68420

ECONOMIC AND SECTOR WORK

RESPONDING TO HIGHER AND MORE VOLATILE WORLD FOOD PRICES

MAY 2012

THE WORLD BANK

REPORT NUMBER 68420-GLB

ECONOMIC AND SECTOR WORK

RESPONDING TO HIGHER AND MORE VOLATILE WORLD FOOD PRICES

REPORT NO. 68420-GLB

THE WORLD BANK

ARD
AGRICULTURE AND RURAL DEVELOPMENT

Cover Photo: Tran Thi Hoa/World Bank.

TABLE OF CONTENTS

LISTS OF FIGURES, TABLES, AND BOXES

FIGURES

TABLES

BOXES

ACKNOWLEDGMENTS

This report was prepared within the World Bank's Agriculture and Rural Development Department (ARD) by a team composed of Robert Townsend, Sergiy Zorya, Iride Ceccacci, Saswati Bora, and Christopher Delgado. It has benefited from the experience and feedback of numerous World Bank staff, including regional and central unit staff working on agricultural and rural development issues, and members of the World Bank's Rural Policies Thematic Group. It draws on the Development Committee paper of the Governors of the World Bank and the International Monetary Fund (IMF) in April 2011 prepared by the same team that benefitted from extensive review within the World Bank.

Andrew Burns, John Baffes, Luc Christiaensen, and Jose Antonio Cuesta Leiva from the World Bank, and George Rapsomanikis from the UN Food and Agriculture Organization suggested improvements through peer review comments at various stages during preparation of this report. Mark Cackler (Sector Manager, ARD), and Juergen Voegele (Sector Director, ARD) provided oversight and guidance for the work. Kimberly Parent edited the report. Kaisa Antikainen provided logistical support.

ABSTRACT

Following the world food price spike in 2008 and again in 2011, there has been increased attention on better understanding the drivers of food prices, their impacts on the poor, and policy response options. This paper provides a simple model that closely simulates actual historical food price behavior around which the analysis of the drivers of food price levels, volatility, and the associated response options is derived. Future food prices are likely to remain higher than pre-2007 levels and recent price uncertainty is likely to continue for the foreseeable future. Accelerated use of food crops for industrial purposes (biofuels) continues to offset the slowing population growth effect on food demand. World food stocks remain at relatively low levels where the likelihood of price spikes is higher. Production gains may be harder to achieve in the future than in the past, with more limited space for area expansion, declining yield growth, and increases in weather variability.

The low responsiveness of the food system amplifies price spikes to shocks. Over time, world food demand will likely become more price inelastic as incomes rise and food becomes a smaller share of household budgets, and if not offset by a more elastic supply response, including more flexible biofuels policies, food price increases per demand and supply shock will be higher in the future than in the past. Policy responses matter—they can either amplify or dampen price spikes, and either prevent or increase the likelihood of price spikes.

Suggested responses to *reduce average food price levels* are to (i) raise food crop yields, and their resilience, as the single most important action needed for an enduring solution to global food security; (ii) improve the rural investment climate to induce a private sector supply response; (iii) facilitate land markets to expand planted food crop areas and strengthen property rights to improve the use of existing cropped areas; (iv) better use price risk management tools; and (v) increase the responsiveness of the food system to price increases through better integrating markets to ensure world price signals reach more producers to induce a supply response. To *reduce world food price volatility*, suggested responses are to (i) develop weather-tolerant crop varieties to reduce food production shocks; (ii) improve management of foodgrain stock purchases and releases to reduce, rather than amplify, local and world food price volatility; (iii) shift to market-based biofuels policies (make biofuels mandates more flexible); (iv) open trade across all markets to diversify short-term production shocks dissipating the associated price effects; and (v) improve market transparency to reduce market uncertainty and the associated large price corrections following revisions to market information (production, stocks, and trade). Suggested measures to *reduce the negative impact of price shocks on food security* are (i) reduce taxes and tariffs (in some cases) to lower domestic prices; (ii) short-term food and cash transfers to preserve purchasing power; and (iii) support for agricultural production to try to prevent a next season shortfall that could add to local price increases.

1: WORLD FOOD PRICES ARE HIGHER AND MORE VOLATILE THAN IN RECENT DECADES

International food prices spiked again in 2011 for the second time in three years, igniting concerns about a repeat of the 2008 food price crisis and its consequences for the poor. By June 2008, the World Bank Food Price Index[1] had increased by 188 percent since January 2000 (figure 1). In February 2011, it reached its 2008 peak, after a sharp decline in 2009 (by 35 percent), and has remained above its average 2009 and 2010 levels. The food price increase over the last five years is in stark contrast to the price behavior over the previous 16 years with food prices in December 2005 being at a similar level as they were in January 1990 (table 1). Since December 2005 food prices increased by 98 percent in nominal terms and by 56 percent in real terms, while the corresponding increases in grain prices were 120 percent and 73 percent, respectively (table 1).

Broader agricultural prices also increased in 2011 exceeding their 2008 peak by 15 percent. The World Bank Agriculture Price Index[2] peaked in February 2011, exceeding price levels reached in 2008. The 2010/11 international price increases were more widespread across agricultural commodities than in 2008 when they were mainly concentrated in grain crops. Since June 2010, agricultural price increases have been broad based, including increases in sugar, edible oils, beverages, animal products, and raw materials such as cotton. World market prices of sugar and edible oil, such as soybean oil, have been rising since June 2010, being 52 percent and 31 percent higher, respectively, in February 2012. Broad agricultural price increases, rather than just grain prices, provide less incentive for farmers to shift to the production of grains and away from the production of other agricultural commodities.

Although seasonal and annual price fluctuations are an intrinsic characteristic of agricultural commodity markets, price volatility of major food grains has increased since 2007 compared to the preceding two decades. The extent of volatility varies depending on how it is measured, but three commonly used indicators of volatility presented in table 2 indicate that price volatility of food grains was higher during the five-year period, 2007–2011 than during the previous two decades (1987–2006). The recent price volatility of grains is now similar to the high levels experienced in the 1970s[3] (Gilbert and Moran 2010), which induced the imposition of costly policies at that time that were subsequently difficult to remove. Concerns of similar policy responses to equivalent price volatility in the recent period remain high, inducing short-term response programs for alternative options (World Bank 2008). As an additional measure of volatility, higher "call" and "put" option prices for major cereals (an implied measure of the market's expectation of future cereal price volatility)[4] increased markedly in 2007–2010 (FAO 2010). In practical terms, this higher price uncertainty means that farmers, deciding what to plant, and countries deciding when to import face less certainty in the likely distribution of world prices and perhaps greater consequences of using past price levels and distributions to guide current decisions.

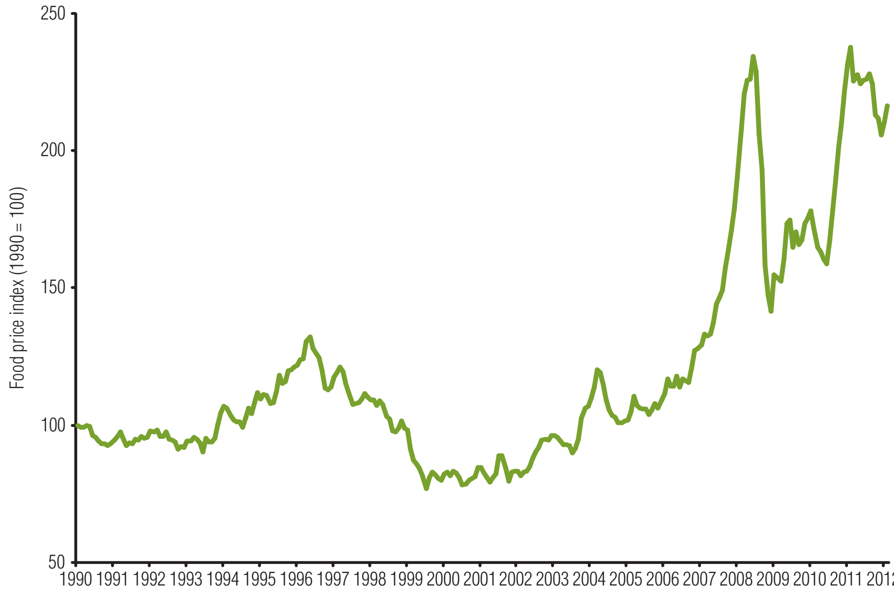
1 The World Bank Food Price Index includes rice, wheat, maize, barley, soybeans, soybean oil, soybean meal, palm oil, coconut oil, groundnut oil, sugar, bananas, beef, chicken, and oranges. Unlike the well-known FAO food price index, it does not include pig meat or dairy.

2 The World Bank Agriculture Price Index includes the food price index, plus cocoa, coffee, tea, cotton, natural rubber, tobacco, and wood.

3 Two indicators of volatility in table 2, which adjust for changing average prices, suggest recent volatility was lower than that in the 1970s, while the standard deviation of logarithmic changes in monthly real U.S. dollar prices suggests recent volatility was similar to the 1970s.

4 An "option" gives the bearer the right to sell a commodity (put option) or buy a commodity (call option) at a specified price for a specified future delivery date. Higher options prices imply higher uncertainty of the price at the specified future delivery date. See Annex A in G20 (2011).

FIGURE 1: World Food Prices Spiked Again for the Second Time in Three Years



Source: World Bank.

TABLE 1: Nominal and Real Commodity Prices Have Increased Significantly since 1990

TIME PERIOD	NOMINAL PRICE INDEX CHANGE (%)					REAL PRICE INDEX CHANGE (%)				
	AGRICULTURE	FOOD	GRAINS	FERTILIZER	OIL	AGRICULTURE	FOOD	GRAINS	FERTILIZER	OIL
January 1990–December 2005	+13	+9	0	+77	+177	+9	+5	–4	+70	+167
December 2005–June 2008	+91	+114	+158	+343	+133	+55	+74	+109	+259	+89
June 2008–June 2010	–21	–32	–47	–62	–43	–11	–24	–41	–57	–36
June 2010–February 2011	+45	+50	+71	+36	+31	+30	+34	+53	+21	+17
February 2011–February 2012	–15	–9	–6	+11	+15	–17	–11	–9	+9	+12
December 2005–February 2012	+88	+98	+120	+157	+100	+48	+56	+73	+103	+58

Source: World Bank.

TABLE 2: Grain Price Volatility Increased over the Last Five Years Relative to the Previous Two Decades

FIVE-YEAR INCREMENTS	MEASURES OF WORLD GRAIN PRICE VOLATILITY		
	RELATIVE PRICE SPREAD (%)*	COEFFICIENT OF VARIATION (%)**	STANDARD DEVIATION (%)***
1972–76	108	33	6.2
1977–81	40	10	3.6
1982–86	80	21	3.5
1987–91	45	12	3.8
1992–96	69	17	4.7
1997–2001	62	18	3.0
2002–06	47	10	3.2
2007–11	74	20	6.0

Source: Authors' estimates based on the World Bank's grain price index deflated by the U.S. consumer price index (CPI).
* Relative price spread is the ratio of the maximum and minimum real U.S. dollar price difference relative to the average real price.
**Coefficient of variation is the ratio of the standard deviation relative to the average real U.S. dollar price.
***Standard deviation is a standard deviation of logarithmic changes in monthly real U.S. dollar prices.

2: IMPACTS

Episodes of high prices and high volatility are a major threat to food security in developing countries.[5] Less predictable food prices reduce incentives for farmers to increase their output, the increase needed to bring food prices down. This uncertainty keeps food prices at high levels for a longer time, leading to fundamental food security risks for consumers and governments. For poor consumers who already spend most of their income on food, high food prices matter, particularly for already malnourished children of preschool age. Impacts of amplified undernourishment on childhood development can be irreversible, even with subsequent declines in food prices.

