (Anderson and Nelgen 2011; Ivanic and Martin 2014b).

7 A similar pattern was observed in the maize market in many African countries (Chapoto and Jayne 2009).
In practice, during the 2007-08 food price spike, close to three quarters of EMDEs took policy action to insulate their economies from the sharp increase in international food prices (World Bank 2009). The most commonly used interventions were reductions in taxes, including import duties and consumer taxes (Figure 7.4). Net importers frequently intervened by lowering import tariffs or even by introducing import subsidies, while net exporters imposed export restrictions or bans to dampen the increase in domestic prices.

**Domestic and world food price dynamics**

Domestic food prices are considerably less volatile than global food prices in the short run, but over the longer term, there is a tendency for domestic prices to return to their original relationship with international prices (Figure 7.5). This does not necessarily imply that protection rates become zero, but that they return to their pre-spike levels.

Governments in EMDEs tend to respond particularly strongly to sharp changes in the world prices of staple foods—such as rice, wheat and maize—to reduce the volatility of domestic prices. For staple foods, domestic price movements can diverge substantially from international price movements in the short run, but converge in the longer term.

The movements of world and domestic staples food prices during the latest two food price spikes (2007-08 and 2010-11) resembled similar earlier episodes: world prices rose rapidly, domestic prices rose only gradually. However, the 2010-11 spike was different from previous episodes in several aspects. The 2007-08 increase in food prices came after a long period of stability in food prices. In 2007-08, world prices of all staple foods increased steeply, led by the strong increase in the world price of rice. Most countries reacted strongly by introducing insulating policies. In contrast, the 2010-11 episode occurred when world markets and policies were still normalizing from the 2007-08 episode. Government interventions therefore differed considerably across countries and across commodities. Government interventions actually raised rice prices more than the modest increase in world prices.

**Rice.** Rice was the staple food with the largest price increase during the 2007-08 food price spike. Between January 2007 and May 2008, world rice prices almost tripled.\(^8\) This sharp increase reflected export restrictions introduced by major suppliers (e.g., India and Vietnam) triggered by food security concerns, panic buying by several large importers, a weak dollar, and record high prices of oil, which is a major input into food production (Childs and Kiawu 2009). During

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\(^8\) The world price of 5 percent broken white Thai rice increased from $313/mt to $902/mt.
This episode, domestic markets were largely insulated from this global rice price spike (Ivanic and Martin 2008). By contrast, during the 2010-11 price spike, rice prices increased much less, by about 30 percent between June 2010 and May 2012. In some countries, adverse supply conditions combined with the use of non-tariff trade policies resulted in domestic rice prices rising above world
FIGURE 7.5 Domestic and global food prices

Domestic food prices tend to be less volatile than global food prices. This partly reflects a sizeable services component in the cost of providing domestic consumers with food, but also policy intervention.

A. Prices of staple foods

B. Rice prices

C. Wheat prices

D. Maize prices

E. Domestic and global staple food prices during 2007-08 and 2010-11

F. Average increase in world and domestic price index, 2010-11

Sources: Ivanic and Martin (2014b), World Bank.
Note: Trade weighted averages.
A. Rice, wheat, maize, edible oil and sugar prices.
E. Event study based on monthly cross-country average domestic staples prices (average of wheat, rice and maize prices) and global staples prices (average of wheat, rice and maize) during 2007-08 and 2010-11. Period 0 represents the month of the peak of the world food price spike.
F. Average percent increase in the price index.

Instead of insulating policies, on average, EMDEs implemented policies that raised domestic prices relative to world prices (Figure 7.5).

In Vietnam, for instance, domestic rice prices rose by 41 percent between July-October 2010 due to lower-than-expected production, prior commitments on exports, and high inflation from a depreciating currency.
Wheat. Between February 2007 and March 2008, world wheat prices more than doubled, partly in response to lower-than-anticipated wheat production caused by drought in Australia, Ukraine and other major exporters.\textsuperscript{10} Strong policy intervention partially insulated domestic markets from the global wheat price spike and their subsequent collapse in the aftermath of the global financial crisis in 2009-10. Similarly, during the 2010-11 event, world wheat prices more than doubled between June 2010 and May 2011.\textsuperscript{11} This time, the increase in world prices was partly driven by lower-than-expected production and exports in Kazakhstan, Russia, and Ukraine and excessive rains in Australia that damaged wheat crops (World Bank 2010). Large orders from major wheat importers in the Middle East and North Africa added to price pressures. Since 2011, global and domestic wheat prices have fluctuated, broadly synchronously.

Maize. During the 2007-08 food price spike, the world price of maize almost doubled, partly as a result of increasing U.S. demand for maize stimulated by mandatory targets for ethanol production.\textsuperscript{12} Similarly, during the 2010-11 episode, the world price of maize increased significantly. As in the case of wheat, adverse weather-related events in major maize exporting countries contributed to the spike in world prices. In contrast, many countries in Sub-Saharan Africa benefitted from excellent maize harvests, which in combination with unpredictable trade policies led to sharp falls in domestic prices.

Insulation of domestic food markets

The degree of insulation of domestic markets from world food price swings can be quantified using an Error Correction Model (ECM; Annex 7.1). In this analytical framework, domestic food prices are represented as the outcome of a policy process where policy makers seek to reduce the cost of adjustment as well as the cost of being out of equilibrium (Nickell 1985).

Specifically, the ECM regresses the log of the protection rate on the log of world prices and the deviation from long-term “equilibrium” food prices. The sample used here includes annual data for 8 food commodity prices in 82 countries, of which 44 are EMDEs and 12 are LICs, during 1955-2011.

The degree of insulation of an increase in global food prices is captured by the coefficient estimate of short-term changes in global food prices. A more negative coefficient indicates a higher degree of insulation in the short-term. The degree

\textsuperscript{10} The world price of U.S. Hard Red Wheat increased from $196/mt to $440/mt.
\textsuperscript{11} The world price of U.S. Hard Red Wheat increased from $158/mt to $355/mt.
\textsuperscript{12} Between January 2007 and June 2008, the world price of maize increased from $165/mt to $287/mt.
of long-term adjustment to a 1 percent increase in global food prices is captured by the coefficient on the error correction term. A coefficient near -1 indicates that, over the long-term, cumulative global and domestic price swings converge.

Estimates from the ECM model point to short-term insulation in markets for key staple foods such as rice and wheat (Figure 7.4). Among these key staples, insulation is the highest for rice. In the short run, a 1 percent increase in global rice, wheat, and maize prices is associated with an increase in domestic prices of 0.6 percent, 0.7 percent, and 0.8 percent, respectively.

Certain types of interventions in markets for staple foods have been found to raise volatility in domestic markets. For example, during the 2008-09 food price spike, several African countries implemented pricing, marketing, and trade policy interventions to stabilize domestic maize markets. Countries that intervened most intensively experienced the highest domestic price volatility, mostly because of the ad hoc and unpredictable nature of these interventions (Chapoto and Jayne 2009).

The use of an export ban during food price spikes, possibly related to a domestic drought, illustrates the tradeoffs between different policy instruments:

- **Ensuring food security.** By restricting the sale of food for exports, an export ban increases domestic supply and dampens domestic food price increases. This can help net-food buyers access food.

- **Alleviating poverty.** Net food-selling farmers are likely to be hardest-hit by a drought. An export ban reduces their ability to mitigate their production losses with higher incomes from higher prices. If these farmers are among the poorer segments of the income distribution, the export ban will likely increase poverty, as observed in Zambia during the 2016-17 El Niño event (Al-Mamun et al. 2017).

- **Volatility.** While export bans may alleviate pressures during a specific situation, they heighten domestic price volatility by preventing domestic shocks from being dissipated through changes in trade levels. If bans are backed up by stockholding measures such as those used in India (Gouel, Gautam, and Martin 2016) they can consistent with domestic price

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13 After abstaining from the use of interventions in staple food markets for several years, policy makers in Eastern and Southern Africa used extensively pricing, marketing, and trade policy tools during the 2015-16 agricultural season to contain the impact of an El Niño-induced decline in output and food security (Al-Mamun et al. 2017; Tschirley and Jayne 2010).
stabilization, although the fiscal costs of this policy approach tend to be high relative to that of price insulation.

While individual countries can succeed at insulating their domestic markets from short-term fluctuations in global food prices, their combined policies make global food prices more volatile. Government interventions tend to increase consumption and reduce production during price spikes and support production and discourage consumption during price plunges. During price spikes, this results in higher import demand and, hence, higher global demand that further drives up global prices. During price plunges, it encourages greater exports from each country and, hence, greater global supply that further depresses prices. Only countries that insulate themselves to an above-average degree are able to reduce the transmission of international price volatility to their domestic markets (Anderson, Martin and Ivanic 2017; Martin and Anderson 2012; Ivanic and Martin 2014b).14

**Impact of the 2010-11 food price shock on poverty**

The impact of the 2010-2011 food price shock on poverty is quantified in two steps. In the first step, the degree of intervention by countries is estimated based on a framework developed by Anderson, Ivanic, and Martin (2014). In the second step, these estimates are fed into a computable general equilibrium (CGE) model to determine the impact of insulation policies on poverty. Two scenarios are modelled. In the first scenario, the impact of countries’ own interventions on poverty is considered. In the second scenario, the combined effect of all policy interventions on global food markets and their feedback to domestic poverty is quantified.

