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Special Issue: Causes and Consequences of the Food Price Crisis

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Introduction to the Issue

The price of food and farm commodities rose steadily throughout 2007, then jumped to record highs in the winter/spring of 2008. Farm commodity prices, like oil prices, have begun to fall recently but several commodities remain priced at more than twice what they were two years ago. Among the likely causes of sharply higher food prices are spikes in oil prices, increasing demand for biofuels (supported by government policies), government efforts to manipulate imports and exports, increasing demand generated by rising incomes in developing countries, slow growth in agricultural productivity levels, and the weak U.S. dollar.

In addition, during the years between the end of World War II and 1990s, agricultural productivity was high—in spite of a rapid rate of population growth, the supply of food per capita increased, reflecting a high return-to-investment for agricultural research. Since then, such investment has stagnated and adoption of the results, especially in the area of agricultural biotechnology, has been limited. These factors have contributed to declines in agricultural productivity. Meeting growing demand for food and for biofuels will require greater productivity, which will depend on investments in agricultural research.

In this issue, we present research under way at the Departments of Agricultural and Resource Economics at UC Berkeley and UC Davis that has already shed light on the current crisis in food prices. A summary of this research was presented at a symposium convened by the Giannini Foundation and the UC Agricultural Issues Center on October 10, 2008.

Three papers—by Carter, Rausser, and Smith; by Sumner; and by Wright—use statistical analyses of historical data, policy simulations, and models of food demand behavior to delineate the current situation and predict the outlook for the future. The paper by Alston, Beddow, and Pardey shows a close relationship between the slowing pace of agricultural R&D and recent imbalances between productivity and growing demand.

Higher food prices benefit farmers and landowners but harm consumers. Farm incomes and land prices in California and the United States set new records in 2007 and rose still higher in 2008 (the recession may paint a different picture in 2009). In developed countries, even drastic increases in prices for agricultural commodities have only a mild effect on the price of food. But in developing countries, where vulnerable populations spend most of their earnings for food, sudden spikes in prices cause severe hardship and hunger, with long-lasting consequences that include physical and mental stunting from malnutrition and reduced schooling for children. Papers by Ligon, and by de Janvry and Sadoulet, examine the effects of skyrocketing food prices in these developing countries.

The Food Price Boom and Bust

Colin Carter, Gordon Rausser, and Aaron Smith

Food commodity prices soared between September 2007 and mid-2008, then fell just as sharply. Macroeconomic factors likely underlie this boom and bust, but biofuel and trade policies continue to hold corn, soybean, and rice prices at approximately double their 2005 levels.

In July 2008, the world found itself in the middle of a food crisis, with sharp food price increases raising concerns about increased hunger and political instability in poor countries and worries over inflation in China and elsewhere. Figure 1 shows that prices of the four major food commodities (corn, rice, soybeans, and wheat) approximately tripled between Fall 2005 and mid-2008. This jump caused food prices paid by consumers to also rise sharply—increasing by 40 percent or more in developing countries. Since July 2008 these prices have dropped just as quickly as they rose, although corn, rice, and soybean prices remain about double their 2005 levels.

What gave rise to the surge in agricultural commodity prices and why did it fizzle out so quickly in the latter part of 2008? The long list of possible explanations includes:

- Biofuel policies in the United States, Brazil, and the European Union (EU) shifting crop utilization from food to fuel.
- Supply shortfalls due to poor weather in Australia, Europe, and elsewhere.
- A gradual tightening of world food supplies due to rapid demand growth in emerging economies (such as China, India, and Russia) and slowing growth in crop yields.
- Higher energy prices that drive up the cost of food production, transportation, and fertilizer.
- Hoarding and export controls.
- Declining value of the U.S. dollar and relatively low real interest rates.
- Speculation and the increasing involvement of hedge and index funds in commodity futures trading.

