ZEF-Discussion Papers on Development Policy No. 161

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Global Food Price Volatility and Spikes: An Overview of Costs, Causes, and Solutions

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Abbreviations

BRICS	Brazil, Russia, India, China, and South Africa
CBOT	Chicago Board of Trade
CFTC	Commodity Futures Trading Commission
CFNSS	Chinese Food and Nutrition Surveillance System
CGIAR	Consultative Group for International Agricultural Research
CPI	consumer price index
DHS	Demographic and Household Survey
FAO	Food and Agriculture Organization of the United Nations
FGLS	feasible generalized least square
GARCH	generalized auto-regression conditional heteroscedasticity
HLPE	High-Level Panel of Experts
IFPRI	International Food Policy Research Institute
MENA	Middle East and North Africa
OECD	Organization for Economic Co-operation and Development
OLS	ordinary least squares
SUR	seemingly unrelated regression
WB	World Bank
WHO	World Health Organization

Acknowledgments

Summary

Since the 2007–08 food crisis, many thoughtful analyses have addressed the causes and impacts of high and volatile international food prices and proposed solutions to the crisis. These studies have covered global as well as local food price dynamics and policy reactions. The food price problem is, however, far-reaching, and its impacts are wide and interrelated. The price formation mechanism has become highly complex and dynamic. Policy actions are politically and economically sensitive. This situation calls for continuous and comprehensive assessments of the problem to provide timely and evidence-based knowledge for policy makers. This paper reviews existing evidence and theories and presents new thoughts and insights from analyses to enlighten the course of actions to be taken.

Our review implies that the current body of literature concentrates on high food prices. Commodity price analysis should, however, differentiate between three types of price changes: trends, volatility, and spikes. While price trends are important in the long term, volatility and spikes are more important in the short to medium terms. Descriptive statistics indicate that all three price changes are increasing over time and show strong correlations among themselves. A rising medium-term price trend has triggered extreme short-term price spikes and increased volatility.

An assessment of the costs of price volatility has shown that the existing literature follows a conventional marginal-cost approach that considers only few cost components. Direct and immediate components have not been adequately analyzed, and long-term effects have been overlooked. The effect on child nutrition and health is one such long-term effect. Under-nutrition in early childhood has negative consequences for lifetime earnings capacity because of the physical and mental impairment it causes. Economy wide distortions and misallocations also threaten the long-term development of commodity-dependent economies. Measuring and estimating the cost of food price volatility should factor in ongoing processes such as economic growth and technological changes.

The supply, demand, and market explanations for high and volatile global prices have been differentiated as exogenous and endogenous factors. To help further identify the drivers of food price changes, they are categorized as root causes, intermediate causes, and immediate causes. Both empirical and theoretical evaluations suggest extreme weather events from the supply side, biofuel production from the demand side, and speculation in commodity futures from the market side are the three most important root causes of observed price volatility. The theoretical and empirical effects of speculation in commodity futures are not yet well understood. However, speculative trading in commodity futures should not be viewed as a random bet that can be smoothed out through the price system. It is important to consider the market and nonmarket contexts that guide the behavioral and strategic choices of speculators. Whereas speculation caused by manipulative, disorderly behaviors and 'financialization' are damaging, speculation caused by demand and supply in physical markets can serve as price discovery, liquidity, and risk-hedging mechanisms. Our empirical analysis to quantify the importance of these factors shows that speculation effect is stronger than demand- and supply-side shocks for short term price spikes.

Overall policy interventions at global, regional, and local levels should concentrate on reducing price spikes and protecting poor people from short- and long-term crises. The

formulation and implementation of such policies must be supported with timely information and research-based evidence. A comprehensive portfolio of policy actions is proposed here, rather than over-extended individual measures to address the root causes or over-regulation of markets to address volatility and spikes. Evaluation of policy instruments should weigh the true costs associated with both, action versus inaction.

Research must focus on developing price and food security indicators and models that will guide policy implementation also in the short run. Such models are currently missing.

Key words: food security, prices, volatility, poverty, food policy, speculation, economic crises

JEL classification: I38, O13, O16, Q11, Q18

1. Global food price dynamics

The state of international food prices

In 2007–08, the price of almost every food item sharply increased in global markets. Prices rose quickly, across the board, as much as they had in the historic 1974 food price crisis. At their peaks in the second quarter of 2008, world food price indices were three times higher than in the beginning of the 2000s (Figure 1). Prices have since dropped, mainly because of favorable weather conditions and slowing food demand resulting from the global financial crisis and recession, but they remain high compared with prices five years ago. Food prices spiked again starting in August 2010. Since then the food price index of the Food and Agriculture Organization of the United Nations (FAO) has stayed high, even surpassing its level of June 2008. Furthermore, because this FAO index is trade weighted (i.e. the prices of the food commodities are weighed by their relative shares in trade), the actual burden of price increases on poor people is not captured, because that is determined by the domestic prices, which they pay.

The two episodes (2008 and 2011) have showed little variation in affected commodities. In both cases, the prices of wheat, maize, and soybeans were much higher than in the early 2000s (Figure 2). Dairy products, meat, palm oil, and cassava also experienced sharp price hikes. The prices of butter and milk, for example, tripled between 2003 and 2008, and the prices of beef and poultry doubled. In contrast to 2007–08, the sugar price in 2011 has spiked to 300 percent of its level in 2002–04. The price of rice, which experienced a fivefold rise in 2007–08, seems relatively low in 2011. However, recent data show increasing rice prices since June 2011 as other prices are edging downward. Nevertheless, all food commodities remain above the long-term average.

A look at historical trends shows that volatile food prices are not new phenomena. Global food prices were in series of crises throughout the early 1970s. Some authors estimate that in real terms the agricultural commodity price peaks of the 1970s were much higher than those of 2007–08 (Piesse and Thirtle 2009). Cereal prices in the 1980s and early 1990s increased between two and five times in the course of a year in famine-prone areas of Africa, causing acute human tragedies (von Braun, Teklu, and Webb 1998). The rate of transmission and the extent of the recent price hikes are, however, different from the previous periods. Current price transmission is quite fast, and the price crisis covers all commodities across the board, including metals, energy, and minerals. Attempts to deflate these nominal price changes raise complex issues of deflators; for instance, comparisons of 'real' values that rely on middle class–based US$ deflators are misleading, as they do not reflect the food basket of the poor.

Many price forecasts predict an increase in agricultural prices in the short to medium term. By the year 2020, real prices are anticipated to be 20 percent higher for cereals and 50 percent higher for meats compared with previous decades (OECD-FAO 2011). Whether high food prices will create incentives to increase production to counteract the price peaks remains to be seen.

Figure 1 - monthly international food price indices, 2004–11 (2000 = 100)
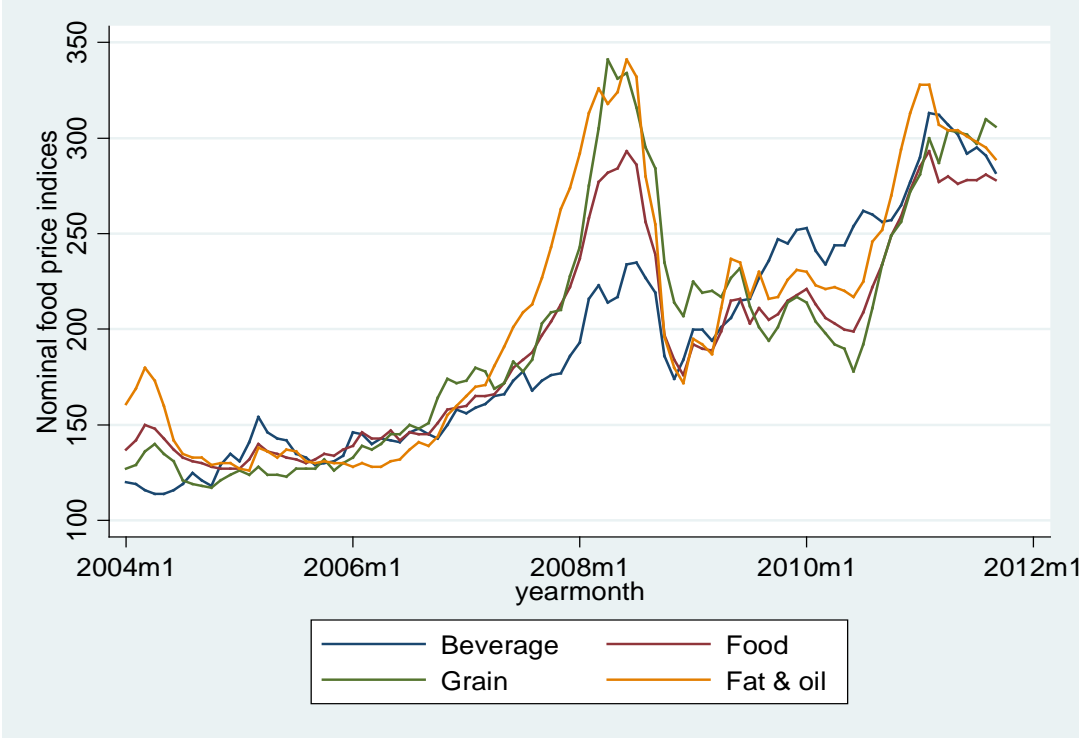
Source: World Bank, 2011a.

Figure 2 - International nominal food commodity prices, 2004–11
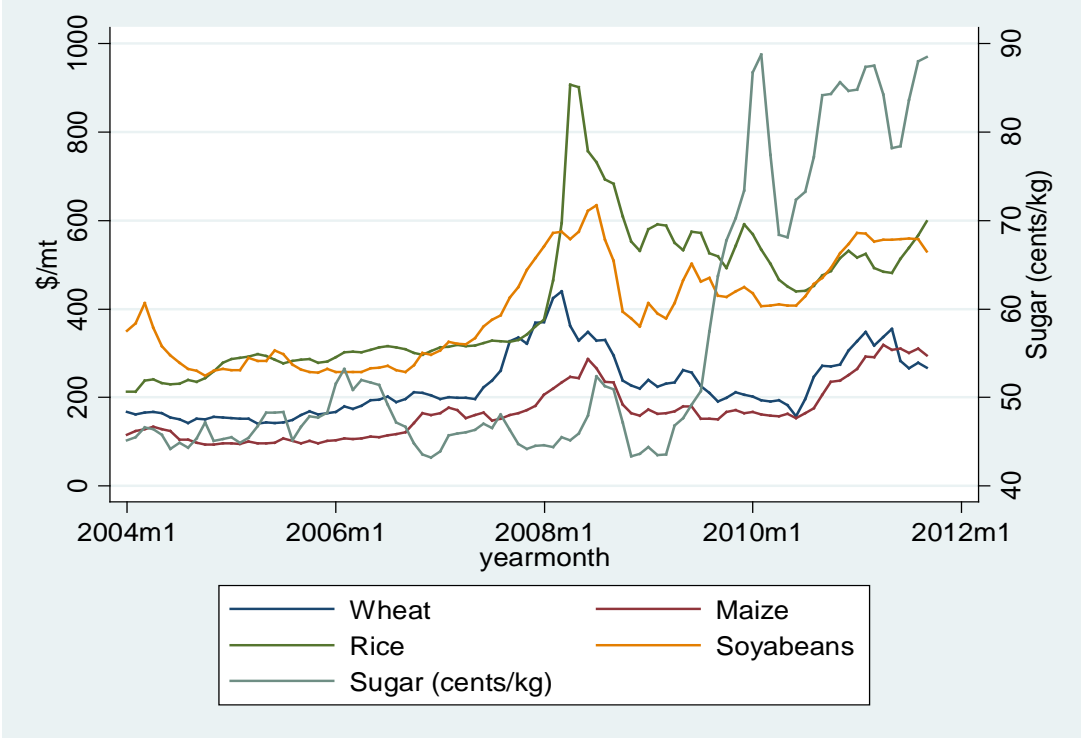
Source: Data from World Bank, 2011a.

Food price changes

Agricultural commodity markets are inherently volatile because of their strong links with natural shocks. In the recent volatility of 2007–08 and 2011, however, the slopes are so steep and the peaks are so high that they seem to reflect an extraordinary phenomenon in commodity markets.