Higher prices are of greatest benefit to farmers if they can be relativity certain about them to better inform production decisions, have access to inputs at a cost that is low enough to expand production profitably, and have the resources and knowledge to expand production beyond their own subsistence needs. This was not the case for many of the world's smallholders in 2008 (Ivanic and Martin 2008). Rising food prices are estimated to have benefited some smallholder farmers in developing countries, particularly in rice monoculture systems of Asia. Yet worldwide, the majority of smallholders are net buyers of grain or are barely self-sufficient, and overall, losers have outnumbered winners among the rural as well as the urban poor, with a net increase in the number of poor (Wodon *et al.* 2008). The 2010 food price spike had significant distributional impacts among the poor with an estimated 68 million losers (net food buyers falling below the poverty line) and 24 million winners (net food sellers being able to escape poverty), with an estimated net increase of 44 million more people in poverty (World Bank 2011a)[6], adding to the 1.2 billion people already living below the extreme poverty line of US$1.25 a day.

5 FAO defines food security as a situation that exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life (FAO, 2002).

6 The poverty impact estimates are over the period June to December 2010.

The impact of world price spikes varies according to the extent these prices are transmitted locally. The transmission of world food prices to local prices is largely dependent on the import share of local food consumption. For example Africa relies on imports for about half its rice consumption, 85 percent of its wheat consumption, and only about 5 percent of its maize consumption. As a result, local wheat and rice prices in Africa are influenced more by world prices, than is the case for local maize prices. Inland cities with poor links to ports and high transport costs are also less exposed than coastal cities. But while low integration with world markets may reduce the impacts of world food price shocks on domestic net consumers during world price surges, it also reduces the pass-through of higher prices to net producers. In addition, domestic prices in isolated markets, with infrastructure and logistical constraints, are typically even more volatile than world prices, exposing consumers to more frequent price shocks.

2.1 HIGHER LEVELS OF UNDERNOURISHMENT

Higher prices of food staples lead to higher levels of undernourishment as poor net consumers find themselves unable to purchase the minimum amount of calories, nutrients, and proteins required for their day-to-day activities. The 2008 food price spike increased the number of undernourished people by an estimated 63 million (Tiwari and Zaman 2010). Higher food prices have two main effects on net buyers of food: an income effect through decreases in purchasing power of poor households; and a substitution effect through shifts to less nutritious food. In response to higher prices, the poor have no choice but to reduce their overall food consumption from levels that are already low. Higher food prices also typically induce lower spending on nonfood items (such as education and health); lower food consumption, especially of meat, dairy products, and fish; and cause shifts to lower-priced and lower quality food. For those households that are close to subsistence and are already consuming the cheapest sources of calories (for example less nutritious food), the substitution possibilities are more limited, with the poorest suffering the most. Intrahousehold discrimination against women and children disproportionately affect their access to food.

Undernourishment can tax current and future economic growth because it increases mortality and susceptibility to diseases and lowers productivity. Higher undernourishment results in the decline in cognitive development of children, reducing school performance, increasing susceptibility to infection and chronic diseases, and diminishing productivity which undermine human capital development critical for future economic growth. Nutritional status during the first 1,000 days of a child's life (between conception to 24 months of age) is critical, and nutritional deprivation in the early years of life has persistent long-term effects into adulthood which are often irreversible (Maluccio *et al*. 2009). Child malnutrition accounts for more than a third of the mortality burden of children under the age of five, and malnutrition during pregnancy accounts for more than 20 percent of maternal mortality. A malnourished child has on average a 7-month delay in starting school, a 0.7 grade loss in schooling, and potentially a 10 to 17 percent reduction in lifetime earnings capacity, with damage to future human capital and potential national gross domestic product (GDP) losses of 2 to 3 percent (World Bank 2006). Malnutrition is therefore not just a result of poverty, but also a cause of poverty.

2.2 BETTER PRODUCTION INCENTIVES, BUT WEAKENED BY HIGHER PRICE VOLATILITY AND INPUT COSTS

Higher food prices provide an opportunity to produce and invest more, an incentive weakened by higher price volatility and higher input costs. Smallholder farmers in developing countries produce more when output prices improve (World Bank 2008). High food prices offer opportunities for many poor countries to develop their agricultural sectors. This can help link local farmers to regional and global supply chains, increase local consumer access to competitively priced food products, and create new export sectors. However, improved output price incentives can be weakened by higher price volatility and input costs. Analysis of price instability[7] on a range of export crops from developing countries estimates a 23 percent decline in production when price instability doubles (everything else held constant); this effect declines with better infrastructure, low inflation (precautionary savings), and financial sector development (reflective of risk management capacity) (Subervie 2008). Longer-term own-price elasticities of supply, which have historically been larger than short-term elasticities (Schiff and Montenegro 1995), are lowered if long-term food prices, to which production adjustments are made, are more uncertain. Higher input prices can further reduce incentives to produce, with recent fertilizer price increases since 2005 far exceeding food crop price increases (table 1).

2.3 HIGHER INFLATION, DETERIORATED BALANCE OF PAYMENTS, AND SPENDING REALLOCATIONS

Food price inflation has accelerated in several low- and middle-income countries where consumers often spend more than half of their income on food, putting further pressure on the poorest. Food price inflation in the large Asian countries in 2010 was in the 9 to 11 percent range, as opposed to nonfood price inflation of between 0 and 3 percent.[8] More than one-third of the countries in Eastern Europe and Central Asia had more than 10 percent food inflation in 2010. Food prices typically account for one-third to a half of consumption expenditure as measured by the Consumer Price Index in developing countries, two to three times more than fuel. Food price increases have fed into overall inflation in several countries. Where this leads to second-round effects on prices, countries may tighten monetary policy (as was done in Brazil, India, and China in early 2011), with a potentially negative impact on near-term growth and social stability.[9]

International cereal price spikes increase the food import bills of some low-income food-deficit countries, putting pressure on their balance of payments. The cereal import bill of low-income food-deficit countries was US$31.8 billion in 2010–11 (29 percent more than 2009–10), in spite of improved 2010 production and the lower volume of cereal imports required (FAO 2011a). North Africa and the Pacific Islands experienced the largest negative impact, paying higher prices and importing more cereals to meet the required domestic demand. Although the cereal import bills of these food-deficit countries is below the record level reached during the 2008 food crisis, the increase in cereal costs combined with that of other food and fertilizer imports by these countries is eroding their balance of payments.

Higher food prices can shift public spending to short-term consumption at the expense of longer-term development

7 In the analysis, price instability is defined as the mean deviation from the trend, which is similar to the coefficient of variation used in table 2.

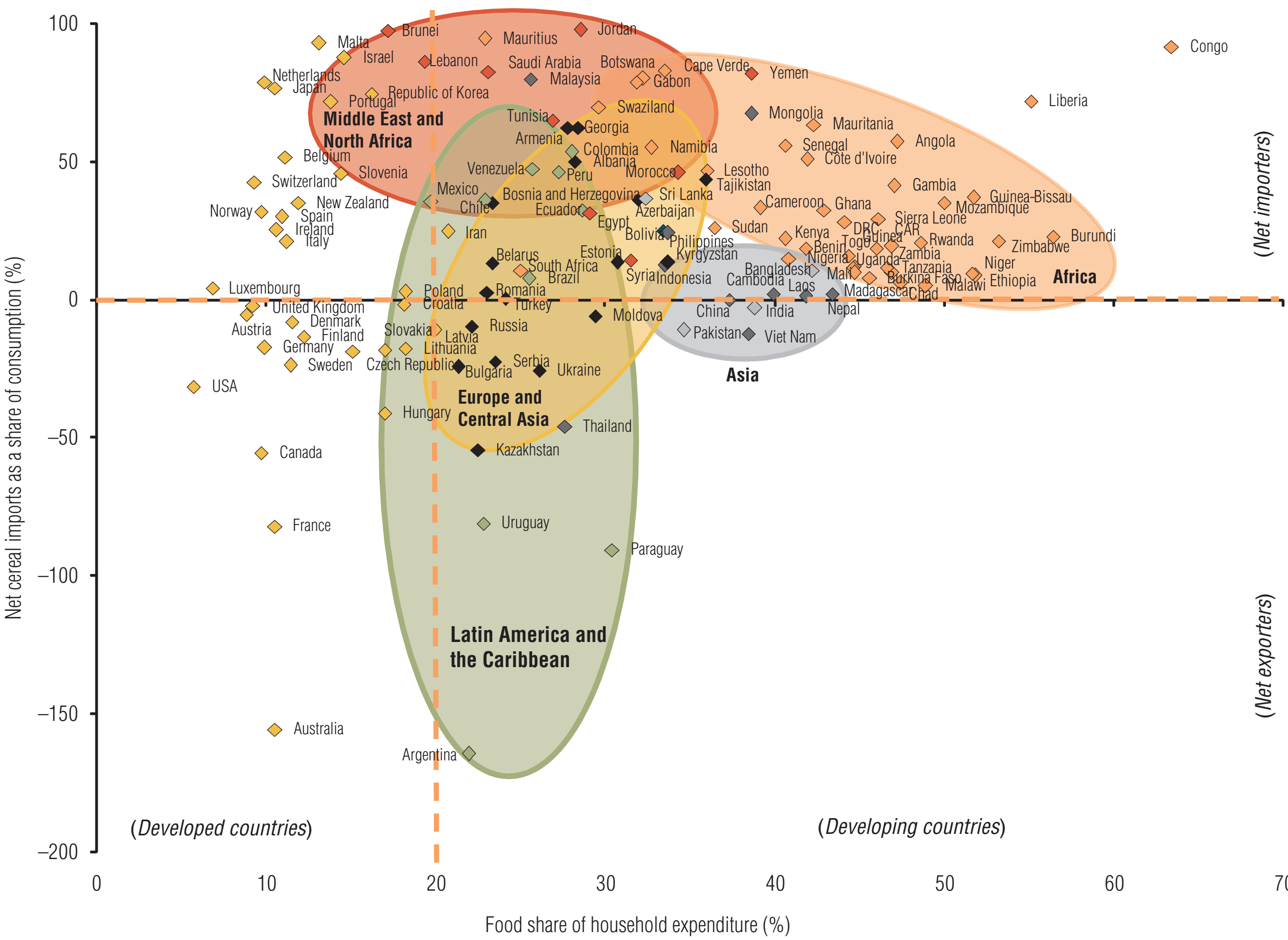
8 From October–November 2009 to October–November 2010, food versus nonfood inflation on average in China was 10.9 versus 0.1 percent, in Indonesia 11 versus 0.6 percent, in Bangladesh 9.1 versus 2.9 percent.

9 International food price increases led to a significant deterioration of democratic institutions in low-income countries, evidenced by an increase in the likelihood of civil conflict and other forms of civil strife, see Arezki and Bruechner (2011).

programs. Developing countries displayed considerable resilience during the 2008–2009 global food and financial crises in terms of preserving core spending on health, education, and infrastructure, but this eroded much of the fiscal space that had been built over a number of years (World Bank and IMF 2010). For many countries the macroeconomic space to mitigate the effects of the recurrent global food price surge has been reduced as public debt is higher now than it was in 2008 because of the global economic crisis and the associated countries' response. The fiscal impact of food price increases depends on their impact on food tax revenue and on the extent to which expenditures on mitigating measures—such as for social protection programs—are increased. Recurrent food crises are likely to put pressure on governments to shift away from capital accumulation spending to arguably less productive expenditures such as universal producer and consumer subsidies, which can be hard to reverse (Delgado *et al.* 2010). Subsidies in particular are hard to stop once in place, even when no longer needed. Revenue measures such as cuts in import tariffs and lower taxes on food entail further budget costs.

Aggregate impacts vary by region. Large net importers of food, such as countries in the Middle East and North Africa and West Africa, face higher import bills, reduced fiscal space, and greater transmission of world prices to local prices for imported goods such as rice and wheat. Higher prices have a significant impact on consumers with high shares of household expenditure on food (as in many African and Asian countries). Corresponding smallholder producer incentives are weakened by higher price volatility and input costs. Larger net exporter countries, as in Latin America and Eastern Europe and Central Asia, stand to benefit but may also face internal pressure to impose export bans or to fix prices if populations spend significant shares of household budgets on food (figure 2).