The first five of these explanations describe demand growth outpacing supply growth. They were the primary drivers in the first two years of the food price boom (Fall 2005–Fall 2007), a period in which corn, soybean, and wheat prices approximately doubled. In the last year, some commodity-specific factors have affected prices, including low Australian wheat production due to drought, rice export controls by India, and floods in the midwestern United States that were initially thought to have severely affected the corn and soybean crops.

Oil, rather than being the cause of the 2007/08 food price spike through the medium of biofuel, appears to be one of many commodities affected by a set of larger forces.

However, two features of the 2008 market situation suggest that commodity-specific supply and demand fundamentals were not the leading cause of the 2007/08 price spike. First, virtually all agricultural commodity prices rose and fell dramatically in 2008, including grains and oilseeds (e.g., corn, rice, soybeans, and wheat) and soft commodities (e.g., cotton, coffee, and cocoa). The only exceptions were some livestock products. Second, the spike in agricultural prices was part of a very broad spike in commodity prices. The prices of energy (e.g., crude oil, natural gas, heating oil) and metals (e.g., copper, gold, and aluminum) also rose and fell sharply in 2008. Could there have been serious supply and demand problems in all of these commodity groups or was there a common factor behind this dramatic across-the-board price move?

High Oil Prices and Biofuel

Figure 2 shows that, until recently, grain and oilseed prices were not strongly correlated with petroleum. In 2003, the correlation in daily price changes between corn and crude oil equaled 0.05, which was slightly above the average for the period between 1986 and 2003. By 2007, this correlation had jumped to 0.33. The UN Food and Agriculture Organization (FAO) and others have recognized that commodities are now tied together more closely than ever before—suggesting that agricultural commodity prices now move up and down with prices for fossil-based fuels.

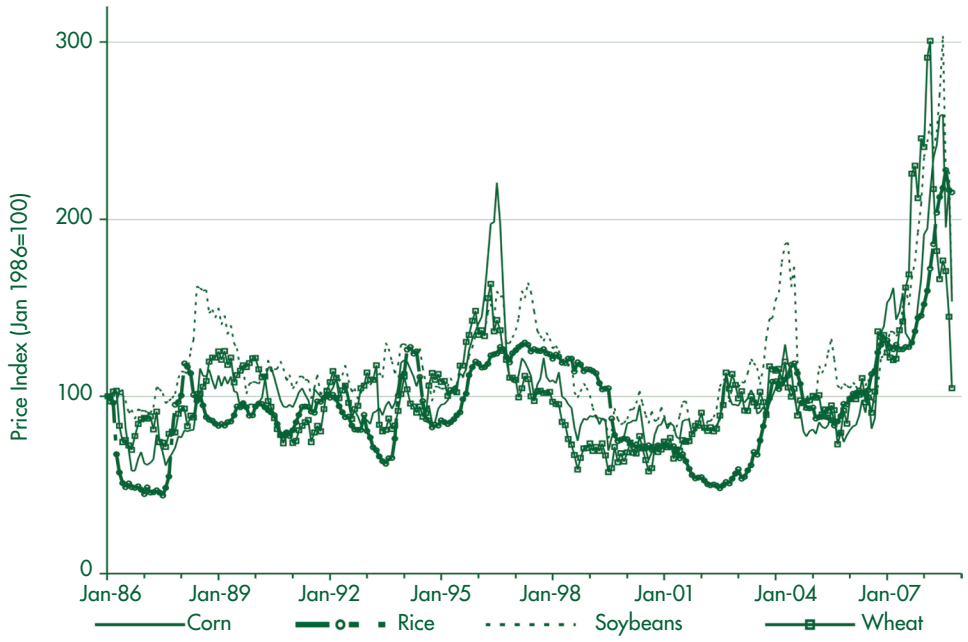
In the past, fossil fuel prices affected agricultural commodities by raising the cost of production, shipping, and fertilizer. The current biofuel era has created a new connection between agricultural and petroleum markets. Increasing fuel prices provide an incentive to move sugar, corn, and oilseed production into fuel channels. Ethanol is produced primarily from sugar in Brazil, whereas the United States produces ethanol largely from corn. In the European Union (EU), biodiesel is produced from canola. Energy policies in the United States and the EU have been criticized in particular because they promote the inefficient production of biofuels through subsidies and mandated blending requirements.

