

# How to Move the Exchange Rate If You Must

## The Diverse Practice of Foreign Exchange Intervention by Central Banks and a Proposal for Doing It Better

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## Abstract

The paper is about the art of exchange rate management by central banks. It begins by reviewing the diversity of objectives and practices of central bank intervention in the foreign exchange market. Central banks typically exercise discretion in determining when and to what extent to intervene. Some central banks use publicly declared rules of intervention, with the aim of increasing visibility and strengthening the signaling channel of policy. There is tentative evidence that the volatility of foreign exchange reserves is comparatively lower in emerging market economies where central banks follow some form of rules-based foreign exchange intervention. The paper goes on to argue that when the

foreign exchange market includes some large strategic participants, the central bank can achieve superior outcomes if intervention takes the form of a rule, or “schedule,” indicating commitments to buying and selling different quantities of foreign currency conditional on the exchange rate. Exchange rate management and reserve management can then be treated as two independent objectives by the central bank. In line with the stylized facts reviewed, this would enable a central bank to pursue exchange rate objectives with minimum reserve changes, or achieve reserve targets with minimum impact on the exchange rate.

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and a Proposal for Doing It Better**

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## 1. Introduction

Central banks intervene in foreign exchange (FX) markets when they target particular levels of the exchange rate, through pegs, crawls, or bands with respect to other currencies or currency baskets. Even when they do not target a particular rate, they may intervene when there is excessive volatility in the exchange rate, which can be destabilizing for traders and ordinary consumers. When faced with current account surpluses or capital inflows, central banks that target the exchange rate end up accumulating large amounts of FX reserves. Accumulation of reserves can also be a symptom of an undervalued exchange rate that some governments have used to promote exports—or to prevent an appreciation that could undermine competitiveness. The extraordinary accumulation of reserves by the People’s Bank of China since the mid-1990s and by the Swiss National Bank in the aftermath of the 2008-09 global financial crisis—especially following the Swiss franc’s peg to the euro in September 2011—have been the focus of a lot of discussion and analysis.<sup>1</sup> By contrast, central banks that intervene to prevent exchange rate depreciation could see their FX reserves get depleted.

Central banks committed to a floating exchange rate intervene in foreign exchange markets for various reasons: When, for instance, a country’s currency appreciates because of some shock and the central bank believes that this is a temporary fluctuation, it may want to prevent the appreciation of the exchange rate that may undermine growth. The central bank may also want to contain excessive currency depreciation, if it is believed to be short-lived, when domestic agents have unhedged foreign currency borrowing exposure that may imperil financial stability. When such temporary shocks occur frequently, central banks may systematically intervene to contain exchange rate volatility. Central banks also intervene to manage FX reserves at levels deemed adequate against volatile capital flows and debt servicing obligations.

The present paper is an amoral one. It takes no stance on the goodness of interventions in the foreign exchange market by central banks. Its concern is with the efficacy of such interventions, no matter what prompts them. It is arguable that our understanding of the mechanics of central

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<sup>1</sup> See, for example, Ross and Jones, (2013), who point to evidence that, in the face of excessive accumulation of FX reserves in a near-zero interest rate environment for US dollar and euro denominated bonds, central banks have been increasingly searching for opportunities to diversify reserve holding into higher-yielding assets, including from emerging market economies. According to IMF statistics, worldwide FX reserve holdings had more than doubled, from US\$ 5 trillion in 2006 to US\$ 10.8 trillion in 2012.

bank intervention is quite rudimentary. Most of the time, the nature of intervention is prompted by rules of thumb instead of a proper understanding of the microeconomic foundations of such policy. We get the interventions approximately right more by virtue of evolution than understanding (Basu, 2013). Over time, the blatantly wrong interventions have perished through a process of imitation and learning. In reality there is much to be gained by observing behavior and rigorously analyzing the microeconomic foundations of such interventions. Accordingly, this paper surveys the response of central banks and then presents a theoretical argument on how central banks can intervene more effectively.

Central banks typically exercise discretion in the timing and amount of their FX interventions. But some central banks also use rules when they intervene, to increase visibility and strengthen the signaling channel of their policy. The focus of interest in this paper is the modality of intervention. If the central bank's interest is in depreciating the exchange rate, not in building up FX reserves, is a discretionary purchase of FX the best way to achieve this? One consequence of such action to depreciate the domestic currency is that it causes a build-up of FX reserves, such as happened recently with the Swiss National Bank. Some countries wish to minimize the opportunity cost of building up large volumes of low-yield FX reserves. Central banks often also want to minimize the quasi-fiscal cost of sterilization that may be necessary to mitigate the impact of intervention on money supply and inflation. Are there other ways of intervening in the foreign exchange market which can help depreciate the exchange rate without a reserve build-up and vice versa? The aim of this paper is to answer this question with a review of the actual experience of central banks and a theoretical analysis.

The next section briefly reviews the diversity of objectives and modalities of FX intervention in countries with managed float or free floating exchange rates. The third section reviews the modalities and extent of FX intervention in selected emerging market and advanced economies, with a view to illustrating cases where central banks follow some rule of FX intervention or practice discretion. It also reviews evidence on FX reserve volatility across countries. There is tentative evidence that the volatility of FX reserves is lower in emerging market economies where central banks follow some form of rules-based FX intervention.

The fourth section draws on simple microeconomic theory presented in Basu (2012) and shows that by appropriately designing the modalities of intervention, the acts of influencing the exchange rate and managing the stock of FX reserves can be separated from each other. When the foreign exchange market includes some big strategic participants, the central bank can influence the exchange rate without necessarily accumulating or drawing FX reserves, if it follows a “schedule intervention,” known to everyone, which conditions interventions on market values of the exchange rate. This is consistent with the stylized facts reviewed regarding the lower volatility of FX reserves when central banks follow some form of intervention rule. The last section discusses the policy implications of the analysis.

## **2. Objectives and Modalities of FX Intervention**

In many emerging market economies, the objectives of FX intervention have evolved along with a gradual change in their exchange rate regimes and frameworks for monetary policy. An increasing number of emerging economies, especially after the East Asian financial crisis, moved away from pegged or tightly managed exchange rate regimes (exchange rate crawls or bands) to flexible exchange rates. At the same time, they adopted inflation targeting, with short-term interest rates used as the main policy instrument to achieve the inflation targets. Under this monetary policy framework, the inflation target serves as a nominal policy anchor while the flexible exchange rate serves as a shock absorber to the economy and an information variable to the monetary authorities, rather than a policy variable.

The objectives of FX intervention have changed over time: From stabilizing the exchange rate—as in exchange rate pegs, crawls, or bands—to containing excessive exchange rate volatility and preventing movements that appear to be inconsistent with fundamentals (exchange rate misalignment). Despite the move toward inflation targeting and flexible exchange rates, there is evidence that inflation-targeting central banks in emerging market economies intervene actively in FX markets, although less so than those central banks which do not explicitly target the inflation rate (Ostry, Ghosh, and Chamon, 2012). The rationale for intervening in the FX market to contain volatility and misalignment is that the exchange rate may not only absorb shocks but also generate shocks. This may happen when the exchange rate fluctuates because of sudden capital flow swings, changes in market confidence, or contagion, unrelated to economic

fundamentals. Cognizant of such risks and their potentially destabilizing impact, central banks often intervene with the aim of building sufficient buffers of FX reserves, despite exchange rate floating, so as to be in a position to better resist the consequences of unforeseen shocks. Even in the case of inflation-targeting central banks, if large deviations of the exchange rate from medium-term fundamentals have to be contained, the use of sterilized FX intervention as a supplementary policy instrument would be justified, along with the use of the interest rate as a primary instrument geared toward the inflation target (Ostry, Ghosh, and Chamon, 2012).