It seems essential at this point to distinguish between the different terms used in referring to price changes. Price movements can be described as ***trends, volatility, or spikes***. A price trend is the smooth, long-term average movement of prices over time; it shows the general tendency of prices for a certain period of time. A price spike refers to a change in price levels over a shorter period of time, usually between two consecutive observations. It takes a negative or positive value that causes a crisis. Positive values are generally perceived as high prices, and the highest positives as price spikes. The most common way of measuring price spikes is using percentage change as the logarithm of the rate of period-over-period prices. Volatility on the other hand is the dispersion of a price series from the mean. It is usually measured in terms of standard deviations of the price change. Volatility includes only ups and downs from the mean. It does not measure direction; rather it measures price risks. Realized volatility can be decomposed into high-frequency volatility and low-frequency volatility (Peterson and Tombek 2005). High-frequency volatility refers to weather- and disease-related shocks that last for a season or less. Low-frequency volatility loosely refers to variability that persists for more than one season. Managing low-frequency volatility is more challenging than managing high-frequency volatility. High-frequency volatility is closely related to short-term price spikes.

It is also important to distinguish between price trends and price volatility in their effects on producers and consumers. High food prices are an incentive for net food producers to produce more food. Whenever food prices are on an upward trend relative to input prices, farm income will grow, encouraging agricultural investment. On the other hand, rising food price trends can impose tremendous challenges on poor people who spend much of their income on food. Price volatility, however, is a challenge for both consumers and producers. Volatility introduces risks that affect a risk-averse agent's decision making. The impact of price risk on smallholder producers has been extensively studied (Binswanger and Rosenzweig 1986). For households in developing countries that are net food sellers, the marginal utility of income is negatively correlated with risk, causing lower input use and production under risk than under certainty. For households that are net buyers, the marginal utility of consumption is negatively related to price risk, causing lower consumption under risk than under certainty.

The formation of volatility may follow a different path from the formation of high food prices. Whereas high food prices are caused by an increase in demand or reduction in supply, volatility can be created by supply and demand shocks, market manipulation, and high prices themselves. However, the relationship between price level and volatility is not well defined. There is a general feeling that an increase in price level increases volatility. What is certain, however, is that the high prices of 2007–08 and 2011 have been accompanied by high price volatility (Gilbert and Morgan 2010).

Figure 3 - International maize and wheat real price trends, volatility, and spikes
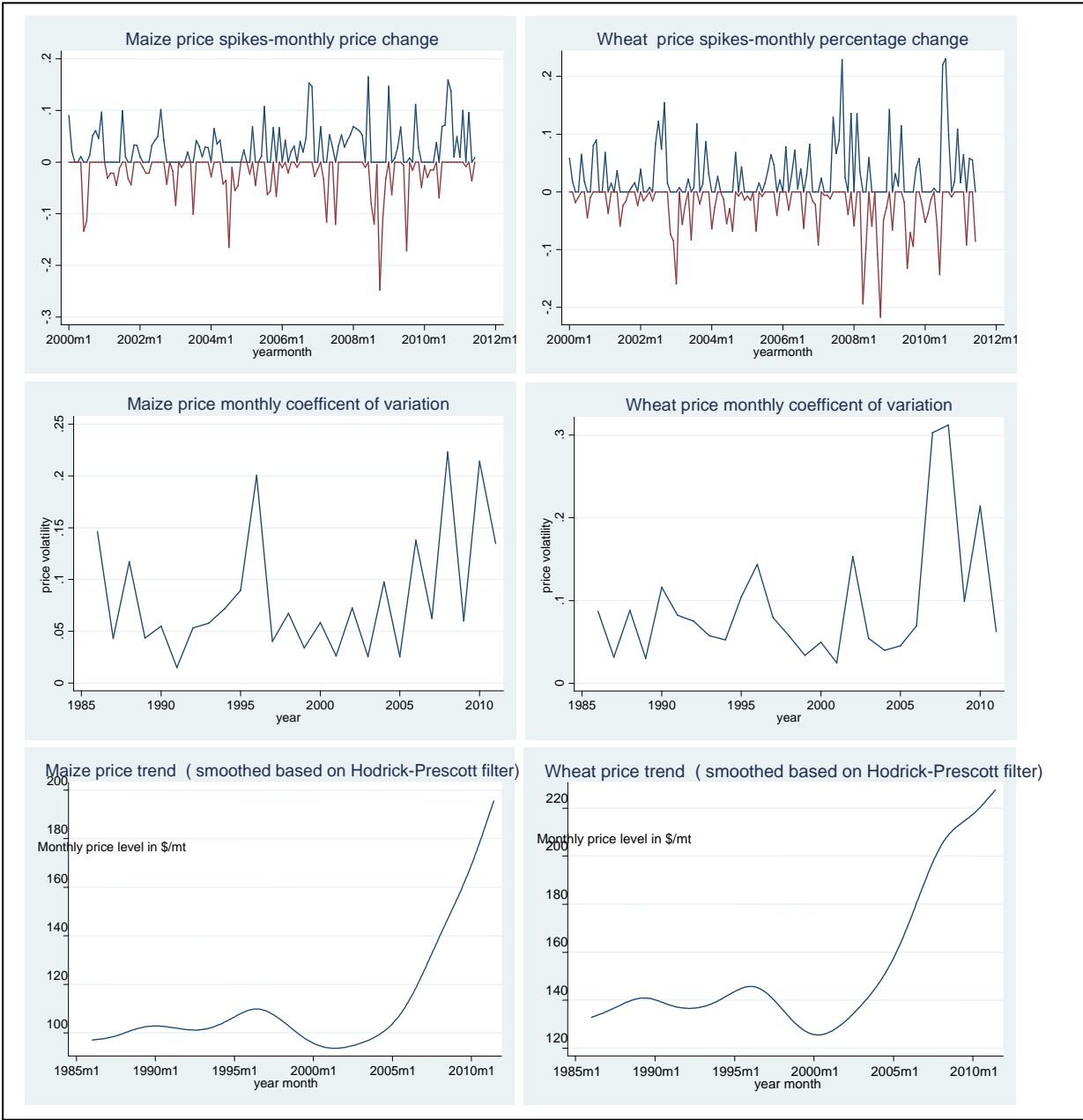
Source: Authors' calculations based on data from World Bank, 2011a.

We estimated trends, spikes, and volatility of world reference prices for the recent past. Trends were estimated using a Hodrick-Prescott time-series filter. Figure 3 shows trends, spikes, and volatility for maize and wheat prices. Contrary to findings reported in some earlier studies (see, for example, Diaz-Bonilla and Ron 2010), both price spikes and volatility have increased in most recent periods. This finding is in line with a recent OCED study (Huchet-Bourdon 2011), which claims that though the recent commodity price volatility is not very much different from the price volatility in 1970s, for some commodities, for example, wheat and rice, the current price volatility is higher than the past 50 years. The price spikes analysis indicates that the positive spikes seem more prevalent in recent times than the negative spikes. As expected both maize and wheat price trends have increased tremendously since 2005.

Nonlinearity in global food price dynamics

The price effects of fundamental changes in demand and supply tend to occur gradually as increasing or decreasing price trends. E.g., when demand for biofuel increases, prices move upward steadily; there is little reason for changes in biofuel demand to lead to extreme price swings because demand tends not to change very quickly. When fundamentals are changing gradually over time, market actors may not change their behavior immediately, but when changes in supply or demand reach a certain level, market actors may start to behave differently. They may be driven by sensations and trends rather than by fundamentals and behave in less rational way. The irrational behaviors triggered by increasing fundamentals may create a tipping point in food price movements beyond which markets become more volatile.

The skewed relationship between spikes and trends indicates the nonlinear dynamics of the food price series. Table 1 shows the size and probability of spikes at different price regimes defined by the size of smoothed price levels (trends). The size and probability of price spikes are higher at higher price regimes than at lower and intermediate price regimes. This pattern implies that increasing price trends could initiate market volatility. Traders and governments could be the major sources of the nonlinearity in food price dynamics.

Table 1 - The relationship between price levels and price spikes for maize and wheat, January 1986–June 2011

Commodity	Low price regime[a]	Lower-medium price regime	Upper-medium price regime	High price regime
Maize				
Mean size of spike (in %)[b]	4.3	3.8	3.5	6.1
Probability of extreme spikes[c]	0.23	0.09	0.12	0.27
Wheat				
Mean size of spikes (in %)[b]	4.0	4.2	4.0	6.4
Probability of extreme spikes[c]	0.14	0.18	0.13	0.30

Source: Authors calculation based on World Bank, 2011a data.

Note: Prices are World Bank monthly real prices.

[a] Price regimes are defined based on price levels. Low price regime indicates a regime below the 25th percentile of the price series; lower-medium, between the 25th and 50th percentiles; upper-medium, between the 50th and 75th percentiles; and high, above the 75th percentile.

[b] The mean size of the spike is calculated based on the absolute value of the percentage price changes.

[c] An extreme spike is defined as a spike above the 90 percentile of prices. An extreme price spike occurs when the maize and wheat prices rise above 7 and 7.7 percent.

When prices are rising, traders and governments may start to panic and aggressively respond through stockpiling, price controls, and trade restrictions. These reactions create tensions and market disruptions. These factors cause not only inter-temporal nonlinearity, but also nonlinearity in spatial price transmission across countries and regions. Nonlinear price movement implies that stabilizing food supply and demand protects consumers and producers against extreme short-term spikes and low-frequency price volatility. The resurfacing of price spikes in 2011 is clear evidence of how markets can remain volatile once they receive a serious shock. Policy actions have to be as quick as the market.

2. Price volatility and the poor

Food prices based on market activities are almost always volatile. Markets follow the natural fluctuations of supply shocks and the instabilities of food demand. Although this volatility brings risks to both consumers and producers, it cannot be avoided. Attempting to avoid such normal volatility costs the economy far more than its direct costs (Newbery and Stiglitz 1981). Price stabilization usually leads to inefficiencies and benefits only part of society. Some observers (such as Bellemare et al. 2011) empirically argue that the welfare gain from eliminating volatility would be concentrated on the upper 40 percent of a society. Given the current worldwide extreme volatility with spikes, however, we argue that certain conditions may justify policy actions to prevent such extreme events. The following subsections discuss factors that range from the interconnections of the global commodity markets to the extent of poor people's dependence on food markets. The costs of inappropriate action and inaction at times when prices are spiking are also considered. The costs of price stabilization and price volatility should be assessed on more than their effects on efficiency and inequality, thus going beyond Newberry and Stiglitz: Short- and long-term perspectives and the human, political, and social crisis must be factored in. The following subsection discusses these perspectives.

Underlying factors and their diverse effects

Because of the changing global economic environment caused by scarcity and technology, the livelihoods of many poor people directly or indirectly depend on global markets to which their local markets are connected. The change in international food prices reaches poor people in poor countries through the global price transmission system. Thus, the impact of international food prices on local economies depends on the extent of price transmission across borders. Price transmission refers to the co-movement of prices in two or more spatially separated markets. The co-movements of prices do not necessarily require physical flow of goods and services; the flow of price information alone can transmit prices across borders. Many studies suggest that the recent high and volatile world food prices have been transmitted strongly to local markets in poor countries (Minot 2011; Dawe 2008; Conforti 2004). However, the transmission is not complete. Whereas some local markets absorb international market shocks in as little as a week, some markets remain unresponsive to global shocks. Prices in regions characterized by permanent surplus or deficit are more correlated to global reference prices than those in regions with an occasional surplus or deficit because of switching transport margins in these cases. Prices of widely traded commodities such as wheat and maize are more highly correlated across countries than prices of spatially restricted commodities, such as rice. Even for rice, though, some empirical studies suggest that one-third of the change in the world rice price has been transmitted to local markets (Dawe 2008). Spatially, price transmission has been less complete in African markets than in Asian and Latin American markets (Conforti 2004). In some cases, for instance where strong regulations determine domestic prices, it is impossible to causally associate local price changes with global price changes. Moreover, large underlying causes of the co-movement of prices (e.g. a global recession or a weather event of global significance) can move the prices of all food commodities simultaneously worldwide.

The transmission of domestic wholesale food prices to retailers and producers also matters for the real cost of volatility at the household or farm level. Agricultural prices have long

been characterized by stickiness: a price reduction spreads to the farm gate price faster than a price increase, and a price increase spreads to the retail price faster than a price decrease. These days, however, there is little empirical evidence for the stickiness of agricultural prices. Prices have been transmitted increasingly quickly and proportionally as a result of a rapid improvement in infrastructure, information, and trade liberalization over the past two decades. Price stickiness might, though, still play a significant role in some developing countries, where infrastructure and competition are not yet well developed.

A rapid rise in food prices associated with an increase in volatility affects poor people in many ways. The most important effects are a reduction in real income and increased income instability. The extent of income reduction and instability depends on a number of factors, including the share of income derived from the food sector and the share of food budget expenditure. If the share of income from agriculture is high, a rise in food prices increases real income, if expenditure share is kept constant. If the food expenditure share is high, a rise in food prices decreases real income. Based on the share of income from the food sector and the amount of expenditure on food, three groups of people can be identified.