During the 2008 crop year, more than 30 percent of the U.S. corn supply will be diverted into ethanol production, up from just 14 percent in 2005. This diversion has a significant impact on world corn prices because the United States typically produces about 40 percent of the world's corn and accounts for 60 percent or more of total exports. According to the FAO, the increase in global corn demand in 2007 was about 40 million metric tons, and 75 percent of that growth was attributable to ethanol production.

This dramatic increase in U.S. corn-based ethanol production stemmed from mandates in the Energy Policy Act of 2005. Because of the long lead time in building ethanol plants, the likely quantity of 2007 and 2008 ethanol production was essentially known by late 2006 and therefore would have been incorporated into corn prices by late 2006. Corn prices doubled between November 2005 and November 2006, and we estimate that ethanol production can account for most of that increase. After the 2008 spike, corn prices returned to November 2006 levels.

Cross-commodity linkages are a big part of the biofuel effect. Corn in the U.S. and canola in the EU compete with other crops for acreage. This competition perhaps was most striking in crop year 2007/08, when U.S. corn acreage jumped 19 percent from the previous year while soybean acreage fell by 16 percent. This crop substitution explains why soybean prices surged in the lead-up to the 2007 harvest, an indirect effect of U.S. ethanol policy on corn acreage.

Figure 1. Soaring Food Commodity Prices



Data Source: Commodity Research Bureau and U.S. Department of Agriculture.

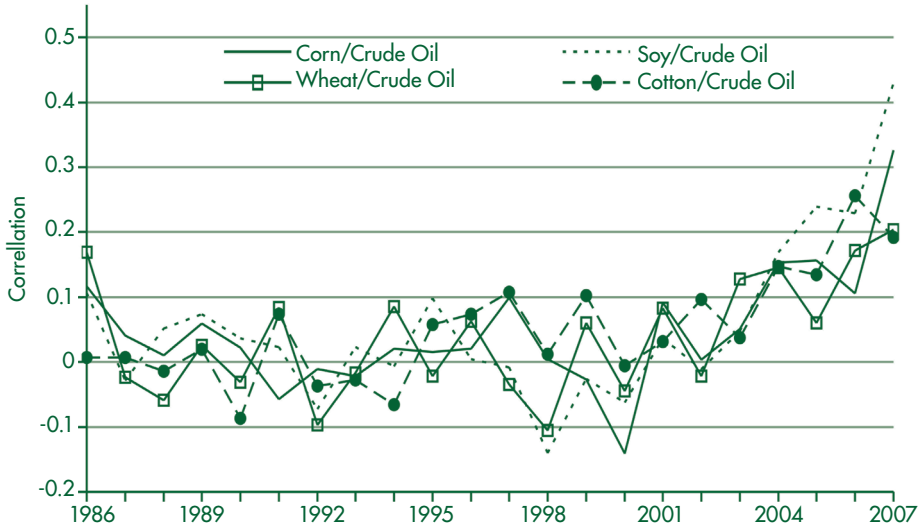
The Energy Independence and Security Act of 2007 mandates further increases in ethanol production beyond those mandated in 2005. By the time this act was signed into law, ethanol production was already so far above the 2005 mandate that the new mandate will not be binding until at least 2010. Mandated 2008 ethanol production rose from 5.4 to 9 billion gallons under the 2007 Act. However, back in November 2006, the United States Department of Agriculture (USDA) projected that 2008 ethanol production would be 9.4 billion gallons. Similarly, in November 2006 the USDA projected that 2012 corn-ethanol production would equal 11.5 billion gallons. The 2007 Act raised the 2012 ethanol production mandate from 7.5 to 13.2 billion gallons, only slightly above projections made in 2006 by the USDA.