**Quantifying trade policy interventions**

The approach to quantifying the extent of trade policy interventions builds on that used in Anderson, Ivanic, and Martin (2014). A primary shock, such as a weather shock, is assumed to generate an initial change in domestic and world prices. In attempting to insulate domestic markets from the increase in world prices, governments make offsetting changes to protection measures, such as the introduction of export bans (food exporters) or the reduction of import duties (food importers). These measures, in turn, reinforce the original shock to world prices. When a country imposes an export restriction, the availability of food to the rest of the world is reduced, and this tends to push up world prices.

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Similarly, when an importing country reduces its import tariffs, it increases the demand for imports and hence puts upward pressure on world prices (Annex 7.1).

The data used for quantifying the extent of trade policy interventions are taken primarily from the Ag-Incentives Consortium database. The database provides estimates of changes in domestic and world prices for 57 countries and 68 agricultural and food commodities during 2005-2015. Where data from the Ag-Incentives database were unavailable, alternative data were used from FAOSTAT, GIEWS and Fewsnet. Overall, this analysis covers 24 major food producing and consuming countries, using data on household income sources and spending patterns from 2011. Of these, 18 are EMDEs and 6 are LICs.

During the food price spike of 2010-11, world prices of maize, wheat and rice rose by 44, 39, and 6 percent, respectively (Figure 7.4). In contrast, domestic prices rose by considerably less, pointing to substantial insulation, with considerable heterogeneity across countries and commodities.

- **Rice.** Some countries (e.g., Bangladesh, Nepal, Panama, Tanzania, and Zambia) reduced trade barriers to partially offset the rise in world rice prices. However, important net rice exporters such as India, Pakistan, and Yemen implemented policy interventions that, ultimately, raised domestic rice prices more than the increase in world prices. In India, the world’s second-largest rice producer, quantitative restrictions initially prevented domestic price increases. However, the subsequent abolition of export quotas in September 2011 (in place since 2007) coincided with the agricultural marketing season and resulted in a surge in exports and a rise in domestic prices. In Pakistan, domestic rice prices rose relative to the world price over this same period because of heavy summer flooding that affected one-fifth of the country’s land area and inflicted extensive damage to crops. A large increase in domestic prices relative to external prices occurred in Yemen, amid persistent water shortages and a shift to less water-intensive non-staple crops. Prices also rose modestly in Ethiopia and Uganda because of drought. The combined intervention of all countries dampened the increase in the world price of rice by about 50 percent compared to a scenario without insulation policies.

- **Wheat.** Most developing countries took measures to offset the increase in global wheat prices in 2010-11. Policy actions and the degree of insulation were broadly similar to those employed during the spike in wheat prices in 2007-08. Policymakers justified efforts to dampen the impact of the global

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15 The data is available at www.ag-incentives.org.
wheat price spike by noting that the world wheat price spike partly reflected a catching up with rising domestic wheat prices. The combined intervention of countries accounted for close to 50 percent of the increase in the world price of wheat.

- **Maize.** Although most countries insulated their domestic maize markets against maize price increase during 2010-11, there was considerable heterogeneity in policy responses. In Bangladesh, Ecuador, Malawi, Tanzania, and Zambia, protection rates were reduced to fully offset the rise in global maize prices. Ethiopia, Uganda, and Yemen increased protection rates or used policies that, in combination with domestic output shocks, reinforced the increase in world prices on domestic prices.

During the 2010-11 event, the combined action of government policies raised global wheat and maize prices, accounting for about 40 percent of the increase in world price of wheat and one-quarters of the increase in the price of maize (Figure 7.4). In the case of rice, combined policy action reduced the rice price surge compared to a non-action scenario.

**Poverty implications**

To assess the poverty implications of the 2010-11 increase in the world price of rice, wheat and maize, the MIRAGRODEP general equilibrium model was used in combination with household models for 285,000 households from 31 countries (Laborde, Robichaud and Tokgoz 2013). MIRAGRODEP is a dynamic, multi-country, and multi-sector computable general equilibrium model (Annex 7.1). The poverty impact depends on price changes, the relative reliance of households on the consumption of individual staple foods, and the net food buying status of households in different segments of the distribution (Deaton 1989).

Results show that a hypothetical 10 percent surge in rice, wheat, and maize prices raises the number of poor by 0.22 percent or 2.1 million. Among staple foods, an increase in wheat prices raises the number of poor most (by 0.01

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16 Ethiopia is an exception, where domestic wheat prices rose 28 percentage points more than world prices during 2010-11. This reflected domestic supply shocks, combined with limited access to global wheat markets to alleviate shortages. In particular, wheat output fell by 10 percent in 2010-11 as a result of a fungus that destroyed the wheat harvest and lowered stocks in 2011. Wheat imports rose but were constrained by tight foreign exchange controls, effectively stopping private sector imports and ensuring that all grain imports are channeled through the state-owned Ethiopian Grain Trade Enterprise (Wakeyo and Lanos 2014; Negassa and Jayne 1997).

17 This primarily reflects the elimination of export restrictions in India and the increased import protection in Pakistan, Indonesia, Uganda, and Yemen.
percentage points for a 10 percent wheat price increase). Rice price increases cause particularly large increases in the number of poor in Sub-Saharan Africa (0.13 percentage points). Finally, maize price increases tend to have a lesser impact on the number of poor.

To model the interaction between food price shocks and government interventions, the effects of a supply shock are traced out in the model. The model assumes that an adverse productivity shock outside developing countries, in particular, in the Black Sea basin and Australia triggers the increase in world prices. In the summer of 2010, major grain producers in the Black Sea basin, such as Russia, Ukraine, and Kazakhstan, were hit by a severe drought that significantly affected their harvest, while excessive rains in Australia caused by La Niña damaged crops, which were downgraded to feed quality (World Bank 2010). Primary shocks in these regions are assumed not to directly contribute to global changes in poverty rates given their small share of the population living below the poverty line of $1.90/day.

The productivity shocks are calibrated to match the observed changes in protection rates and changes in world prices given in Figure 7.6. For examples, given initial protection rates, a negative production shock of 55 percent for rice, 27 percent for wheat, and 35 percent for maize in advanced economies and Russia generates an increase of 10 percent in average world prices for these commodities. The policy experiments are implemented by eliminating individual trade policy measures for each country. In each case, world prices are recomputed endogenously in the model and therefore capture both the direct and indirect effects of the policy changes.

As the model used in the simulations distinguishes between domestic and imported goods, two potential policy instruments are considered—an import duty (or subsidy) and an export subsidy (or tax). The use of such policies can distort trade flows to such an extent that they switch between net-exporting and net-importing status. As a result, many countries typically put in place flanking policies. In 2007-08, for example, Egypt and Indonesia subsidized imports of wheat and rice, respectively, to hold down domestic consumer prices. To avoid subsidizing exports of the same goods, export restrictions were also introduced. To represent this in the model used here, it is assumed that, for every good with

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18 Because rice, wheat, and maize are bulk commodities that are less strongly differentiated than manufactured products, two-way trade in these goods is unusual—except when there are regional differences in varieties. Regionally differentiated varieties could create two-way trade flows such as, for example, Indian exports of Basmati rice and imports of Jasmine rice. While the limited extent of two-way trade in these products might suggest treating them as homogenous products, models of differentiated products are needed to adequately capture actual bilateral trade flows in these commodities (Thursby, Johnson, and Grennes 1986).
an import tariff that initially raises import prices by $T_0 = (1+t_0)$, there is a flanking export subsidy at rate $T_0 = (1+t_0)$. The two measures are assumed to adjust in the same proportion.

Model results suggest that the food price spikes of 2010-11 raised poverty in most countries, despite widespread government intervention (Figure 7.7). On average, the share of extreme poor increased by 0.12 percentage point from 13.7 percent. This is equivalent to an additional 8.3 million, or a 1 percent increase in the number of extreme poor. The increase in world food prices, combined with government intervention, was most strongly felt in countries such as India.
and Uganda, where the extreme poor tend to be net food-buyers whose real incomes declined.\footnote{Results reported here do not take into account the impact of safety-net programs such as India’s Public Distribution System, which distributes food to poor households at fixed prices and so automatically makes larger transfer to the poor when food prices rise.}

The poverty impact of the 2010-11 food price spike on some regions such as East Asia and the Pacific (EAP), and Latin America and the Caribbean (LAC) is estimated to be limited: low rates of poverty combined with the benefits of the

\footnote{Results reported here do not take into account the impact of safety-net programs such as India’s Public Distribution System, which distributes food to poor households at fixed prices and so automatically makes larger transfer to the poor when food prices rise.}
price increase for countries that are heavy exporters of rice (EAP) or maize (LAC) offset some of the losses incurred due to the increase in prices. Even in Sub-Saharan Africa—the region that accounts for two-thirds of the global increase in poverty—, countries like Ethiopia and Nigeria implemented insulation policies that reduced poverty.

Results reported here contrast with those of Anderson, Ivanic, and Martin (2014) who find that during the 2007-2008 food price spike, most countries’ own policies, considered individually, reduced poverty while the combined effect of all policy interventions was close to zero. The overall impacts are different because the 2007-2008 price shocks were much larger, the transmission of price changes from world to domestic markets was assumed to be more pronounced and due to the fall in the poverty rates over time (the poverty headcount in India, for instance, fell from 33 percent to 21 percent).