FIGURE 2: Countries' Vulnerability to Global Food Price Shocks Tracked by Share of Cereal Imports in Domestic Consumption and Food Share in Household Expenditure



Source: FAOSTAT for net cereals import as a share of consumption, and USDA for food share in household expenditure.
Note: The two dimensions reflected in the above figure are important contributors to vulnerability, while other factors include whether a country has a safety net program in place and fiscal space to scale it up and mitigate impacts on the poor.

3: DRIVERS

World food price changes are and have historically been associated with changes in food supply and demand, and the corresponding responsiveness of the food system. A simple simulation model of world grain price behavior that reflects actual changes in world food demand and supply tracks actual price behavior fairly closely over the period with available data (box 1). This provides a basic framework for organizing discussion of the main drivers of world food prices.

Drivers of food prices can be divided into those determining average price levels and those inducing price volatility. Longer-term demand increases from growth in population, income, and industrial uses of food; long-term changes in supply from agricultural productivity growth (technical efficiency and technological change) inducing yield gains and expanded areas; and the long-term responsiveness of the food system drives long-term average world food price levels. Short-term shocks such as droughts, floods, trade restrictions, volatile demand for associated inputs and outputs (such as oil and ethanol), and market expectations shaped by low stock levels tend to drive food price volatility (table 3).

3.1 LONGER-TERM TRENDS IN DEMAND AND SUPPLY

Longer-term Trends in Demand [Component of $\Delta\alpha_d$]

Increases in aggregate global demand for food are driven by population and income growth and by an accelerated use of food crops for industrial purposes, such as biofuels. The world population has more than doubled over the last 50 years from 3 billion to 7 billion. Aggregate food consumption over this period increased 1.4 times the population growth (2.5 percent per year food consumption growth compared to 1.6 percent population growth), driven by additional demand for grain as animal feeds as the consumption of meat increased with per capita income growth, and additional demand for food-based industrial products such as biofuels (figure 3). Future food demand is expected to continue to increase from population growth (every year there are more people to feed) and from per capita income growth (raising the demand for meat). Future food demand from the biofuels industry will be dependent on ethanol policy mandates, oil prices, and alternative biofuels technologies.[10]

While more food is consumed every year, slower population growth has reduced the rate of food consumption growth (table 4). Aggregate consumption growth of major grains (rice, maize, and wheat) halved from 3.4 percent per year in 1971–80 to 1.7 percent in 1991–2000 and then increased in the 2000s to 2.3 percent per year in 2006–11. Slowing population growth contributed to the decline in overall food consumption growth in 1991–2000. Consumption growth in 2006–11 relative to 2001–05 was higher for all the major grains (rice, maize, and wheat) but was highest for maize driven by demand from the biofuel industry. Food and industrial demand for maize increased from 1.7 percent in 1991–2000 to 8.7 percent per year in 2006–11. The demand for feed grains from the livestock industry declined with the increased feed-conversion efficiency, using more soybeans, and managing pastures more effectively. The growth rate of meat consumption also declined, from 4.8 percent in 1971–1980 to 2.1 percent in 2001–05 with slowing population growth. Meat consumption growth declined further in 2006–11 to 1.8 percent per year as household expenditures became more constrained with higher food prices, and reduced incomes from the global economic crisis. Future

10 While demand for biofuel feedstock can raise food prices, biofuels production can also have positive impacts on the environment, farm incomes, and energy security, especially where feedstock production costs are low as is often the case in the interior of Brazil's Center-South sugarcane production area, for example. Biofuels production through crops that do not directly compete with food consumption has less impact on food prices. Each case needs to be addressed separately in a specific geographic and temporal context.

BOX 1: Actual World Grain Price Behavior 1963–2011 Is Simulated Fairly Well by a Simple Model of Supply and Demand Changes and the Responsiveness of the Food System

A simple static world grain supply and demand model can be expressed as

Supply: $S = \beta_s p + \alpha_s$

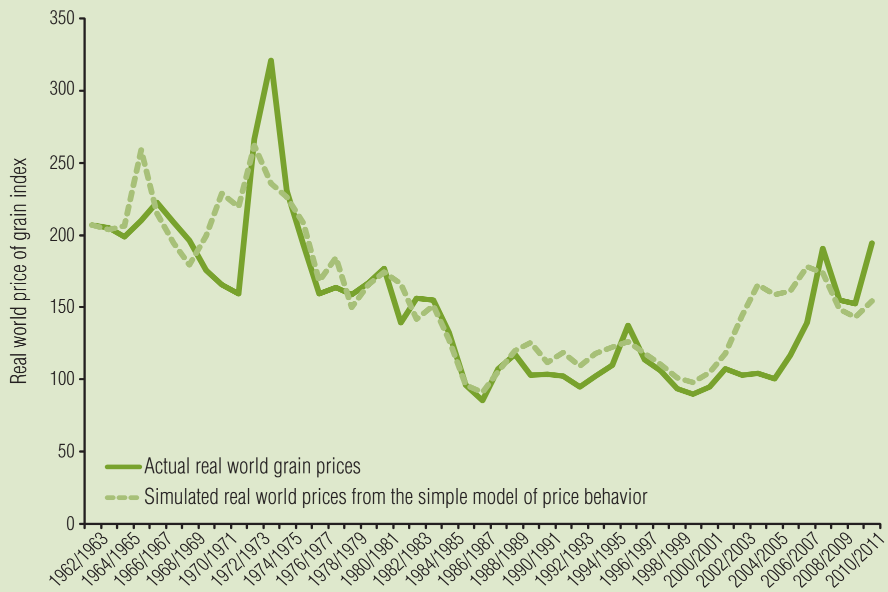
Demand: $D = \beta_d p + \alpha_d$

Market equilibrium: $S = D$

Market price: $p = \frac{(\alpha_d - \alpha_s)}{}$

Market price changes: $\Delta p = \frac{(\Delta\alpha_d - \Delta\alpha_s)}{(\beta_s - \beta_d)}$

where p is the real price index of grain; β_s is the grain price elasticity of supply; β_d is the grain price elasticity of demand; Δp is the change in real price of grain; $\Delta\alpha_s$ is the shift in the grain supply curve (change in intercept, α_s); $\Delta\alpha_d$ is the shift in the grain demand curve (change in intercept, α_d); S is grain production, including previous year stocks, for an estimate of overall supply; and D is grain consumption. Grain supply and demand are inelastic (small elasticities of β_s and β_d), with recent empirical estimations of $\beta_s = 0.11$, and $\beta_d = -0.04$ (Roberts and Shlenker, 2009). Following the above model, large shifts in supply and demand (the numerator) with small elasticities (the denominator) can lead to large price changes. Using this simple approximate model to simulate world grain price changes using the actual changes in world grain supply and demand (using USDA data), and a combined elasticity ($\beta_s - \beta_d$) of 0.2 fairly closely matches actual world grain price index behavior (figure below). This suggests that most of the supply and demand changes have been from shifts in the supply and demand curves (both in the short and longer run).



Source: Derived from USDA and World Bank data.

meat demand is expected to vary by region, for example, while meat demand growth is expected to decline globally, it is expected to continue to increase in large economies of Asia and Latin America, and the oil-exporting countries.

Longer-term Trends in Supply [Component of $\Delta\alpha_s$]

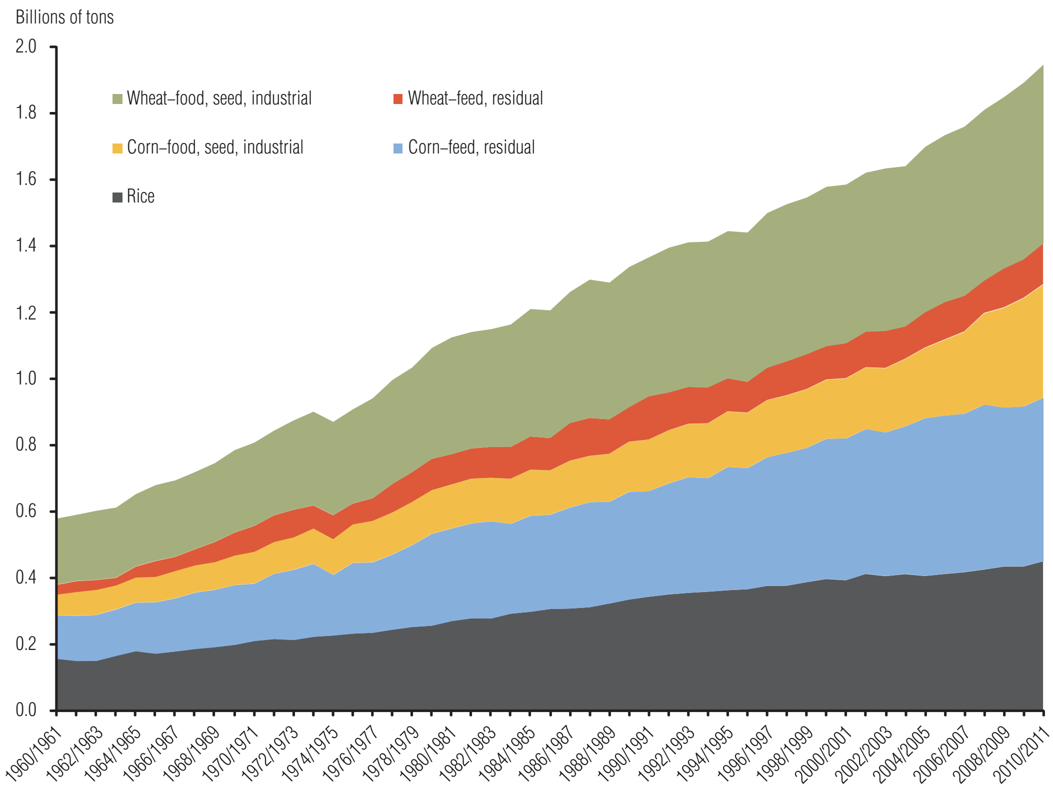
Increases in world food supplies depend on land area planted to food crops and subsequent yields. Long-term growth in grain production over the last 50 years has been similar to growth in grain consumption, but with large annual variability. During 2001–11 grain production growth (1.6 percent per year) lagged grain consumption growth (1.9 percent per year), with a resulting decline in global food stocks. Production growth over the last several decades has been driven more by yield improvements than area expansion. However, yield growth rates have declined from 2.6 percent per year in 1971–80 to 1.1 percent in 2001–11 (table 5). The increased growth in

TABLE 3: Drivers of World Food Prices

AVERAGE FOOD PRICE LEVELS		FOOD PRICE VOLATILITY	
DEPENDENT ON:		**DEPENDENT ON:**	
Long-term change in demand [component of $\Delta\alpha_d$] • Population • Income • Biofuels	*Long-term demand responsiveness to prices [component of β_d]* • Share of food in consumption • Biofuels mandates • Oil/maize price ratio	*Short-term change in demand [component of $\Delta\alpha_d$]* • Oil prices volatility • Exchange rate volatility • Precautionary/speculative hoarding	*Short-term demand responsiveness to prices [component of β_d]* • Biofuels mandates • Oil/maize price ratio
Long-term change in supply [component of $\Delta\alpha_s$] • Area planted • Yield changes	*Long-term supply responsiveness to prices [component of β_s]* • Output and input market integration • Price risk management	*Short-term change in supply [component of $\Delta\alpha_s$]* • Droughts and floods • Share of exports in more volatile production and trade regions • Trade policy responses (export bans and sharp reductions in import tariffs) • Food reserves	*Short-term supply responsiveness to prices [component of β_s]* • Trade openness • Stock release policies

Source: Authors' presentation.

FIGURE 3: The World Continues to Consume More Food



Source: USDA.