In spite of the passage of the 2007 Act, there seems to have been little change in the ethanol production landscape in 2007/08, so it is difficult to rationalize ethanol production as the cause of the second boom in corn and soybean prices, which began in September 2007. This contention is reinforced by the fact that many other commodity prices also started increasing at that time. Thus, oil, rather than being the cause of the 2007/08 food price spike through the medium of biofuel, appears to be one of many commodities affected by a set of larger forces.

If Not Biofuel, Then What?

In grain and oilseed markets, rising demand in Asia was often mentioned as an important factor behind higher prices. But the trade statistics do not support this contention. China remains a net exporter of corn, rice, and wheat and is a small player in world markets for these commodities. Soybean imports into China have grown rapidly, but that alone cannot explain the recent price increases for all grains and oilseeds. Moreover, the

Figure 2. Increasing Correlation with Crude Oil Prices



Correlation of daily log price changes by crop year.
Source: Commodity Research Bureau.

growth in Chinese soybean imports displays a smooth pattern over the last decade, suggesting that it was not the catalyst for the price boom.

The 2007/08 food price explosion was part of a general commodity price boom and bust, and therefore we must look beyond the agricultural sector for causes and consequences.

The rise in agricultural commodity prices coincides with the view that agricultural commodities have become a new asset class, attracting investment from banks, hedge funds, etc. It was argued that these institutional investors were responsible for a large share of the recent commodity price spike. But research by the U.S. agency that regulates the commodity futures market (the Commodity Futures Trading Commission–CFTC) shows that financial speculation is not an important factor in explaining high commodity prices. The CFTC also pointed out that high prices have been achieved in commodity markets that have no futures trading (e.g., durum wheat) and in markets with little index trading (e.g., rice).

Commodity prices surged in September 2007, around the same time that the U.S. Federal Reserve began to lower interest rates. Low interest rates raise commodity prices by reducing the cost of storage, thereby creating an incentive to store for future consumption rather than sell today. Low U.S. interest rates also encourage investors to move into currencies with higher interest rates, which causes the U.S. dollar to lose value. A falling dollar increases the dollar value of commodities because the value of dollar-denominated commodities must go up by at least as much as the dollar goes down; otherwise, the value of the commodity falls. These monetary factors likely played a large role in the 2007/08 food price boom, just as they did in the 1970s commodity price boom. The end of the 2007/08 boom coincided with the financial crisis, which generated extreme tightening of credit, financial deleveraging, and predictions of a severe global recession. Recent relatively high correlations among commodity price changes also suggest a strong role for these macroeconomic factors (see Figure 2).

The 2007/08 price spike led to some unfortunate trade policy choices, especially in the rice market. In March 2008, India banned the export of non-basmati rice and Vietnam also restricted rice exports. India and Vietnam are the second and third largest rice exporters in the world, and their export restrictions reduced global trade by more than 10 percent in 2008. Because of low global stocks and the small share of world rice production that is traded internationally, world prices were extremely sensitive to this reduction. The export restrictions were a significant source of skyrocketing rice prices in 2007/08 and threatened food security in large rice-importing nations such as the Philippines and Nigeria. India's ban remains in effect and rice prices remain double their level of three years ago.

Conclusion

The 2007/08 food price explosion was part of a general commodity price boom and bust, and therefore we must look beyond the agricultural sector for causes and consequences. In all likelihood significant macroeconomic forces, with loosening monetary policy serving as a catalyst, generated the rise and the financial crisis acted as the catalyst for the fall. At the time of writing, many food commodity prices have returned to their Fall 2007 values. However, corn and soybean prices remain about double their 2005 values due to biofuel policies that divert grain from food to fuel. Similarly, rice prices remain twice their 2005 values due to export controls. The food crisis is not over.

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Impacts of Recent Commodity Price Fluctuations on Farms in California and a Historical Perspective on Prospects for the Future

Daniel A. Sumner

As low-income consumers have suffered from high commodity prices, farmers have gained. Farm incomes were high in 2007 and are likely to be equally high in 2008. But high prices usually do not last. The extreme price spikes that occurred in the spring and summer of 2008 have dramatically fallen. We can learn from considering the past 150 years of price history and especially the episode of the 1970s.