1. Urban consumers: These consumers do not produce food, so increased food prices have no effect on their nominal income, but rising food prices do reduce their initial real income. The size of the reduction depends on the share of food expenditures in their total spending and on overall inflation. Poorer people spend most of their income on food. In some Asian countries, the first quintile expenditure group spends more than the fifth quintile by about 20 percentage points (Table 2).
2. Rural net buyers: Because these buyers buy more than they sell, the net-income effect may be negative. In general, poor rural people tend to have a high food expenditure share and a low supply response, so their real income is likely to fall. Many poor rural people in developing countries are landless and earn their incomes mainly from off-farm activities and employment. Such people are highly vulnerable to food price spikes.
3. Rural net sellers: This group of households benefits both from increased income (keeping production constant) and from increased production. Both effects raise their total income. The size of the production effect depends on supply elasticity. In areas where factor markets are imperfect, the supply response is generally low. Though the real income of this group has a chance of increasing with increased food prices, it could remain constant or even decline if food inflation disproportionately pushes up overall inflation. The benefit to these households also depends on access to markets and the cost of inputs. If the cost of inputs increases proportionally with food prices, the net benefit would be reduced.

Table 2 - Share of food expenditures in total expenditures (%)

Quintile	Bangladesh	India	Indonesia	Philippines
1st	69.3	62.0	63.3	64.6
2nd	66.9	59.4	58.1	59.2
3rd	63.2	56.2	54.1	54.1
4th	58.7	50.8	49.0	47.7
5th	45.2	36.4	37.9	36.4

Source: Asian Development Bank, 2008.

Consumers' responsiveness to changes in prices and real income determines the size of the total impact of rising food prices. The higher the elasticity of demand for food, the higher the impact on consumption. Poor people respond to price changes more strongly than the rest of the population by changing caloric intake. Calorie price elasticity of the whole food demand taken together is less than for individual food items, because of the possibility of shifting from high-calorie foods to low-calorie foods when prices increase. Both income and price elasticity are generally high for poor people. Estimates of price elasticity with a two-stage demand model from 114 countries show that food demand in low-income countries is more responsive to changes in food prices than in middle- and high-income countries, with price elasticity for food averaging -0.59 for low-income countries and -0.27 for high-income countries (Seale et al. 2003). The food consumption loss is large for highly responsive people. Even when consumers are compensated for an increase in food prices by increases in their income, evidence from Pakistan suggests that price elasticity drops only slightly (ul Haq et al. 2008). Even when wages increase or governments provide income subsidies to compensate for price increases, consumers still are highly sensitive to food price changes.

Besides reducing real income and consumption, food price volatility causes asset draw-down. Poor producers - such as the rural net buyers mentioned above - often sell their animals and farmland in distress sales to purchase food during shortfalls. They may increasingly spend their work time on richer farmers' fields to earn a living or get food donations. The urban poor often borrow money for consumption or use their small working capital, becoming indebted in ways that are difficult to recover quickly. The overall impacts of such draw down of assets are reflected in the long-term production and income generation capacity of the poor. Thus, food price volatility of this kind increases and prolongs poverty and makes income distributions more unequal.

Empirical estimates on poverty and hunger

Empirical estimates of the impacts of high and volatile food prices on poor people use three major approaches: simulation (such as FAO 2008; Ivanic et al. 2011), self-reporting (Headey 2011a), and actual measurement. The simulation approach applies elasticity parameters to observed price changes to predict the effect of those price changes on income and consumption. A variety of market and economy wide models have been developed to simulate price effects. The simplest simulation is made using household surveys and elasticity coefficients. In contrast, the self-reporting approach depends on direct questions to sample households or individuals, who are asked to report on how the food price crisis affected their purchasing power, their probability of being hungry, and their consumption. Reported effects might include, for example, the number and size of meals consumed each day or changes in children's school enrollment. This method seems more reliable than simulation, but the answers to these questions are highly subjective and dictated by many uncontrollable factors. The impacts of economic crisis and food crisis, for example, cannot be separated. Finally, the measurement approach estimates impact using data recorded before and after the crisis. This approach may compare, for example, rates of child malnutrition before and after price spikes or between different seasons. This is the most reliable method of estimating food price impacts, but it requires consistent *ex ante* and *ex post* data. Because of the differences among these three methods, researchers may arrive at different conclusions regarding the cost of volatility. Furthermore, measuring and estimating the cost of food price volatility should factor in ongoing processes such as economic growth

and technological change. The pros and cons of each of the approaches suggest tri-angulated assessments employing all three methods.

A recent World Bank simulation suggests that the 2011 food price hike has pushed 68 million people into poverty and pulled 24 million people out of poverty, a net increase of 44 million poor people (Ivanic et al. 2011). Household-level analyses also suggest that – as expected - poor consumers are affected much more than rich households. An 11-country study of the impacts of high food prices shows that the poorest households, in both urban and rural areas, are the worst affected (Zezza et al. 2008). An increase in food prices often constitutes a transfer from the large majority of consumers to a minority of producers and results in an overall increase in poverty. The domestic food price increase in 2007–08 in Pakistan is estimated to have increased poverty by 35 percent (45 percent in urban areas and 33 percent in rural areas) (ul Haq et al. 2008). Even in agricultural exporting countries, the net effects of increases in food prices can be negative. For instance in Thailand, the positive effects on poor food producers are smaller than the negative effects on poor food consumers (Warr 2008). Similarly, a study by Wodon and Zaman (2009) in Sub-Saharan Africa finds that rising food prices are likely to lead to higher poverty because the negative impact on net consumers outweighs the benefits to producers.

The 2007–08 food crisis threw 75–80 million people into hunger and food insecurity, according to the FAO (2008). A similar simulation conducted in 2010 showed a hunger impact of close to 63 million people worldwide from the 2008 crisis (Tiwari and Zamen 2010). In some countries, such as in Ethiopia, the crisis reduced households' calorie intake by about 25 percent (Ulimwengu et al. 2009). Rural households in Ethiopia experienced higher losses in calorie intake than urban households. This difference is partly attributed to variation in households' consumption responsiveness to income and price changes.

Malnutrition impact

The impact of food price spikes lasts far longer than the temporary increases in poverty and hunger. One long-term effect is the impact on child nutrition and health; because under nutrition in early childhood impairs physical and mental development, which has negative consequences for lifetime earnings. High and volatile food prices raise malnutrition through both substitution and income effects for consumption. When food prices increase, people often shift from more nutritious food to less nutritious food. For instance, they may eat fewer animal products, such as meat and milk, and more cereals and root crops, which are cheaper to compensate for reduced income. Children are the immediate victims of this adjustment. Anriquez et al. (2010) simulated the impact of rising food prices on child malnutrition using food-demand equations with household-level information. Their simulation results conclude that a food price increase not only reduces the average consumption of dietary energy, but also worsens the distribution of food calories within a household, possibly leading to undernourishment of children. The income effects also reduce the capacities of households to spend on health which further increases the risks for malnutrition.

Given many national and international programs dedicated to cutting malnutrition, price spikes may not immediately raise malnutrition. Instead, they may retard the rate of decline in malnutrition prevalence. Child malnutrition in Bangladesh, for example, continued to

decline when food prices were increased (Figure 4). The rate of decline, however, has slowed significantly. The broken green line shows how much more malnutrition would have fallen if food prices and economic conditions had continued on previous tracks. Examining the rate of decline in malnutrition, therefore, is more useful than examining the level of malnutrition alone. Yet, circumstances and policy measures matter: a study by Bellemare et al. (2011) found that stabilizing food prices had only small benefits for lower-income people in Ethiopia.

Figure 4 - Percentage of stunted children and food price in Bangladesh
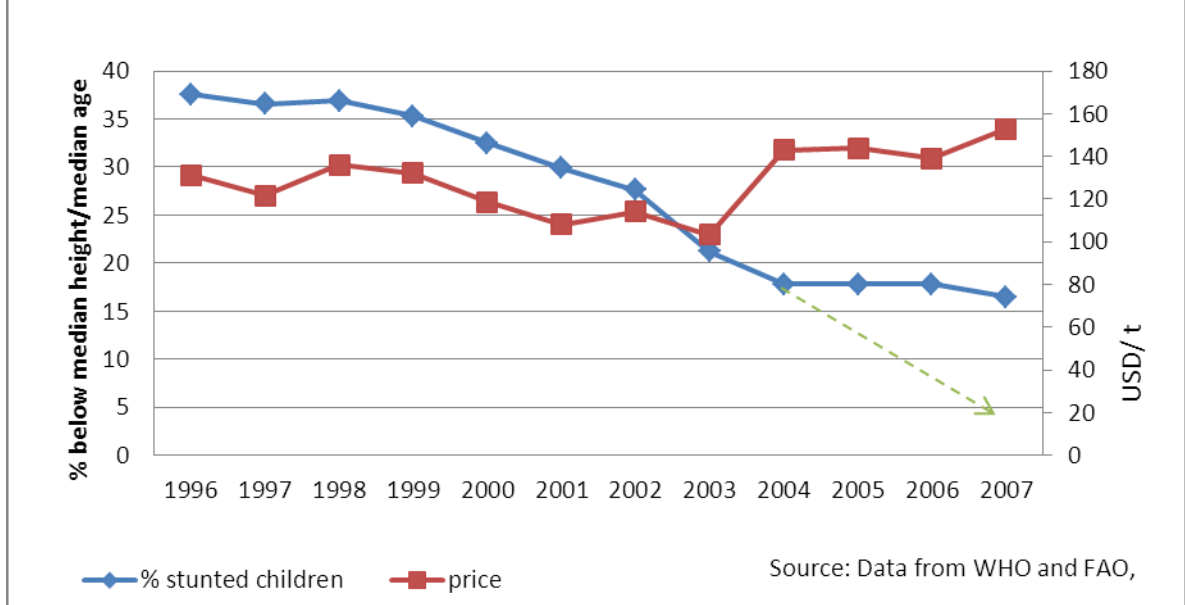
Source: Authors calculation based on World Bank, 2011b and FAO, 2011 price data.

To further investigate the impact of rising food prices on child malnutrition, average malnutrition rates for three periods (1999–2002, 2003–06, and 2007–10) were calculated for a sample of developing countries that have related data. Figure 5 illustrates the rate of change in child stunting before and after/during the 2007-08 crisis. Sierra Leone is a special case here because of the extraordinary change it underwent during this period after the war. Of the remaining 10 countries in the sample, the level of malnutrition increased in three countries: Egypt, Indonesia, and Guinea – in the latter case less so than before, and the pace of progress in reducing malnutrition slowed for five countries: Bangladesh, Cambodia, rural China, Kenya, and Vietnam. Only Burkina Faso was able to accelerate the rate of child malnutrition decline during the crisis, and Nigeria managed to somewhat curb the rate of increase in malnutrition. In sum, in 8 out 10 countries for which data are available, the food price crisis and its economic circumstances undermined progress in reducing child malnutrition, even in middle income countries. Thus, any economic assessment should consider the effects of food price change on human wellbeing.

