The Economics of Food Price Volatility

1. Introduction

Historically, food markets have been subject to much instability, and the last few years have seen very large swing in food prices. This price volatility has had large effects on farmers, market participants and consumers. Higher commodity prices benefit sellers (including grain farmers), but they hurt buyers (including consumers, and dairy/livestock farmers who face higher feed cost). Lower prices have the opposite effects. Market instability makes anticipating future price patterns difficult and creates significant price risk/uncertainty for market participants. It can also lead to hasty and injudicious policy responses that might be difficult to reverse. This puts a premium on understanding the factors that contribute to large price swings and on designing policy schemes that can help reduce this uncertainty or to ameliorate its effects.

The recent increase in food price volatility raises three important sets of questions.

- What are the main causes of food price instability? Does instability arise primarily from technological or weather related supply shocks or from demand shocks such as those induced by biofuels? Does financial speculation and globalization lead to increased or decreased volatility? And is the current market instability just a short-term phenomenon or is it the beginning of a longer term trend?
- What are the welfare effects of increased food price volatility for farmers, traders and consumers? How does volatility affect the welfare of poor households in developed as well developing countries?
- What are the management and policy implications of increased volatility in agricultural markets? What is the role of private stockholding in reducing price instability? How can

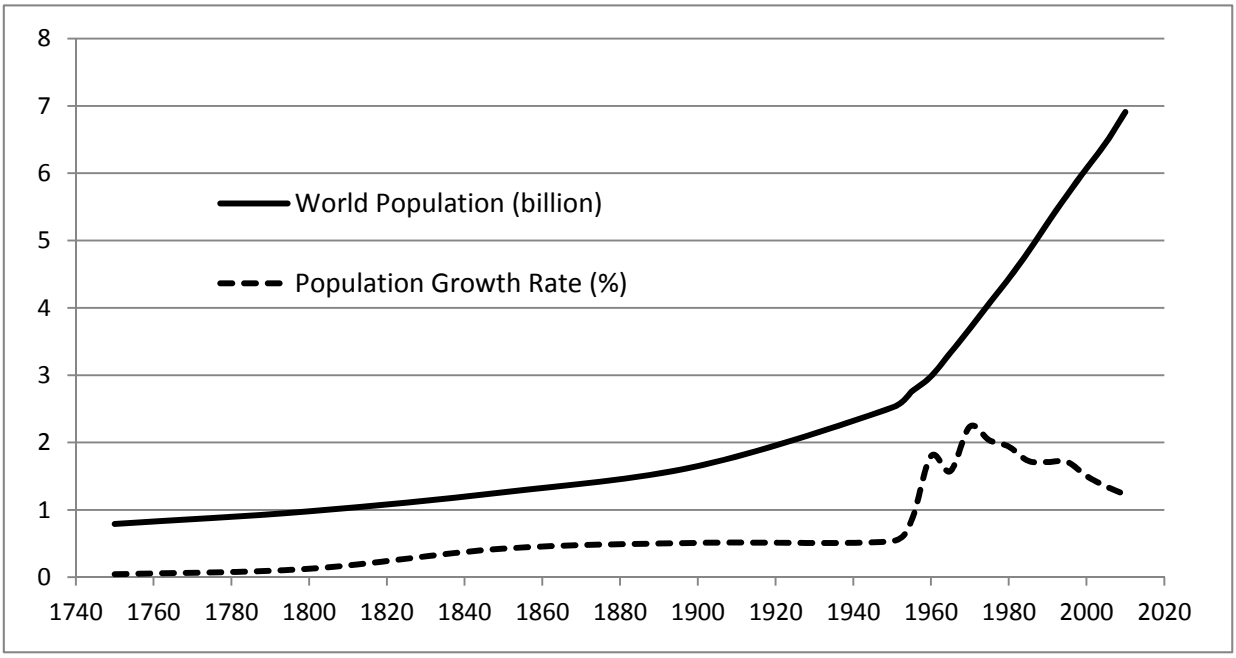
financial markets help improve the allocation of food price risk? Do existing agriculture and trade policies mitigate or exacerbate volatility and can reforms of those policies lead to better management of food price volatility and the reduction of food insecurity around the world?