Price increases from 2005 through 2008 have affected consumers and producers in California, the United States, and the world. Other articles have reviewed recent history and considered why prices increased and then declined precipitously in the fall of 2008. Higher commodity prices raised broad international concern because the world's poor spend most of disposable income on food and rely on basic commodities for much of their diet. But, of course, what harms buyers benefits sellers and field crop farmers in the United States have gained from higher commodity prices. Here we examine how farm revenue and expenses have performed in recent years as prices of many items have risen.

U.S. gross farm income is on track to nearly $380 billion in 2008, up from less than $300 billion on average from 2004 through 2006 (Table 1). The major increases have been in crop receipts, especially for feed crops, oilseeds, and food grains. Receipts for fruits, vegetables, and nuts have risen relatively little. Production expenses rose steadily from 2004 through 2007 and will have jumped by about $40 billion from 2007 to 2008. So net incomes were low in 2006 and only slightly exceeded the 2004 level of about $86 billion in 2007, as gross income gains finally caught up with growth in expenses. The forecast for 2008 is for gross income to grow by more than expenses so net income will roughly equal the 2004 and 2007 figures (Table 1).

Higher prices caused net farm income in California to rise sharply from 2006 to 2007, as costs were relatively stable and value of production rose by about $4.5 billion. Net farm income in California rose by about 38 percent, to $12.7 billion, in 2007. Both receipts and costs will be up substantially in 2008, but net incomes are expected to rise slightly when the final data are available.

Higher expected crop incomes are reflected in higher cropland values in California. Farmland values rose from an average of about $6,000 per acre in January 2004 to about $10,000 per acre in January 2008. The biggest jump in farmland values was from 2004 to 2007, with only a slight rise in the 2008 figures. This suggests that farmland buyers discounted the long-run sustainability of farm receipts growing substantially faster than expenses.

When crop prices rise, costs for livestock producers rise. In 2007, livestock prices rose as much or more than feed prices and profits from dairy, egg, and other parts of animal agriculture rose. Most important in California, the dairy industry received substantially higher prices in 2007 and 2008 than in 2006. The U.S. Department of Agriculture (USDA) and futures prices indicate that over the next year feed prices are likely to remain about the same as in 2007 while milk prices will decline—putting added pressure on the profits of this major California industry.

The Recent Price Increases in a Historical Perspective

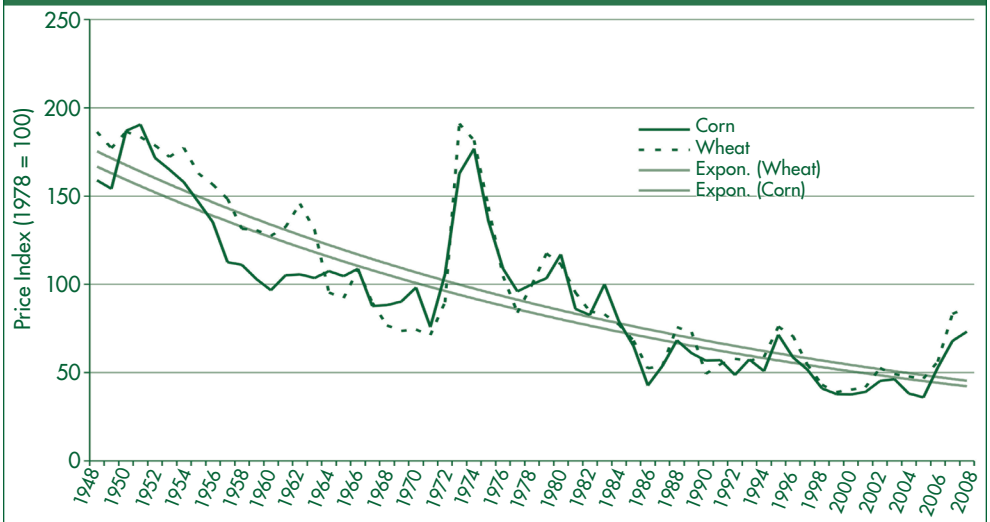
In considering the future pattern of commodity prices, it is useful to put the current period in some historical perspective. Figure 1 displays the pattern of deflated corn and wheat prices since 1948, along with exponential trend lines that show the 2.3 percentage rate of decline of prices over the six-decade period. Real prices jumped dramatically in 1973 and 1974 and then declined over the next few years so that, given rapid inflation in the general economy, real prices were back to the pre-surge range by 1977. However, it took a decade for real grain prices to get back to their long-term trend. Also note from Figure 1 that the three-year period 2006–2008 represents one of only a handful of periods when prices for either corn or wheat have been above the post-war trend. Evidence from a 140-year history promotes the notion that prices that have jumped up soon fall again. The handful of extreme spikes in commodity prices—in the late 1890s (only for corn), around World War I, around the New Deal and the 1934 drought, around World War II, and in the 1970s—were all followed