Conclusion

The unusual event of having two food price spikes in short succession—in 2007-08 and 2010-11—raised concerns about the stability of food markets and global poverty. During the 2007-08 event, coming after a long period of relatively stable prices, many countries used trade policies that insulated domestic food prices from the surge in world prices. While each country’s policies can dampen domestic price movements, the result of the combined use of policies increases global food price volatility. For example, widespread insulation policies accounted for 40 percent of the increase in world wheat prices and one-quarter for world maize prices.

The 2010-11 food price rise differed from the 2007-08 price surge in its economic context, policy responses, and poverty implications. While the 2007-08 episode was led by rice prices, exacerbated by export restrictions imposed by major rice producers, the 2010-11 food price surge was led by maize and wheat prices, triggered by adverse weather events in major wheat and maize producers in Australia and the Black Sea Basin. During 2007-08, large rice consumers, such as India, imposed export restrictions to contain domestic rice price increases. These were gradually unwound over the following years. In 2010-11, some large wheat and maize producers, such as Russia and Ukraine, also introduced export restrictions and import bans to contain domestic price pressures.

There is uncertainty around poverty estimates due to systematic measurement errors in household surveys that may bias the poor’s dependence on food purchases (Headey and Martin 2016) and because sustained periods of higher prices result in declines in poverty (Ivanic and Martin 2014a; Jacoby 2016).
During the 2007-08 food price spike, policy interventions of individual countries helped to reduce poverty (Anderson, Ivanic, and Martin 2014). In contrast, during the 2010-11 food price spike, individual government policy responses raised global poverty by 1 percent, about the same amount as the increase in poverty of these interventions considered collectively.

The 2010-11 food price spike preceded a rise in world hunger and severe food insecurity between 2014-17, reversing the declining trend observed in the previous decade. In 2017, the number of undernourished people reached 821 million, up by 5 percent since 2014 and a major step backwards in achieving the second Sustainable Development Goal target (SDG2) of hunger eradication by 2030 (FAO et al. 2018).

The results presented in this chapter highlight that the use of trade policy interventions to insulate domestic markets from food price shocks compounds the volatility of international prices and may or may not be effective in protecting the most vulnerable populations groups. Instead, storage policies and targeted safety net interventions such as cash transfers, food and in-kind transfers etc. can mitigate the negative impact of food price shocks while reducing the economy-wide distortionary impacts of trade policies. Additional measures such as crop and weather insurance, warehouse receipt systems, commodity exchanges and futures markets could also be used as risk management instruments.

Despite the growing body of literature on food price stabilization policies, several questions remain to be explored. How can measures that seek to influence market outcomes—such as trade and storage policies—be combined with social safety net policies to optimize their development impacts? In a second best environment, when trade policy interventions are still used, how can coordination between countries be improved to reduce their negative effects? We leave these questions open for future research.
TABLE 7.1 Impact of policy responses to the 2010-11 food price increase on the number of extreme poor (Thousands)

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Combined action</th>
<th>Individual action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>644.3</td>
<td>628.3</td>
</tr>
<tr>
<td>China</td>
<td>42.4</td>
<td>401.7</td>
</tr>
<tr>
<td>Ecuador</td>
<td>42.4</td>
<td>45.9</td>
</tr>
<tr>
<td>Ethiopia</td>
<td>-51.2</td>
<td>41.2</td>
</tr>
<tr>
<td>Guatemala</td>
<td>33.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Indonesia</td>
<td>-13.8</td>
<td>-68.1</td>
</tr>
<tr>
<td>India</td>
<td>1,797.2</td>
<td>1,819.7</td>
</tr>
<tr>
<td>Kenya</td>
<td>376.9</td>
<td>441.5</td>
</tr>
<tr>
<td>Cambodia</td>
<td>15.6</td>
<td>11.6</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Malawi</td>
<td>77.6</td>
<td>172.5</td>
</tr>
<tr>
<td>Nigeria</td>
<td>-359.8</td>
<td>-150.7</td>
</tr>
<tr>
<td>Nicaragua</td>
<td>-4.0</td>
<td>-1.5</td>
</tr>
<tr>
<td>Nepal</td>
<td>2.1</td>
<td>4.1</td>
</tr>
<tr>
<td>Pakistan</td>
<td>-211.2</td>
<td>-354.3</td>
</tr>
<tr>
<td>Panama</td>
<td>-0.9</td>
<td>-1.5</td>
</tr>
<tr>
<td>Peru</td>
<td>-18.2</td>
<td>-39.7</td>
</tr>
<tr>
<td>Rwanda</td>
<td>45.0</td>
<td>47.4</td>
</tr>
<tr>
<td>Tanzania</td>
<td>514.4</td>
<td>525.7</td>
</tr>
<tr>
<td>Uganda</td>
<td>668.7</td>
<td>550.4</td>
</tr>
<tr>
<td>Vietnam</td>
<td>198.7</td>
<td>108.5</td>
</tr>
<tr>
<td>Yemen</td>
<td>-123.5</td>
<td>-233.0</td>
</tr>
<tr>
<td>South Africa</td>
<td>0.0</td>
<td>476.0</td>
</tr>
<tr>
<td>Zambia</td>
<td>5.8</td>
<td>78.4</td>
</tr>
<tr>
<td>Sub-Saharan Africa</td>
<td>6,350.0</td>
<td>6,721.2</td>
</tr>
<tr>
<td>Central America</td>
<td>28.9</td>
<td>-3.0</td>
</tr>
<tr>
<td>Latin America</td>
<td>-476.4</td>
<td>-328.8</td>
</tr>
<tr>
<td>Middle East and North Africa</td>
<td>-124.2</td>
<td>-226.7</td>
</tr>
<tr>
<td>South Asia</td>
<td>2,232.3</td>
<td>2,097.9</td>
</tr>
<tr>
<td>South-East Asia</td>
<td>36.9</td>
<td>14.0</td>
</tr>
<tr>
<td>Developed Countries</td>
<td>-5.5</td>
<td>6.2</td>
</tr>
<tr>
<td>Developing Countries</td>
<td>8,350.0</td>
<td>9,513.0</td>
</tr>
<tr>
<td>World</td>
<td>8,344.5</td>
<td>9,519.2</td>
</tr>
</tbody>
</table>

Source: Authors’ estimates.
Note: Thousands. Based on estimates using the computable general equilibrium model MIRAGRODEP, described in detail in Annex 7.1. Assuming increases in the price of maize, rice, and wheat as represented in Figure 7.4.D and based on a poverty line of $1.90/day.
ANNEX 7.1 Methodology and Database

Error Correction Model

The analytical framework used to represent the imperfect transmission of changes in international prices into domestic markets relies on an Error Correction Model (ECM) as described in Ivanic and Martin (2014a). As noted by Nickell (1985), this model represents a situation in which policy makers seek to reduce both the costs of change, and the costs of being out of equilibrium. A simplified version model used by Ivanic and Martin (2014a), expressed in logs, is:

$$\Delta \tau = \alpha (p_w - p_{w,t-1}) + \beta [p_{t,t-1} - \gamma p_{w,t-1}],$$

where $p$ represents domestic prices; $p_w$ world prices; $\tau$ the rate of protection, approximated by $(p-p_w)$; $\alpha$, $\alpha < 0$, the coefficient of price insulation ranging from 0 for countries that do no insulate against the rise in world prices, to -1 for countries that adopt policies that fully insulate domestic markets; $\beta$, $\beta < 0$, the cost of being out of equilibrium or the speed with which policies achieve the target level of protection or at which policy makers move back toward this equilibrium after being forced away from it by a shock to world prices; $\gamma$ determines the long run relationship between a country’s protection and the global level of agricultural protection; and $[p_{t,t-1} - \gamma \times p_{w,t-1}]$ is the deviation from the political-economy equilibrium. It depends on factors like income levels, exportable/importable status, the elasticity of import demand, and the share of real incomes gains from higher protection that will accrue to politically-organized producers (Anderson 1995; Grossman and Helpman 1994).

The database on Distortions to Agricultural Incentives (Anderson and Valenzuela 2008; Anderson and Nelgen 2013) is the main data source for estimating the ECM model. It includes estimates of domestic and world price levels which also determine the level of protection. The price data used in the model capture both natural shocks (oil prices, weather events) as well as the impact of trade policy interventions the separate impact of which is not possible to disentangle. The model is estimated for eight food commodities with data for 82 countries, of which 26 are advanced economies, 44 EMDEs, and 12 LICs.

Measuring the extent of trade policy interventions

The approach to quantify the extent of trade policy interventions builds on that used in Anderson, Ivanic, and Martin (2014). It is assumed that a primary shock, such as weather shock, generates an initial change in domestic and world
prices. In attempting to insulate consumers and producers from price increases, governments make offsetting changes in protection measures, such as the introduction of export bans or reduction in import duties. These measures, in turn, reinforce the original shock to world prices. When a country imposes an export restriction, the availability of food to the rest of the world is reduced, and this tends to push up world price. Similarly, when an importing country reduces its import tariffs, it increases the demand for imports and hence puts upward pressure on the world price.