Providing better answers to these questions is the main motivation for this book. This book presents and assesses the latest research on central issues related to recent food price volatility. This research evaluates current knowledge on the causes and effects of food price volatility, examines the extent to which particular current economic conditions contribute to this volatility, and identifies issues that are in need of further investigation. By disseminating new research on food price volatility, it intends to help both private and public decision makers to develop improved management strategies and policies that can address current and future market instability.

2. Food Price Volatility: A Long-Term Perspective

Agriculture is in the business of feeding people. Figure 1, which is drawn from the U.S. Census Bureau (2010), shows the increase in the human population over the last few centuries.. The growth rate in population peaked in the late 1960's (when it exceeded 2 per cent a year) and has now declined to 1.2 per cent a year. Yet, one billion people have been added to the world's population over the last 11 years, and in 2011, the world population reached 7 billion people. Feeding the growing world population is a significant challenge.

Figure 1: Evolution of the world population.



This challenge has generated a debate involving two polar scenarios. On the one hand, increases in human population put pressure on natural resources and the ability of the earth to provide food for all. This is the Malthusian scenario, which associates population increases with rising resource scarcity and the spread of famine. On the other hand, technological progress has greatly increased the productivity of land and labor. Under a positive feedback from the size and density of human population to technological change, productivity growth can help deal with increased resource scarcity. This is the Boserupian scenario, which emphasizes the role of induced innovations (Boserup, 1965, 1981). The induced innovation hypothesis states that new technologies are likely to develop and be adopted in response to changes in resource scarcity (Hicks, 1932; Binswanger, 1974; Ruttan, 2001; Acemoglu, 2002; Acemoglu et al., 2009). For example, it means that increasing (decreasing) the cost of a resource tends to stimulate the development and use of technologies that reduce (increase) the use of this resource.

Agriculture provides a great case study of the induced innovation hypothesis. The rise of agriculture some 10,000 years ago appears consistent with induced innovations. As documented by Boserup (1965, 1981) and Kremer (1993), the historical evidence shows that the switch from hunting-gathering to agriculture did not take place without a rise in population density. The argument is that farming requires more effort than hunting-gathering, implying that no individual would want to switch from hunting-gathering to farming unless the former fails to provide enough food to satisfy human needs. This latter scenario develops when the human population rises beyond some threshold where the ecosystem can no longer feed the human population through hunting-gathering activities alone. It means that the historical rise of agriculture was an induced response to food scarcity associated with a rising population. This includes the cultivation of wheat and barley in Mesopotamia starting around 8000 B.C., of maize in Mexico and of rice in China starting around 5000 B.C. (Heiser, 1990: 6-8).

The evolution of food prices over the last decade is shown in Figure 2 for three agricultural commodities: corn, wheat and rice. This figure, drawn from FAO (2010), shows very large changes in food prices in 2008. In a period of few months, food prices basically doubled, followed by a very sharp decline. The changes were most dramatic for rice. These rapid price fluctuations are quite unsettling for any market participant.

Figure 2: Nominal prices of food, 2000-2010, US $/ton.