Table 1. U.S. Farm Income, 2004–2008*

	2004	2005	2006	2007	2008*
	— $ billions —				
Gross Farm Income	295.6	301.1	292.4	341.1	379.4
Production Expenses	209.8	221.8	233.9	254.4	292.5
Net Farm Income	85.8	79.3	58.5	86.8	86.9

Source: U.S. Department of Agriculture. ** Denotes forecast*

Figure 1. Index of Real Corn and Wheat Prices and Long-Term Trends, 1948–2008



Note: The 1948–2007 prices are marketing year average prices. The 2008 prices are the November 2008 World Agricultural Supply and Demand Estimates (WASDE) season averages, mid-point of range for the 2008/09 marketing year. Prices deflated by Bureau of Economic Analysis (BEA) annual implicit GDP deflator.

by extreme price downturns. The price drop observed at the end of 2008 seems to be consistent with this pattern.

The 1970s was the most recent previous period of dramatic increases (and subsequent declines) in farm prices, and it may be fruitful to explore similarities between that period and 2006 through 2008. Figure 2 shows the real corn price index by month from January 1972 to December 1975 with July 1972 set at 100 and the real corn price index for January 2006 through October 2008 with July 2006 set at 100. A graph for wheat would tell a similar story, but is not displayed to avoid clutter in the figure.

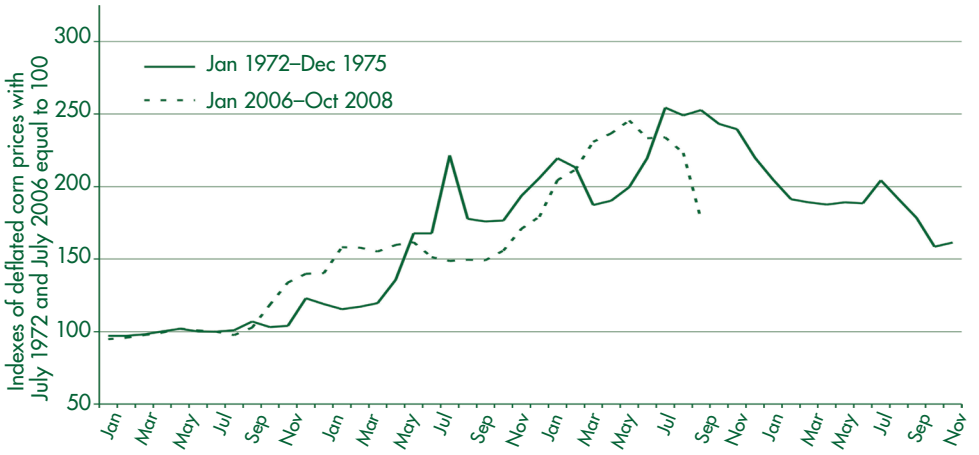
Starting in the summer of the first year in each period, the corn price rose more rapidly in 2006 than in 1972, reaching about 50 percent more than the base price in just six months (January 2007), where it remained for most of 2007. The corn price then rose over the next eight months to reach 2.5 times the base price by the summer of 2008, before collapsing back to about 1.8 times the base price in October 2008. In the 1970s, corn prices rose gradually to only about 20 percent above the base through April of 1973 before rising by 90 percent by August 1973. Prices moved erratically before peaking at more than 2.5 times the base price in the fall of 1974. Prices then declined in stages reaching about 1.5 times the base price by the end of 1975. As shown in Figure 1, prices were back to 1972 levels by 1977.