Figure 5 - Annual rate of change in child malnutriton (stunting in children under 5 years old) in the periods 1999–2002 to 2003–06, and 2003-06 to 2007–10
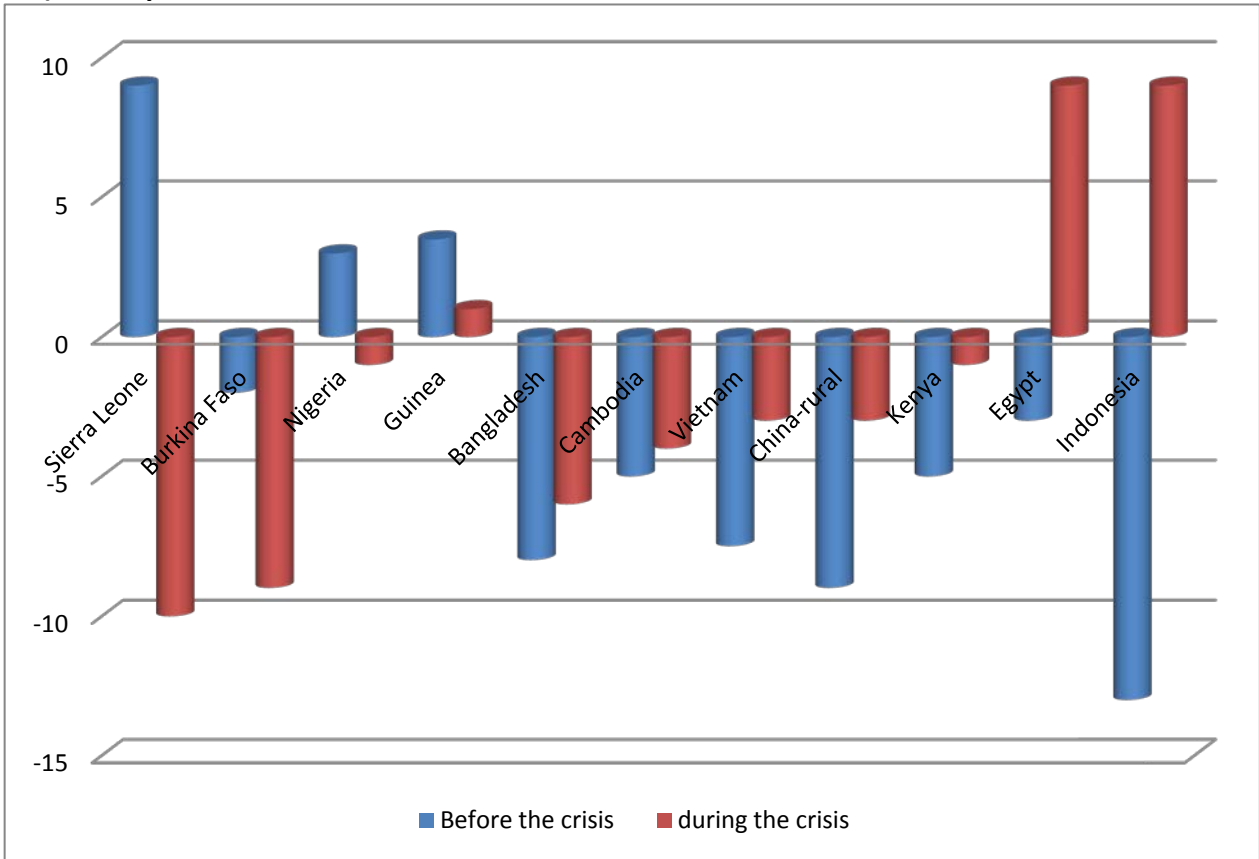
Source: Authors calculation based on World Bank, 2011b, except for China. For China, CFNSS.

3. Macroeconomic impacts of food prices

Inflation and public finance

Food accounts for the largest share of consumer budgets in low-income countries (Table 3). A rise in food prices therefore has significant inflationary impact on the whole economy. A 10-percentage-point increase in world food prices causes as much as 3-percentage-point increase in headline inflation (Babihuga and Gelos 2009). The pass-through is significantly different from country to country depending on the country's integration with the world food market, its price restriction policies, and its food budget share. The inflationary impact of higher food prices in food-importing countries is greater than in net exporting countries. The damage is serious for low-income countries, which are caught between two problems: high inflation and high unemployment. The problem is especially severe for poor urban people who have fixed incomes. Economic development partly depends on providing low price food for the workforce which permits low wages. When food prices are inflating, wage rates tend to rise, and higher wages tend to reduce both public and private investments and may induce relatively more capital intensive investment.

The short-term effect of food price spikes on public finance and balance of payments is reflected in the public policy response. To prevent social unrest and stabilize prices, many countries engaged in safety net programs that consumed scarce government budgetary resources. In addition, many countries, including Argentina, Ethiopia, and India, restricted exports of food items during the crisis.

Table 3 - Weight of food in CPI in some developing countries

Country	%
Bangladesh	58.8
Ethiopia	60.0
Kenya	50.5
Nigeria	63.8
Philippines	46.6
Tajikistan	72.0

Source: National statistical offices in von Braun 2009a.

Food price volatility exacerbates the real income gap between the poor and the rich. Rising food prices affect different income groups differently. Whereas the income of better-off net sellers increases, the income of poor net buyers declines. Apart from this, prices of all goods and all resources are unlikely to move uniformly and proportionally. This is particularly the case in most poor countries, where wages do not rise as fast as food prices. The incomes of civil servants and low-skill casual workers are usually unresponsive to changes in price level. The incomes of the rural and urban poor who engage in selling firewood, petty trading, and other nonfarm activities may change little compared with the change in food price. If high food prices are not compensated through increased incomes, the real income of nonfood resource owners declines and the income of net food producers increases. Unexpected food price increase causes some who happen to have food stocks to gain. The slow and asymmetrical transmission of food retail price to farm gate, which might be the case for many poor countries, worsens the income inequality between middlemen, farmers, and consumers.

Foreign exchange

Many developing countries depend heavily on agricultural commodities for foreign exchange earnings. The growth and development of these countries to a large extent depends not only on the size of foreign exchange earnings but also on its stability. Volatile prices for these commodities have a clear negative impact on economic growth in these countries. At first glance, one might expect a positive windfall in foreign exchange income as a result of the short-term global commodity price hike. There is, however, a long-term danger if the short-term price hike is prolonged by market-induced speculative actions. Traditionally, volatility in agricultural commodity markets originates from the supply side. If speculative actions create price bubbles, it means a new force for volatility is emerging from the demand side, connected to financial investments in commodities. Stable demand will no longer be the norm. The ups and downs of speculative investments that are tied to events in financial markets will create ups and downs in international commodity prices. This is particularly the case for coffee, sugar, and cotton markets, where prices sharply decline following declines in international financial markets. Thus, the short-term price spike seems attractive to commodity producers, but it may create volatility in foreign exchange earnings in the long run.

Distortions and misallocations

The cost of food price spikes is not limited to direct effects such as hunger, malnutrition, and macroeconomic imbalances. New knock-on effects can arise when governments act to protect against price increases or their adverse effects. National and international interventions to curb food market volatility can distort markets and lead to resource misallocation if food markets are not properly regulated. Some governments panicked in the face of the 2007–08 food price rise and the subsequent political unrests. They set price caps, banned exports, and increased subsidies without analyzing the long- and short-term effects of their actions. In the short term, the welfare gains from these interventions may exceed the welfare losses, but in the long term these policies can have serious unintended effects. Domestic market distortions can create disincentives to investment. When government responds abruptly to shocks, consumers start to rely on state actions instead of on the market. Such actions also create government-related risks for food market traders and investors. The establishment of administrative structures and institutional hierarchies to implement new programs and policies in response to food price increases can on the one hand create conditions for inefficiency and corruption and on the other hand, they may establish capacity to respond more effectively to future crises.

High and volatile food prices have also affected trade between countries. Table 4 shows the change in cereal trade for selected countries. The record reveals that food-deficit countries are relying less on international trade and attempting to rely more heavily on domestic production. Most of the countries shown have reduced imports and / or exports. Japan, one of the largest cereal importers, has reduced imports by about 17 percent. Other countries such as China, India, and Nigeria have reduced both imports and exports, implying that global volatility has induced these countries to depend more on their domestic sources as a security strategy. In this situation trade restrictions are collective action failures; they cause a global misallocation of resources and increase the volatility of food prices. Countries

whose comparative advantage suggests that they should import food will be forced to produce domestically but inefficiently. Because resources must then be moved to the food sector, other sectors will also be affected and growth will ultimately decline due to such self-sufficiency policies.

Table 4 - Changes in cereal trade, 2002–04 to 2008

Country	Change in import per total production (%)	Change in export per total production (%)
Argentina	-0.02	17.77
Brazil	-2.10	2.39
China	-1.41	-3.21
Egypt	12.93	-2.01
Ethiopia	0.42	-0.25
India	-0.02	-1.56
Japan	-17.09	-1.56
Kazakhstan	0.56	17.93
Mexico	-2.68	2.59
Nigeria	-12.29	-0.15
Pakistan	4.58	-1.30
South Africa	-5.68	1.49
Thailand	0.59	1.81
Ukraine	-7.08	7.87
United States	0.43	-1.08

Source: Authors' calculations based on FAO (2011)
Note: The 2002–04 figures are an average for those years.

Political unrests

A particularly complex matter of costs of food price spikes are political unrests triggered by price changes. Unrests may have short term costs and long run benefits for societal change and political reforms, or they may lead into perpetuated political conflicts with adverse consequences. Attribution of unrests to price changes is not straight forward, but rises in food prices have instigated or were combined with political instability in many low- and middle income countries. More than 40 countries had significant food-related riots in late 2007 and early 2008. The riots affected parts of Asia and Africa— for instance Cameroon, Côte d'Ivoire, Egypt, Mauritania, Morocco, and Senegal—as well as Bolivia, Haiti, and Yemen. Figure 6 shows the timing of food price spikes and the incidence of riots and clearly indicates a strong association between food price spikes and popular unrest.

In some countries the riots have caused political and economic changes. Though the strength of food prices as one of the causes of the Arab Spring is controversial, the riots in the Middle East and North Africa have been extensive and even led to regime changes. Evidence suggests, , apart from democratic aspirations, demonstrations were sparked in part by the high cost of living mainly due to increased food prices and by high rates of unemployment. In Egypt for instance, child under-nutrition had increased significantly in the context of the price crisis prior to the unrest (see Figure 5 above).

Figure 6 - International food price spike and number of riots, 2007/08
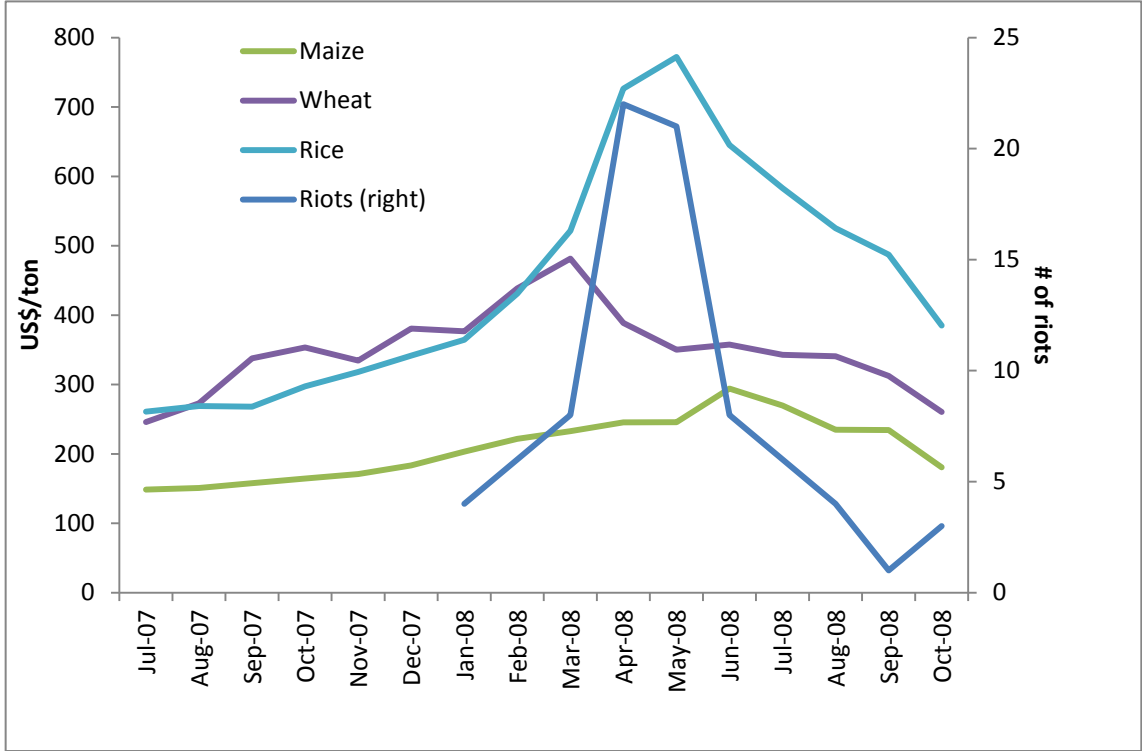
Source: von Braun 2009b.

In some cases food riots have worsened political freedom when incumbent governments have reacted harshly. In other cases they have led to increasing cross-border migration. The majority of food riots in countries identified as having low levels of governance have been violent (von Braun 2009b), causing loss of human life, irrecoverable injuries, and destruction of already underdeveloped infrastructure. These political problems have cost not only domestic resources but also international resources of humanitarian and aid agencies.

4. Supply and demand shocks

Global food price drivers

Several studies have been conducted to identify the drivers of high commodity prices in 2007–08 and 2010–11 (see, for example, Roache 2009; Gilbert 2010; Abbott et al. 2011). These studies have identified both market-specific and general macroeconomic determinants and explained how these factors have translated to demand and supply to explain the observed spikes. Most of them, however, have failed to differentiate endogenous and exogenous causes. For example, a decline in cereal stocks is not an exogenous factor and hence cannot be considered a primary driver of price spikes. However, decline in world food reserves can be viewed as immediate and to some extend intermediate cause. Changes in international trade policy (i.e. liberalization) may have led to a decrease in national food reserves in the 1990s and early 2000. Additionally, just in time inventory management may have reduced incentives for private storage. Thus, food price drivers should be differentiated as *root, intermediate,* and *immediate* causes (Figure 7).