Although, as mentioned, this paper is not concerned with the rationale behind the central bank's interventions, it is useful to briefly summarize the several objectives often sought by central banks when they intervene under floating exchange rates (see also Moreno, 2005; Shogo et al, 2006; Basu and Morita, 2006):

- i. **Containing volatility:** High exchange rate volatility can be costly to foreign trade and undermine inflation targets. There is evidence that exchange rate pass-through to inflation is relatively high in developing countries (Hausmann, Panizza and Stein, 2001). Moreover, because of imperfect competition in product markets, exchange rate fluctuations may affect prices asymmetrically, with depreciations reflected in price increases more than appreciations are reflected in price decreases. Among 22 emerging market central banks surveyed by the Bank for International Settlements (BIS) over 2000-04, 48 percent intervened to dampen volatility (BIS, 2005).
- ii. **Preventing exchange rate misalignment:** Persistent exchange rate overvaluation may undermine the economy's external competitiveness, while undervaluation may cause overheating and inflation. Among the central banks surveyed by BIS, 28 percent intervened to prevent misalignment.
- iii. **“Leaning against the wind”:** While central banks intervene with the aim of reversing exchange rate trends, they are also often concerned with slowing the pace of exchange rate fluctuations without reversing the underlying trend. Reduced market uncertainty is seen as a benefit of this practice.

- iv. Countering disorderly FX markets: Liquidity shortages in FX markets can threaten currency convertibility and trigger financial stress. Among the central banks surveyed by BIS, 41 percent had intervened to supply liquidity to thin FX markets.
  
- v. Managing FX reserves: Reserve accumulation has often been a central bank priority, especially in the aftermath of currency crises—as, for example, in Turkey in 2001 and South Africa in 2002. A key objective has been to ensure an adequate level of reserves against debt repayment obligations and bolster market confidence. Another objective is to build sufficient buffers against volatility of capital flows and market contagion. However, correcting excessive reserve accumulation can also be an aim of FX intervention, as holding excessive reserves entails quasi-fiscal and opportunity costs. When pursuing goals of FX reserve management, central banks seek to minimize the impact on the exchange rate, contrary to the other objectives of FX intervention where a maximum impact on the exchange rate is generally sought.

To ensure consistency with the broader objectives of monetary policy, central banks usually need to sterilize FX interventions. This is done through changes in their net domestic asset positions (by issuing interest-bearing liabilities; selling government bonds; issuing reverse repos) that offset changes in their net FX position resulting from FX interventions. However, sterilization entails a quasi-fiscal cost, equivalent to the interest paid on the liabilities used by central banks to insulate the monetary base from FX interventions. Sterilization costs can be non-negligible: An IMF study estimated the average cost of FX interventions in six Latin American countries over 2004-10 at 0.5 percent of GDP (Adler and Tovar, 2011).

Intervention typically takes place in the spot FX market because this market is more liquid than forward FX markets, which helps the objective of influencing the spot exchange rate or managing the outstanding stock of FX reserves. Some central banks also practice interventions in forward markets—the markets for currency delivery in more than two business days. As the forward FX price is linked to the spot FX price through the “covered interest parity” condition,



forward market intervention can influence the spot exchange rate as well.<sup>2</sup> But in contrast to spot market interventions, forward market interventions do not require immediate funding because payment takes place when the transaction is completed at a future date with the purchase or the sale of the foreign exchange. Forward market intervention can thus be conducted discretely, with little impact on FX reserves, as long as the factor that triggers the intervention is short-lived. Influencing the spot exchange rate without affecting the level of FX reserves is also a feature of the strategic approach to intervention outlined in this paper (Section 4), although the mechanism is very different from forward market intervention. The Bank of Thailand used forward market sales of FX to prop up the currency early in the East Asian financial crisis. The Reserve Bank of South Africa and the Reserve Bank of India have on occasions resorted to forward market FX intervention, along with other central banks.<sup>3</sup> FX options have also been used tactically by some central banks (Mexico, Colombia, Chile), mainly with the aim of accumulating FX reserves with minimum disruption in the spot FX market (see below).

Most central banks exercise discretion in determining when and in what amount to intervene, usually releasing actual transaction data with a lag (if at all). Discretion allows central banks to evaluate market conditions and keep room for tactical maneuvering. It is commonly argued that although intervention rules may be useful as rules of thumb, discretion may be preferable as rules might be unnecessary in the presence of other nominal anchors (such as inflation targeting). It is sometimes argued that market participants can possibly take advantage of intervention rules to speculate against the central bank (Shogo et al, 2006).

However, some central banks also use forms of rules-based intervention:

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<sup>2</sup> Covered interest parity can be illustrated by considering the options open, for example, to an investor who can hold either a US\$ or a euro-denominated asset for one year. Holding the US\$-denominated asset yields a return of  $1+R_{\$}$  per US\$ (where  $R_{\$}$  is the interest rate on the US\$ asset). Investing an equal amount of US\$ into euro-denominated assets, at the spot exchange rate of  $S$  euros per US\$, would yield a return of  $(1+R_{e})\cdot S$  in euros per dollar invested. If the investor contracts to convert the proceeds back into US\$ in one year at the prevailing euro-per-dollar forward exchange rate  $F$  at the beginning of the investment period, the expected return per dollar would be  $(1+R_{e})\cdot(S/F)$ . Covered interest parity (CIP) establishes no-arbitrage (equality) between the returns under the two strategies:  $1+R_{\$} = (1+R_{e})\cdot(S/F)$ . If CIP holds, FX intervention that changes the forward market exchange rate should also be reflected into a proportional change in the spot exchange rate.

<sup>3</sup> According to a central bank survey reported in C.J. Neely (2000), 52.9 percent of 17 responding central banks were sometimes intervening in the forward FX market. This percentage was lower in the survey reported by BIS (see Archer, 2005).

- i. Quantity-based rules typically preannounce a volume of interventions over a certain period, usually to achieve some reserve accumulation target. Such rules have been used in Mexico after the 1994 peso crisis; in Turkey after the 2002 crisis; and in Chile in 2011.
- ii. Exchange-rate based rules specify the type of intervention to be triggered by some exchange rate development, usually with the aim of containing volatility. Such rules have been used by Colombia, Mexico, and Guatemala. These come to some extent close to the concept of “schedule intervention” outlined in the theory of strategic intervention below (Section 4).