TABLE 4: Food Demand Growth Slowed from the 1970s to 1990s, Then Increased in the 2000s

	CONSUMPTION GROWTH RATES (%)					
	1971–1980	1981–1990	1991–2000	2001–2011	2001–2005	2006–2011
Total (three grains)	**3.4**	**2.0**	**1.7**	**1.9**	**1.5**	**2.3**
Rice	**2.6**	**2.7**	**1.7**	**1.1**	**0.4**	**1.6**
Maize, Total	**4.2**	**1.5**	**2.4**	**3.1**	**2.7**	**3.5**
Maize, FR	4.4	1.6	2.7	1.5	2.4	0.7
Maize, FSI	4.0	1.4	1.7	6.3	3.6	8.7
Wheat, Total	**3.0**	**2.1**	**1.0**	**1.1**	**0.8**	**1.3**
Wheat, FR	3.1	1.0	–0.3	1.0	1.2	0.9
Wheat, FSI	3.0	2.4	1.3	1.1	0.7	1.3
Meat	**4.8**	**2.8**	**3.1**	**1.9**	**2.1**	**1.8**
Population growth	**1.9**	**1.8**	**1.4**	**1.2**	**1.2**	**1.2**

Source: USDA for grains and meat, and United Nations for population.
Note: FR, feed and residuals; FSI, food, seeds, and industrial use. Meat refers to beef, pork, and poultry. Growth rates are calculated as the annualized growth over the respective periods.

TABLE 5: Food Supply Growth Declined, Driven by Declining Yields, but Offset Recently by Increases in Area Planted

	PRODUCTION GROWTH RATES (%)					
	1971–1980	1981–1990	1991–2000	2001–2011	2001–2005	2006–2011
Total (three grains)	**3.4**	**2.1**	**1.8**	**1.6**	**1.5**	**1.8**
Area	0.8	0.1	0.2	0.5	0.2	0.9
Yield	2.6	2.0	1.6	1.1	1.3	0.9
Rice	**2.4**	**3.1**	**1.8**	**1.0**	**–0.4**	**2.1**
Area	0.7	0.5	0.5	0.1	–0.5	0.6
Yield	1.7	2.6	1.3	0.9	0.1	1.5
Maize	**4.6**	**0.8**	**2.8**	**2.9**	**3.3**	**2.5**
Area	1.5	0.0	0.9	1.5	0.9	2.0
Yield	3.1	0.8	1.9	1.4	2.4	0.5
Wheat	**3.2**	**2.5**	**1.0**	**1.0**	**1.3**	**0.6**
Area	0.5	–0.1	–0.4	0.3	0.1	0.4
Yield	2.7	2.6	1.4	0.7	1.2	0.2

Source: USDA.

area expansion in 2006–11 was not able to fully offset the yield growth declines, with production growth subsequently lagging consumption growth. Future food supply will be largely dependent on yield growth as the scope for future area expansion is limited.

Land has become an increasingly limited resource, and food demand cannot continue to be matched by an expansion of cultivated areas. The land frontier is closing across much of the developing world, except for parts of Eastern Europe, Latin America, and some countries in Sub-Saharan Africa (mainly in Sudan, Democratic Republic of Congo, Mozambique, Zambia, and Chad). The total cultivated area to all crops is about 1.5 billion hectares, and although there is about 400 million hectares that could potentially be cultivated, much of the unused land has low fertility and is distant from market infrastructure and in areas of high disease incidence (over 70 percent of land with rainfed crop production potential in

Sub-Saharan Africa and Latin America have one of these constraints [Fisher *et al*. 2002]). Overall, agricultural area use per person to produce food has declined from 1.30 hectares to 0.72 hectares in the period 1967–2007 (Foresight Report 2011). In the five years since 2005/06 land area for 13 major world crops increased by 27 million hectares. Twenty-four of the 27 million hectare expansion was in six countries or regions: China, Sub-Saharan Africa, former Soviet Union (Kazakhstan, Russia, and Ukraine), Argentina, India, and Brazil. In the United States, land area was fairly stable but with shifts in land use from lower-demand to higher-demand crops. In the European Union (EU), the cultivated area under these crops even declined, pointing to rising land constraints in Organization for Economic Cooperation and Development (OECD) countries. Use of more marginal land lowers average yields with current technologies and agricultural practices.

Future long-term yield improvements may be harder to achieve than in the past. Higher total factor productivity growth will be needed to meet rising global demand to keep food prices affordable (Fuglie 2010). With continuing demographic pressures, gains in land productivity, sustainable land management, and increased water use efficiency are critically important. World yield growth rates have more than halved since the 1970s (table 5). More binding water constraints, rising inputs costs, and lags in development of improved varieties may make yield gains harder to achieve: (i) water constraints limit the future expansion of irrigated agriculture. Approximately 1.2 billion people live in river basins with absolute water scarcity, with the Middle East and North Africa and Asia facing the greatest water shortages with scope for expansion of irrigated areas in Africa.[11] Countries such as Saudi Arabia have explicit policies to reduce the share of domestic food production and rely more on imports for consumption, due to water constraints; (ii) rising input costs (fertilizer and energy) may reduce their use and lower yields. Crude oil prices underpin production costs of agricultural products relying on fertilizers and fuel (particularly important in both developed and emerging economies[12]), and transport costs (particularly important in many developing countries[13]). Crude oil prices rose sharply from 2002 along with fertilizer prices increasing farm production costs (e.g., agriculture is more than four times more energy intensive than manufacturing), increasing the need for more efficient use of energy-intensive inputs; and (iii) lags in development of improved food crop varieties (needing less water and inputs) may delay future yield gains, and the yield gains eventually made may not be as high as those achieved with more water and inputs.

Improved use of existing technologies can lead to short-term yield gains. There are still gains to be made by reducing the yield gap between what is achievable (demonstrated through on-farm research trials) and what is currently achieved as average yields. For example, better use of existing crop and nutrient management practices alone could increase rice yields in East Asian countries by at least 25 percent (Christiaensen 2011). About 15 percent of the value of the total rice crop in South East Asia could be saved through better postharvest technology (especially drying and milling), while irrigation efficiency could be bolstered through better water management, proper incentives, and regulation. A shift from area-based to volume-based charges for irrigation water in the Tarim Basin in China, for example, resulted in a 17 percent decrease in water use. In Cambodia, addressing poor land layout through adequate leveling and higher bunds to retain wet season water has been shown to increase yields by 27 percent (Christiaensen 2011). Future long-term supply of food will need to rely more on productivity gains than on area expansion, and achieving these long-term productivity gains will need to rely more on technical change (improved varieties) than on technical efficiency (improving efficiency of input use), although both are important.

3.2 SHORT-TERM SHOCKS IN DEMAND AND SUPPLY

Short-term Changes in Demand [Component of $\Delta\alpha_d$]

Higher oil price volatility has spilled over to food prices with a stronger integration of crude oil prices with other commodities' prices in recent years (Baffes 2010). The links between crude oil and agricultural markets have considerably strengthened since 2005, with the pass-through elasticity from crude oil prices to agricultural prices increasing from 0.22 for the pre-2005 period to 0.28 through 2009. Crude oil prices increased sharply from early 2002 to mid-2008, more

11 Water use projections to 2050 suggest that the water supply to some 47 percent of the world's population, mostly in developing countries, will be under severe stress, largely because of developments outside of agriculture, see OECD-FAO (2011).

12 In U.S. agriculture, the share of energy-intensive inputs (fertilizers, chemicals, and fuel) in total farm production costs increased from 22 to 35 percent for maize and from 19 to 28 percent for wheat between 1996–2000 and 2006–09 (www.ers.usda.gov).

13 In most countries of Sub-Saharan Africa, a 1 percent increase in fuel costs increases transport costs by 0.5 percent, resulting in large increases in farm input costs and declines in farm output prices, see World Bank (2009).

than doubling from early 2007 (table 1). Crude oil prices have historically been more volatile than agricultural commodities, and the greater link between oil and agricultural markets, through biofuels, will likely contribute to short-term food price volatility.

The fluctuating value of the U.S. dollar contributed to higher volatility of U.S.-dollar-denominated world crop prices, relative to euro-denominated prices over the 2006 to 2011 period. From January 2002 to April 2008, the U.S. agricultural trade-weighted dollar exchange rate depreciated by 21 percent, appreciating again in March 2009 resulting in larger U.S. dollar food price fluctuations than euro-denominated food prices. The extent of transmission of changes of the U.S. dollar prices to local prices in other countries has been influenced by the extent of appreciation or depreciation of local currencies. However, irrespective of the extent of pass-through, changes in the value of the U.S. dollar have a significant impact on reference world market prices due to their U.S. dollar denomination (Padetzki 1985).

Financial investment in agricultural commodities has become a much discussed factor in the determinants of the recent food price spikes, but the evidence on its effects remains weak. Much of the recent increase in commodity financial transactions has occurred in the futures markets, including for maize and wheat. This was driven mainly by demand from fund holding and continuously rolling over future positions in commodity markets, without taking physical delivery. There are five reasons to question the impact of financial investments in grain future markets on their spot prices: (i) maize and wheat futures have on average historically been in contango with negative "roll returns" on continuously rolled-over futures positions (unlike some other commodities), reducing their relative attractiveness as a financial investment[14]; (ii) there was no corresponding significant increase in maize and wheat stocks beyond additional production (a significant increase would be expected if higher futures prices are driving higher spot market purchases in response to the storage arbitrage opportunity)[15]; (iii) the futures market for rice whose price also increased significantly, is very thinly traded; (iv) high volatility in the term structure of futures prices for maize and wheat suggests a weak link between the use of futures prices as a price discovery mechanism for spot prices; and (v) overall investment flows into commodities were 78 percent lower in 2011 than in 2010, yet food prices remained high. The Dow-Jones Grains Index declined by 14 percent in 2011 while the grain "spot" price index increased 2 percent. As a result, there seems to be weak evidence of the impact of financial investments in grain futures markets affecting grain spot prices, particularly over the long term.

Precautionary hoarding had a significant short-term effect on food prices, particularly rice. Short-term expectations about movements in rice prices resulted in precautionary hoarding by households sparking a sudden surge in demand for rice in 2007–08. With nearly half the world's population consuming rice as a food staple, short-term changes in household storage can have significant effects on rice prices. Estimates, on the base assumption that households hold about a one-week supply of rice consumption, suggest that increasing this to a two-week supply (i.e., doubling home storage), can have a dramatic impact on world prices,[16] and that this is what happened in 2007–08 (Timmer 2010).

Short-term Shocks in Supply [Component of $\Delta\alpha_s$]

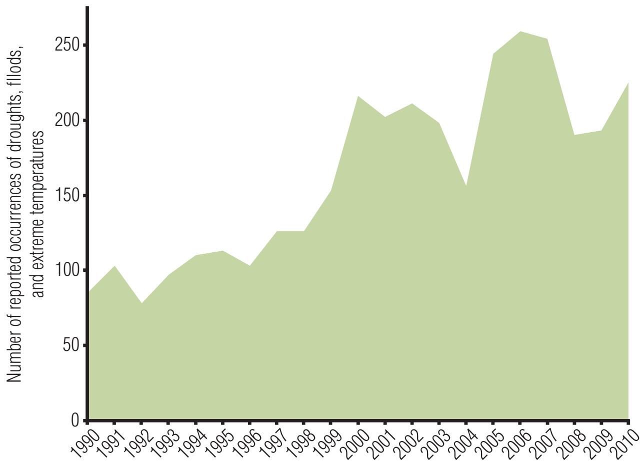
Adverse weather has played a significant role in the recent price spikes. In 2010, weather was a stronger factor in reducing production and stocks than in 2008. Simultaneous production losses in Canada, Russia, Ukraine, and EU-27 fed into world price expectations. Following subsequent production declines, cereal stocks of the traditional developed country exporters fell by 27 percent in 2010–11 (FAO 2011a). More generally, the number of reported droughts, floods, and extreme temperatures seems to have increased; in 2010 alone a record number of 19 nations set temperature records (figure 4). The Russian heat wave was only one of many recent extreme weather events, from dry weather in Brazil to flooding in Australia, Pakistan, and West Africa. Floods are especially damaging as they often require large reconstructions of irrigation systems and other infrastructure, and their frequency has been going up as also has the frequency of droughts. Overall, weather variability, possibly due to climate change, is having and will likely to continue to have a significant impact on international food prices.