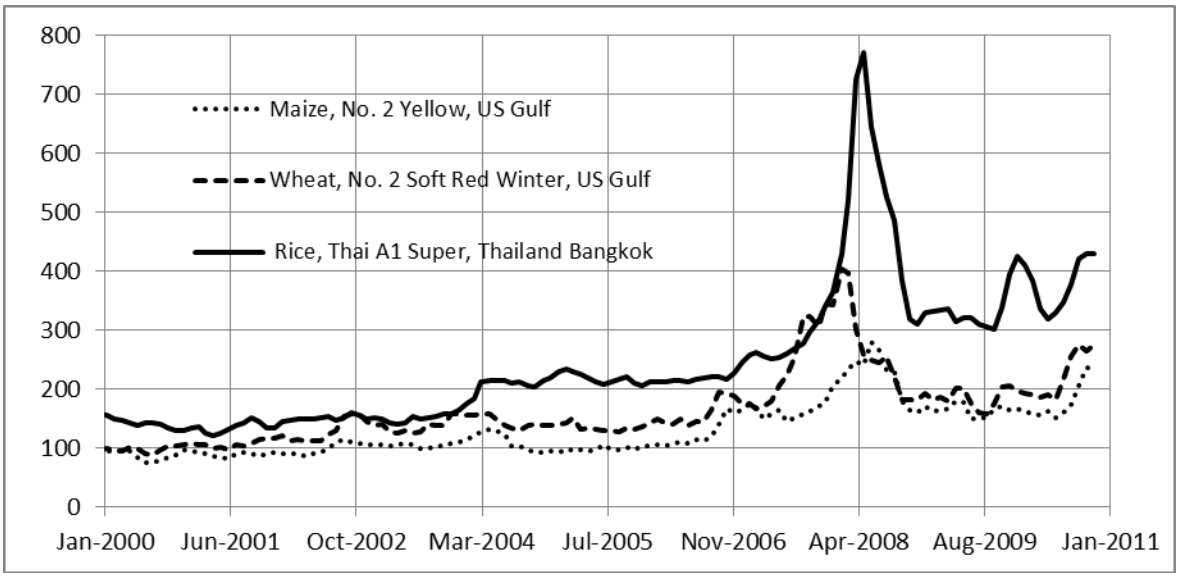


Figure 3, which presents data from ERS (2010) and USDA (2010), shows longer-term data on agricultural prices. It shows the real price of food (nominal dollar prices divided by the US CPI) over the last century for three farm commodities: corn, milk and wheat. There is a long term declining trend in real prices. Over the last 90 years, the