The impact of the changes in trade policies can be distinguished from those of the primary shocks by in the following equation:

\[ \sum_i S_i(p_i) + v_i = \sum_i D_i(p_i), \]

where \( S_i \) is supply in region \( i \); \( D_i \) is supply in region \( i \); \( p_i = p^*(1 + t_i) \) is the domestic price; \( p^* \) is the world price; \( t_i \) is a country-specific trade barrier, such as a proportional tariff; and \( v_i \) is a random production shift variable for region \( i \). Totally differentiating the equation above, rearranging, and expressing the results in percentage changes yields an expression of the impact of a set of changes in trade distortions on the world price:

\[ \hat{p}^* = \frac{\sum_i H_i \hat{v}_i + \sum_i (H_i \gamma_i - G_i \eta_i) \hat{T}_i}{\sum_i (G_i \eta_i - H_i \gamma_i)} \]

where \( \hat{p}^* \) is the proportional change in the international price; \( \hat{v}_i \) is an exogenous output shock such as might result from good or bad seasonal conditions; \( \eta_i \) is the elasticity of demand in market \( i \); \( \gamma_i \) is the elasticity of supply in market \( i \); \( G_i \) is the share at world prices of country \( i \) in global demand; \( H_i \) is the share of country \( i \) in global production, and \( \hat{T}_i = (1 + t_i) \).

In other words, the impact on the world price of a change in trade policies in country is given as a weighted average of the changes in trade distortions in different markets, with the weight on region \( i \) depending on the importance of that country in global supply and demand, as well as the responsiveness of its production and consumption to price changes in the country, as represented by \( \gamma_i \) and \( \eta_i \).

It is thus assumed that elasticities of demand are equal between countries, i.e., that imported and domestic goods are perfect substitutes, and that there are no supply responses. Alternatively, one could allow for differentiation between imported and domestic products, as well as a limited supply response (Jensen
and Anderson 2017). The result would be an expression with weights that depend on, for instance, the shares of imports in consumption in each market. However, the overall result is similar in expressing the change in world prices as a weighted sum of changes in trade distortions.

To avoid having to deal with difficult-to-interpret interaction terms, all proportional changes are converted into log changes in $T_i$, $p_i$’s, and $p$ as:

$$\hat{p}_i = \hat{p} + \hat{T}_i$$

Changes in relative prices are measured as in the Agricultural Incentives database and capture a wide range of policy measures used to assess agricultural trade distortions—including tariffs, export subsidies, export taxes, export bans and import subsidies.

If products are homogeneous, and a country is small, the change in $\Delta t$ represents the change in the domestic price of the good. Additionally, if $\hat{T}_i$ is negative in a period of rising world prices, countries are seeking to insulate their markets from the increase in prices. If it is positive, policy makers are compounding the increase in world prices with an increase in protection. This may be due to the correction of past “errors”. This might occur if domestic prices fall below policy makers’ desired long-run level, or if policy insulated the domestic market from world markets and an exogenous shock—such a harvest shortfall—has caused the domestic price to rise relative to the world price. Such insulation patterns have been observed in the maize markets in many African countries (Chapoto and Jayne 2009).

The MIRAGRODEP model

The analytical framework to measure the poverty implications of the 2010-11 food price spike relies on the MIRAGRODEP model (Laborde, Robichaud, and Tokgoz 2013) complemented with household surveys for more than 31 countries and 285,000 representative households. MIRAGRODEP is a dynamic, multi-country, and multi-sector computable general equilibrium (CGE) model. The model relies on GTAP 9, a global database for 2011. The GTAP database includes input-output tables linked by bilateral trade flows for 140 regions (countries or country aggregates) and 57 sectors. For the purposes of the simulations these countries and sectors were aggregated into 31 countries/regions and 15 sectors among which rice, wheat, and maize are represented separately.

On the supply side, the production function is a Leontief function of value-added and intermediate inputs. The intermediate inputs are represented by a
nested, two-level constant elasticity of substitution (CES) function of all goods. Based on this, substitutability exists between intermediate goods, but these are more substitutable when they are in the same category (such as agricultural inputs or service inputs). Value-added is also represented by a nested structure of CES functions of unskilled labor, land, natural resources, skilled labor, and capital. This nesting allows the modeler to incorporate some intermediate goods that are substitutes of factors, such as energy or fertilizers.

On the demand side, a representative consumer is assumed to have a constant propensity to save. The remaining national income is used for the purchase of final consumption goods. Consumers' preferences are represented by a linear expenditure system—constant elasticity of substitution (LES–CES) function, calibrated based on the U.S. Department of Agriculture Economic Research Service (ERS/USDA) income and price elasticities to best reflect non-homothetic demand patterns with changes in revenue. Given an increase in the price of staple foods such as rice, wheat, or maize, consumers substitute away to consume other food products. Armington elasticities, which measure the elasticity of substitution between products of different countries, are drawn from the GTAP database and are assumed to be the same across regions.

Factor endowments are assumed to be fully employed. The supply of capital goods is modified each year because of depreciation and investment. New capital is allocated among sectors according to an investment function. Growth rates of labor supply are fixed exogenously. Land supply is endogenous and depends on the real remuneration of land. Skilled labor is the only factor that is perfectly mobile; unskilled labor is imperfectly mobile between agricultural and nonagricultural sectors according to a constant elasticity of transformation (CET) function. Unskilled labor’s remuneration in agricultural activities is different from that of nonagricultural activities. The only factor whose supply is constant is the natural resources factor. It is, however, possible to endogenously change the factor endowment in the baseline in order to reflect long-term depletion of resources with respect to a price trajectory.

The poverty impact is captured through a top-down approach using a dataset of household surveys for more than 31 countries and 285,000 representative households. The impact of a policy shock on poverty depends on price changes, the relative reliance of households on the consumption of individual staple foods and the net food buying status of households in different segments of the distribution (Deaton 1989).

Beyond the standard features of a global dynamic CGE model, the MIRAGRODEP model includes several improvements: sub-national land markets (agro-ecological zones or administrative districts) and endogenous land
supply; poverty analysis through either a top-down approach for global coverage or a bottom-up approach (for a subset of countries); dual-dual approach for formal/informal and rural/urban labor markets (Stifel and Thorbecke 2003); a consistent aggregator for trade policies (Laborde, Martin, and van der Mensbrugghe 2017); differentiated datasets on actual trade and farm policies and existing policy space for scenario design and endogenous policy responses; macro nutrient (calories, fats, proteins) accounting system based on FAOSTAT food balance sheets and a global Input-Output matrix; and sensitivity analysis framework based on Monte-Carlo simulations.

While the elasticities of substitution for rice, wheat, and maize used in this model, are higher than for manufactured goods, they are not infinite as assumed using the perfect substitutes model (Thursby, Johnson, and Grennes 1986). This specification has important implications for both the economy-wide analysis and at the household level. Given these assumptions, an increase in the price of an imported good has a muted impact on the domestic consumer price of that good. Since, with the Armington assumption—imported goods differentiated based on their country of origin—, the composite price of the consumer good is weighted by the shares of domestic and imported goods, the impact of a unit change in the world price, or in trade policy, is given by the share of imports in total consumption. Because the share of imports in total consumption of staple foods is typically small, the impact of trade policy on consumer prices is much more muted than under the assumption of perfect substitution used in Anderson, Ivanic, and Martin (2014). On the production side, the assumption that each country’s export product is the same as the products sold domestically means that changes in export trade policies will have a more direct impact on producer prices if the country is an exporter and not too large in the markets it supplies.
References


The database contains a wide range of inflation measures and key country characteristics, including macroeconomic and structural variables, for up to 175 countries for 1970-2018. This annex describes the data sources and definitions of variables, and their construction in detail.

Measures of inflation

Measures. Data are available for six measures of inflation: headline, food, energy, and core CPI inflation, PPI inflation, and GDP deflator changes. The database also includes headline CPI inflation expectations. Data sources include Haver Analytics, ILOSTAT, IMF’s International Financial Statistics and World Economic Outlook, OECDStat, UNdata, and the World Bank’s Development Prospects Group (DECPG) internal databases.\(^1\)

Country coverage. Headline inflation data are available for 175 countries, including 34 advanced countries and 141 emerging market and developing economies (EMDEs), including 31 low-income countries (LICs). A complete (balanced) dataset of annual data for all six inflation measures is available for 25 countries between 1970-2017, including 20 advanced economies and 5 non-LIC EMDEs. One- or two-year data gaps are completed through interpolation. Quarterly data for headline CPI inflation are available for up to 34 advanced economies and 78 EMDEs, including 5 LICs for 1971Q1 until 2018Q2 (of which all but seven non-LIC EMDEs have updated data to 2018). A balanced sample with quarterly data available for 1971Q1-2018Q2 includes 24 advanced economies and 22 non-LIC EMDEs. Table A.1 provides a breakdown of the number of countries with data available for every year of the period indicated in the column title.

Headline inflation. Data are drawn primarily from three databases: Haver Analytics, OECDStat, and the IMF World Economic Outlook. The IMF Consumer Price Index database has data for its member countries for long time periods, but with gaps. The ILOSTAT database has coverage of most countries through 2011, but with some gaps.