14 The term structure of future prices for maize and wheat have been in contango (futures prices higher than spot prices) on 70 to 80 percent of the trading days since 1970. A continuously rolled-over futures position which buys futures contracts at a "higher" price and sells before maturity at a "lower" price (reflective of the term structure) will yield a negative "roll return."

15 World maize and wheat production in 2008/09 were, respectively, 12 and 15 percent higher than in 2006/07, and about 40 percent of this increase is reflected in higher stock levels.

16 Timmer (2010) estimates that world rice prices would have to rise by 167 percent to get to a new equilibrium following a sudden and unexpected 25 percent increase in short-term rice demand in world markets (using short-run price elasticities of –0.1 for demand and 0.05 for supply).

FIGURE 4: Significant Rise in Reported Droughts, Floods, and Extreme Temperatures



Source: www.emdat.be.

A larger share of world exports is being produced in the countries with more variable production and trade performance. Major expansion of world grain exports in the last twenty years is in large part due to rapid increases in production for exports in the Southern Cone of Latin America. More recently, world markets have become more dependent on supplies from the Black Sea region (Kazakhstan, Russia, and Ukraine).[17] The world export shares of wheat from the Black Sea region and Latin America doubled from 14 percent to 28 percent in the period between 1990–95 and 2006–10. For maize, the share has more than tripled from 9 percent to 29 percent over the same period. The recent OECD-FAO agricultural outlook predicts a further shift of export shares away from OECD countries to the Black Sea region in particular (OECD-FAO 2011). Production and exports are more variable in these newer export regions than in the traditional breadbasket areas of the developed world where better natural conditions, applications of the most up-to-date technologies, and management practices have increased and stabilized yields (figure 5).[18] In addition, the increased use of grain for industrial purposes by traditional exporters is further reducing their world export shares. For instance the share of the U.S. maize crop, which was used for ethanol production, increased from 31 percent in 2008 to a projected 37 percent in 2011 according to the U.S. Department of Agriculture (USDA) (Trostle *et al.* 2011). The higher but more variable share of production and exports from the Black Sea region and Latin America, coupled with the more positive correlation of production and exports with OECD countries in 2005 to 2011 led to an increase in world wheat production and export volatility.[19] With the changing geographic distribution of production away from traditional exporters and more frequent use of export taxes and bans by the new world food exporters, supply may become more variable over time, contributing to potentially higher world food export and price volatility. For example, when factoring extreme forecasts of climate events, food production shortfalls in Russia are projected to triple by 2070 (Alcamo *et al.* 2007).

Trade policy responses further raised the amplitude of the grain price spikes. Export bans and tactical reductions in import duties[20] used by many countries in 2008 accounted for an estimated 45 percent of the world price increase for rice and 30 percent of the increase for wheat (Martin and Andersen 2011). These impacts were compounded by governments aggressively building up grain stocks in the face of high and escalating prices (Dawe 2010). Exporters and importers have been more restrained with respect to insulating trade interventions in 2010 and 2011 compared to 2008, but some were still using them. Although export bans and reductions in import tariffs could be pragmatic answers to the food price spikes in individual countries, both instruments insulate domestic economies and shift the adjustment cost to the rest of the world, with their impact depending on the size of the economy. While a single individual food tariff reduction can serve to lower the domestic price of imported food for that country, if the same tariff reduction is pursued by a larger number of importing countries, it would put upward pressure on global

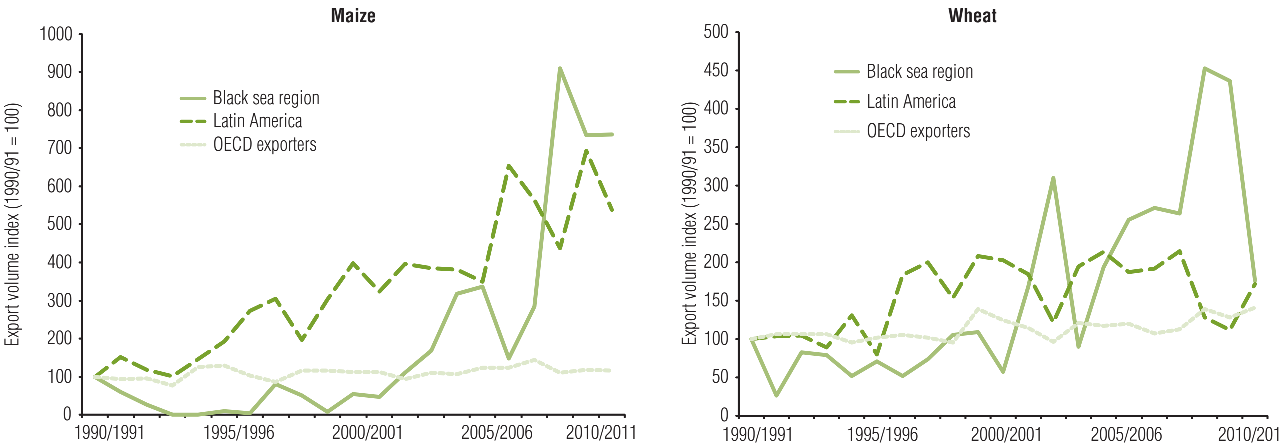
17 Although Kazakhstan is located in Central Asia, for grain exports it is often said to belong to the Black Sea region due to its use of the seaport facilities in Russia and Ukraine for overseas exports.

18 For example, for wheat, the volatility of production and exports from 2005/06 to 2011/12 was higher in the Black Sea region and Latin America than in the OECD. For wheat production, the respective coefficients of variation for the three regions were 17, 11, and 8 percent. For wheat exports, the respective coefficients of variation were 34, 20, and 12 percent.

19 The impact on world wheat export volatility of the rising share of exports from these newer more volatile production regions was muted in 1998–2004 due to their high negative correlation with OECD exports. However in 2005–11, with a further increase in export share and a more positive correlation (more similar to 1991–97), world wheat export volatility increased. Its coefficients of variation for the seven-year periods, 1991–97, 1998–2004, and 2005–2011, was 4.5 percent, 4.4 percent, and 10.3 percent, respectively. The corresponding world wheat production coefficient of variation for the same periods was 5.2 percent, 3.8 percent, and 6.2 percent, respectively.

20 Reducing import tariffs as part of a program of overall liberalization should be pursued under the Doha Round of World Trade Organization (WTO) negotiations, which would help limit the negative externalities of selective temporary reductions in tariffs for the rest of the world.

FIGURE 5: Maize and Wheat Exports from the Black Sea Region and Latin America Are More Volatile than from Traditional Exporters and Have Risen in Relative Importance



Source: USDA PSD online database.

prices and offset the tariff reduction. Insulating policies reduce the role that trade between nations can play in bringing stability to the world's food markets.[21] National trade policies are key to providing positive incentives to national producers of food and to attracting investment from all sources.

Short-term supply is influenced by carryover stocks, which can add to available production to meet consumption demand. Since the 1980s there has been a decline, with annual variation, in the relative size of grains stocks (figure 6) as large stocks able to fully offset production shortfalls had become fiscally unsustainable. A series of policy reforms to reduce grain stock levels and subsequently more recent changes in producer income support mechanisms were undertaken in the United States and the European Union (Mitchell and Le Vallee 2005). Over half of global stocks of rice and wheat are estimated to be held by China and India, where public sector stocks play a major role.[22] In addition, the United States, which accounts for 55 percent of global exports of maize, had a domestic maize stock-to-disappearance ratio of 7 percent in 2010–11, lower than the recent past.[23] For wheat, France, a major exporter to North Africa, had a 7 percent stock-to-disappearance ratio in 2010–11, which is very low compared to the global stock-to-use ratio of 29 percent.[24]

Historical evidence suggests that the likelihood of grain price spikes is higher when global stock-to-use ratios, a measure of physical liquidity of grain markets,[25] decline to low levels (Wright 2009; Stigler and Prakash 2011).[26] Fiscally sustainable carryover stocks held by major grain producers were not large enough to compensate for recent production shocks that contributed to the recent food price spikes. This reemphasized the role of trade as a vital mechanism to smooth prices. Weather-related production disruptions reduced cereal stocks in developed countries by an estimated 28 percent between 2009–10 and 2010–11, in contrast to a 4 percent increase in stocks in developing countries. According to the Food and Agriculture Organization of the United Nations (FAO) (2011a), the stocks of major grain exporters in 2011–12 are

21 While export bans imposed by larger exporting countries with a readily available surplus have a greater impact, all export bans have a market impact as it leads to a perception of larger-than-actual shortages and could result in beggar-thy-neighbor actions.

22 The USDA made major revisions to its estimates of Chinese stocks in 2001, but this had little impact on global price behavior at the time, possibly because China in 2002–03 was a significant grain exporter (see Wright 2009, *op. cit*).

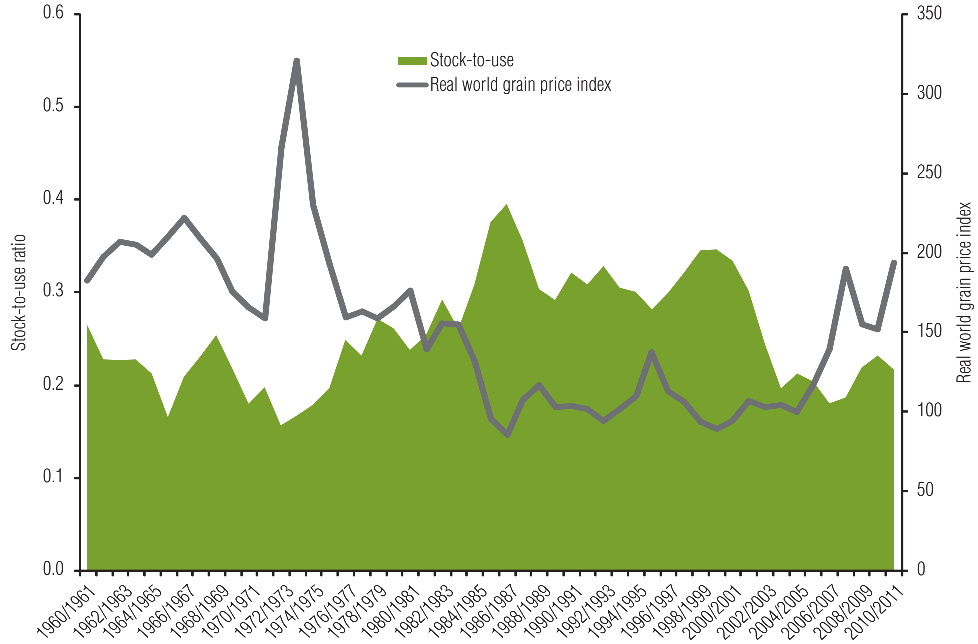
23 The global stock-to-disappearance ratio for maize was also about 7 percent. "Disappearance" is domestic utilization plus exports.

24 The global stock-to-disappearance ratio for wheat was about 17 percent.

25 Both FAO and USDA publish stock-to-use estimates. They reflect the difference between estimated production and carryover stocks on the one hand, and estimated consumption and trade on the other. The stock-to-use measure thus includes (conceptually) all commercial, public, and household stocks, whether or not the stocks in question are actually available for international sale.

26 Stigler and Prakash (2011) using a volatility regime-switching model concluded that in the absence of market tightness, commodity prices do not appear to be influenced by inventories. However, when inventories fall low, agricultural commodity prices become highly linked to information on stocks and especially to supply and demand disturbances that reduce the stock-to-disappearance ratio further.

FIGURE 6: Low Stock-to-Use Ratios Have Been Associated with World Food Price Spikes



Source: Derived from USDA and World Bank.

projected to decline further, causing the global stocks-to-use ratio to be 2.2 percent lower than in 2010–11. Added to this is global uncertainty on the exact size and quality of stocks, uncertainty on the triggers for their release or buildup, and measurement revisions that can have significant market impacts. For example when the USDA downsized its estimates of U.S. maize production in Fall 2010, the upward impact on global maize prices was sharp and immediate.