Figure 7 - Global food price drivers

Root causes		Intermediate causes		Immediate causes		Effects
Extreme weather events		Concentration of world food production in few areas/few exporters		Export restrictions		Increase in prices
Increasing biofuel feedstock demand		Lack of information on world food		Aggressive food imports		
		Economic growth in emerging markets		Decline in world food reserves		Volatility
Increasing volume of futures trading in commodity markets						Spikes

Source: Authors' design.

Both empirical and theoretical evaluations suggest that climate change from the supply side, biofuel production from the demand side, and speculation in commodity futures from the

market side are the three most important root causes of observed price spikes and volatility. Their effect on volatility is transmitted through trade and changes in stocks. The process is reinforced by the prevailing production, exchange, and growth conditions. The dependence of world food exports on just a few countries makes the global market vulnerable to shocks coming from these countries. Global economic growth, along with a rising population, has also created favorable conditions for a fast response in trade flows and stock declines. Many developing countries including China and India showed remarkable income growth for the past two decades. The increase in incomes has increased per capita consumption and changed consumption patterns with a shift toward animal products and fats. The following sections will explain the details of the other drivers. Subsequently, commodity futures speculation is dealt with in detail.

Supply shocks

According to FAO data, global grain production has not shown any significant change over the past 10 years (Figure 8). Total grain production increased for a while in 2007 and 2008 and declined again in 2009. It continues to be volatile and less predictable as a result of climate change that causes extreme events in different parts of the world. Simulations and empirical evidence show that climate change continues to initiate volatility in food grain markets (Nelson et al. 2009; Abbott et al. 2011; Gilbert 2010). On average, climate change may push world food prices about 35 percent higher by 2050 (Nelson et al. 2009). The impact is greater for major food crops such as maize, wheat, and rice. These high grain prices will raise the price of livestock products by increasing the cost of animal feeds. In addition to contributing to this long-term trend, climate variability will continue to have a significant impact on short-term volatility.

Recent observations in different parts of the world show the significance of weather-induced market volatility. For example, the 2010 summer harvest was not as good as expected, particularly in major wheat-producing countries. The drastic drought in Russia and Ukraine substantially reduced wheat supplies. Drought in southern China caused severe food shortages that forced the country to turn to large-scale imports. Flooding in Australia also pushed up global food prices. Flooding in Pakistan devastated more than a million acres of sugarcane, wheat, and rice fields (Anis 2010). The 2010/2011 harvest in Sub-Saharan African countries seems relatively better than previous year, but millions of people are still in need of food aid assistance. The current food crisis in East Africa is strongly associated with frequent climate events that have triggered not only food shortages but also internal conflicts.

Supply factors, however, are believed to be weak explanations of price volatility at the global level (Abbott et al. 2011). This is because commodity-specific shocks are compensated for across a wide range of geographic regions. For example, Europe's poor grain harvest in 2007 was offset by a good harvest in Argentina, Kazakhstan, and Russia. An examination of international records shows that the association between supply shocks and price volatility is getting stronger.

A supply shock is defined here as the absolute value of the difference between Hodrick-Prescott (HP) de-trended supply time series and the crude production time series. The relationship between supply shocks and the coefficient of variation of food prices is shown in

Table 5. In 1970s, the correlation was insignificant, or even negative, perhaps because of poor global market integration that limits the dependence of the international reference price on global supply. Similarly, from 1980 to 2005, the correlation was not strong. Since then, however, it has become much stronger. This observation may be associated with increasing climate change or with declining global food stocks. According to the storage theory (Williams and Wright 1991), whenever the stock-to-use ratio is very small, even a small supply shock can have large impacts on the market. Since the stock-to-use ratio was declining before the food crisis in 2008, many believe that the deterioration of inventory was a major factor contributing to increased price volatility. A decline in stock-to-use ratio did indeed cause part of the food price volatility of 2008 (Wright 2009).

Table 5 - Correlations between supply shocks and volatility of prices

Years	Maize	Wheat
1970–79	-0.29	-0.28
1980–2005	0.24	0.48
2006–09	0.59	0.56

Source: Authors' calculations based on World Bank (2011a) and FAO (2011).

There is a strong belief that in the long term, the solution to high prices is high prices, i.e. a rise in food prices will create incentives for producers to boost production and productivity. Comparison of area and production change before and after the 2007-08 food crisis shows that positive changes were made in some parts of the world (Table 6).

Table 6 - Changes in cereal area and production (three-year average before and after 2007)

Country/region	Area (%)	Production (%)
BRICS	1.0	3.9
United States	2.9	4.4
EU	-0.3	-0.3
Africa	0.5	1.9
Least-developed countries	2.1	5.6
World	0.9	2.9

Source: Authors' calculations based on FAO, (2011)
Note: The BRICS countries are Brazil, Russia, India China and South Africa. The data show the % change in area and production from the 2005-07 average to the 2007-09 average.

The BRICS (Brazil, Russia, India, China, and South Africa) and the United States expanded area and production following the food price increase, but Europe shows negative change in area or production of cereals. These patterns may have various reasons, incl. non-price and policy causes. In general, however, the short term changes in cereal production observed in Table 6 are small compared with the price changes. On average, annual world market prices changed by about 50–70 percent and resulted in a supply response elasticity of 0.04 to 0.06—small compared with expected long-term supply response elasticity of between 0.1 and 0.2. It seems that price change was not transmitted to producers in a way that created incentives for greater production in the short run. This result may be due to price protection that shields producers from responding to world market price changes, or it may be that

price movements creates spikes that creates risks for producers rather than incentives or perhaps due to increased price of inputs. Increasing supply is an essential part of the overall strategy of making the food sector resilient to short-term shocks. World grain production needs to increase more than it did in recent years (Figure 8).

Figure 8 - World grain production, 1999–2009
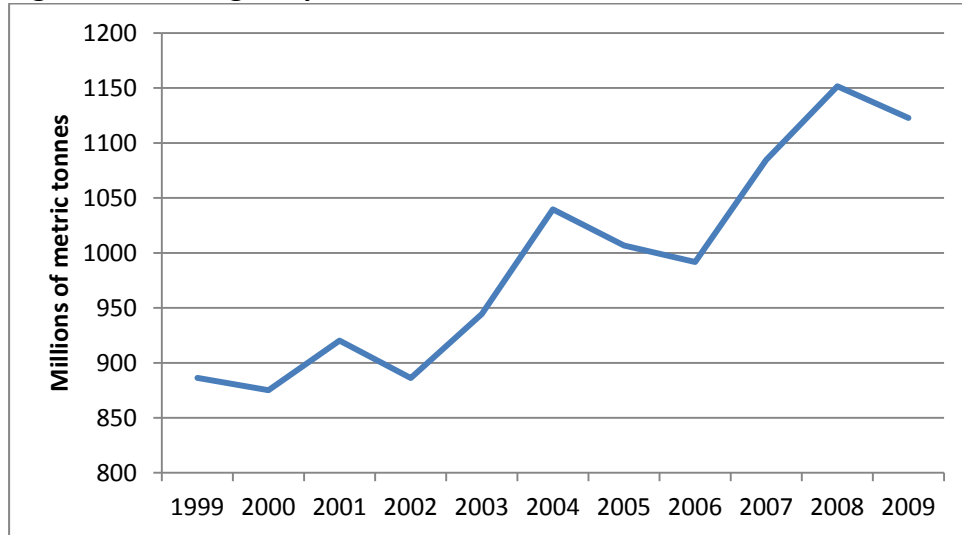
Source: Data from FAO, 2011.

Both the supply of and demand for agricultural commodities must be managed through the creation of incentives or the lifting of disincentives. Many researchers and policy makers have focused on enhancing public and private investment in agriculture. Public investment in agriculture in developing economies has either declined or has been stagnant over the past two to three decades (Fan and Rao 2003; Fan and Saurkar 2006). As a percentage of gross domestic investment (GDP), public investment in agriculture has changed little since 1980. The average was less than 8 percent for Africa, 10 percent for Asia, and 13 percent for Latin America in 1980s and 1990s. The growth rate as a percentage of GDP was declining in Latin America and stagnant in Africa during the 1980s. Only Asian countries steadily increased public agricultural investment during this period. But private investment in agriculture in developing countries is growing rapidly. These investments are partly characterized by irregularities, including lack of transparency on land deals, unclear mechanisms of land allocation, and skewed priority to foreign investors and farmers (Cotula et al. 2009; von Braun and Meinzen-Dick 2009). To turn them into opportunities requires a lot more policy attention.

Biofuel demand

Demand for biofuel feedstock is increasing because of increases in oil prices and biofuel mandates in the European Union and the United States. Demand is also increasing in developing countries. This heavy demand has created a huge burden on the availability of food and feed. Agricultural resources such as land and labor are being diverted to the production of biofuel feedstock. The impact of biofuel expansion on prices of certain commodities is large (Table 7). If biofuel production continues to expand according to current plans for expanded quota, the price of biofuel feedstock crops (maize, oilseeds and sugar) will increase further by more than 11 percent by 2020. If biofuel production expands drastically, the price of these feedstock crops will rise by more than 27 percent. The effect is

also significant for non-biofuel feedstock crops (wheat and cassava), though substitutions and resource diversion. These figures show the significance of biofuel production in explaining unprecedented price hikes (see also Abbott et al. 2011 and Lagi et al. 2011). Moreover, biofuel production has created a link between food and crude oil prices that will make food prices extremely volatile. Thus, biofuel is a significant factor that explains part of the food price increases in both 2008 and 2011 and the increased hunger in the developing countries.

Table 7 - Changes in world prices of biofuel feedstock crops by 2020 under two scenarios compared with baseline levels (%)

Crop	Biofuel expansion[a]	Drastic biofuel expansion[b]
Cassava	11	27
Maize	26	72
Oilseeds	18	44
Sugar	12	27
Wheat	8	20

Source: IFPRI IMPACT projections (in constant prices) in von Braun 2007.
[a] Assumptions are based on actual biofuel production plans and projections in relevant countries and regions.
[b] Assumptions are based on a doubling of current biofuel production plans and projections in relevant countries and regions.

Some studies reported a strong link between oil and food commodity prices (Huchet-Bourdon, 2011 and Harri et al. 2009). Historically, the association was positive until 1996, and then it remained strongly negative until the food crisis started in late 2006, when the association between the volatility of crude oil and agricultural prices became strongly positive (Figure 9). This correlation allows the natural volatility of crude oil prices to initiate volatility in food prices. The literature on the sources of this link, however, shows mixed findings. The link might have operated through higher demand for gasoil, a petroleum product that is a close substitute of ethanol. An increase in ethanol demand thus increases the price of maize. While some observers (such as Mitchell 2008 and Abbott et al. 2011) support the significant effect of potential and actual demand for biofuel on food prices, others (such as Gilbert 2010) argue that the correlation between oil prices and food prices occurs not because of biofuel demand but rather because of the presence of a common factor that affects both prices. Speculation in commodities could be one such factor.

Management of biofuel feedstock diversions is an important area of concern despite the political support for biofuel production. The partly policy induced competition between biofuels feed stocks and food for people needs to be reduced quickly. The policy instruments to reduce the diversion of feedstock include the lifting of biofuel subsides and easing of mandatory ethanol quote in transport fuels. Making biofuel mandates conditional on the level of world food stocks or prices could also help decouple biofuels demand and food prices, and this would actually reduce food price volatility.