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\(^1\) ILOSTAT is a database maintained by the International Labour Organization (ILO). OECDStat includes data and metadata for countries in the Organisation for Economic Co-operation and Development (OECD) and select non-member economies. UNdata is a database provided by the United Nations (UN).
Food inflation. Data are drawn from four data sets. The ILOSTAT database on CPI components is the main source as it has the most comprehensive coverage. Data for some years are missing and coverage ends in 2011. The IMF Consumer Price Index database is used to fill data gaps. Haver Analytics provides coverage for some remaining data gaps. OECDstat covers data for Organisation for Economic Co-operation and Development (OECD) members and some nonmembers starting in 1970.

Energy, core, and PPI inflation. Data are primarily drawn from Haver Analytics (energy, core, and PPI inflation), ILOSTAT (energy), UNdata (energy), and OECDstat (energy, core, and PPI inflation). Data from these sources are merged only if there are no large discrepancies in values between the databases. Official core inflation data are available for 70 countries, including 36 non-LIC EMDEs and 2 LICs. For the other countries, missing core inflation series are constructed using CPI weights and inflation in CPI components (Table A.2).

Calculation of core inflation. For the countries for which official measures of core inflation are unavailable, core inflation series are obtained by subtracting the contribution of volatile components of CPI (food and energy) from headline inflation.

For most EMDEs and LICs, monthly energy inflation series are not available. For these countries, the calculation of core inflation uses the housing, water, electricity, gas, and other fuels category of the CPI as a proxy for energy inflation. The following formula is used to calculate core inflation in each period:

$$\text{Core inflation} = \frac{[\pi - \omega_F \pi_F - \omega_E \pi_E]}{1 - \omega_F - \omega_E}$$

where $\pi$, $\pi_F$, and $\pi_E$ are the monthly inflation rates for headline, food, and energy, respectively, and $\omega_F$ and $\omega_E$ are the weights for food and energy, respectively. The weights of the sub-indexes in the total index are obtained from the IMF Consumer Price Index database as well as OECDstat and Haver Analytics. The information for the following categories is obtained for 66 countries: food and non-alcoholic beverages; alcoholic beverages, tobacco, and narcotics; clothing and footwear; housing, water, electricity, gas, and other fuels; furnishings, household equipment, and routine household maintenance; health; transport; communication; recreation and culture; education; restaurants and hotels; and miscellaneous goods and services.

Cyclical and trend inflation. Cyclical and trend inflation series are produced using the methodology in Stock and Watson (2016). Trend inflation is defined
as the part of inflation that follows a permanent stochastic trend while cyclical inflation is a serially uncorrelated transitory component of inflation.

**GDP deflator.** For 1970-2017, data are drawn from Haver Analytics, OECDstat, and the World Economic Outlook database. Quarterly data, defined as quarter-on-quarter percent change, seasonally adjusted, are available for 95 countries. Annual data are available for 175 countries.

**Inflation expectations.** Inflation expectations are from two sources. First, the survey of professional forecasters on medium- to long-term expectations is conducted by Consensus Economics multiple times each year. It provides forecasts for annual average CPI inflation over the next 5-10 years for 46 countries (including Euro Area) since 1989. The exceptions are the Russian Federation and Latin American countries. Their inflation forecasts are surveyed on end-of-period (December-to-December) basis. Historical long-term

### TABLE A.1 Number of countries with available inflation data

<table>
<thead>
<tr>
<th></th>
<th></th>
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<tbody>
<tr>
<td><strong>Headline inflation</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Annual</td>
<td>175</td>
<td>153</td>
<td>154</td>
<td>161</td>
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<tr>
<td>Quarterly</td>
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<tr>
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<td>Annual</td>
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<td>105</td>
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<td><strong>Energy inflation</strong></td>
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<tr>
<td>Annual</td>
<td>175</td>
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<td>137</td>
<td>142</td>
<td>172</td>
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<tr>
<td>Quarterly</td>
<td>96</td>
<td>8</td>
<td>15</td>
<td>24</td>
<td>67</td>
</tr>
<tr>
<td>Monthly</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Note: "..." indicates that data are not available for the full sample period.
consensus forecasts are available from October 1989 for the G-7 and 6 Western European economies. The dataset contains long-term consensus forecasts for 7 Latin American countries since 1993, and for 12 Asia Pacific countries (excluding Japan) and 14 Eastern European countries since 1998. Second, the IMF World Economic Outlook database provides 5-year-ahead annual average headline CPI inflation forecasts on a bi-annual basis for 47 countries for the period 1990-2017.

Global commodity price indexes. Global commodity prices and indexes are available from 1960 from the World Bank’s Pink Sheet of commodity price data. The following global price indexes are available at monthly, quarterly, and annual frequencies: agricultural commodity; energy commodity; non-energy commodity; and food commodity. All indexes are in nominal U.S. dollars, scaled to 2010 equal to 100.

Measures of country characteristics

This section describes measures of country characteristics available in the database: macroeconomic variables; monetary policy-related variables; variables related to global integration; exchange rate variables; and structural variables. The section also describes the classification of countries. Table A.3 includes detailed information on each variable, including those related to inflation discussed in the previous section.

Macroeconomic variables

Gross domestic product (GDP). Annual and quarterly data (quarter-on-quarter, seasonally-adjusted percent change) are available from Haver Analytics and OECDstat.
**Industrial production.** Both unadjusted and seasonally-adjusted series of industrial production are available from Haver Analytics and OECDstat for 63 countries at monthly frequency for 1970-2018. Country-specific indexes are rebased to 2010 equal to 100.

**Savings.** Gross national savings (as percent of GDP) are computed as gross disposable income less final consumption expenditures after taking into account an adjustment for pension funds, when possible. These series are available from the IMF World Economic Outlook for around 170 countries for the period 1980-2017.

**Investment.** Investment is expressed in percent of GDP. Investment or gross capital formation is measured by the total value of gross fixed capital formation and changes in inventories and acquisitions less disposals of valuables. It is available from the IMF World Economic Outlook for 173 countries for the period 1980-2017.

**Gross public debt.** This measure is defined as gross public debt in percent of GDP. It uses four data sources for constructing debt-to-GDP ratios. First, Mauro et al. (2015) provide a historical dataset of government debt for 55 countries for the period 1800-2011. Second, Abbas et al. (2011) provide a comprehensive database of gross central government debt-to-GDP ratios, covering 174 countries for the period 1700-2012. Data are updated to 2017 using the IMF Historical Public Debt Database and World Economic Outlook database.

**Fiscal rules.** A fiscal rule imposes a long-lasting constraint on fiscal policy through numerical limits on budgetary aggregates. The IMF Fiscal Rules Dataset 1985-2015 (Schaechter et al. 2012) provides systematic information on the use and design of fiscal rules covering national and supranational fiscal rules in 96 countries from 1985 to 2015. The dataset covers four types of rules: budget balance rules, debt rules, expenditure rules, and revenue rules, applying to the central or general government or the public sector. It also presents details on various characteristics of rules, such as their legal basis, coverage, escape clauses, as well as enforcement procedures, and takes stock of key supporting features that are in place, including independent monitoring bodies and fiscal responsibility laws.

**Monetary policy-related variables**

**Monetary policy framework.** This variable classifies the monetary policy regimes into those with exchange rate anchors, monetary aggregate targets, inflation targeting frameworks, and other (hybrid) regimes. It is available for 197 countries for the period from 1990. The main sources are the IMF Quarterly
Report on Exchange Arrangements and the IMF Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER). The database includes the following categories:

- Monetary aggregate targeting;
- Inflation targeting regimes;
- Free floating without inflation targeting regimes (including all euro area countries);
- Exchange rate anchor, U.S. dollar (including ECCU);
- Exchange rate anchor, euro (including WAEMU and CEMAC);
- Exchange rate anchor, composite; and
- Exchange rate anchor, other currency.

**Inflation targeting framework.** The IMF’s AREAER provides country-specific information on inflation targeting frameworks starting from 2010. It describes the de jure monetary policy regime as declared by the national monetary authorities. An electronic version of the data is provided by Caceres, Carrière-Swallow, and Gruss (2016). For countries with inflation targets, the dataset provides the month and year of adoption of the inflation targeting framework. Because AREAER (and its online version) only provides information on inflation targeting frameworks since 2010, Carare and Stone (2006) are used to determine the exact year each country adopted inflation targeting. This variable is available for up to 170 countries for the period 1990-2017 on monthly, quarterly, and annual basis.

**Inflation targets.** Information on “inflation target” ranges is available on a monthly basis for 37 countries from 1990. The data include three variables: the midpoint as well as the upper and lower bounds of inflation target ranges. For ease of analysis, those countries that target a midpoint and do not have an official upper and lower bound, a range adding +/-1 is calculated as the target ranges. Similarly, for those countries that do not have a mid-point of their inflation target, and instead target only a range, the mid-point was assumed to be the average of the lower and upper bounds of the announced target range. The data sources include national central banks, the Central Bank News website, AREAER database, and other sources.