average annual rate of change in real price was -1.8 per cent for corn, -1.9 per cent for wheat, and -0.8 per cent for milk.. This is a remarkable fact: agriculture has been able to feed the growing world population at a lower price for consumers.

Figure 3: Real prices of food, 1913-2010, U.S. 1983 $.

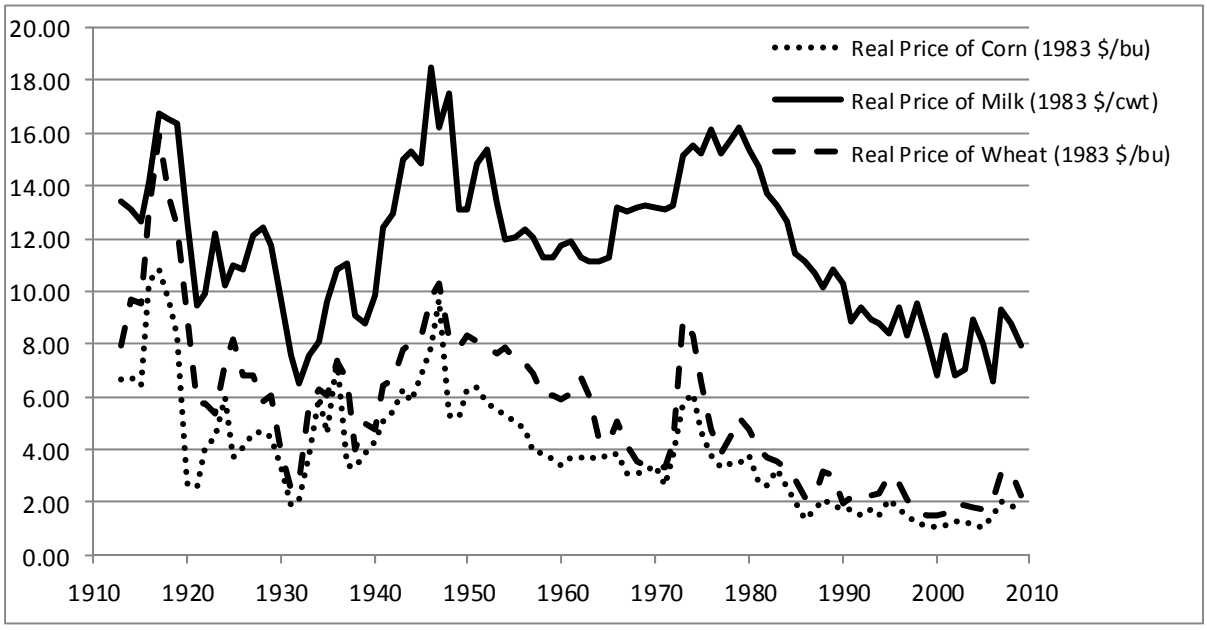
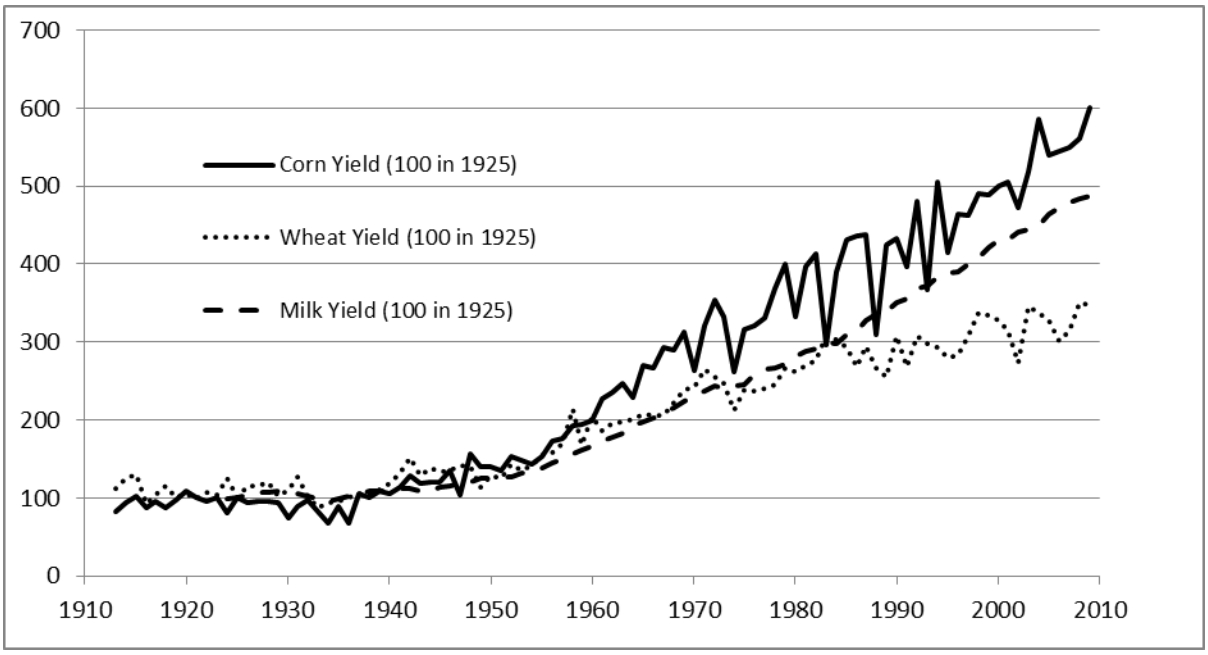