Figure 9 - Food and energy price volatility, 1970–2011
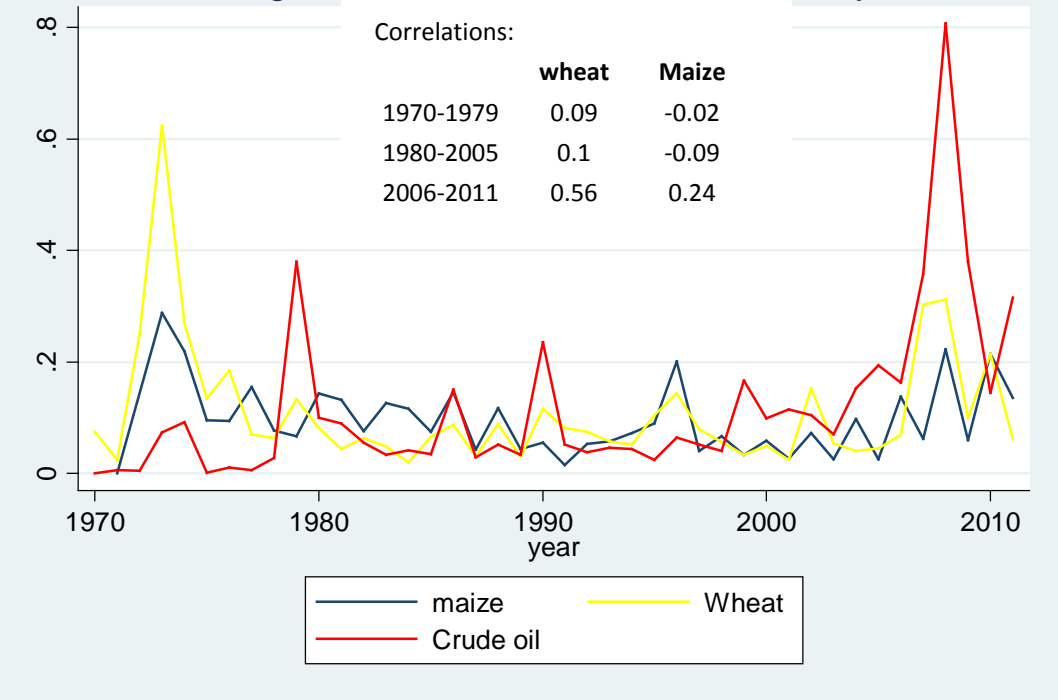
Source: Based on World Bank (2011a) data

5. Food stocks and trade policies

Stocks and food prices

The effect of storage on commodity prices has been under discussion since Gustafson (1958). This long discussion has resulted in the simple conclusion that when the level of stocks is high, shocks can easily be absorbed and prices will remain stable. If the level of stocks is low or nil, demand and supply shocks will create large movements in prices. Storage causes the presence of extreme but rare spikes in the upward swings and short but frequent troughs in the downward swings of commodity prices. The extreme spikes are motivated by the non-negativity constraint in commodity storage. If the price of a good increases, stock holders sell the inventories until the whole stock is exhausted. Once the stock has been exhausted, the price tends to soar and create extreme spikes. As the price eventually falls, traders build stocks until stockpiling brings the price up. Thus, the downward side of the price movement remains stable. Empirical tests have used stock-to-use ratio to explain volatility.

The 2007–08 food crisis was characterized by a sharp decline in the stock-to-use ratio, and many authors (such as Wright 2009) consider this decline a prime factor in the price spikes. Sometimes an increase in stocks can also create high prices depending on the behavioral characteristics of stock holders. In competitive markets, stock holding may not have a substantial impact on price dynamics because of the arbitrage condition that sets limits on stock holding. In less competitive markets, which are the norm for most poor countries, stock holding leads to hoarding of grain and inflates prices above the pure market-clearing price.

Food reserves have been recognized as an effective instrument to tackle price spikes and their humanitarian crises. Critics, however, point out the negative impact of food reserves on markets and cost-effectiveness. The use of strategic reserves to buffer food prices could harm the smooth functioning of markets. The cost of handling large reserves is also beyond the reach of poor countries. One potential solution is a regional reserve that can serve as an emergency humanitarian stock (FAO et al. 2011), such as the proposed West African or East Asian food reserves. These proposals should be welcomed, but should integrate policies that foster private stock holding. Conceptually a global reserves system would be advantageous and could combine physical with virtual reserves (von Braun and Torero 2008).

Trade policies

Agriculture is one of the most highly restricted sectors in international trade. Direct and indirect trade barriers are many and diverse. Nevertheless, trade plays a significant role in the food equation of most countries. Unlike other commodities, agricultural products are traded by a large number of countries. Yet few of them control the dynamics of world food exports and imports. The United States is the largest wheat- and maize-exporting country, followed by Canada and Argentina. According to the FAO, the United States supplied about a quarter of the world's wheat exports and more than half of its maize exports in 2007 and 2008 (FAOSTAT 2011). The market for rice is highly concentrated in Asia, where the largest suppliers and consumers are located. More than 90 percent of the total export supply for wheat, maize, and rice originates in the top 10 countries. The maize export market is more

highly concentrated than the others. The world food market is characterized by a skewed supply-side power concentration.

Japan and Egypt constitute the largest food-importing countries, followed by North Korea, Brazil, and Mexico. Japan imports about 16 percent of the world maize supply. As noted, the market for rice import is concentrated in Asia. In contrast to the export market, only 45 percent of total (wheat, maize, and rice) imports are purchased by the top 10 importing countries. However, the concentration varies across commodities. The rice import market has the smallest concentration ratio: 36 percent. Because the import concentration ratio does not correspond to the variation in food price movements for rice, market power may not be an important driver of the 2007–08 price hikes.

All 51 countries classified as least-developed countries by FAO are net cereal importers. Egypt imports close to 6 percent of the world wheat supply, and more than one-third of its total cereal supply on the international market. The share of imported cereals for most countries of the Middle East and North Africa is greater than 50 percent. Small countries such as Congo, Djibouti, and Yemen were severely hit by the crisis because of their heavy dependence on international markets. Big countries such as Bangladesh, China, and Ethiopia have been importing more than a million tons annually although imports have been less than 10 percent of their total supply. India and Pakistan, regarded as food-deficit countries, were net exporters during the crisis period.

Aggressive imports of agricultural commodities contributed much to the 2007–08 price crisis (Headey 2011b). High soybean imports by China were also considered an important factor in the 2011 price increase (Abbott et al. 2011). Excessive imports are not, however, a root cause; instead, they reflect an increase in income and a general tendency toward scarcity in importing countries. Although the demand for commodities in importing countries is increasing, the production has not increased commensurately in exporting countries.

Export restrictions and domestic agricultural subsidies remain important concerns in international food trade. During the crisis in 2007–08, many countries banned food exports, which created panic in importing countries. Simulations suggested that export restrictions increased grain prices by about 30 percent (von Braun and Torero 2008). Export bans not only affected spot markets, but also created nervousness in futures markets. More recent data suggest that the impact was severe for certain agricultural commodities, increasing rice and wheat prices by about 24 percent and 14 percent, respectively (Yu et al. 2011).

Stability in global food prices requires open and free international food trade. The major instruments for achieving open trade are disciplines on export barriers, and trade subsidies. Exemption of food aid purchases from export restrictions should be part of international policy and has recently been called for by the G20. The facilitation and implementation of the Doha Development Round would be a way to bring about the needed food trade regulations. For too long, however, the Doha Round did not embrace the more recent problem of export restrictions that were a major cause of price spikes in recent years. An either-or-choice between trade and stocks must also be revisited. Trade and stocks can optimally be used to reduce both the incidence and the impacts of crisis (Gilbert 2011).

6. Speculation in commodity futures

The speculation effect

Speculation in commodity exchange markets[1] has remained conceptually and empirically ambiguous. We define speculation as taking large risks or gambling with the hope of making large, quick gains. Speculation takes place in both spot and futures commodity markets but in different forms. Speculation in the spot market involves buying a quantity of a commodity from the spot market and holding it for future sale. This type of speculation involves physical handling of the product and is common in local markets in underdeveloped economies. Speculation in organized futures markets is carried out through futures trading. The major speculators in futures markets are commercial hedgers and noncommercial speculators. The hedgers use futures markets to transfer risks to speculators by selling or buying futures contracts. The traditional speculators aim to earn profits by taking risks. The role of these speculators is limited to the discovery of prices determined by market fundamentals. A third type of market actor has emerged in commodity markets: noncommercial index speculators. They differ from traditional speculators in terms of holding positions, commodity mix, and maturity period of their contracts (for instance see Gilbert 2010). All of these market actors implicitly interact and are involved in some sort of speculation activities and hence are broadly referred to as speculators.

The speculative effect on food prices is explained in two competing hypotheses: the efficient market hypothesis and the speculative bubble hypothesis. The efficient market hypothesis claims that there is little reason for speculation to destabilize the market. Futures markets affect spot prices through inventory accumulation, sometimes called hoarding. If the futures price is determined purely by the readily available information—the efficient market hypothesis—then excessive inventory will not be created, and any inventory holding at this level may even stabilize spot prices (Gustafson 1958; Williams and Wright 1991). Hence, according to the efficient market hypothesis, speculation on futures markets provides the market with the necessary liquidity and is an essential part of the price discovery process. The speculative bubble hypothesis, on the other hand, claims that excessive speculation drives futures prices above their market-clearing level. Excessive speculation[2] refers to the volume of futures contracts that are not motivated by demand for and supply of the physical commodity, but rather by speculative actions and behaviors (see Figure 10). The effect of the volume of futures trading on the spot price is transmitted through stock accumulation. The mechanism works like this. If the volume of futures traded long in the market is increasing, the futures price will increase. A rise in the futures price increases the expected future spot price. Traders, packers, food processors, and warehouse operators then have an incentive to hold stocks, but this action increases the current spot price. This scenario is an extreme case

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[1] Commodity exchanges operate differently in different countries. Commodity exchange markets can be broadly classified as organized or unorganized commodity exchanges. Unorganized commodity markets are common in developing countries where local and informal trading constitutes the majority of agricultural exchanges. In these markets, the pricing system is quite decentralized and personalized (Tadesse 2010). Organized commodity exchange markets, common in developed countries and central markets of developing countries, provide a central location to potential buyers and sellers to make bids and offers. Organized commodity exchanges such as the Chicago Board of Trade (CBOT) and the Kansas City Board of Trade determine global food prices.

[2] The volume of futures contract caused by speculative behaviors and actions may be estimated as the difference between the volume of contracts handled by speculators and those handled by hedgers.

of the speculation effect. A less extreme effect is the divergence of the futures price (taking into account the time difference) from the spot price, which is formed based on actual supply and demand. If both prices are formed based on physical market demand and supply conditions, they should converge. If the market is driven by speculative behaviors, futures prices will diverge from market-clearing spot prices.

Figure 10 - Speculation in commodity futures
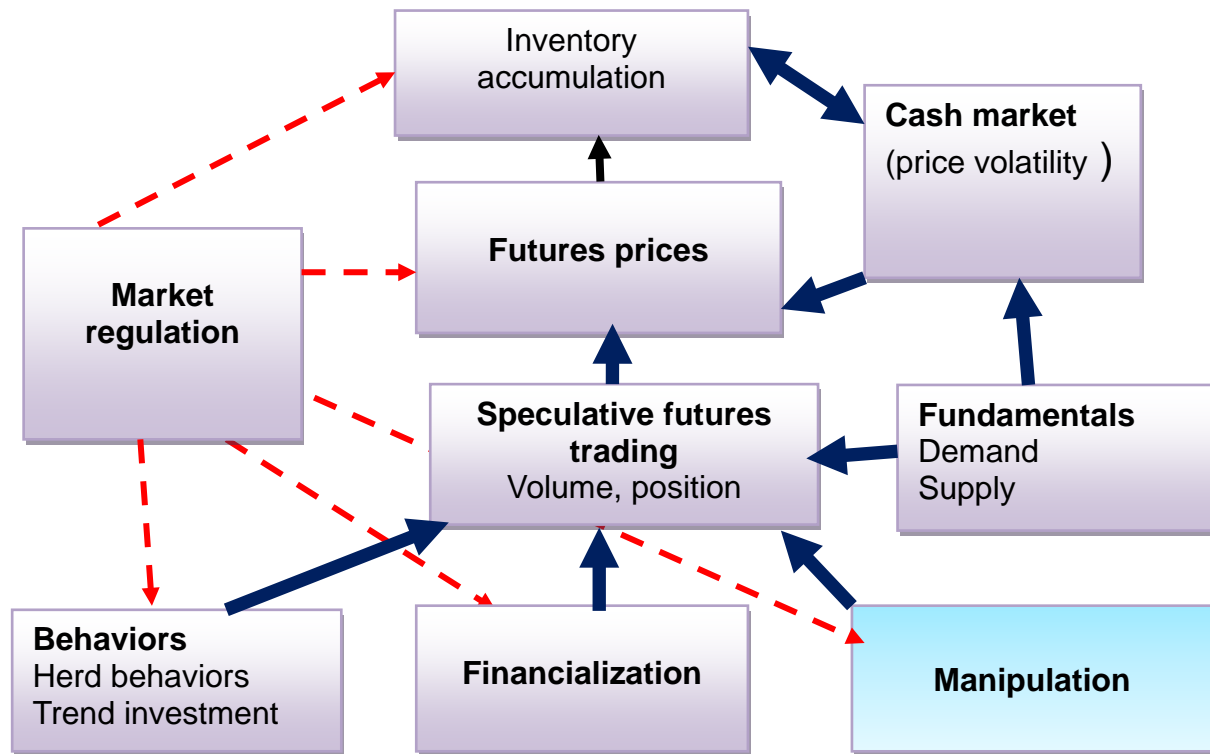
Source: designed by Authors

This speculation debate leaves two major questions unanswered. First, *what is the theoretical reason for the volume of futures trading to affect futures prices*? Many authors argue that speculation is a random bet, whereby the actions of informed and uninformed participants cancel one another out (Krugman 2008 and Irwin et al. 2009). If one person assumes the price will go up and the other believes the price will go down, how can a trade between these people affect prices? Second, *where is the empirical evidence*? The following sections will attempt to answer these questions.