3.3 LOW RESPONSIVENESS OF THE FOOD SYSTEM

The inelastic nature of world food demand and supply leads to large price increases from shocks to the system (i.e., the system has limited flexibility to respond, at least in the short term). Over time, world food demand will likely become more price inelastic as incomes rise, and if not offset by a more elastic supply response, price increases per demand and supply shock will be higher in the future than in the past (following the simple framework in box 1).

Demand Responsiveness to Prices [β_d]

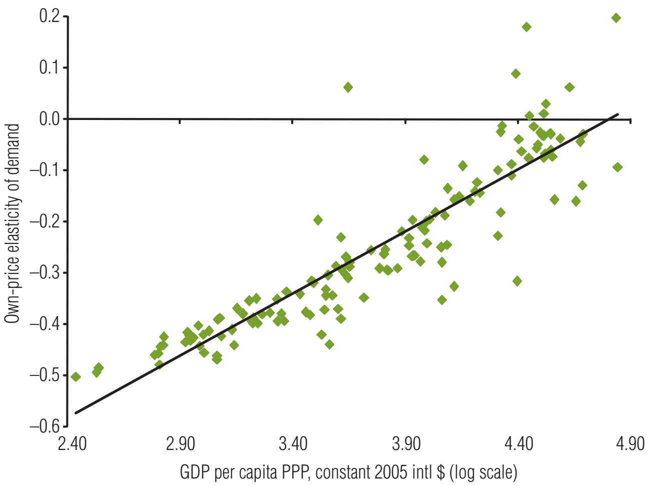
Demand responsiveness to price changes is influenced by per capita income, biofuels mandates, and oil prices. Demand responsiveness is relatively low and declines as per capita incomes rise with declines in the share of household budgets spent on food, especially in counties with rapid urbanization (figure 7).[27] The increased demand for agricultural commodities for producing biofuels can partially compensate for that decline, but the net effect on price responsiveness will depend on a number of factors. On the one hand biofuels mandates act to fix demand for maize-based ethanol, thereby reducing overall demand responsiveness to price changes. On the other hand, if long-term oil prices rise dramatically making maize-based ethanol profitable beyond the mandates, then the overall demand responsiveness to price changes would increase (oil prices relative to maize have on average been higher since 2005 than from 1990 to 2004) (figure 8). The net effect will be dependent on which of these two effects dominate (GAO 2009).

Supply Responsiveness to Prices [β_s]

Long-term supply responsiveness to price changes is influenced by output and input market integration, and price

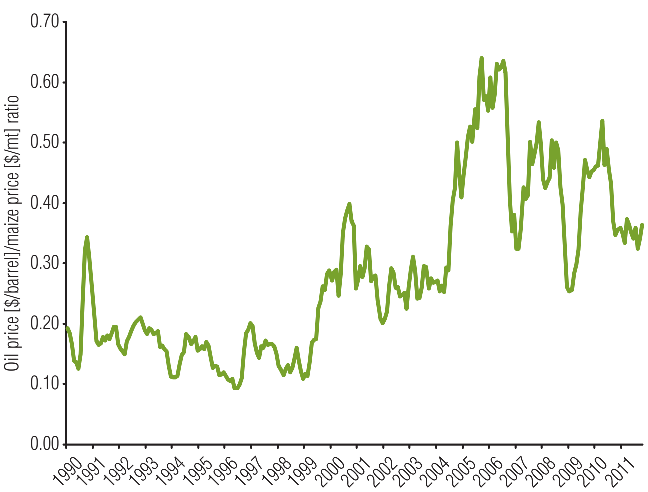
27 The elasticity estimates are from the USDA. They are based on data from the 2005 International Comparison Project (ICP), which allows for comparisons of consumption across 146 countries. Details of the methodology used to calculate the demand elasticities are provided in Seale *et al.* (2003), http://www.ers.usda.gov/publications/tb1904/tb1904.pdf, that used the earlier 1996 ICP data, but the same methodology was used with the updated 2005 data.

FIGURE 7: Demand Responsiveness to Food Price Changes Decline as Per Capita Income Increases



Source: USDA and World Bank.

FIGURE 8: The Oil to Maize Price Ratio Has Increased



Source: World Bank.

volatility impacts on production decisions. World food supply response in the short run is estimated to be fairly low (i.e., estimated price elasticities of 0.1). Price elasticities tend to be larger in developed than in developing countries, in part because of more developed and integrated input and output markets. In addition, higher price volatility in food markets increases price risks and likely lowers the production response to higher prices (Subervie 2008). The longer-term supply response may go up as countries develop (with greater output and input market integration), but this may be partly offset by lower supply response induced by higher price volatility.

Short-term supply responsiveness to price change is influenced by trade policies and food reserve operations. Sudden changes to output market integration can have significant effects on short-term world supply responsiveness. For example, export bans reduce supplies to world markets and raise world prices, as they did in 2008, contributing a substantial share of world price increases for rice and wheat (Martin and Anderson 2011). Food reserve levels and purchase and release policies impact supply responsiveness (i.e., impact the price elasticities of supply). For example, a large food price increase that induces food stock releases, increases supply responsiveness more than in the absence of stocks, thus increasing to overall immediate price elasticity of supply.

3.4 OUTLOOK

The bottom line is that the recent agricultural commodity price uncertainty is likely to continue for the foreseeable future, largely due to persistent uncertainty on the supply side, projected rising aggregate demand, and the inherent low responsiveness of the global food system. The prevailing formal medium-term outlook suggests the perpetuation of global prices higher than pre-2007 levels driven by fundamental factors (OECD-FAO 2011; World Bank 2011b). Accelerated use of food crops for biofuels continues to offset the slowing population growth effect on food demand. World stocks remain at relatively low levels where the likelihood of price spikes is higher. Production gains may be harder to achieve in the future than in the past, with more limited space for area expansion, declining yield growth, and increases in weather variability. The low responsiveness of the food system amplifies price spikes to shocks, and if the declining demand responsiveness with per capita income growth is not offset by more flexible biofuel policies and higher food supply responsiveness, then the amplitude of price spikes per shock will likely be higher. Policy responses matter, they can either amplify or dampen price spikes, and either prevent or increase the likelihood of price spikes.

4: RESPONSES

4.1 MEASURES TO ADDRESS THE DRIVERS OF HIGHER AND MORE VOLATILE WORLD FOOD PRICES

Demand and supply-side responses can help in reducing future food price escalation. Responses are needed at both global and local levels (table 6). Stimulating a sustainable supply response is a priority in order to meet the steadily growing demand for food. While a few of the large and technology-intensive exporters such as the United States retain significant capacity to expand production in the near- to medium term, there is no substitute for improving agricultural productivity and facilitating trade in most developing countries.

Measures to Reduce Average World Food Price Escalation

A broad range of actions are needed across both developed and developing countries to sustainably reduce world food prices. In spite of the high level of farm productivity, many OECD countries can further increase productivity and efficiency of their agriculture by reforming their farm and biofuel policies.[28] Middle- and low-income countries can also play a significant role in supply response, enhanced by improved policies and investment in productivity growth. Middle-income countries, including Argentina, Brazil, Uruguay, Russia, Ukraine, and Kazakhstan, have significant potential for productivity gains and have accounted for a larger share of recent global food exports. With lower conflict, macroeconomic stability, and lower agricultural taxation, agricultural growth in Africa is also improving. But more is needed, particularly through more and better public policies, as well as public and private investments.

Longer-term Trends in Supply [$\Delta\alpha_s$]

Raise Crop Yields

Raising food crop yields through sustainable intensification, and their resilience, is the single most important action needed for an enduring solution to global food security. More and better investments are needed to narrow the yield gap between average farm and experimental yields, generate yield-enhancing technologies, promote less energy–intensive inputs, and improve water management. Some of this increase in investment will be induced by higher prices (Hayami and Ruttan 1985), but a long-term sustained commitment (from donors and governments) is necessary to prevent future food crises, rather than simply responding with cyclical commitments to technology development after food price spikes (e.g., the 1970s and 2000s) (Timmer 2010).

- *Narrow the gap between average farm and experimental yields:* Average crop yields in many countries are well below experimental farm yields. Closing the yield gap requires (i) use of well-adapted, high-yielding varieties with resistance to biotic (e.g., pest and disease) and abiotic (e.g., drought and flood) stresses; (ii) improved soil fertility through crop rotations and judicious use of organic and inorganic fertilizer; (iii) better integrated management of pests, diseases, and weeds; and (iv) more efficient water management (FAO 2011b). Investments will be needed to better align extension services with farmer needs, complemented by better use of information and communication technologies; increased use of matching grants for technology adoption; and strengthened seed and fertilizer markets. Improved access to these services by women can help raise productivity growth. For example, if women farmers were to have the same access as men to fertilizer and other inputs, maize yields would increase by almost one-sixth in Malawi and Ghana (World Bank 2011c).
- *Generate yield-enhancing technologies*: Increased attention is needed on generating new and improved yield-enhancing varieties of the main staple crops important for smallholder farmers in regions with a high prevalence of hunger, particularly Africa and South Asia. Investments are needed in national agricultural research

28 World Bank (2007).

TABLE 6: Main Measures to Address the Drivers of Higher and More Volatile World Food Prices

MEASURES TO REDUCE AVERAGE FOOD PRICE ESCALATION		MEASURES TO REDUCE FOOD PRICE VOLATILITY	
Long-term change in supply [*component of* $\Delta\alpha_s$] • Raise crop yields • Facilitate land markets • Improve rural investment climate	*Long-term supply responsiveness to prices* [*component of* β_s] • Strengthen market integration • Better use of price risk management tools	*Short-term change in supply* [*component of* $\Delta\alpha_s$] • Develop more weather-tolerant varieties	*Short-term supply responsiveness to prices* [*component of* β_s] • Trade openness • Efficient food reserve management
Long-term change in demand [*component of* $\Delta\alpha_d$]	*Long-term demand responsiveness to prices* [component of β_d] • Shift to market-based (more flexible) biofuels policies	*Short-term change in demand* [*component of* $\Delta\alpha_d$] • Increase transparency of agricultural markets	*Short-term demand responsiveness to prices* [*component of* β_d] • Shift to market-based (more flexible) biofuels policies

Source: Authors' presentation.

systems, particularly for adaptive research, and as many developing countries are too small to achieve efficient scale in basic research, regional and global research programs such as those carried out by the International Agricultural Research Centers of the Consultative Group on International Agriculture Research (CGIAR) are needed to support national efforts.

- *Promote less energy–intensive technologies*. With the steadily rising energy prices, it is essential to promote technologies that can help deliver significant yield gains while lowering the use of more expensive energy-intensive inputs. A greater adoption of improved seeds is one example of reducing the energy-intensity of input use. Another example is biotechnology. In 2011, developing countries, mainly China and India, grew similar amounts of biotech crops as developed countries (ISAAA 2011). The increased use of biotech cotton varieties has reduced chemical applications by 40 to 50 percent while increasing yields by 15 to 20 percent, with relatively larger benefits accruing to cotton growers in developing countries (Baffes 2011). Transgenic varieties offer significant opportunities for poverty reduction; however, to mitigate potential risks, they should be used in situations where international biosafety standards are in place and are being implemented. A greater use of such technologies also requires strengthening capacity for assessing the potential risks and benefits of transgenics, and for developing cost-effective and transparent regulations and production programs with expertise and competence to manage their adoption and use.
- *Improve water management, including irrigation:* Investments in improved and sustained water management can enhance the returns to investments in other soil and crop management practices. Greater attention is needed to ensure sustainable water management practices through water user associations, through incorporation of broader river basin management aspects, and through improved use of shared watercourses, including support for cooperation between different riparian states on the water use from transboundary rivers and lakes. Expanding irrigated areas and improving water use efficiency of existing irrigation schemes are both needed as are better water control and erosion prevention at both field and river basin levels.

Facilitate Land Markets

Facilitating land markets can expand area planted to food crops, and strengthening property rights can improve the use of existing cropped areas. Land sales and rental markets, and strengthened property rights can improve the productive efficiency of existing land areas, and better use remaining areas available for crop production. Attention is needed to ensure responsible agro-investment from rising interest from foreign investments, including secure land rights of poor farmers.