In the 1970s, Lester Brown was among the more prominent observers who projected that the price jumps presaged a long-term food crisis caused by permanently high prices. Several economists, however, (perhaps best represented by D. Gale Johnson) provided calmer (and ultimately more correct) assessments, suggesting that commodity prices would be back on trend within a few years.

Policy-created mandates for ethanol use together with stiff import tariffs on ethanol suggest that corn prices may remain high in the next few years even if oil prices do not rise again soon. It may take relatively high corn prices to sufficiently stimulate production to supply about five billion bushels of corn for ethanol. After a few years, however, national and international substitutes for corn for livestock feed will moderate the ethanol effect even if the mandate and tariff policies remain.

Each period of history is different and no one can be sure where commodity prices will be a few years from now. However, recognition that relatively short-term price spikes have occurred many times in the past does suggest caution in predicting an unprecedented reversal of long-term price trends this time. A bit of history helps buyers and farmers place recent events in perspective.

Figure 2. A Comparison of Corn Prices During 1972 Through 1975 with Corn Prices During 2006 Through October 2008



Note: The vertical axis shows indexes of deflated corn prices with July 1972 and July 2006 equal to 100. Monthly prices received by farmers are deflated by the Bureau of Economic Analysis (BEA) quarterly implicit GDP deflator. The October 2008 price is deflated by the Q3 2008 implicit deflator.

Sources: U.S. Department of Agriculture, National Agricultural Statistics Service, "Agricultural Prices." BEA "National Economic Accounts."

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Speculators, Storage, and the Price of Rice

Brian Wright

Recent experience in the world rice market does not reveal irrational speculation, greedy manipulation, or disruption due to soaring Asian incomes or recent biofuels mandates. The real lesson is that, without serious steps to ensure collaboration in maintaining market access when supplies are tight, the market could collapse into autarky if stocks appear to be low and aggregate harvests fail to increase as expected.

The past two years have seen steep increases in the prices of major food and feed grains, followed very recently by substantial declines. After several decades of relatively stable, generally down-trending prices for staple foods on the world market, recent market behavior has come as a shock to consumers and governments. Was the prediction of Parson Malthus not wrong but merely premature? Is recent experience due to an aberration—an irrational bubble in prices unconnected to market fundamentals? Or are we witnessing the beginning of a new, less stable price regime? Is global warming changing production prospects? Are biofuels causing supply problems?

Let's first consider the evidence about aggregate food price behavior over the past few years. In 2005 the UN Food and Agriculture Organization (FAO) food price index was less than 20 percent higher than the 1998–2000 average but with no clear trend. In 2006 prices started higher and, by October, were on a sharp uptrend that continued until March 2008, when the price was more than three times the 2005 level. At that time, many started talking of a new food price regime. However, by late summer 2008 prices had started on a steep downward path.

How should we interpret this roller-coaster behavior of food prices? By April 2008 the rise in food prices had caught the attention of the worldwide press, which lined up a confusing array of suspects. To keep things manageable, I focus on the rice market because some major economic relations in this market are more clear-cut.

The Lineup of Suspects

In the global rice market, one widely discussed suspect was the Australian drought, which reduced the supply of irrigation water so dramatically that major rice producing areas (including the region where my family used to grow rice) were shut down altogether. Whether the drought reflects long-term global warming is unclear. But Australian production is only a few percent of the world export market, which in turn is about 5 percent of world consumption. The Australian drought aggravated the situation, but for prime causes we must look elsewhere.