Figure 3 also shows that prices exhibit substantial variability. Two periods are particularly noteworthy: the 1930's (during the Great Depression) when food prices were very low; and the early 1970's when food prices were very high. The 1970's was a period exhibiting high population growth and increased resource scarcity. But it was followed by three decades of fairly steady decline in real prices for food. While this may be good news for consumers, it raises the question about what is coming next.

Since the Great Depression, the main source of the long-term decline in real food prices has been improvements in agricultural productivity. Figures 4 and 5 illustrate the evolution of agricultural yields over the last few decades. Figure 4 shows how US yields have changed for three commodities: corn, wheat and milk. Over the last 80 years, the average annual growth rate in yield was 2.0 per cent per year for corn, and 1.4 per cent per year for wheat, reflecting very large increases in land productivity. Similarly, the last 80 years have seen an average annual

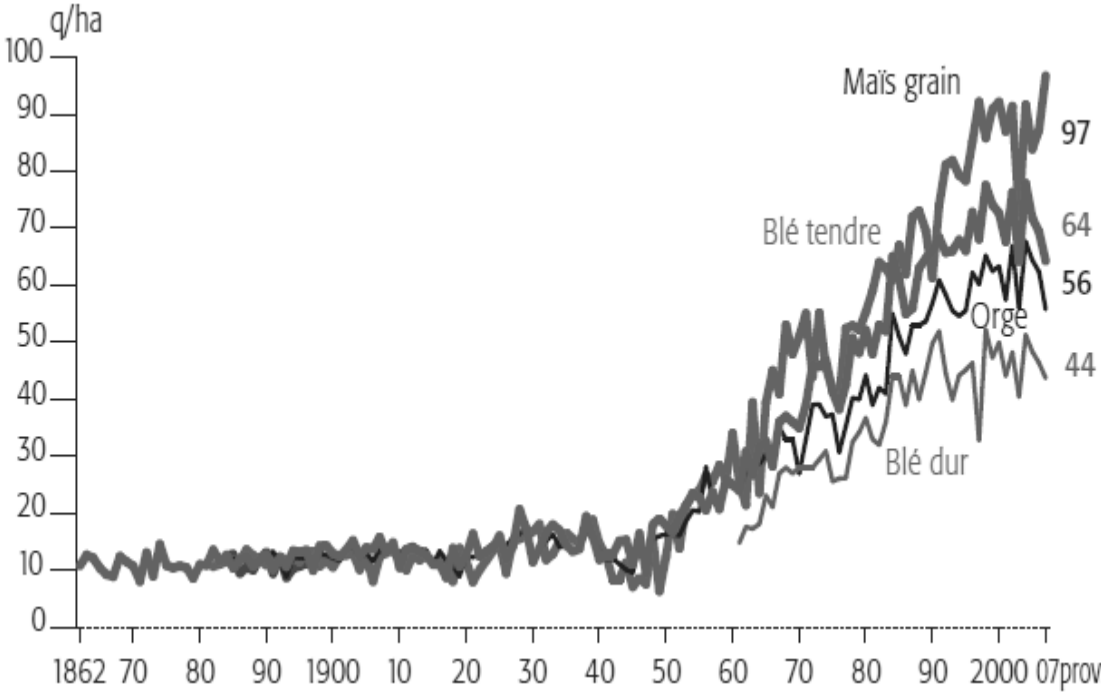
growth rate in milk production per cow of 1.9 per cent per year. Figure 5 shows the evolution of yield for selected farm commodities in France. Like Figure 4, it shows a large and steady increase in land productivity over the last 50 years. Since 1930, the average annual growth rate in yield was 2.3 per cent per year for corn and 1.9 per cent per year for soft wheat. These are very large increases that were crucial in increasing food production. Figures 4 and 5 also show significant variability in yields over time, reflecting in large part the effects of weather shocks.

Figure 4: Evolution of agricultural yields, US, 1913-2010.



Source: ERS, USDA (2010).

Figure 5: Evolution of agricultural yields, France, 1862-2007.



Note: The Figure is from Agreste Primeur (2008). The yields are in quintals (100 kg) per hectare. "Maïs grain" is corn, "Orge" is barley, "Blé tendre" is bread wheat, and "Blé dur" is durum wheat.

How much of these increases come from technological change? Part of the historical increases in food production came from increased input use (e.g., fertilizer, pesticides, capital). But the evidence shows that most of these increases came from technological improvements (Ball et al., 1997; Gardner, 2002; Fuglie, 2008). For example, Ball et al. (1997) documented that US agricultural production grew at an average rate of 2 per cent annual rate over the last few decades, most of it (1.94 per cent) coming from productivity growth (as measured by a total factor productivity TFP index). Remarkably, such changes took place while US agricultural labor input was declining at an average rate of 2.7 per cent a year (reflecting both rural-urban migration and increased mechanization). In addition, Fuglie (2008) found that, over the last four decades, agricultural productivity has been growing at fairly high rates in most regions of the

world. This reflects the important role played by innovations in farming systems, fertilizer use, pest control methods, mechanization, and genetic improvements. It means that technological change has been the principal factor responsible for increased food production around the world. Although the rates of growth in yields of rice and wheat appear to have declined recently, at this point there is no definitive evidence of a general slowdown in agricultural productivity growth.

What is less clear is what is coming next. Is the recent increase in food price volatility a short-term issue? Or is it a sign of significant and longer-term changes in agricultural markets? What are the main causal factors? What are the management and policy implications? In addition, the prospects of climate change raise new questions about weather shocks and their impact on future food production and its variability. The objective of this book is to present the latest research and inquiries addressing these questions.

3. Overview of the Book

The book includes ten papers that investigate the economics of food price volatility along five directions of inquiry. First, they document the recent and historical patterns in food price volatility, including the evolving food supply and demand conditions. Second, they study how food price volatility relates to linkages between food markets and energy markets, with special attention given to the role of biofuel policy. Third, they assess the impact of storage and speculation on food price volatility. Fourth, they examine the role of international markets, with a focus on the role of trade policy. Finally, they evaluate the distributional and welfare effects of food price volatility and their effects on the poor around the world.

The role of innovation and technological progress in agriculture has been significant. As noted above, large productivity gains in the food sector have been major drivers of the long run decline in food price. The paper by Alston, Martin and Pardey evaluates the role of agricultural technology and its effects on food price volatility. Technological change affects the variability of food prices by changing the sensitivity of aggregate farm supply to external shocks. After reviewing patterns of production, yields, and prices for the major cereal grains—wheat, maize, and corn—over the last fifty years, the Alston et al. paper studies how technological change can help reduce food price variability. It also examines effects on the poor.