Rules often aim to increase visibility of FX interventions so as to strengthen the signaling channel of policy and achieve FX reserve targets with minimum market noise. The signaling channel assumes that central banks possess superior information than market participants, which is revealed through FX intervention. This additional information changes the expectations of market participants—including about future monetary policies—and affects exchange rates through the forward-looking FX market (Sarno and Taylor, 2001). If the signaling channel is sufficiently strong, central banks have an incentive to clearly communicate their intentions by following some form of FX intervention rule. By affecting perceptions of market participants, intervention rules may thus possibly change exchange rates with minimum transactions taking place. This possibility will be theoretically demonstrated below.

### **3. The Nature of FX Intervention in Selected Countries and Some Stylized Facts**

This section reviews the modalities and extent of FX intervention in selected emerging market economies and high-income economies. Emerging market economies have been selected so as to illustrate cases where central banks follow some rule of FX intervention (Mexico, Colombia, Turkey) or practice discretionary intervention (India). Central banks of advanced economies that manage major reserve currencies (US Fed, ECB) generally do not intervene in the FX market. The specific cases of Japan and Switzerland are discussed as they present notable exceptions to this practice.

### 3.1. Mexico

Mexico has been operating a free floating exchange rate regime since the peso crisis in 1994. The Bank of Mexico (BOM) occasionally intervenes in the FX market to mitigate exchange rate volatility and manage FX reserve buffers. Bank of Mexico intervention has relied on both indirect and direct, rules-based mechanisms, with relatively little use of discretion. Indirect intervention has consisted in diverting large FX operations by public entities—especially the national oil company Pemex—from the FX market so as to mitigate their impact on the exchange rate. Pemex FX earnings from oil exports have been used to service directly external public debt, with the balance reflected in FX reserve accumulation. As Pemex’s FX earnings have usually exceeded the federal government’s external debt servicing needs and have not been channeled to the FX market, the appreciation of the exchange rate was arguably mitigated and the central bank ended up accumulating a growing stock of FX reserves.<sup>4</sup>

Direct intervention has been conducted since 1996 through exchange rate-based rules, initially, to build up reserves in the aftermath of the peso crisis; later with the aim of slowing down the accumulation of reserves. The rule granted to market participants the right to sell a certain amount of US dollars to the central bank, by auctioning FX put options on a monthly basis. The holders of the options could sell dollars to the central bank provided the dollar exchange rate of the peso the day before the exercise of the option was more appreciated than the 20-day moving average of the spot exchange rate. This condition mitigated the risk of loss because BOM would not be bound to buying dollars through the exercise of the options if the peso had depreciated compared to its 20-day moving average (which would also further depreciate the peso). The rule operated from 1996 to 2001 and again from February 2010 to October 2011. It enabled BOM to build FX reserves with minimum interference with the functioning of the market as BOM purchased US\$ when there was ample supply (i.e., when the peso was strong) while refraining from doing so when there was a shortage of US\$ in the market (Sidaoui, 2005). This rule

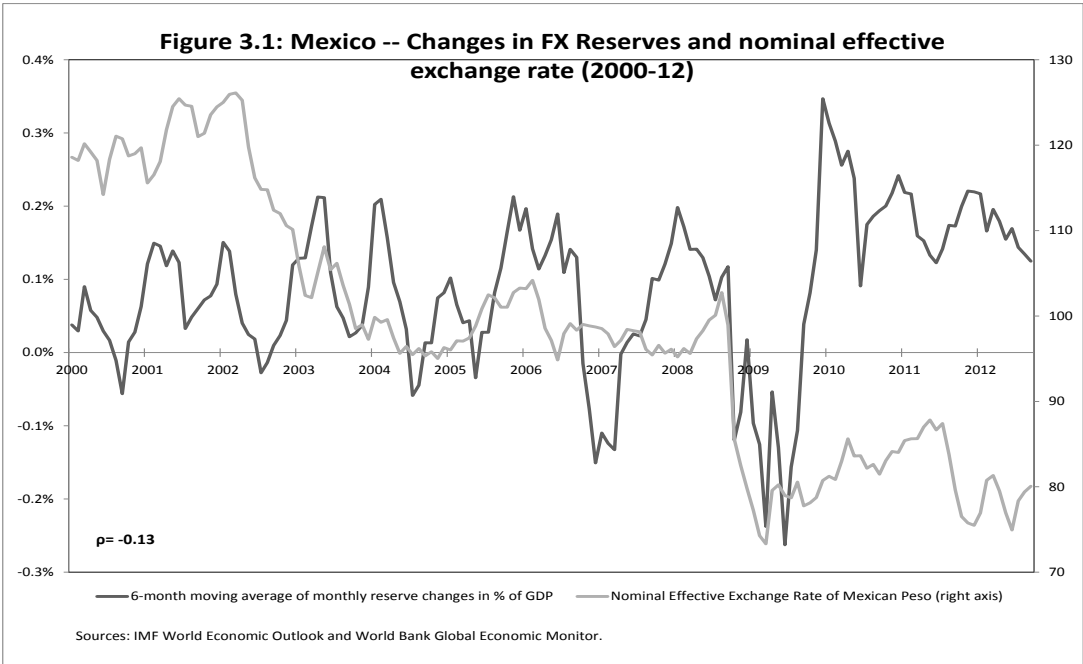
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<sup>4</sup> It can be argued that the accumulation of export earnings by primary commodity exporting countries in sovereign wealth funds invested abroad is a form of indirect FX market intervention as it deflects sizeable sums of FX earnings from the FX market, thus mitigating the appreciation of the domestic currency and the need to accumulate FX reserves. Norway is an example that illustrates this point. The size of the sovereign wealth fund (Norwegian Government Pension Fund Global) managed by the central bank was the equivalent of US\$ 649 billion at the end of 2012. In comparison, FX reserves stood at US\$ 44.5 billion (comprising both a money market and a long-term portfolio).

followed by BOM, which conditioned FX interventions to exchange rate values in the FX market, comes conceptually close to the theory of schedule intervention explored below.

Significant accumulation of FX reserves prompted the BOM to introduce, in May 2003, a reverse quantity-based rule aimed at slowing the pace of reserve accumulation. According to this rule, a preannounced amount of FX reserves was to be sold every quarter, through evenly distributed daily auctions, equivalent to 50 percent of the reserves accumulated in the preceding quarter. In addition to the rules-based intervention, if necessary, due to market conditions, the BOM reserves the right to organize unscheduled FX auctions, which it has not done since January 2009.

There is no significant correlation between changes in BOM FX reserves and the peso nominal effective exchange rate (Figure 3.1). This may partly reflect the focus of FX interventions on reserve management, as opposed to mitigating exchange rate volatility. It may also partly reflect the accumulation of FX reserves through excess Pemex export earnings, which were diverted from the FX market and thus did not affect the exchange rate.