- *Promote responsible agro-investments from foreign investors interested in land acquisition:* Large-scale investments create opportunities and risks for recipient countries. Increased investments (including by multinationals, sovereign wealth funds, or government-owned corporations) may spur agricultural productivity growth, fiscal revenue, employment, and local incomes, but may also result in local people losing land on which their livelihoods depend. Country capacity strengthening is needed to ensure terms and conditions of land deals seize opportunities and mitigate risk.
- *Secure land rights for poor farmers*: Making land rights more transferable increases investment incentives; allows access to land through sales, rental markets, or through public transfers; and is a precondition for land consolidation needed to apply more capital and exploit

economies of scale. In some countries, particularly in Latin America and Southern Africa, inequality in land ownership often leads to underutilization and deep-rooted rural poverty. In these cases, increased access through targeted programs of financial assistance to smallholders to enter land markets can potentially increase productivity and promote equality. Land programs also help agricultural regions to rebuild after conflicts and natural disasters, such as in Sri Lanka and Aceh, Indonesia. Significant gains can therefore be generated from (i) land policy and legal reforms; (ii) increasing security of existing customary or informal land tenure; (iii) modernizing land administration; (iv) land redistribution through socially manageable processes; and (v) preventing and reducing land conflicts, including due to foreign investment in large-scale agriculture, an issue of growing significance.

Improve Rural Investment Climate

Improving the rural investment climate can help induce a private-sector-led supply response. Issues that often affect the rural investment climate include access to finance, land, and other property rights; various licensing and registration requirements; sector-specific regulations; and taxes and tax administration. Addressing these potential bottlenecks will reduce the cost of doing business, will increase competition, and will help to induce a private sector response.

Long-term Supply Responsiveness to Prices [Component of β_s]

Strengthen Market Integration

Better market integration ensures world price signals reach more producers to induce supply response, thereby increasing the responsiveness of the food system to price increases. By linking farmers more closely to consumers, marketing systems better transmit signals to farmers on new marketing opportunities and guide their production choices to meet consumers' preferences. Strengthening the links between local suppliers and food retailers can help to provide locally produced goods at more competitive prices.

- *Improve market infrastructure and market information to better integrate markets*: Investments are needed to expand the reach and quality of rural roads, improve the collection and dissemination of market information, and improve technologies for postharvest storage to reduce product losses.
- *Improve the productivity and quality of production throughout the agribusiness supply chain*: Investing to improve the food retail infrastructure, including modern processing, packaging, and storage can enhance food safety, traceability, and environmental sustainability, and ensure competitive pricing. Investing in agribusiness logistics and distribution infrastructure with both the private and public sectors (through private-public partnerships) can facilitate trade, lower costs, and reduce postharvest waste.
- *Strengthen producer organization*: Strengthening the bargaining power of smallholder farmers, especially women, through their producer organizations can help reduce transaction costs, overcome economies of scale, and hence better link them to markets. Technical assistance and financing can help strengthen producer organizations.

Better Use Price Risk Management Tools

Ensuring food supply response to higher prices, and ensuring that smallholder farmers participate more in this supply, require better use of price risk management tools. Earlier analysis showed that developing-country crop supply response declined significantly when price instability doubled, but that use of risk management tools (precautionary savings, access to financial services) reduced the negative impact of price volatility on production decisions. Improved farmer access to price risk management tools can help ensure supply response to higher prices (and help prevent a decline in the price elasticity of supply).

- *Create an institutional environment that enables farmers to have better access to price risk management instruments, including finance and savings mobilization*. Improving smallholder farmer and microenterprises access to financial services for agriculture and food retail through direct service provision, market facilitation, and an improved enabling environment will likely have broader impacts than focusing on improving access to more formal price hedging instruments (e.g., commodity exchanges, warehouse receipts), although both are important and require an improved policy environment, improved access to information, awareness-raising, and training. Traders have typically used formal hedging instruments more than farmers, although basis risks (price correlation between domestic markets, and the closest futures market) are often too high to justify their use. These risks can be lowered but often require significant long-term investment in transport infrastructure and a nondistortive price policy environment.

Long-term Demand Responsiveness to Prices [Component of β_d]

Shift to Market-Based Biofuels Policies

Curbing biofuels mandates can reduce food price volatility through improving the responsiveness of the food system. If less land is "mandated" for biofuels production it will allow more flexibility (more land to be used) to respond to shocks. In the United States alone, about 37 percent of maize planted area, which is about 10 percent of total planted area, is projected to have been used for ethanol in 2010–11 (Trostle *et al*. 2011). Supportive policy measures by governments have promoted biofuels: crop production subsidies, infrastructure for biofuels storage, blending and production mandates, import tariffs, and tax incentives; which for ethanol equates to US$0.28 per liter in the United States, and US$0.60 per liter in Switzerland; and for biodiesel, to US$0.20 per liter in Canada, and US$1.0 per liter in Switzerland (Steenblik 2007). Even though biofuels offer a source of renewable energy and possible large new markets for agricultural producers, current biofuels programs have a mixed record of financial viability without subsidies.[29]

- *Reduce mandates and subsidies for biofuels production to improve the responsiveness of the food system to shocks*. As ethanol demand and corresponding prices have been raised by government regulation, deregulation is part of the solution to reducing food price escalation. Removing both nonmarket actions that raise demand for biofuels and subsidies for its production can reduce competition for grains among fuel, food, and feed. The recent abolishment of tax credits for biofuels production and import tariffs by the United States has been an important step in the right direction, but more remains to be done to increase flexibility of the mandate, reduce it, or eventually abandon it. Open international markets should be encouraged so that production of biofuels could occur where it is economically, environmentally, and socially sustainable to do so (G20 2011).
- *An alternative consideration is for governments to purchase call options on grain from biofuel producers to be exercised when food markets are under pressure*. Diversion could be triggered by specified indicators of food shortages (with the overall objective being to assure the needs of poor and vulnerable consumers, rather than to stabilize prices), and the biofuels supplier would commit to making a corresponding reduction in output (rather than substitute other foodgrain as feedstock) (Wright 2010). More research would be needed on the feasibility and design of this mechanism taking into consideration political economy issues.

29 National biofuel strategies need to be based on a thorough assessment of financial viability and the opportunity costs of biofuel policies. One recent case that was viable on a significant scale is the use of sugarcane for ethanol in Brazil.

Measures to Reduce World Food Price Volatility

Some measures to reduce average world food price escalation may also serve to dampen price volatility, while there are several actions that can directly address the source of volatility. These include more weather-tolerant varieties (to respond to more variable weather), more efficient stock management (both to ensure sufficient stock levels to reduce the likelihood of price spikes, and to reduce stock purchase and release policies amplifying volatility), trade openness (to reduce trade policy responses from amplifying food price spikes), and market transparency (to reduce market uncertainty).

Short-term Change in Supply [Component of $\Delta\alpha_s$]

Develop More Weather-Tolerant Varieties

Weather-tolerant crop varieties can reduce shocks to both food production and prices. Yield advantages of existing drought tolerant maize varieties can be up to 20 percent under drought conditions in Sub-Saharan Africa (CIMMYT, 2006), similar to millet and sorghum. There also remains substantial room for research on transgenic methods to improve crop drought resistance in semiarid regions. Transgenic drought-resistant maize varieties have been found to yield up to 20 percent more than nontransgenic drought-resistant varieties (Kostandini *et al.* 2011).

- *Increase public investment to develop more weather-tolerant varieties* through national systems and at regional and global levels through International Agricultural Research Centers such as the CGIAR.

Short-term Supply Responsiveness to Prices [Component of β_s]

Trade Openness

Open trade across all markets can diversify short-term production shocks dissipating the associated price effects. Price insulation reduces the effectiveness of world markets to dissipate shocks, and trade policy responses in 2007–08 acted to amplify the food price spike rather than reduce it. Trade is even more important when food stocks are low as more countries need to enter markets as net buyers.

- *Strengthen social protection systems of net exporters to reduce the risk of export bans when food prices spike*. This is particularly relevant for large net-exporting countries such as Argentina, Kazakhstan, Russia, and Ukraine (figure 2).
- *Continue analytical support highlighting possible gainers and losers from trade policy changes* as inputs for short-term action, and longer-term policy dialogue on identification and eventual implementation of cooperative trade solutions to reduce the adverse impacts of unilaterally chosen policies on trading partners.

Efficient Food Reserve Management

Ensuring sufficient stock levels can reduce the likelihood of price spikes and good management, particularly purchases and releases can reduce, rather than amplify, local and world food price volatility. Historically, when the world grain stock-to-use ratio fell below 20 percent, the likelihood of a world food price spike increased (Wright 2009). Purchasing stocks as food prices are increasing, amplifies food price increases (as was the case with major rice importers in 2007–08). While higher world ending stocks are often associated with lower world food price volatility, this is not always the case at the country level. The ability of public stocks to stabilize local prices and promote pro-poor growth depends on how stocks are managed (World Bank forthcoming). Further technical and consistent guidance to national governments on levels and use of food stocks is needed.

- *Provide technical guidance (good practice examples) of optimal stock levels.* Small emergency public grain reserves, related to the consumption needs of the most vulnerable, have an important role to play in alleviating the consequences of high and volatile prices, provided that they are well targeted to this specific purpose (most vulnerable people). In contrast, using stocks as an instrument of domestic price stabilization has proven difficult because of their high costs, both in terms of financial costs (implicit interest, hidden quality losses, physical storage losses, and transaction costs on stock rotation), as well as efficiency costs through disincentives to (generally more efficient) private sector storage and trade (Dorosh 2009). Clear technical guidance on balancing these trade-offs is needed.
- *Provide technical guidance (good practice examples) on optimal stock management*, particularly on stock purchases and releases, what triggers them, to whom, and at what volumes.

Short-term Change in Demand [Component of $\Delta\alpha_d$]

Increased Transparency of Agricultural Markets

Greater market transparency is needed to reduce market uncertainty and the associated large price corrections following revisions to market information (production, stocks, and trade). Clearer and more accurate monitoring can help to reduce food price spikes.

- *Increase public access to information on the quantity and quality of grain stocks to reduce uncertainty.* The capacity of international and national food market information providers to monitor market developments and disseminate timely and accurate information in relation to food prices and food security should be strengthened. A good step in this direction is the establishment of the Agricultural Market Information System (AMIS).[30] AMIS is a major partnership effort of multilateral international organizations to leverage their scarce resources and use the comparative advantage and expertise of different organizations to (i) improve global short-term agricultural outlook and policy analyses of global production, trade, stocks, and price developments; and (ii) promote early information exchange and discussion on crisis prevention and responses among policy makers through a Rapid Response Forum. More efforts are needed to ensure that better market information is shared and used for agricultural policy decisions.
- *Deepen our understanding of the relationship between international prices and local prices in poor countries*. Better monitoring and analysis of links between international, national, and subnational food prices are required to improve the speed and targeting of responses to problems, and the tools available.

30 AMIS and the associated Rapid Response Forum decided by the G20 Ministers of Agriculture Meeting in Paris on June 23, 2011, were launched by the French Presidency of the G20 in Rome on September 15–16, 2011. The Secretariat is housed in FAO, Rome. The participants of AMIS are the G20 counties, Spain, and seven developing countries that together (all 28) account for more than 90 percent of world food production and consumption. Initial commodities to be tracked are wheat, rice, maize, and soybeans. The AMIS seeks to (i) improve market transparency through better information on commodity balances, especially stocks; (ii) strengthen capacity of participating countries for global market assessment; and (iii) accelerate early policy discussion among key players when price spikes are likely, to avoid the beggar-thy-neighbor policy responses to price uncertainty observed in 2008 and 2010. Policy discussion would occur through a Rapid Response Forum composed of senior officials for ministries of agriculture in G20 countries and up to eight other associated countries, meeting on an ad hoc basis.