The paper by Berry, Roberts and Schlenker presents estimates of the elasticity of aggregate supply and demand for food and the implications for agricultural price volatility. These estimates are important because price volatility depends not just on the magnitude of shocks but the elasticity of response to them. The paper also provides important insights on two sets of issues: 1/ the effects of ethanol and biofuel policy on the food sector; and 2/ the effects of weather shocks on food supply. The first issue is timely given current biofuel policy. The United States is now diverting about 30% of the food or feed value of corn to bioethanol production. And Europe and the United States are using a substantial amount of oilseeds to generate biodiesel. This new demand contributes to diverting agricultural land away from food production, thus reducing food supply and increasing food prices. Finally, the issue of evaluating weather shocks is particularly relevant as agriculture is a sector most vulnerable to climate change.

The paper by Abbott provides a refined analysis of the effects of recent biofuel policy and its implications for linkages with the food and energy markets. The paper argues that current biofuel policy has created incentives to increase ethanol plant capacity, thus creating a new and

persistent demand for corn and upward pressure on corn and food prices. It also provides evidence that these effects vary over time, depending in part on whether the capacity of ethanol plants is binding or not.

In a period of globalization, market linkages across sectors are important. The dynamic linkages between agricultural, energy and other markets are studied in the paper by Enders and Holt. Relying on refined multivariate time series models, the paper examines the factors that contributed to recent changes in the grain markets. It documents how energy prices, exchange rates, and interest rates have affected grain prices. It also examines how the introduction of ethanol as an important fuel source has contributed to the run-up in grain prices. Finally, economic growth in emerging economies such as China, India, and Brazil are identified as possible contributing factors.

The recent increase in food price volatility has raised questions about its relationship with the functioning of markets. One question is about the role of storage as a means of reducing price volatility. The paper by Bobenrieth and Wright examines what the theory of stock holding offers on this issue. The paper studies the implications of storage behavior for the time series properties of market prices. In this context, the analysis rules out "bubbles" as defined in financial economics. Yet, it shows the presence of price runs that could be characterized as "explosive" and might seem to be bubble-like.

With the rapid development of financial markets over the last decade, there have been some concerns about the "financialization" of commodity futures markets (Domanski and Heath, 2007). This has generated a debate on the role of financial markets in the recent increase in market volatility. The paper by Irwin, Garcia and Aulerich examines this issue in the context the food markets. It provides a refined analysis of the market impact of financial index investment

on agricultural futures markets. It adds to the growing body of literature showing that buying pressure from financial index investment in recent years did not cause massive bubbles in agricultural futures prices.

In a period of globalized exchange, the role of trade and its effects of food price volatility have been the subject of much interest. If domestic shocks are large and uncorrelated with foreign shocks, trade can reduce domestic volatility. But trade can also transmit volatility from foreign shocks into an otherwise tranquil domestic market. And when food price spikes in countries with large numbers of poor people, public interventions involving both domestic and trade policies can help alleviate hunger and malnutrition. This has raised many questions. How effective can domestic economic policy be in reducing price instability? How does trade liberalization relate to price volatility? What has been the quantitative impact of ad hoc export restrictions in transferring volatility from domestic to foreign markets? Are certain trade instruments especially problematic in transmitting or helpful in diminishing volatility? Are temporary trade restrictions beneficial to individual nations even as they distort and destabilize global markets?

The paper by Gouel evaluates the relationships between food price volatility and domestic stabilization policies in developing countries. The paper analyzes the tradeoff existing between government interventions in the domestic markets to stabilize food prices (e.g., storage and restrictive trade policies) and greater reliance on international trade. It evaluates the economic and policy challenges to balance the benefits of greater integration in world markets and the domestic welfare effects of economic and trade policy.

The paper by Anderson, Ivanic and Martin investigates the effects of the 2008 world food price crisis, with implications for welfare distribution. Many governments pursued policies

intended to insulate domestic prices from changes in world prices. But such policies also substantially increased world prices for key food crops such as rice, wheat, maize and edible oilseeds. High food prices benefit food sellers but hurt food buyers and consumers. These effects are particularly severe on low-income households who spend a large share of their income on food. The Anderson et al. paper presents evidence showing that the actual poverty-reducing impact of insulation may have been much less than originally anticipated. This raises the challenge of designing effective policies that can reduce the impact of higher food prices on the poor.