**Central bank independence.** A measure of central bank independence relies on two sources. Garriga (2016) includes annual data on de jure central bank independence for 182 countries for the period 1970-2012. The dataset identifies statutory reforms affecting central bank independence and their impact. Dincer
and Eichengreen (2014) measure transparency and independence for about 120 central banks spanning the period 1998-2014. The index ranges from 0 to 15. The Dincer-Eichengreen Index is selected as the main measure of central bank independence because it is available over a long timeframe (1998-2014). To expand the sample, the index is extrapolated to 2015-17 using 2014 data and extrapolated to 1970-1997 using 1998 data. For countries not included in the dataset of Dincer and Eichengreen (2014), the fitted values from an OLS regression of the Dincer-Eichengreen Index on the Garriga Index are used.

Central bank head turnover. Central bank head turnover data are available from Dreher, Sturm, and de Haan (2010). This dataset contains information on the term in office and month and year at which a central bank governor is replaced. It also provides the official term in office according to the central bank law for 159 countries covering the period 1970–2014. The turnover rate (number of changes in central bank heads before the end of his/her legal term in office) using a four-year rolling average preceding a central bank governor change is calculated (similar to Klomp and de Haan 2010). The four-year window matches the average turnover rate of central bank governors.

Variables related to global integration

De jure financial openness. Three sources are used to measure financial openness. Quinn and Toyoda (2008) have a Capital Controls Index Database of de jure measures of capital account and financial current account openness for 94 countries over the period 1980-2014. Fernandez et al. (2016) have a Capital Control Measures dataset of restrictions on capital account inflows and outflows for ten categories of assets for 100 countries between 1995-2013. Chinn and Ito (2006) provide a de jure measure of Capital Account Openness for 182 countries between 1970-2016. The annual and quarterly datasets contain all three measures for financial openness. To obtain the widest possible coverage, the primary source of financial openness is the Chinn-Ito Index.

De facto financial openness. International financial integration provides a proxy for de facto financial openness. It is measured as the sum of foreign assets and liabilities in percent of GDP in current U.S. dollars. The External Wealth of Nations Mark II database (Lane and Milesi-Ferretti 2007) is the main source of financial integration through 2014. Data from the IMF Balance of Payments and International Investment Position Statistics are used to expand cross-country coverage. Data are available for 128 countries for the period since 1976.

Participation in global value chains (GVCs). Three measures of global value chain participation are provided: backward- and forward-participation and the intermediate trade share of GDP. Backward-participation in GVCs measures the foreign value added embodied in a country’s exports, in percent of total gross
exports. Forward-participation in GVCs measures a country’s value added embodied in foreign exports, in percent of total gross exports. Both data series are available from the OECD-WTO TiVA database for 58 countries for 1995, 2000, 2005, and 2008-11. The series of intermediate trade share of GDP are defined as the sum of intermediate imports and exports, in percent of GDP. Data are available for up to 166 countries, but with uneven year coverage. For the period 1988-2016, the series are available for 137 countries. Data are taken from the World Bank World Integrated Trade Solution (WITS) and World Development Indicators. These three data series are used to construct a dummy variable indicating high participation in global value chains. A country is classified as highly integrated into global value chains (the dummy is assigned a value 1) if one of two conditions is met: the sum of backward- and forward-participation in GVCs is greater than the median of the sample in a particular year, or the intermediate trade ratio is greater than the median of the sample in a particular year.

**Trade openness.** The indicator for trade openness is defined as the sum of exports and imports of goods and services in percent of GDP. Data are available for 170 countries for the period 1970-2017, taken from the World Bank World Development Indicators. Data gaps are filled with data on exports, imports, and GDP obtained from the IMF World Economic Outlook database.

**Average effective tariff.** This measure is the average rate of effectively applied tariffs, weighted by the product import shares corresponding to each partner country. Data are classified using the UN’s Harmonized System of trade at the six- or eight-digit level. This variable is available from the WITS website for a maximum of 149 countries, but with uneven year coverage; it is available for 109 countries for the period 2000-16.

**Exchange rate variables**

**Bilateral exchange rate against U.S. dollar.** IMF International Financial Statistics provides exchange rates in national currencies per U.S. dollar. Exchange rates in the database are classified into three broad categories, reflecting the role of the authorities in determining the rates and/or the multiplicity of the exchange rates in a country. The three categories are the market rate, describing an exchange rate determined largely by market forces; the official rate, describing an exchange rate determined by the authorities—sometimes in a flexible manner; and the principal, secondary, or tertiary rate, for countries maintaining multiple exchange arrangements. Data for the market exchange rate against the U.S. dollar is available for 34 advanced economies and 137 EMDEs, including 30 LICs, for 1970-2018.
Nominal and real effective exchange rates. The nominal and real effective exchange rates rely primarily on Darvas (2012). The database includes annual and monthly data for 178 countries, considerably more than in any other publicly available database. The series are available through mid-2017. The annual database covers 171 countries over the period 1960-2017, and the monthly database includes data for 165 countries over the period 1970-2017.

De facto exchange rate regime. The exchange rate regime classification of Shambaugh (2004) is used to determine whether a country has a pegged or flexible exchange rate. The original classification has four categories: “1” reflects no fluctuation at all; “2” indicates movements within 1 percent bands; “3” indicates movements within 2 percent bands; and “4” indicates a one-time devaluation with no change in the remaining 11 months of the year. Shambaugh (2004) assesses these movements against relevant base currencies. The constructed dummy variable indicating a pegged exchange rate regime is defined to equal 1 for countries classified as 1, 2, 3, or 4. A value of 0 is assigned to flexible exchange rates—i.e., exchange rates that routinely fluctuate outside a 2 percent band. The indicator is available on an annual basis for 176 countries for the period 1960-2014.

De jure exchange rate regime. An alternative measure of the exchange rate regime is taken from Ilzetzki, Reinhart, and Rogoff (2017). They present annual and monthly data for 194 countries for the period 1946-2016. The classification includes the following categories:

1. No separate legal tender or currency union;
2. Pre-announced peg or currency board arrangement;
3. Pre-announced horizontal band that is narrower than or equal to +/-2 percent;
4. De facto peg;
5. Pre-announced crawling peg; de facto moving band narrower than or equal to +/-1 percent;
6. Pre-announced crawling band that is narrower than or equal to +/-2 percent or de facto horizontal band that is narrower than or equal to +/-2 percent;
7. De facto crawling peg;
8. De facto crawling band that is narrower than or equal to +/-2 percent;
9. Pre-announced crawling band that is wider than or equal to +/-2 percent;
10. De facto crawling band that is narrower than or equal to +/-5 percent;
11. Moving band that is narrower than or equal to +/-2 percent (i.e., allows for both appreciation and depreciation over time);

12. De facto moving band +/-5 percent / Managed floating;

13. Freely floating;

14. Freely falling; and

15. Dual market in which parallel market data is missing.

All countries with classification categories 1-11 are considered fixed exchange rate regimes and assigned a value of 1. Categories 12-15 are treated as flexible exchange rate regimes and assigned a value of 0.

**Structural variables**

**Demographic variables.** Population growth is the average annual growth of mid-year population. It is available for 209 countries for the period 1970-2017 and obtained from the World Bank World Development Indicators. The old-age dependency ratio measures the ratio of people older than 64 in percent of the working-age population (aged 15 to 64 years). The young-age dependency ratio is the share of people younger than 15 in percent of the working-age population. The dependency ratios are also collected from the World Bank World Development Indicators and available for 189 countries for the period 1970-2017.

**Labor market flexibility.** The labor market flexibility indicator uses the Fraser Institute’s Economic Freedom of the World database. The labor market flexibility index uses survey responses to construct labor market flexibility indicators in four areas: minimum wage; hiring and firing practices; collective bargaining; and unemployment benefits. The survey asks respondents to answer questions on a scale from 1 (disagree) to 7 (agree), where 7 indicates strongest agreement. The index is standardized on a 0-10 scale. A higher value represents a more flexible labor market. Data are available for 152 countries for every five-year period between 1980 and 2000, and annually for the period 2001-14 (Gwartney, Lawson, and Hall 2017).

**Collective bargaining coverage rate.** The collective bargaining coverage is an indicator of the degree to which wages and working conditions are regulated by collective agreements. It measures the number of workers in employment whose pay and/or conditions of employment are determined by one or more collective agreement(s) as a proportion of all those who are eligible to conclude a collective agreement. The collective bargaining coverage rate is available from ILOSTAT for 62 countries from 2001-13.
Trade union density rate. Trade union membership, defined as the total number of workers that belong to a trade union, can be an indicator of trade union strength. The trade union density rate expresses union membership as a proportion of the eligible workforce and can be used as an indicator of the degree to which workers are organized. Data for this measure are available from ILOSTAT for 49 countries for the period 2000-13.

Rainfall. Rainfall data, defined as precipitation in millimeters per month, comes from the Climate Change Knowledge Portal. The dataset is produced by the Climatic Research Unit of University of East Anglia and reformatted by International Water Management Institute. It contains historical precipitation data aggregated from 2-degree gridded data to the country and basin levels. It is derived from observational data and provides quality-controlled temperature and rainfall values from thousands of weather stations worldwide, as well as derivative products including monthly climatologies and long-term historical climatologies. Data cover more than 180 countries for the period 1901-2017.

Country classification

Country groups. Advanced economies include Australia; Austria; Belgium; Canada; Cyprus; the Czech Republic; Denmark; Estonia; Finland; France; Germany; Greece; Hong Kong SAR, China; Iceland; Ireland; Israel; Italy; Japan; the Republic of Korea; Latvia; Lithuania; Luxembourg; Malta; the Netherlands; New Zealand; Norway; Portugal; Singapore; the Slovak Republic; Slovenia; Spain; Sweden; Switzerland; the United Kingdom; and the United States.