Short-term Demand Responsiveness to Prices [Component of β_d]

Shift to market-based (more flexible) biofuels policies. As indicated earlier, this would improve the long-term demand responsiveness to price changes and will also improve the short-term responsiveness allowing more short-term flexibility in production (with more land to use). Removing both nonmarket actions that raise demand for biofuels and provide subsidies for its production can reduce competition for grains among fuel, food, and feed. As indicated earlier an alternative consideration is for governments to purchase call options on grain from biofuel producers to be exercised when food markets are under pressure, but more research would be needed on the feasibility and design of such as mechanism.

4.2 MEASURES TO REDUCE THE NEGATIVE IMPACTS ON FOOD SECURITY

Should the previous actions prove insufficient in preventing future food price spikes, measures to mitigate adverse impacts can be taken.[31] These include interventions to ensure food access through trade and fiscal policy, better targeting and faster mobilization of safety nets, and promotion of short-term supply response through increased fiscal space or in some circumstances "market-smart" subsidies.[32] The choice of actions should not undermine longer-term farm incentives to invest and produce more (such as ad hoc provision of inputs).

- *Trade and taxes*: Lower taxes and tariffs (in particular cases) can lower food costs to poor consumers. Short-term budget financing can provide necessary and rapid offsetting funds to compensate for associated revenue losses and prevent cuts in public spending on key social assistance programs.
- *Food and cash transfers*: Temporary food and cash transfers help households facing food price shocks avoid irreversible losses, allowing them to maintain household assets, on which their livelihoods are based, and to adequately nourish and school their children. Where markets are functioning well, cash may be a more cost-effective means of providing assistance but leaves poor people exposed to price risks. When food markets are functioning poorly, or where prices are increasing rapidly, food transfers may be a more effective means of providing assistance to the poor and vulnerable (WFP 2008). Cash or food for work programs that develop infrastructure should consider implications for future maintenance, and opportunities to develop skills in the types of work selected (e.g., road paving). Physical food transfers need to be exempted from arbitrary movement restrictions that tend to arise in rural areas in times of crisis. Cash transfers combined with nutritional services are effective ways to mitigate the effects on the nutritional status of the poor. Continued effort is needed, especially in stable times, to develop social safety nets that are flexible and able to respond to shocks. A systemic approach involves developing various capacities such as (i) data to identify vulnerable groups; (ii) a targeting system to ensure the right group is reached; (iii) payment mechanisms; (iv) monitoring and evaluation systems; and (v) coordinated programs tailored to different groups of poor and vulnerable.
- *Short-term agricultural production*. Actions to induce next season agricultural supply response can help reduce interseasonal impacts of price spikes on food security. Targeted input support can enhance the ability of smallholders to respond. Provision of inputs works best when it mobilizes the private sector (through vouchers, for example) and is complemented by reductions in logistical overheads, especially in ports and on roads. Anticipating and enlisting policy support for dealing with potential bottlenecks that restrict delivery of inputs to national borders is essential. In addition, demand estimates for fertilizer and seeds need to be periodically reviewed in an environment of rapidly changing inputs prices to prevent waste from overestimates and constrained impacts from underestimates.

While there are many measures to respond to higher and more volatile world prices, the single most important one is to raise food crop yields, and their climate resilience, particularly in low-income countries. This requires focused efforts to ensure (i) scaling up of investments (by governments and donors) to improve food crop productivity growth, and (ii) maximizing returns to investments through support to irrigation expansion and water management (particularly in Africa), to adoption of improved seeds (particularly in more arid regions), and in the development of improved higher-yielding weather-tolerant crop varieties (through investment in agricultural research).

31 World Bank (2008).

32 World Bank (2007).

REFERENCES

Alcamo, J., N. Dronin, M. Endejan, G. Golubev, and A. Kirilenko. 2007. "A New Assessment of Climate Change Impacts on Food Production Shortfalls and Water Availability in Russia." *Global Environmental Change* 17(3–4). pp. 429–444.

Arezki, R., and M. Bruechner. 2011. "Food Price and Political Instability." IMF Working Paper, No. 11/62. Washington, DC.

Baffes, J. 2010. "More on the Energy/Nonenergy Price Link." *Applied Economics Letters* 17: pp. 1555–1558.

Baffes, J. 2011. "Cotton, Biotechnology, and Economic Development." World Bank Policy Research Working Paper 5896, Washington, DC.

Christiaensen, L. 2011. "Rising to the Rice Challenge: A Perspective from East Asia." World Bank, PREM, East Asia and Pacific.

CIMMYT. 2006. "Winning in the Long Run." International Maize and Wheat Improvement Center (CIMMYT), Mexico. Dec., 2006.

Dawe, D., Ed. 2010. *The Rice Crisis: Markets, Policies and Food Security*. Rome: FAO.

Delgado, C., R. Townsend, S. Bora, I. Ceccacci, and P. Zwaans. 2010. "Food Security: The Need for Multilateral Action." In *Post-crisis Growth and Development: A Development Agenda for the G20*, eds. S. Fardoust, Y. Kim, and C. Sepulveda, Washington, DC: World Bank: pp. 383–425.

Dorosh, P. 2009. "Price Stabilization, International Trade and National Cereal Stocks: World Price Shocks and Policy Response in South Asia." *Food Security* 1, pp. 137–149.

FAO. 2002. "The State of Food Insecurity in the World." 2001. Rome.

FAO. 2010. "Food Outlook." November 2010. Rome.

FAO. 2011a. "Food Prospects and Crop Situation." October 2011. Rome.

FAO. 2011b. "Save and Grow: A Policymakers' Guide to the Sustainable Intensification of the Smallholder Crop Production." Rome.

Fisher, G., H. Van Velthuizen, M. Shah, and F. Nahctergaele. 2002. "Global Agro-Ecological Assessment for Agriculture in the Twenty-First Century: Methodology and Results." http://www.iiasa.ac.at/Admin/PUB/Documents/RR-02-002.pdf

Foresight Report. 2011. "The Future of Food and Farming." The Government Office for Science, London.

Fuglie, K. 2010. "Total Factor Productivity in the Global Agricultural Economy: Evidence from FAO Data. The Shifting Patterns of Agricultural Production and Productivity Worldwide." The Midwest Agribusiness Trade and Research Information Center, Iowa State University, Ames.

G20. 2011. "Price Volatility in Food and Agricultural Markets: Policy Responses." Policy Report for G20 with the contributions by FAO, IFAD, IMF, UNCTAD, WFP, the World Bank, the WTO, IFPRI, and the UN HLTF, May 3, 2011.

GAO. 2009. "Biofuels: Potential Effects and Challenges of Required Increases in Production and Use." The U.S. Government Accountability Office, Report GAO-09-446, Washington, DC.

Gilbert, C., and C. Moran. 2010. "Food Price Volatility." *Philosophical Transactions of the Royal Society B* 365: pp. 3023–3034.

Hayami, Y., and V. Ruttan . 1985. *Agricultural Development: An International Perspective*. Baltimore, MD: Johns Hopkins University Press.

ISAAA. 2011. Global Status of Commercialized Biotech Crops: 2011. Brief 43, Executive Summary, International Service for the Acquisition of Agri-Biotech Applications.

Ivanic, M., and W. Martin. 2008. "Implications of Higher Global Food Prices for Poverty in Low-Income Countries." *Agricultural Economics* 39: pp. 405–416.

Kostandini, G., B. Mills, and E. Mykerezi. 2011. "Ex Ante Evaluation of Drought-Tolerant Varieties in Eastern and Central Africa." *Journal of Agricultural Economics* 62(1). pp. 172–206.

Maluccio, J., J. Hoddinott, J. Behrman, R. Martorell, A. Quisumbing, and A. Stein. 2009. "The Impact of Improving Nutrition during Early Childhood on Education among Guatemalan Adults." *Economic Journal* 119(537). pp. 734–763.

Martin, W., and K. Anderson. 2011. "Export Restrictions and Price Insulations during Commodity Price Booms." World Bank Policy Research Working Paper 5645, Washington, DC.

Mitchell, D., and J. Le Vallee. 2005. "International Food Price Variability: The Implication of Recent Policy Changes." World Bank, Washington, DC.

OECD-FAO. 2011. "Agricultural Outlook 2011–2020." Paris and Rome.

Padetzki, M. 1985. "Effects of a Dollar Appreciation on Dollar Prices in International Commodity Markets." *Resources Policy* 11: pp. 158–159.

Roberts, M.J., and Shlenker, W. 2009. "World Supply and Demand of Food Commodity Calories." *American Journal of Agricultural Economics,* 91(5). pp. 1235–1242.

Schiff, M., and C. Montenegro. 1995. "Aggregate Agricultural Supply Response in Developing Countries: A Survey of Selected Issues." World Bank Policy Research Working Paper 1485. Washington, DC.

Seale, J., Regmi, A., and Bernstein, J. 2003. "International Evidence in Food Consumption Patterns." Technical Bulletin 1904. U.S. Department of Agriculture, Washington, DC.

Steenblik, R. 2007. "Biofuels: At What Cost? Government Support for Ethanol and Biodiesel in Selected OECD Countries." The Global Subsidies Initiative of the International Institute for Sustainable Development, Geneva, Switzerland.

Stigler, M., and A. Prakash. 2011. "The Role of Low Stocks in Generating Volatility and Panic. Safeguarding Food Security in Volatile Global Markets." Rome: FAO, pp. 319–333.

Subervie, J. 2008. "The Variable Response of Agricultural Supply to World Price Instability in Developing Countries." *Journal of Agricultural Economics* 59(1). pp. 72–92.

Timmer, P. 2010. "Reflections on Food Crises Past." *Food Policy* 35: pp. 1–11.

Tiwari, S., and H. Zaman. 2010. "The Impact of Economic Shocks on Global Undernourishment." World Bank Policy Research Working Paper 5215, Washington, DC.

Trostle, R., D. Marti, S. Rosen, and P. Westcott. 2011. "Why Have Food Commodity Prices Risen Again?" Washington, DC: USDA Economic Research Service WRS-1103.

WFP. 2008. "Vouchers and Cash Transfers as Food Assistance Instruments: Opportunities and Challenges." Rome.

Wodon, Q., C. Tsimpo, P. Backiny-Yetna, G. Joseph, F. Adoho, and H. Coulumbe. 2008. "Potential Impact of Higher Food Prices on Poverty." World Bank Policy Research Working Paper 4745, Washington, DC.

World Bank. 2006. "Repositioning Nutrition as Central to Development." Washington, DC.

World Bank. 2007. "World Development Report 2008: Agriculture for Development." Washington, DC.

World Bank. 2008. "Framework Document for Proposed Loans, Credits, and Grants in the Amount of US$1.2 Billion Equivalent for a Global Food Crisis Response Program" Washington DC. http://imagebank.worldbank.org/servlet/WDSContentServer/IW3P/IB/2008/06/30/000333038_20080630001046/Rendered/PDF/438410BR0REVIS10and0IDAR20081016212.pdf

World Bank. 2009. "Transport Prices and Costs in Africa: A Review of the Main Trade Corridors." Washington, DC.

World Bank and IMF. 2010. "How Resilient Have Developing Countries Been during the Global Crisis?" Development Committee Paper, Washington, DC 2010-0015

World Bank. 2011a. "Food Price Watch." February 2011. Washington, DC.

World Bank. 2011b. "Global Economic Prospects: Maintaining Progress and Turmoil." Volume 3, June 2011, Washington, DC.

World Bank. 2011c. World Development Report 2012: "Gender Equality and Development." Washington, DC.

World Bank (forthcoming). "Managing Public Stocks for Food Security." Agriculture and Rural Development Department, Washington, DC.

Wright, B. 2009. "International Grain Reserves and Other Instruments to Address Volatility in Grain Markets." World Bank Policy Research Working Paper 5028. Washington, DC.

Wright, B. 2010. "Addressing the Biofuels Problem: Food Security Options for Agricultural Feedstocks." Paper presented at the IPC Conference, Sao Paulo, Brazil, October 24.

AGRICULTURE AND RURAL DEVELOPMENT

THE WORLD BANK

Agriculture and Rural Development (ARD)
1818 H Street, NW
Washington, D.C. 20433 USA
Telephone: 202-477-1000
Internet: www.worldbank.org/ard

ARD
AGRICULTURE AND RURAL DEVELOPMENT