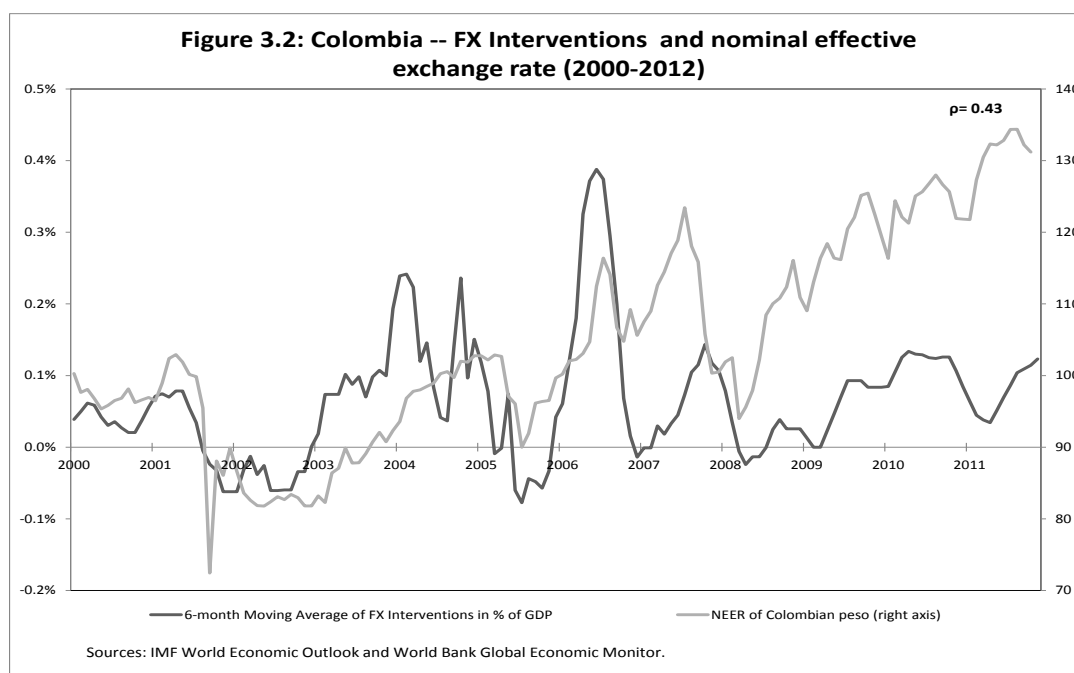
### 3.2. Colombia

Colombia operates a floating exchange rate regime. The central bank (Banco de la Republica) intervenes in the FX market to manage the level of international reserves, limit excessive exchange rate volatility, and influence the speed of adjustment of the nominal exchange rate. The central bank uses exchange rate-based rules for FX intervention through auctions of FX options—a program first introduced in 1999 after the adoption of floating and inflation targeting. There are two types of interventions through FX options that operate symmetrically: (i) Auctions of FX options that target both accumulation and reduction of FX reserves; and, (ii) auctions of FX options aiming to prevent excessive exchange rate depreciations or appreciations, inconsistent with the inflation target (Uribe and Toro, 2005).

The mechanism of FX options to accumulate (or reduce) FX reserves is similar to the one used by the Bank of Mexico but operates symmetrically with put and call options. Auctions of put (call) grant the holder the right to sell (buy) FX to (from) the central bank provided that when the option is exercised the exchange rate has appreciated (depreciated) compared to its 20-day moving average. Auction amounts are set at discretion by the central bank. On the other hand, the mechanism to dampen exchange rate volatility consist in auctions of put (call) FX options that grant the holder the right to sell (buy) FX to (from) the central bank. These auctions are respectively held on days when the exchange rate has appreciated (depreciated) more than 4 percent compared to its 20-day moving average. The option strike price is the market exchange rate at the exercise date of the option. As in the case of Mexico, Colombia’s FX intervention rules come relatively close to the theoretical concept of “schedule intervention” outlined below.

Since 2000, the central bank has been mostly purchasing FX through its interventions. The amount of purchases peaked at the equivalent of 0.4 percent of GDP in 2006-07, while periods of FX sales were relatively short (Figure 3.2). Interventions were thus apparently conducted with the aim of “leaning against the wind,” in view of the long-term appreciation trend of the peso. There is also a significant positive correlation between FX interventions and the nominal effective exchange rate of the peso. This suggests a focus on mitigating exchange rate volatility, as the central bank has tended to step up FX purchases when the exchange rate appreciated and,

conversely, refrained from FX purchases, or sold foreign currency, when the exchange rate was under pressure to depreciate.



### 3.3. Turkey

Turkey too operates a floating exchange rate regime with inflation targeting. The Central Bank of the Republic of Turkey (CBRT) reserves the right to intervene to mitigate exchange rate volatility and manage foreign exchange reserves. A strong foreign exchange reserve position has been consistently stated as a prime CBRT objective, especially in the aftermath of the 2001 economic crisis when Turkey switched the lira’s crawling peg to floating (February 2001). When accelerated reserve accumulation is deemed necessary, CBRT holds FX buying auctions under preannounced terms and conditions (Ozatay, 2005). The program was first put in place in 2002 to build up the FX reserve position with minimum interference in exchange rate movements. In addition, CBRT holds FX selling auctions when it deems necessary to provide liquidity to the market. Auction programs may be complemented by discretionary intervention. The CBRT publishes the results of its daily FX auctions.

In September 2011, the CBRT introduced a new instrument, the Reserve Option Mechanism (ROM), as a complementary tool to mitigate the impact of volatile capital flows on the exchange

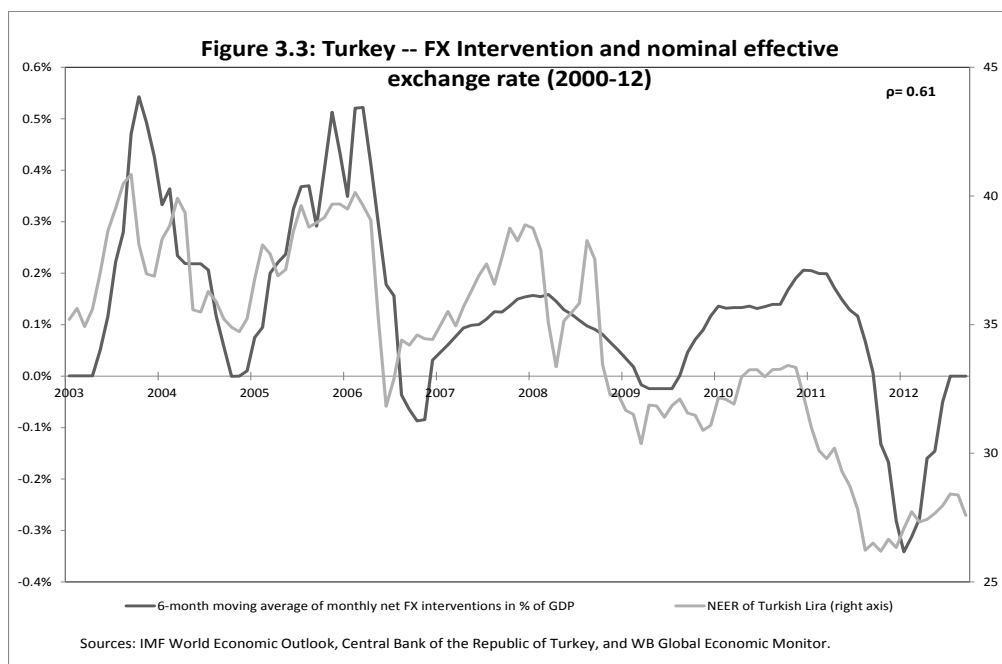
rate and the domestic supply of credit.<sup>5</sup> The ROM provides banks the option of holding up to a fraction of their required reserves in FX or gold, according to a “reserve option coefficient” (ROC) that sets the amount of reserves in FX or gold needed per unit of Turkish lira (TL) of required reserves (Alper, Kara, and Yorukoglu, 2012). Individual banks are expected to optimize the use of ROM with reference to their relative funding costs in FX and TL. These costs vary with the size of net capital flows: When capital inflows are abundant, FX funding costs are low, while when capital outflows intensify shortages of FX raise FX funding costs.