Why does the volume of futures trading affect the futures price?

An important practical challenge to speculation analysis is the assumption of random and exogenous speculation. Many researchers consider commodity futures speculation as random betting, not motivated by behavioral and structural conditions. We argue, however, that the effect of the volume of futures trading on the futures price depends on market and nonmarket forces that shape the strategic choices of speculators. The total volume of futures trading handled by speculators is the sum of contracts motivated by fundamentals, unfounded behaviors, and manipulative actions. As a result we distinguish between four

causes of excessive speculation, as shown in Figure 10. These causes present the reasons for the presence of excessive speculation volumes that can inflate futures prices.

1. *Fundamentals*: Speculators can be informed or uninformed (O'Hara 1995). The informed speculator stabilizes and the uninformed speculator destabilizes the market. In a purely random situation, the actions of informed and uninformed speculators cancel one another out and the market remains at equilibrium. This is what is predicted in the efficient market hypothesis. Speculation generated through this process has little power to disrupt the market and create extreme volatility. Thus, the volume of futures trading may have no significant effect on futures prices.

2. *Manipulation*: Market power enjoyed by traders and financial institutions is an important source of manipulative action that creates excessive speculation. Market power can be established in formal and informal ways. Asymmetric information, simultaneous participation in financial and commodity markets, and deregulation are favorable conditions for the presence of power in commodity futures market. Whereas some traders have access to secret information, including forthcoming policy actions, or actually influence such policy actions through lobbying, others—particularly commercial market participants—have little such information or political power (Oxfam 2011). Most financial institutions such as banks, insurance companies, and pension funds are noncommercial speculators themselves. They participate in both commodity and financial markets, giving them opportunities to play or manipulate the two markets asymmetrically. Extensive deregulation of commodity futures in the EU and the United States since 2000 has created tremendous opportunities for speculative actions. The presence of commodity investors with high risk-preferences induced widespread lobbying for deregulations that serve them. Only recently (in 2011) some of the increased deregulation of speculative commodity futures trading from the past decade have been reconsidered in the United States and European Union.

3. *Financialization*: Speculators' strategic choices on positions, the commodity mix, and the maturity period of contracts are potential sources of market disruption. Hedgers and traditional speculators hold both long and short positions. Index funds usually hold long positions. Long positions normally increase futures prices. These strategic actions are increasing as a result of the increasing financialization of commodities. Financialization refers to the increasing use of commodities as financial instruments. A commodity index, consisting of a basket of commodities including oil, minerals, and agricultural commodities, is widely recognized as a financial instrument. Agricultural commodities often make up about 10–20 percent of the index portfolio (Wahl 2009). Including a wide range of commodities reduces the risk associated with the futures. The lower the risk, the higher the investment, and the more prices swing upward. Hedgers and traditional speculators buy short-term futures—that is, the contracts are settled within days or weeks. However, index funds invest in long-term futures, settled over months and years. Unsettled futures are common in index funds. The time of maturity may affect the futures price positively or negatively.

4. *Unfounded behaviors*: Any economic analysis is only as good as its behavioral assumptions. In most market analysis, behaviors are assumed to be rational, individualistic, and self-motivated. This assumption often does not hold, however. The

commodity futures market is one place where economic decisions can be motivated by unfounded behaviors such as a herd mentality, emotions, and sensations. These behaviors lead to trend investment that has little connection with actual market factors. Speculators' unfounded behaviors have emerged partly because of a lack of necessary market information and understanding of the essentials for forming expectations. Often only a few of the market actors have practical knowledge and understanding of the operation and movement of fundamentals. The majority of speculators may be driven by sensations and emotions. The emergence of powerful noncommercial investors increases the share of uninformed investors. Index funds, for example, have no commercial interest in the commodity and hence have little understanding about how to create expectations based on expected fundamentals. Instead, they depend on past price trends. If speculators set their expectations based on past information and the price has been increasing, they tend to keep large volumes of futures contracts for longer periods. This practice will send futures prices soaring. Trend expectations are partly motivated by policy actions in commodity markets and the macro-economy. Recurrent deregulation, financial bailouts, and increase in money supply all lead to trend expectations and higher numbers of trend investors in commodity derivatives.

Empirical evidence on the speculation effect

Empirical measurements of speculation are difficult and lack uniformity. The two major approaches used to measure the speculation effect are private stocking or stock-to-use ratio approach (Williams and Wright 1991; Wright 2011) and comparison of futures contract trading (both futures price and volumes of futures) with spot prices (Robles et al. 2009 and Gilbert 2010). The two approaches are not mutually exclusive. The first approach measures the existence of speculative stock. According to this approach, if the speculative stock is high (hoarding), then speculation is playing a role in creating extreme spikes. The problem is how to detect the presence of stocks caused by speculation. One possibility is to look at inter-temporal price efficiency. A stock is said to be speculative when the marginal return from holding stock is significantly different from its marginal cost (Tadesse and Guttormsen 2011). The second approach—comparing futures prices and contract volumes with spot prices—is also widely used to measure the speculation effect. This comparison can take place using a variety of descriptive and econometric methods, ranging from a simple comparison of spot and futures prices to a more sophisticated Spline-GARCH method. Granger causality and linear association tests have also been implemented. The comparison of commercial and noncommercial volumes of trading has been used to examine the market disequilibrium.

Table 8 summarizes some of the empirical and conceptual findings for and against the speculation effect. These studies used different methods—mainly co-integration, Spline-GARCH, and Granger causality.

Table 8 - Evidence for and against the speculative effect in food prices

Authors	Speculative effect	Arguments	Comments
Robles et al. 2009	Yes	Granger causality test on futures trading and spot prices	No evidence of excessive stock; samples significant in price peak periods
Wahl 2009	Yes	Volume of index funds, dissociation between their investments and fundamentals	No empirics
Essl 2009	Yes	Comparison of upward and downward runs in futures prices	Lack empirical tests
Gilbert 2010	Yes (not strong)	Granger causality and IV regressions tests on volume of futures trading and food price index	Aggregate index
Roache 2009	Yes, but small	Spline-GARCH on historical data that measures low frequency volatility	Endogeneity and old data
Krugman 2008	No	No accumulation of stock	Failed to control other determinants of stock
Wright 2009	No	No evidence that prices do not reflect fundamentals	No direct measurement
Irwin et al. 2009	No	No theoretical and statistical links between volume of speculative positions and futures prices	Links are not conditioned upon markets' nervousness
Timmer 2009	Yes/no	Speculative money moves in and out of the commodity market (Granger causality)	Commented on rice only

Robles et al. (2009) used the Granger causality test to test the direction of causality between spot and futures prices. They found evidence of strong causality (from futures prices to spot prices) during the food crisis period (2005–08), but not before (2002–04)—a finding that signifies the importance of speculation for the price bubbles. Some authors (such as Wright 2009 and Krugman 2008) use the absence of excessive stocks to claim that speculation was inconsequential in the 2007–08 food price spikes. The absence of excessive stock, however, is not a necessary and sufficient condition to falsify the presence of speculative bubble in commodity markets. The presence of speculative stock is more indicative than the presence of excessive stock. Stock holding is determined not only by speculative actions, but also by supply and demand factors (non-speculative stock), and the amount of stock is the sum of speculative and non-speculative stock.

Speculative action has helped macroeconomic shocks and money supply generate food price hikes. Gilbert (2010) suggests that index-based investments in agricultural futures are channeling the macroeconomic shocks to food prices. The 2008 and 2009 market observations imply that when financial markets are in turmoil, food prices decline. Financial crisis makes speculation activity difficult. The revival of the financial sector in late 2010 has also witnessed the reemergence of commodity speculation as a major cause for the rise of

food prices in 2011. This same analysis can be made for the financial crisis in mid-2011 and a small decline in food prices since September 2011. Many other qualitative analyses also suggest the presence of a speculation effect in the 2007–08 price spikes. However, most of the studies lack a strong analytical framework for effectively quantifying the total and marginal effects of speculation. The marginal effect is particularly important to identify speculation impacts in price spike situations, as found by Robles et al. (2009). Section 7 offers an analysis of a more formal statistical relationship between financial crisis and commodity prices.

Regulating speculation

Appropriate regulation of commodity futures trading is necessary, as for any rules based market. Transparency enforcing rules are basic for that, and the more so, the more food markets have become interlinked with other markets, i.e. energy and finance. Further regulatory actions must include disincentives for excessive speculation, and for prevention of unfounded trend or herd behaviors discussed above.

Despite a lack of empirical and theoretical consensus about the role of speculation in producing price spikes, a number of policy instruments for improving and regulating commodity derivative markets have been proposed (see, for example, G20 2011; IOSCO 2011). These instruments may include
(1) regulating futures traders and trading that includes regulating abuses, manipulation, imposing restrictions on volume of trade, setting deposit requirements on pledged trading (HPLE 2011; Oxfam 2011); this includes the limited ability to regulate over the counter trading (OTC);
(2) creating shared physical and virtual reserves to serve as a market signal to curb speculative behavior and to facilitate emergency aid operations (von Braun and Torero 2008, 2009);
(3) information and transparency on stock levels, expected demand, supply shocks, and trading volumes to force market actors and non-actors to make private business information available for public consumption (FAO et al. 2011; HPLE 2011), and
(4) progressive taxation of food commodity market transactions by speculating non-commercial traders (i.e. a progressive Tobin tax when prices increase into spikes) to help prevent the emergence of speculative price spikes, i.e. taxing speculative revenues as a disincentive.

An appropriate regulatory regime would include a portfolio of all four sets of the above mentioned policy instruments with a modest role played by each of them individually but capturing the synergies among the four sets of actions by the portfolio to control the speculation effect on price spikes and volatility. An attempt to address matters with very restrictive actions applying just one or two of the instruments would not be appropriate because of the complexities of the drivers of speculation and the risks of over-regulation. Moreover, the speculation effect must be captured contextually in time: at normal times, it serves as a price discovery mechanism, and in unusual times, it can destabilize markets. Hence regulation of speculation should be based on market context rather than on transactions generally. Permanent transactions controls would undermine the stabilizing role of speculation.

7. Volatility and spike effects of supply, demand, and market shocks

From a policy perspective, it is important to know which of the individual factors are more relevant than the others for price volatility and spikes. It is also essential to understand which factors are responsible for spikes and which for volatility, as the factors for the two may differ. To explain these issues, we used a variety of econometric models. The models are fitted for price spikes and volatility as a function of supply shocks, demand (energy price) shocks, and market (speculative) shocks.

Effects on food price spikes

We used seemingly unrelated regression to test the statistical and economic importance of supply shock, oil price shock, and speculative actions in the commodity futures market. The model is specified as

$$d \ln P_t = R_t \beta + \varepsilon_t$$

where ε_t is the vector of errors that are correlated across commodities in a given time period, t is an $m \times y$ time period where m is month and y is year. $d\ln P_t$ is a vector of price spikes (the logarithm of the ratio of two consecutive prices, usually referred as returns) for four commodities (maize, wheat, rice, and soybeans). R_t represents a vector of explanatory variables such as volume of supply residuals, oil price returns, and excessive speculation.
- Supply residuals are measured by the deviations from trends of disaggregated monthly production. Disaggregation of annual production to months is done using the crop calendar of major world producers of a crop. Since harvesting takes place in different months in different countries, summing up all the countries' harvest in a month has given us a more or less smooth production across months. The deviation from the trend is calculated as $SS = |Q_t - HQ_t|$, where Q is the crude world production series, and HQ is the Hodrick-Prescott smoothed production series.

- Excessive volume of speculation is calculated as $St_t = \sum_{d=1}^{N} (NCL_d - NCS_d) - (CL_d - CS_d) \Big/ N$

, where *NCL* is the volume of noncommercial long positions in a marketing day, *NCS* is volume of noncommercial short positions in a marketing day, *CL* is volume of commercial long positions in a marketing day, *CS* is volume of commercial short positions in a marketing day, and *N* is the number of marketing days in a month.