Emerging market and developing economies (excluding low-income countries) include Albania; Algeria; Angola; Antigua and Barbuda; Argentina; Armenia; Azerbaijan; The Bahamas; Bahrain; Bangladesh; Barbados; Belarus; Belize; Bhutan; Bolivia; Bosnia and Herzegovina; Botswana; Brazil; Brunei Darussalam; Bulgaria; Cabo Verde; Cambodia; Cameroon; Chile; China; Colombia; the Republic of Congo; Costa Rica; Côte d’Ivoire; Croatia; Djibouti; Dominica; the Dominican Republic; Ecuador; the Arab Republic of Egypt; El Salvador; Equatorial Guinea; Eswatini; Fiji; Gabon; Georgia; Ghana; Grenada; Guatemala; Guyana; Honduras; Hungary; India; Indonesia; the Islamic Republic of Iran; Iraq; Jamaica; Jordan; Kazakhstan; Kenya; Kiribati; Kuwait; the Kyrgyz Republic; the Lao People’s Democratic Republic; Lebanon; Lesotho; Libya; the former Yugoslav Republic of Macedonia; Malaysia; Maldives; the Marshall Islands; Mauritania; Mauritius; Mexico; the Federated States of Micronesia; Moldova; Mongolia; Montenegro; Morocco; Myanmar; Namibia; Nauru; Nicaragua; Nigeria; Oman; Pakistan; Palau; Panama; Papua New Guinea; Paraguay; Peru; the Philippines; Poland; Qatar; Romania; the Russian Federation; Samoa; São Tomé and Príncipe; Saudi Arabia; Serbia; the Seychelles; the Solomon Islands; South Africa; Sri Lanka; St. Kitts and Nevis; St.
Lucia; St. Vincent and the Grenadines; Sudan; Suriname; Thailand; Tonga; Trinidad and Tobago; Tunisia; Turkey; Turkmenistan; Tuvalu; Ukraine; the United Arab Emirates; Uruguay; Uzbekistan; Vanuatu; República Bolivariana de Venezuela; Vietnam; and Zambia

Low-income countries include Afghanistan; Benin; Burkina Faso; Burundi; the Central African Republic; Chad; the Comoros; the Democratic Republic of Congo; Eritrea; Ethiopia; The Gambia; Guinea; Guinea-Bissau; Haiti; the Democratic People’s Republic of Korea; Liberia; Madagascar; Malawi; Mali; Mozambique; Nepal; Niger; Rwanda; Senegal; Sierra Leone; Somalia; South Sudan; the Syrian Arab Republic; Tajikistan; Tanzania; Togo; Uganda; the Republic of Yemen; and Zimbabwe. The classification of LICs is based on the World Bank Group classification as of June 2018.

**Commodity exporter status.** A country is classified as “commodity exporter” if one of the two conditions was met during 2012-14: on average, commodity exports accounted for 30 percent or more of total goods exports, or exports of any single commodity accounted for 20 percent or more of total goods exports. Economies for which these thresholds were met because of re-exports were excluded. When data were not available, judgment was used. This taxonomy results in the classification of some well-diversified economies as importers, even if they are exporters of certain commodities (e.g., Mexico). Commodity importers are all economies that are not classified as commodity exporters.

**Regions.** Regional dummy variables for East Asia and Pacific (EAP), Europe and Central Asia (ECA), Latin America and the Caribbean (LAC), Middle East and North Africa (MNA), South Asia (SAR), and Sub-Saharan Africa (SSA) follow the World Bank Group classification.

**Net food importer status.** Net food importers are classified based on net food imports (food imports minus food exports) in percent of GDP. Food comprises the commodities in sections 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils and fats), as well as division 22 (oil seeds, oil nuts, and oil kernels) in the UN Standard International Trade Classification. A country is classified as a net food importer (the dummy is assigned the value 1) if its net food imports in percent of GDP are above the median of net food imports across countries in a given year.

**Net energy importer status.** Net energy importers are classified based on net fuel imports (fuel imports minus fuel exports) in percent of GDP. A country is classified as a net energy importer (the dummy is assigned the value 1) if its net fuel imports in percent of GDP are above the median of net fuel imports across countries in a given year.
## TABLE A.3 Database