The ROM thus operates as a stabilizer of the FX market in the face of capital flow volatility: When capital inflows are high (funding costs in FX are low), a fraction of FX liquidity is withdrawn by the banks from the FX market and converted into reserves with CBRT, thus containing exchange rate appreciation. Conversely, when capital outflows increase (relative funding costs in FX are high), a fraction of FX balances held by banks as reserves with CBRT is converted back into TL and released into the FX market, thus limiting exchange rate depreciation. The ROM has an effect similar to rules-based, unsterilized FX interventions to the extent it withdraws (supplies) FX liquidity when capital net inflows are high (low). It could thus limit the need for preannounced or discretionary FX intervention to smooth exchange rate volatility.

Foreign exchange intervention in Turkey was significant in the first half of the 2000s, approaching 0.5 percent of GDP in 2004 and 2006 (Figure 3.3). The central bank intervened at a smaller scale, before and after the global financial crisis, to counter appreciation of the TL, and again from mid-2011 to mid-2012, by selling foreign exchange, in response to depreciation pressures on the TL. There is a significant positive correlation between FX interventions and the nominal effective exchange rate, higher than in Colombia, indicating a focus on mitigating exchange rate volatility.

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<sup>5</sup> The ROM was introduced as part of a series of “unconventional” measures the CBRT started taking in the fall of 2010 to mitigate the impact of a post-crisis surge in capital inflows on the exchange rate, credit growth, and financial stability. In October 2010, the CBRT resorted to an unconventional combination of lower interest rates and higher required reserve ratios to discourage short-term capital inflows and curb domestic credit growth. This policy failed to achieve its goals because of continuing unchecked provision of liquidity to banks through the repo window. The framework was amended in October 2011, with a tightening of liquidity provision, an increase in interest rates, and the introduction of ROM.



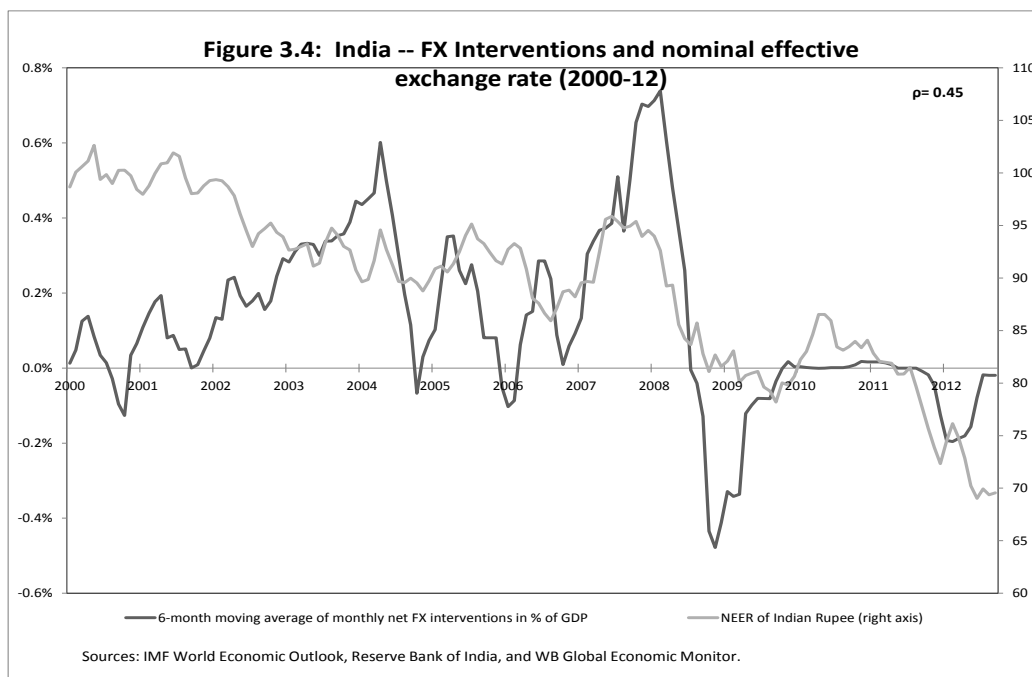
### 3.4. India

India operates a floating exchange rate regime. The Reserve Bank of India (RBI) has no fixed or preannounced target or band for the exchange rate. The RBI intervenes in the interbank FX market in a discretionary manner, with the aim of modulating excessive volatility and maintaining orderly market conditions. As persistent unidirectional movements of the exchange rate tend to amplify expectations of one-way movements, FX intervention aims at times to moderate speculative expectations of such movements (Gokarn, 2012). The RBI intervenes in both the spot and forward interbank FX markets depending on market conditions. It deals only with authorized dealers and publishes monthly intervention data.

The nominal effective exchange rate of the rupee followed a moderately depreciating trend over 2000-07. The rupee depreciated substantially as a result of “flight to safety” at the onset of the 2008-09 global financial crisis and, again, during the turmoil unleashed by the Eurozone crisis in mid-2011 (Figure 3.4). Overall, there is a significant positive correlation between the effective exchange rate and FX intervention, indicating that the central bank has been intervening with the objective of smoothing exchange rate fluctuations and doing so successfully. Intervention in the FX market in India did not attempt to reverse fundamental exchange rate trends. Most often, during the first sub-period of relative exchange rate stability (2000-07), the RBI conducted net



purchases of foreign exchange, with occasional sales in response to short-lived depreciation pressures. The amount of net FX purchased reached the equivalent of 0.7 percent of GDP in 2007.



More recently, since August 2011, the RBI has intervened in FX markets in response to depreciation pressures, but has not attempted to change the direction of exchange rate movements. During the recent turmoil, from August 2011 to August 2012, the RBI conducted a combination of spot and forward FX market intervention. Direct sales in the spot market amounted to over US\$ 20 billion from September 2011 to March 2012—reaching about 0.2 percent of GDP (Figure 3.4). From April to August 2012, the RBI intervened mainly in the forward FX market, with outstanding net FX sales approaching US\$ 15 billion in June and July 2012. During this period, when intervention in the forward market was prevalent, FX sales in the spot market were kept to a minimum.

### 3.5. Advanced Economies

Japan and Switzerland illustrate cases of advanced economy central banks that have practiced various degrees of FX intervention. *Japan* operates a floating exchange rate but the authorities have frequently intervened to counter disorderly conditions in the market, and often with the aim

of slowing or reversing the appreciation of the yen. Contrary to common practice, interventions fall within the mandate of the Ministry of Finance (MOF), which publishes daily intervention amounts. The Bank of Japan (BoJ), acting as agent of the MOF, intervenes in the FX market through financial institutions and/or brokers.