The paper by Do, Ravallion and Levchenko provides a theoretical analysis of this issue. It evaluates conditions under which trade insulation can provide social protection against food price volatility. It shows that in the presence of consumer preference heterogeneity, implementing an optimal social protection policy can potentially induce higher food price volatility. The Do et al. paper calls for a reassessment of food stabilization policies.

Finally, the paper by Cafiero and Schmidhuber provides a broad worldwide view of the economics of food security, as seen from the FAO. It reviews the data currently available and their use in the assessment of the 2008 food crisis. It evaluates the quality and coverage of available data and the methods used to assess the state of food security around the world. It stresses the importance of good data (on agricultural prices, production, trade, and food consumption) to support economic analyses that can help inform market participants and policy makers about the evolution of the food sector around the world.

4. Looking Ahead

The recent increase in food price volatility has stimulated much academic research. The chapters presented in this book provide a broad overview of the current state of academic inquiries on the economics of food price volatility. They document the progress made in identifying the factors that have contributed to the 2008 food crisis, along with their economic and policy implications. Yet more research is needed to refine our understanding of evolving food markets. Below, we briefly discuss a few directions for future inquiries.

It is important to distinguish between price volatility and high prices. Under price instability, prices are at times high (benefiting producers and hurting consumers) and at times low (benefiting consumers and hurting producers). It is possible to have an increase in the price level without changes in price volatility. And it is also possible to have both simultaneously (which may have been the case in the food crisis of 2008). The distinction appears to be important for at least two reasons.

First, if price changes are anticipated, economic analysis can focus on analyzing structural change issues. In econometrics, this can be done by examining changes in the "regression line". In this case, studying changes in means (or conditional means) would be sufficient. But if price changes are not anticipated, a change in price volatility means a change in the distribution of the anticipated variables. In econometrics, this would mean examining changes in variance (or higher moments) of the price distribution, as seen from the viewpoint of market participants. This raises the issue of empirically evaluating both changes in market conditions and changes in the information available to market participants. For example, how much of the 2008 food crisis was due to poor information available to market participants about food stocks? To the extent that there was no obvious food shortage in 2008, could better

information about food stocks have prevented the large increase in food prices observed in 2008? These questions stress the need to have good information about the causes and nature of evolving market conditions. Unfortunately, access to such information by economists and policy makers is often limited. This reduces our ability to provide an in-depth analysis and evaluation of price volatility issues. This argument emphasizes that future progress on understanding the economics of food price volatility must rely on access to good data.

Second, the distinction between anticipated versus non-anticipated price changes is important for an economic and policy viewpoint. Anticipated changes are easier to manage by both private agents as well as policy makers. For example, if a supply shock is anticipated, then production, consumption and storage behavior can adjust ahead of time and reduce the economic and welfare effects of the shocks on market participants. But if the shock is not anticipated, the economic implications are quite different. First, the welfare and distributional effects can be stronger. Second, the adjustments must be contingent on the particular shock, implying state-contingent decisions that are in the realm of insurance and risk markets. But insurance and risk markets are known to be incomplete. Why such markets tend to be incomplete remains a significant puzzle. Recent experience indicates that insurance markets in agriculture do not develop easily (in the absence of heavy government subsidies). This is at the heart of the economics of food price volatility. Is it possible to improve on the welfare outcome associated current food price volatility? What is the role of markets? What is the role of government policies (including both domestic policy and trade policy)? As discussed above, free trade can help reduce the welfare effects of location-specific shocks in food supply (e.g., the case of a drought, flood, heat wave or cold spell in a given region). But it would be less effective in addressing the effects of worldwide shocks to the food sector.

Two sources of shocks are of particular interest. First, globalization has strengthened the linkages between food markets, energy markets and financial markets. It means that shocks to the energy or financial markets now have stronger effects on the food sector. How are the food markets adjusting to these shocks? Second, climate change is increasing the prospects of seeing significant weather shocks in agriculture. The implications for food markets and agricultural and trade policies remain unclear. While we know that markets and free trade can help improve aggregate efficiency, the issue of private and public risk management schemes associated with unanticipated shocks to the food sector needs further investigations. This is particularly crucial when considering that large food price increases can have devastating effects on the welfare of poor households around the world.

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