<table>
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<tr>
<th>Variable name in database</th>
<th>Description</th>
<th>Units</th>
<th>Country coverage</th>
<th>Year coverage</th>
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<td>inflation</td>
<td>Consumer price inflation</td>
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<td>From 1970</td>
<td>Central bank websites; IMF International Financial Statistics (IFS); Haver Analytics; OECDstat</td>
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<td>ppi</td>
<td>Producer price inflation</td>
<td>Percent</td>
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<td>From 1970</td>
<td>Central bank websites; IFS; Haver Analytics; OECDstat</td>
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<td>Core consumer price inflation</td>
<td>Percent</td>
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<td>From 1970</td>
<td>Central bank websites; IFS; ILOSTAT; Haver Analytics; OECDstat</td>
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<td>GDP deflator change</td>
<td>Percent</td>
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<td>From 1970</td>
<td>Central bank websites; IFS; Haver Analytics; OECDstat</td>
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<td>Food and non-alcoholic beverages consumer price inflation</td>
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<td>From 1970</td>
<td>ILOSTAT database on CPI Components; IMF Consumer Price Index database; Haver Analytics; OECDstat</td>
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<td>Energy consumer price inflation</td>
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<td>From 1970</td>
<td>Central bank websites; Haver Analytics; ILOSTAT; OECDstat</td>
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<td>co_energy</td>
<td>Global energy commodity price inflation</td>
<td>Percent</td>
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<td>From 1970</td>
<td>World Bank Pink Sheet commodity price data</td>
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<td>From 1970</td>
<td>World Bank Pink Sheet commodity price data</td>
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<td>Dummy variable; 1=fixed, 0=flexible</td>
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<td>Shambaugh (2004); IMF AREAER</td>
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<tr>
<td>xr_regime</td>
<td>De jure exchange rate regime</td>
<td>Dummy variable; 1=fixed, 0=flexible</td>
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<td>From 1970</td>
<td>Ilzetzki, Reinhart, and Rogoff (2017)</td>
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<tr>
<td>cbi_trans</td>
<td>Central bank transparency</td>
<td>Index; 0=least transparent; 15=most transparent</td>
<td>108</td>
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<tr>
<td>cbi_trans_fit</td>
<td>Central bank transparency, extended sample</td>
<td>Index; 0=least transparent; 15=most transparent</td>
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<td>cbi_trans extended using Garriga (2016)</td>
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<tr>
<td>saving_wdi</td>
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<td>Percent of GDP</td>
<td>169</td>
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<tr>
<td><strong>mon_policy</strong></td>
<td>Dummy variable: 2=Monetary aggregate targeting 3=Inflation targeting regimes (incl. all euro area countries) 4=Free floating without inflation targeting regimes 11= Exchange rate anchor, U.S. dollar (incl. ECCU) 12= Exchange rate anchor, euro (incl. WAEMU and CEMAC) 13= Exchange rate anchor, composite 14=Exchange rate anchor, other currency</td>
<td></td>
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<td><strong>IT</strong></td>
<td>Presence of inflation targeting framework Dummy variable; 1=inflation targeting; 0=not inflation targeting</td>
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<td>IMF AREAER; Carare and Stone (2006); Caceres, Carriere-Swallow, and Gruss (2016)</td>
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<tr>
<td><strong>TOR_i</strong></td>
<td>Central bank head turnover Number of changes in central bank heads before the end of his/her legal term in office</td>
<td></td>
<td>143</td>
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<td><strong>CMA, CXA</strong></td>
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<td><strong>region</strong></td>
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<td><strong>incomegroup</strong></td>
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<tr>
<td>it, it_lower, it_upper</td>
<td>“it” refers to Inflation target, mid-point target, or average of target range; “it_upper” refers to upper bound of target range; and “it_lower” refers to lower bound of target range</td>
<td>Percent</td>
<td>38</td>
<td>From 1990</td>
<td>National central bank websites; Central Bank News website; IMF AREAER; other documents</td>
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<td>cap100_new</td>
<td>De jure financial openness (Quinn-Toyoda Index)</td>
<td>Index; 0=least open; 100=most open</td>
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<td>Index; 0=least open; 1=most open</td>
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<td>Chinn and Ito (2006)</td>
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<td>De Jure Financial Openness Capital Control Measures dataset of restrictions on capital account inflows and outflows for ten categories of assets for 100 countries between 1995-2013</td>
<td>Index; 0=least open; 1=most open</td>
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<td>From 1995</td>
<td>Fernandez et al. (2016)</td>
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<td>De facto financial openness, defined as the sum of international assets and liabilities in percent of GDP</td>
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<td>Lane and Milesi-Ferretti 2007; IMF Balance of Payments and International Investment Position Statistics</td>
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<td>Percent</td>
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<td>gvc_total</td>
<td>Sum of intermediate exports and imports in percent of GDP</td>
<td>Percent of GDP</td>
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<td>1995, 2000, 2005, and 2008-11</td>
<td>WITS; World Development Indicators</td>
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<tr>
<td>gvc_dummy</td>
<td>High integrations into global value chains, defined one of two conditions being met as the sum of backward and forward participation in global value chains is greater than the median of the sample in a particular year, or the intermediate trade ratio is greater than the median of the sample in a particular year</td>
<td>Dummy variable; 1=highly integrated; 0=not highly integrated</td>
<td>From 1970</td>
<td>Constructed from back_gvc, for_gvc, and gvc_total</td>
<td></td>
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<td>trade_open</td>
<td>Sum of exports and imports of goods and services in percent of GDP</td>
<td>Percent of GDP</td>
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<td>Percent</td>
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<td>1988-2016</td>
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<td>debt_gdp</td>
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<td>Abbas et al. (2011); Mauro et al. (2015); IMF Historical Public Debt Database; IMF World Economic Outlook</td>
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<td>Index, 2007=100</td>
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<td>Darvas (2012)</td>
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<td>Percent</td>
<td>173</td>
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<td>old_dep</td>
<td>Old-age dependency ratio, defined as number of people older than 64 in percent of the working age population (aged 15 to 64 years)</td>
<td>Percent of working-age population</td>
<td>From 1970</td>
<td>World Development Indicators (WDI)</td>
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<tr>
<td><strong>foodnet</strong></td>
<td>Net food imports, defined as food imports minus food exports in percent of GDP. Food comprises the commodities in SITC sections 0 (food and live animals), 1 (beverages and tobacco), and 4 (animal and vegetable oils, and fats), as well as SITC division 22 (oil seeds, oil nuts, and oil kernels)</td>
<td>Percent of GDP</td>
<td>167</td>
<td>From 1970</td>
<td>WDI</td>
</tr>
<tr>
<td><strong>foodnet_dum</strong></td>
<td>High net food importer status defined as net food imports in percent of GDP above the median of net food imports across countries in a given year</td>
<td>Dummy variable; 0=net food imports below cross-country median; 1=net food imports above cross-country median</td>
<td></td>
<td>From 1970</td>
<td>Constructed from foodnet</td>
</tr>
<tr>
<td><strong>energynet</strong></td>
<td>Net fuel imports, defined as fuel imports minus fuel exports in percent of GDP</td>
<td>Percent of GDP</td>
<td>167</td>
<td>From 1970</td>
<td>WDI</td>
</tr>
<tr>
<td><strong>energynet_dum</strong></td>
<td>High net energy importer status defined as net fuel imports in percent of GDP above the median of net fuel imports across countries in a given year</td>
<td>Dummy variable; 0=net fuel imports below cross-country median; 1=net fuel imports above cross-country median</td>
<td></td>
<td>From 1970</td>
<td>Constructed from energynet</td>
</tr>
<tr>
<td><strong>young_dep</strong></td>
<td>Young dependency ratio, defined as number of people younger than 15 in percent of the working age population (aged 15 to 64 years)</td>
<td>Percent of working-age population</td>
<td>171</td>
<td>From 1970</td>
<td>WDI</td>
</tr>
<tr>
<td><strong>bargaining</strong></td>
<td>Collective bargaining coverage, defined as the number of workers in employment whose pay and/or conditions of employment are determined by one or more collective agreement(s) as a proportion of all those who are eligible to conclude a collective agreement</td>
<td>Percent of workers eligible to conclude a collective agreement</td>
<td>62</td>
<td>2001-13</td>
<td>ILOSTAT</td>
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<tr>
<td><strong>inv</strong></td>
<td>Gross capital formation</td>
<td>Percent of GDP</td>
<td>162</td>
<td>From 1980</td>
<td>IMF World Economic Outlook</td>
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<tr>
<td><strong>fiscal_rule</strong></td>
<td>Adoption of a fiscal rule</td>
<td>Dummy variable; Yes=fiscal rule has been adopted; No=no fiscal rule has been adopted</td>
<td></td>
<td>1985-2015</td>
<td>Schaechter et al. (2012)</td>
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<td><strong>ener_weight</strong></td>
<td>Weight of energy in the consumer price index; when unavailable, weight of housing, water, electricity, and gas</td>
<td>Percent</td>
<td>143</td>
<td>From 1970</td>
<td>OECDstat; Haver Analytics; IMF International Financial Statistics</td>
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<tr>
<td><strong>food_weight</strong></td>
<td>Weight of food and non-alcoholic beverages in the consumer price index</td>
<td>Percent</td>
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<td>OECDstat; Haver Analytics; IMF International Financial Statistics</td>
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<td><strong>crude_petro</strong></td>
<td>Crude oil price (unweighted average of Dubai, Brent, and WTI prices)</td>
<td>U.S. dollars per barrel</td>
<td>170</td>
<td>From 1970</td>
<td>World Bank Pink Sheet commodity price data</td>
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<tr>
<td><strong>kcrude_petro</strong></td>
<td>Crude oil price (unweighted average of Dubai, Brent, and WTI prices) at constant 2005 U.S. dollars</td>
<td>U.S. dollars per barrel</td>
<td>170</td>
<td>From 1970</td>
<td>World Bank Pink Sheet commodity price data</td>
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<td><strong>gdp_weo</strong></td>
<td>Gross domestic product in billions of U.S. dollars</td>
<td>Billions of U.S. dollars</td>
<td>169</td>
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<td><strong>gdp_growthweo</strong></td>
<td>Real GDP growth</td>
<td>Percent</td>
<td>174</td>
<td>From 1981</td>
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<td>PPP valuation of country GDP, in billions of U.S. dollars</td>
<td>Billions of U.S. dollars</td>
<td>169</td>
<td>From 1980</td>
<td>IMF World Economic Outlook</td>
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<tr>
<td><strong>union</strong></td>
<td>Trade union density rate, defined as union membership as a proportion of the eligible workforce</td>
<td>Percent of the eligible workforce</td>
<td>75</td>
<td>2000-2013</td>
<td>ILOSTAT</td>
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<td><strong>trend</strong></td>
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<td>Percent</td>
<td>148</td>
<td>From 1970</td>
<td>World Bank estimates</td>
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<td>Variance of trend component of inflation, estimated as in Stock and Watson (2016)</td>
<td>Percent</td>
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<td>Quarter-on-quarter, seasonally adjusted, annualized CPI inflation</td>
<td>Percent</td>
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<td>From 1970</td>
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<td>Quarter-on-quarter, seasonally adjusted, annualized energy CPI inflation</td>
<td>Percent</td>
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<td>From 1970</td>
<td>Haver Analytics; ILOSTAT; UNdata; OECDstat</td>
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<tr>
<td>ppi_qoq</td>
<td>Quarter-on-quarter, seasonally adjusted, annualized PPI inflation</td>
<td>Percent</td>
<td>103</td>
<td>From 1970</td>
<td>Haver Analytics; OECDstat</td>
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<td>core_qoq</td>
<td>Quarter-on-quarter, seasonally adjusted, annualized core CPI inflation</td>
<td>Percent</td>
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<td>Haver Analytics; OECDstat; IMF International Financial Statistics</td>
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<td>Percent</td>
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<td>Consumer Price Index, month-on-month inflation rate</td>
<td>Percent</td>
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<td>Percent</td>
<td>169</td>
<td>From 1970</td>
<td>ILOSTAT database on CPI Components; IMF Consumer Price Index database; Haver Analytics; OECDstat</td>
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<td>Core</td>
<td>Core inflation, month-on-month inflation rate</td>
<td>Percent</td>
<td>112</td>
<td>From 1970</td>
<td>Haver Analytics; OECDstat; IMF International Financial Statistics; Calculated</td>
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<td>Official core inflation</td>
<td>Percent</td>
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<td>Industrial Production</td>
<td>Index, 2010=100</td>
<td>60</td>
<td>From 1970</td>
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<td>Index, 2010=100</td>
<td>34</td>
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<td>Local currency units</td>
<td>42</td>
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<td>broad_money</td>
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<td>Local currency units</td>
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<td>2001-17</td>
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Emerging market and developing economies, like advanced economies, have experienced a remarkable decline in inflation over the past half-century. Yet, research into this development has focused almost exclusively on advanced economies. This book fills that gap, providing the first comprehensive and systematic analysis of inflation in emerging market and developing economies. It examines how inflation has evolved and become synchronized among economies; what drives inflation globally and domestically; where inflation expectations have become better-anchored; and how exchange rate fluctuations can pass through to inflation. To reach its conclusions, the book employs cutting edge empirical approaches. It also offers a rich dataset of multiple measures of inflation for a virtually global sample of countries over a half-century to spur further research into this important topic.

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MAURICE OBSTFELD
Economic Counsellor and Director of Research
International Monetary Fund

“A remarkable resource for anyone interested in inflation in the modern world, clear and easy to follow. This book is an order of magnitude more comprehensive than anything else out there, not only in its country coverage, but in its exploration of all the major issues and debates surrounding inflation. Curiously, most of the existing academic literature has focused on advanced economies—which are also thoroughly covered here—yet there is so much to be learned from the dramatic inflation decline in emerging markets and low-income economies, including for design of advanced economy institutions. Any student, academic researcher or policy economist who wants to understand the big picture on world inflation, and when and where it might surprise in the future, will find this book fascinating.”

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