Foreign exchange intervention was particularly frequent in 1992-95 and 2003-04. The BoJ intervened on 18 and 39 percent, respectively, of working days during these periods, mostly with net FX purchases (Marwa, 2012). Intervention was relatively infrequent from 1996 to 2002 and from 2005 to 2009. Intervention to counter excessive appreciation of the yen was mainly motivated by the deflation that Japan confronted from 1991 to 2003, further to the collapse of the real estate market. With interest rates cut to nearly zero and as successive rounds of quantitative easing failed to decisively lift the economy from deflation, depreciating the exchange rate of the yen was a last-resort means of boosting export-driven growth. Since 2004 intervention has been less frequent. For the first time since 2004, the MOF intervened in September 2010, and subsequently in March 2011, following the earthquake and tsunami, in coordination with other G7 countries, to weaken the yen.<sup>6</sup> The MOF intervened again in August 2011 and in October-November 2011 to address excess volatility and appreciation of the yen due to the financial turmoil.

In *Switzerland*, the free-floating exchange rate regime was reclassified by the IMF as managed float as of September 6, 2011, reflecting official action to influence the exchange rate of the Swiss franc vis-à-vis the euro. The Swiss franc had been subject to sharp appreciation as a result of a “flight to safety” in the aftermath of the 2008-09 global financial crisis and the Eurozone debt crisis. In March 2009, the Swiss National Bank (SNB) announced its intention to buy foreign exchange to prevent the SwF from appreciating. By the end of June 2010, when the SNB suspended intervention, it had purchased the equivalent of US\$ 179 billion, amounting to 33 percent of Swiss GDP. Appreciation recurred as a result of the mid-2011 financial market turmoil. On September 6, 2011, to combat what was perceived as massive overvaluation of the franc, the SNB set a minimum exchange rate of SwF 1.20 per euro and committed to maintaining

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<sup>6</sup> The appreciation of the yen in the wake of the March 2011 earthquake is attributed to the repatriation of reserves by Japanese insurance companies and to the closing of carry-trade positions in which yen borrowing is used to finance investment and lending abroad (Neely, 2011).

the limit by buying unlimited amounts of euros. The SwF did not appreciate beyond this limit but SNB's FX reserves ballooned from about SwF 200 billion prior to September 2011 to SwF 424 billion in October 2012, turning Switzerland into one of the biggest FX reserve holders in the world.<sup>7</sup>

### **3.6. Modalities of FX Intervention and Volatility of FX Reserves**

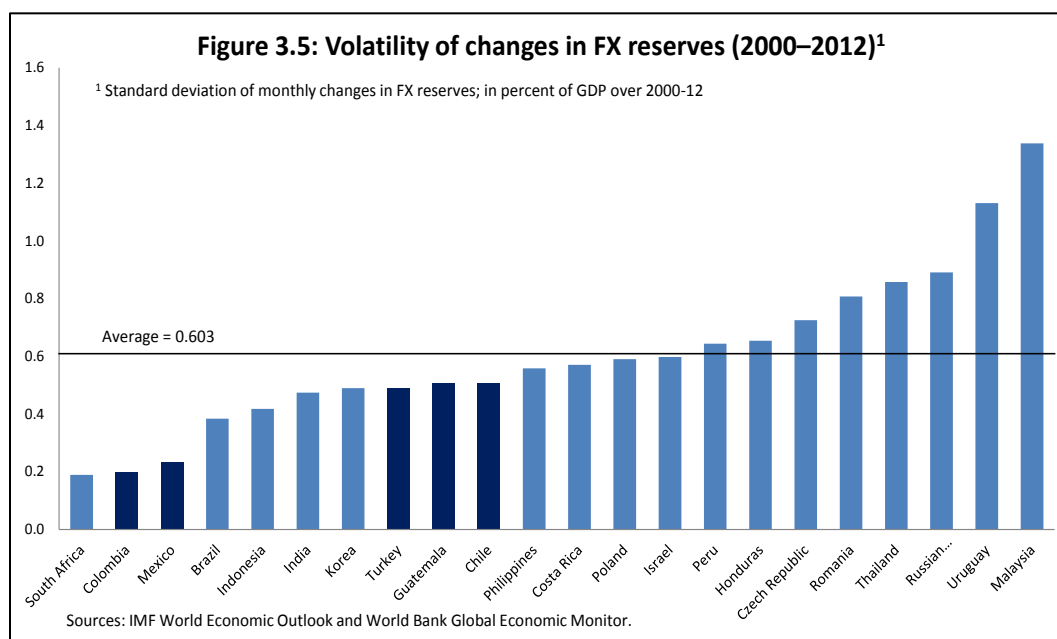
Is there an association between the way central banks intervene and the volumes of FX intervention? Although systematic knowledge of central bank practice in FX markets is often limited, differences in volumes of FX intervention (scaled by GDP) can be significant, as suggested by a cursory look at the countries reviewed above. Comparison of volumes of FX intervention across countries is difficult because of the paucity of central bank intervention data. A common practice in empirical studies has been to use changes in gross FX reserves as a proxy for FX intervention. This approximation is imperfect because, in addition to FX intervention, changes in FX reserves also reflect valuation effects from changes in exchange rates, income flows (accrual or payment of interest), and FX operations of the central banks on behalf of other government entities. Correlations of actual volumes of intervention (when available) with changes in gross FX reserves are generally low at high frequency data (daily or weekly). However, at lower frequencies (monthly data) changes in FX reserves provide a reasonable approximation of FX intervention (Adler and Tovar, 2011). Correlations between monthly FX interventions and changes in FX reserves for the countries reviewed above are significant: India=0.84; Colombia=0.77; Turkey 0.43.

The volatility of changes in gross FX reserves—measured by the standard deviation of monthly changes over 2000-12 scaled by GDP—varies broadly across countries (Figure 3.5). Volatility ranged from 0.2 percent of GDP in South Africa, Colombia, and Mexico, to around 1.3 percent of GDP in Uruguay and Malaysia, with an average of 0.6 percent. A stylized fact in this comparison is that where central banks practiced some form of rules-based FX intervention (Mexico, Colombia, Guatemala, Chile); or preannounced intervention (Turkey), the volatility of changes in FX reserves was below the average for the 22 countries considered.

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<sup>7</sup> The top ten FX reserve holders, based on 2011 data, were: China; Japan; Saudi Arabia; Russia; Brazil; South Korea; Hong Kong SAR, China; Switzerland; India; and Singapore. The SNB now holds 60 percent of its FX reserves in euros.

The evidence seems thus to suggest that discretionary FX intervention is associated with larger volumes of intervention, and thus higher variability of FX reserves, compared to rules-based intervention. This stylized fact would be consistent with the signaling channel for the transmission of the effects of FX intervention analyzed in the literature: To the extent rules improve the visibility of central bank intentions they may affect the perceptions of market participants and thus change exchange rates with relatively lower volumes of intervention.<sup>8</sup> This tentative evidence would also be consistent with a microstructure of the FX market that includes some big strategic players. If the central bank could direct these players to a desired equilibrium exchange rate through a preannounced schedule of intervention contingent on market outcomes, it could affect the exchange rate with low volumes of intervention. This theoretical model of strategic central banking is analyzed in the next section.