Table 9 - Seemingly unrelated regression (SUR) results on food price spikes

	Samples from January 1986 to December 2009		Samples from January 2000 to December 2009	
	Coefficient	Z	Coefficient	Z
Maize				
Maize production shock in millions of tons	-0.0000359	-0.79	4.48E-06	0.07
Maize excessive volume speculation in thousands of contracts	0.0000687***	7.28	0.0000758***	3.4
Crude oil price (%)	0.0160064	0.46	0.1268987**	2.08
Wheat				
Wheat production shock in millions of tons	-0.0000584	-0.87	0.0000449	0.43
Wheat excessive volume speculation in thousands of contracts	0.0002245***	5.96	0.0003172**	2.53
Crude oil price (%)	0.0416096	1.21	0.1511349**	2.52
Soybeans				
Soybeans production shock in millions of tons	-0.0004751***	-2.86	-0.0004193*	-1.92
Soybeans excessive volume speculation in thousands of contracts	0.0000804***	5.72	0.0001834***	4.22
Crude oil price (%)	0.0705766	2.26	0.160431***	2.97
Rice				
Rice production shock in millions of tons	-0.0003588***	-2.76	-0.0002696	-1.46
Crude oil price (%)	0.0256881	0.65	0.1078755*	1.75

Source: Authors' estimations

We used food and oil nominal prices[3] from the World Bank commodities database and production data from FAOSTAT. We also used the daily volumes of futures trading from the Chicago Board of Trade of the U.S. Commodity Futures Trading Commission for maize, wheat, and soybeans. Since data on rice futures are not available for 1986 to 2000, the rice equation does not include excessive speculation. We used data from January 1986 to December 2009 mainly because of lack of data for futures trading before 1986 and for production after 2009.

The results indicate a significant difference between the data sets used for the analysis (Table 9). If the whole data set from January 1986 to December 2009 is used, only excessive speculation is a highly significant determinant of food price spikes. But if price data since 2000 are used, oil price also has a significant effect on price spikes. The effect of supply shocks on spikes is limited to one commodity—soybeans.

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[3] Nominal prices are used to avoid misrepresentation of the global real price by the US consumer price index.

- Generally, supply shocks are not an important cause of the price spikes. This result is in line with what would be expected because price spikes are very short-term fluctuations.
- This also indirectly implies that declines in stock that may in fact aggravate the effect of supply shocks do not adequately explain the emergence of food price spikes.
- As hypothesized, a market factor—excessive speculation—has significantly driven the extreme spikes seen in global food price dynamics.
- The strong effect of oil price changes on recent food price spikes also highlights the increasing role of biofuel demand in the global food system. While the energy price mainly represents a demand shock via biofuels demand, it also impinges on supply via input- and transport costs, but much less so than via biofuels.
The general conclusion on price spikes is that they were driven by excessive volumes of futures trading more than by demand side (oil price) and supply side shocks.

Effects on volatility

To quantify the relative importance of supply, demand, and financial shocks, we used annual data over commodity panels. In this case, volatility is measured as a coefficient of variation in a year using monthly prices. Some authors (such as Roache 2010; Karali and Power 2009; Peterson and Tombek 2005) classify volatility as high-frequency and low-frequency volatility. Although high-frequency volatility can be related to annual price spikes, we do not make such a distinction. Instead we attempt to explain the realized total volatility using the percentage of annual standard deviation from the long-term average price. The explanatory variables included in this volatility equation are the same as above, except for two differences. First, the variables are measured only annually; for example, the supply shock is calculated using annual production data,[4] excessive speculation is calculated for the number of marketing days in a year, and oil price volatility is measured based on annual coefficients of variation. Second, we also included the financial crisis index developed by Reinhart and Rogoff (2009). This index combines measures of banking crises, foreign debt defaults, domestic debit defaults, inflation crises, and exchange rate crises. The index was used as a proxy for speculation in the commodity futures market, and hence the speculation variable and financial index are used alternatively.

The panel commodities are maize, wheat and soybeans. Rice is omitted because of a lack of data on the volume of futures trading, but it is included when the financial crisis index is used instead of the commodity-specific excessive volume of futures trading. In each case, two models are estimated. The first imposes a strong restriction of homogeneity across commodities and is estimated using a simple OLS regression. The second controls the fixed-effect heterogeneity across commodities and is estimated using an FGLS regression.

Table 10 presents the different estimates of the models. The slight difference in the last two columns (under the financial crisis index) was included in von Braun and Tadesse (2011).

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[4] The production shock is calculated based on the difference between crude production and Hodrick-Prescott smoothed trend. However to align with the volatility, which measures only magnitude, we used the absolute value of the supply shock. Thus this shock measures only magnitude. We expect a positive relationship between the absolute value of supply shock and price volatility as opposed to the negative relationship between supply shock and price spikes

- The comparison of the effect of excessive volume of futures trading and the financial crisis index on volatility indicates the importance of commodity-specific and common economic factors in affecting food prices.
- The result shows that the volume of futures trading has no significant effect on volatility, in contrast to price spikes.
- The effect of the financial index, on the other hand, is significant and robust across all specifications. The positive relationship between financial crisis and food price volatility implies the significance of food commodities as financial instruments (financialization). Whenever banks, sovereign debt, exchange rates, and inflation enter crisis, the food market enters crisis too. Financial crisis is more relevant than speculation in creating price volatility. However, speculative activity in commodity markets is one of the reasons for the linkage between financial crisis and food markets.
- The result also shows that demand-side shocks are stronger than market shocks (speculative volumes and financial crisis) and supply-side shocks. Both oil price shocks and supply shocks are statistically significant in all specifications. However, the effect of oil shocks is stronger. A 1 percent increase in oil price volatility increases food price volatility by about 0.47 percent (elasticity), which is stronger than the 0.35 percent increase due to financial crisis and the 0.19 percent increase due to a supply shock.

In general, a market-related shock (speculation) is a stronger cause than demand- and supply-side shocks for *spikes*, and a demand shock (oil price) is a stronger cause than market and supply-side shocks for *volatility*.

Table 10 - OLS and FGLS regression results on food price volatility

Explanatory variables	With speculation		With financial crisis index	
	Homogeneity imposed	*Heterogeneity controlled*	*Homogeneity imposed*	*Heterogeneity controlled*
Production shock in millions of tons	0.001066*** (2.62)	0.0011315** (2.31)	.0009825** (2.55)	0.0010175** (2.18)
Oil price coefficient of variation	0.3226112*** (8.36)	0.3216481*** (8.34)	0.355329*** (9.74)	0.3551883*** (9.61)
Excessive volume of speculation in thousands of futures	0.0000579 (1.2)	0.0000744 (1.53)		
Financial crisis index			0.0007027** (2.43)	0.0007019** (2.4)
N	72	72	92	92

Source: Authors' estimations**.**

8. Policies and further research

Policies

Since the emergence of the 2007–08 food crisis, a number of policy issues have been under discussion. Besides the broad consensus that increased investment for expanded production and accelerated productivity growth is called for, some of the discussions focus on whether intervening in food markets is warranted, and others concern the choice of instruments and approaches to intervention. The first issue is where to intervene: at the global, regional, or local level. Food price volatility is a global problem that affects many countries, both poor and rich, although it has had disastrous impacts in poor countries. The global economy is increasingly integrated. A shock in one corner of the world can disrupt the entire global food economy. Thus, global and multilateral actions are more effective and efficient than local and unilateral actions. However, the urgency of the problem and the panic associated with a dramatic increase in domestic prices has forced many governments to act unilaterally. Though global policies are more effective than local policies, the time and costs required for reaching consensus and agreement have remained excessive. Differences in power and interests among and within countries have slowed global policies to avert global hunger and crisis. Thus global-level actions to prevent price spikes must be supplemented with local-level risk management strategies.

A strong policy debate has focused on regulating commodity markets and trades. A number of economists believe that food price volatility reflects a short-term boom and bust cycle and must be left to be corrected by the market alone, following the belief that any regulatory intervention in the functioning of the market distorts the market's long-term ability to respond to shocks. According to this argument, a rise in food prices attracts investment in agriculture that will increase supply and push prices downward. Empirical evidence shows, however, that the supply response is far smaller than expected. The market is not adjusting to price changes at a scale to prevent spikes. The price movements might have been too erratic to serve as incentives for greater production.

Leaving the academic debate aside, policy makers continue to take global and local actions aimed at reducing food price spikes, managing price trends, and protecting vulnerable individuals, sectors, or groups (Demeke et al. 2008). The potential instruments for achieving these goals are many and diverse. Actions range from subsidizing poor consumers to making long-term investments in agriculture. Table 11 presents a subjective evaluation of proposed global policies. Economists and policy makers must attempt to identify the best options out of all of these alternatives in a given context. The challenge in evaluating this mix of instruments is deciding on criteria for ranking them. Criteria relevant to the current situation would include the timing of the response, the cost of implementing the intervention, effectiveness at attaining the proposed objective, and the long-term effect on the economy. It is difficult and not advisable to try to find a single policy action that satisfies all these criteria. For example, food price volatility is tied to time: upward swings eventually turn downward, but the reversal may not happen fast enough to prevent a human crisis. Some interventions require a year or more before their impacts reach the market. Other interventions, such as release of reserves, have an immediate impact on the market provided that adequate institutional frameworks are in place. The choice of policy actions depends on the relative importance of the criteria, but because the criteria are not easily

calculable, the optimal mix is highly subjective. Moreover, policy choice, especially at the global level, is not value free: any chosen policy will have both positive and negative consequences and externalities, making it essential to monitor and evaluate policies.

Table 11 - Subjective evaluation of proposed global food price policy instruments

Objective	Instruments	Impact [a]	Market friendly	Feasibility[b]
Regulating excessive speculation in commodity derivative markets	*Information and transparency*	Medium	High	High
	Physical and virtual reserves	Medium	High	Low
	Limits on futures trading	High	Low	High
	Transaction tax	High	Low	High
Keeping international trade open	*Disciplines on export barriers and excessive imports*	High	High	Medium
	Exemption of food aid purchases from export restrictions	Low	High	High
Balancing supply with demand	*Research and development*	Medium	High	Medium
	Expansion of agricultural foreign direct investment	Medium	High	Medium
	Relaxation of biofuel mandates	High	High	Low
	Use of alternative biofuel feedstocks	Medium	High	Low
	Strategic food reserves	High	High	Medium
Protecting the poor from hunger and crisis	*Emergency reserves*	Medium	Medium	High
	International finance for crisis	Low	High	High
	Food subsidy	Low	Low	Medium

Source: designed by Authors.

Note: definition of colors: Red=low, green=high, yellow=medium

[a] Impact depends on (1) whether the instrument is effective or not in addressing the problem and (2) whether the problem to be addressed by the instrument is a strong driver or not **of food price changes.**

[b] Feasibility depends on (1) cost of implementation, (2) technical feasibility, and (3) political feasibility.

Further research

Speculation in commodity futures has become an integral part of the global food system and an important area of concern for development and politics. A close investigation of the commodity futures market requires a theoretical and empirical understanding of financial markets. Currently, speculation is understood in financial economics as a tool to discover prices, but this theory may not hold true for speculation in food commodities. Therefore, the hypothesis and the empirical tests must be updated and refined as new data sets and thinking evolve.

Though the general trend in food prices seems similar across the globe, there exist huge differences in terms of timing and causes of the problem. Country-specific studies can effectively capture general and market-specific causes and help identify national strategies for stabilizing prices and managing risk. Poor countries face not only fundamental changes and volatility from international markets, but also imperfections in local food markets. The imperfections are mainly associated with competitiveness and behavioral distortions as a result of global and local economic and political changes. A sound policy to address food security has to address the problems facing local traders, retailers, and consumers.

High output prices create incentives for agricultural investment. Many believe that high output prices could represent an important opportunity, even for smallholders. High prices not only encourage existing farmers, but also attract new agricultural investors from inside and outside the country. Institutional and structural bottlenecks may, however, limit the potential of this opportunity. Furthermore, cross-border investments may raise unforeseen economic and social conflicts if not managed properly. The huge pension and insurance funds, which usually invest in commodity futures, may find a new form of low-risk agricultural production investments. Agricultural producers and input suppliers must be put in a position to be more responsive to high prices to better utilize the new opportunities that may be created. Researchers studying the impact of high price must look at all these possibilities and challenges and come up with recommendations for investors, farmers, and policy makers.

Despite many improvements in data monitoring and analysis, many countries currently lack the capacity to generate timely and reliable datasets and carry out moderate and advanced data analyses. Relevant information is often outdated, spotty in coverage, and insufficiently disaggregated to local levels. Even basic and essential information such as up-to-date representative income and expenditure panel surveys are still scarce in developing countries. Therefore countries and/or international institutions should invest in data collection so that policy makers aren't operating in the dark. Many global food models have been developed and used to forecast future scenarios, but almost all models make their forecasts based on annual outcomes. These long-frequency models cannot capture price volatility - let alone spikes - when prices move up and down within days, because they are based on annual averages.

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