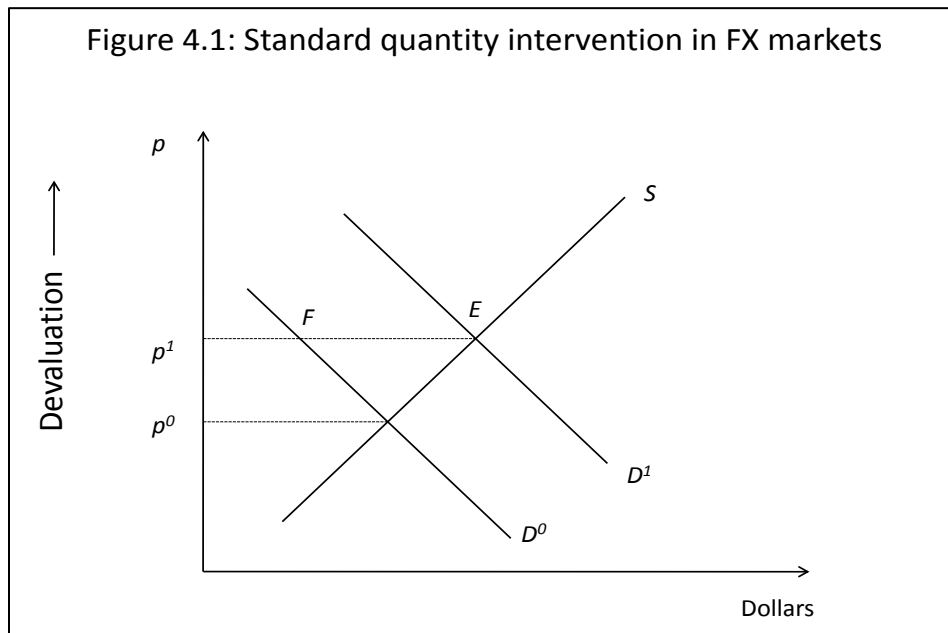


<sup>8</sup> An equivalent stylized fact could be that, for a given level of FX intervention, the impact on the exchange rate would be stronger when the central bank uses an exchange rate-based FX intervention rule than when it intervenes with discretion. A study by Adler and Tovar (2011) examined the impact of FX intervention through an empirical exchange rate model on a panel of 15 countries over six common episodes when flows into emerging markets were high or rising strongly. The regressions found evidence that FX intervention affects the pace (acceleration) of exchange rate appreciation but not the rate (speed) of appreciation. When the regression controls for discretionary vs. rules-based central bank intervention, the estimated impact of intervention on the pace of exchange rate appreciation is higher when intervention is rules-based than when it is discretionary, although the difference is not significant.

#### 4. Theory of Strategic Intervention by Central Banks

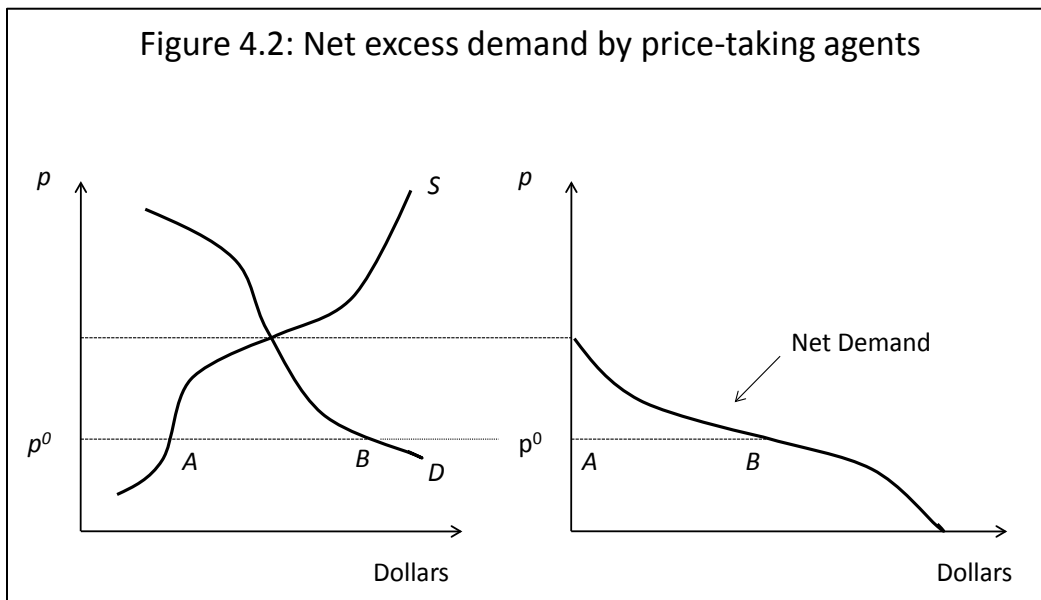
What we want to demonstrate in this section is what was suggested by the above discussion, namely, that a central bank can be much more effective in its interventions in the FX market if it adopts a different kind of intervention from the standard ones used. To demonstrate this let us begin by explaining the logic behind the standard “quantity intervention” typically used by central banks, when they want to influence the market exchange rate.

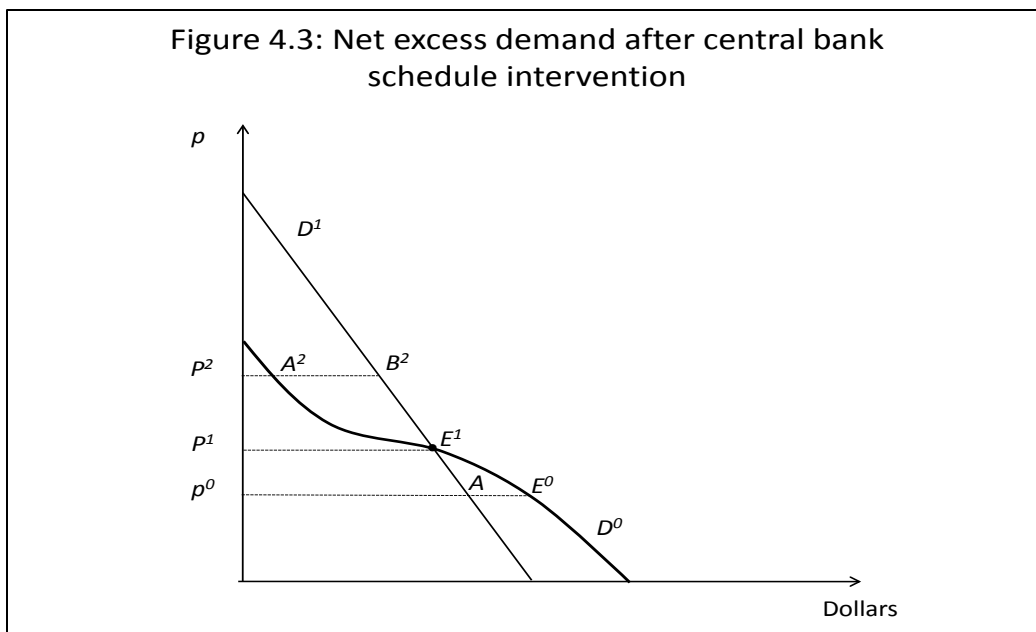
Suppose the demand and supply of a foreign currency (henceforth, dollars) is shown by the curves  $D^0$  and  $S$  in Figure 4.1. The vertical axis expresses the price of dollars in terms of the domestic currency (henceforth, rupees) and the horizontal axis shows the quantity of dollars. Given these demand and supply curves, the price of dollars (in rupee terms), or the exchange rate, is given by  $p^0$ . Suppose the central bank decides to depreciate the rupee to  $p^1$ . A natural way to do this is to demand more dollars. If it demands  $FE$  dollars, the demand curve will shift from  $D^0$  to  $D^1$ . As a result, the equilibrium exchange rate moves to  $p^1$ . It is easy to see that while the quantity intervention (buying an amount  $FE$  of dollars) will succeed in depreciating the rupee, this would entail buying up additional foreign exchange equal to  $(FE \times p^1)$  dollars.



Is this necessary? The answer is no and that is what is demonstrated below. The analysis just concluded assumes a competitive market. Each agent, whether she is buying or selling dollars, is treated as a price-taking (in this case, exchange rate-taking) agent. In reality, in most FX markets there will be many small, price-taking agents, but also large players who, like Cournot oligopolists, can affect the exchange rate. So, suppose now that, as before, there are some price-taking buyers and sellers of dollars. They have the demand curve  $D$  and supply curve  $S$  as shown in the left panel of Figure 4.2. This gives rise to the net demand curve for dollars as shown in the right-hand panel of Figure 4.2. This net demand is reproduced in Figure 4.3 as  $D^0$ . Assume now that there are  $n$  large Cournot firms that supply dollars on this market. Suppose they buy dollars on some faraway international market at price  $c$  and sell it domestically.

Let  $E^0$  depict the Cournot equilibrium of these  $n$  firms. Suppose now the central bank decides it wants to depreciate the currency from  $p^0$  to  $p^1$ , as shown in Figure 4.3. Is it necessary for the central bank to buy dollars to achieve this? The answer, interestingly, is no. To see this, denote by  $E^1$  the point on the original (net) demand curve  $D^0$  that happens to be at the same height as  $p^1$ . The standard theory of oligopoly shows, and this is established in Basu (2012), that if we pivot the demand curve suitably around the point  $E^1$ , we can ensure that the Nash equilibrium of the Cournot players will occur at  $E^1$ .





To get an intuitive idea of the proof, consider the case where there are only two Cournot firms and the cost of supply is zero. It is well-known and easy to check that in this case, if the demand curve is linear, then the Cournot equilibrium is at a point located at two-thirds of the length of this line starting from the top end. That being so, for any point on the demand curve  $D^0$  in Figure 4.3 the Cournot equilibrium can be directed there by having a demand curve which is a straight line and for which the point at two-thirds the line's length occurs there.<sup>9</sup> Hence, if starting from  $E^0$ , the central bank wants to deflect the equilibrium to  $E^1$ , it has to pivot and straighten the demand curve to  $D^1$ , which is such that point  $E^1$  is at two-thirds of the length of this line from the top end. It is now clear what the central bank has to do. It has to commit to buying and selling dollars at different exchange rates such that the demand curve confronted by the large foreign exchange dealing firms is  $D^1$ . In other words, it has to announce that if the exchange rate is  $p^0$  it will sell  $AE^0$  dollars; if the exchange rate is  $p^2$  it will buy  $A^2B^2$  dollars, and so on. This is what a “schedule intervention” is and it contrasts with the traditional “quantity intervention”. It entails buying or selling a certain amount of foreign exchange with conditioning this on the exchange rate.

<sup>9</sup> In case the cost of supply is  $c$ , what is being established is that the exchange rate can be shifted to any level greater than or equal to  $c$ , with no change in FX reserves.

Note that once the central bank makes the schedule intervention and moves the demand curve to  $D^1$  equilibrium exchange rate will be  $p^1$ . At that rate the central bank does not buy or sell dollars. In other words, the exchange rate will have been moved with the announcement of the intention to accumulate or drain specific amounts of reserves at various exchange rate levels.

## **5. Discussion and Policy Implications**

As we have argued, standard quantity intervention in the FX market, even if effective in influencing the exchange rate and achieving the objectives pursued by central banks, leads to a building up or running down of FX reserves. This entails costs and risks: To the extent a reserve build-up is not fully sterilized, it may boost domestic liquidity and undermine inflation targets. At the same time, full sterilization comes with quasi fiscal costs, in addition to the opportunity cost of holding low-yield FX reserves. Conversely, an excessive decline of reserves to prevent the currency from depreciating may lead market participants to question reserve adequacy and trigger speculative attacks. Thus, except when the purpose of FX intervention is to manage FX reserves, it is desirable to achieve the exchange rate objectives sought with minimum variation in FX reserves. Our paper demonstrates that this is possible.

As demonstrated above, when the foreign exchange market includes some big strategic participants, the central bank can achieve superior outcomes if intervention takes the form of a “schedule”, indicating commitments to buying and selling different quantities of foreign currency conditional on the exchange rate. This would enable a central bank to pursue exchange rate objectives with minimum reserve changes, or achieve reserve targets with minimum impact on the exchange rate.

An implication of the theory of strategic intervention is that if some central banks were to use schedule intervention they would be expected, all else equal, to intervene less in the FX market compared to central banks that intervene with discretion. Even though no central bank currently intervenes according to the modalities explored in this paper, rules-based intervention used by some central banks comes close to the concept of “schedule intervention”. The theory of



strategic intervention accounts for the stylized fact that FX reserves are less volatile in countries where central banks follow some form of rules-based intervention.

A question that arises when considering practical implementation is whether schedule intervention could work symmetrically, when a central bank signals its readiness to buy foreign exchange to prevent exchange rate appreciation and when it signals a commitment to selling foreign exchange to avert depreciation. While the central bank's capacity to purchase foreign exchange is virtually unlimited, its ability to prevent undue exchange rate depreciation by selling foreign exchange could be limited by its stock of foreign exchange reserves—possibly augmented by currency swaps that provide extra foreign exchange liquidity, arranged with other central banks. The credibility of schedule intervention aimed to prevent excessive exchange rate depreciation could thus be limited by the stock of foreign exchange reserves. However, the very large cushions of foreign exchange reserves accumulated by many countries in recent years could mitigate such credibility concerns. This being said, the credibility of a fundamentally misaligned exchange rate would come necessarily into question, because the misalignment would affect the performance of the economy as a whole, so that schedule intervention—as, in fact, any kind of standard quantity intervention—could only postpone the inevitable day of reckoning.

Converting the theory of schedule intervention outlined in this paper into practice will require time and significant empirical work. A key step toward operationalization would be a reliable estimation of the net FX demand, based on the FX market microstructure, which would allow calibrating the schedule intervention function. Proceeding by trial and error would be unavoidable as it is unrealistic to expect a precise enough estimation of the intervention needed at each exchange rate level to achieve a specific FX market outcome. However, undertaking some risk may pay off by helping discover superior policy instruments.

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