A second widely cited factor is rapid increases in demand in China and India due to unprecedented income growth in both countries. Gross domestic product (GDP) has risen very quickly in China in the past few years, but what is really amazing is that the rapid increase is the continuation of a trend that has been sustained for a decade. The rate of growth since the food prices took off in late 2005 can hardly have been the kind of surprise that could explain the sudden price acceleration. India's GDP growth, too, has been sustained too long to be called a recent shock that can explain the reversal of the price trend in rice. Moreover, perhaps even more noteworthy is the high and increasing saving rate in both countries, reportedly reaching about 40 percent in China this year. It seems that consumption expenditures have risen more slowly than income. Any direct effect on human rice consumption is surely modest. As incomes increase beyond some threshold, rice consumption per capita tends to stabilize and then fall. For populations that consume rice as a staple, consumption increases generally reflect population increases more than rising personal income, and the rate of population growth in China and India is generally slowing down, not speeding up.

Competition from Feed and Biofuels Markets

Income increases in China and India could affect rice prices indirectly by increasing the demand for animal products and, in turn, diverting some food grains from use as human food to use as animal feed. In China in particular, meat consumption is increasing quickly as incomes rise. The official data show a much smaller effect in India, where many consumers are vegetarians or follow religious restrictions on consumption of animal products.

Another currently popular suspect blamed for recent price increases is the conversion of grains and oilseeds into biofuel in Europe and the United States. In the United States in particular, the diversion of corn and soybeans to biofuel is now substantial (approaching 30 percent for corn and 20 percent for soybeans) and will continue to increase to fulfill federal mandates. By comparison, a drought or pest infestation that reduced output by 20 percent would be viewed as a major market disruption. For example, the southern corn leaf

Figure 1. Global Consumption of Grains

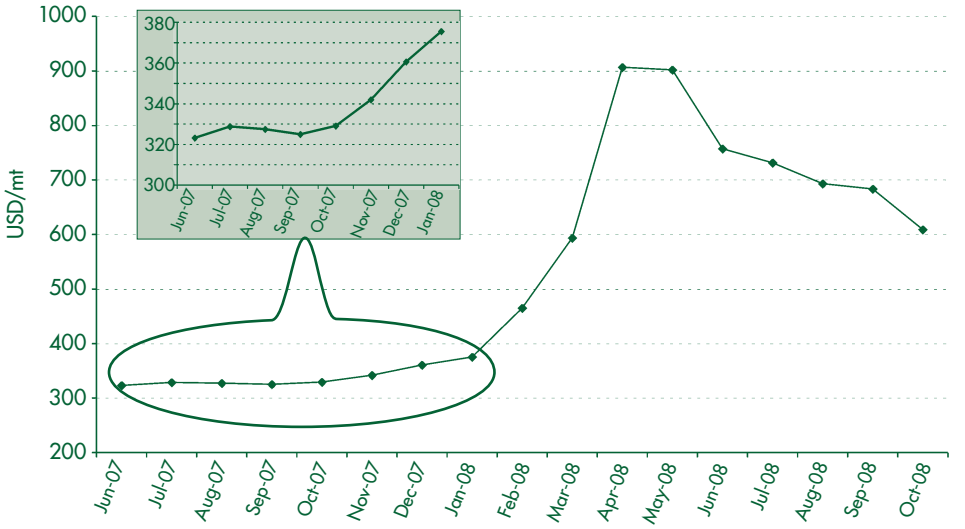
Source: U.S. Department of Agriculture, Foreign Agricultural Service data.

blight infestation of 1971, which cut U.S. corn supply by around 15 percent, was viewed at the time as a serious shock and prompted new concern about the security of the U.S. food supply. Diversion of an equivalent amount of grain for biofuel is even more of a threat to food security since it is a quasi-permanent development rather than a transitory event like a weather-related infestation. On the other hand, the crop diversion can hardly have come as a surprise in 2006. The increasing trend of usage started no later than 2004 and, being the result of government mandates for ethanol use, was clearly foreseeable before prices took off. Similarly, increased demand for oilseeds for biofuel use in Europe and the United States was no surprise.

Although aggregate supply of grains, including carryover stocks available for human consumption has no doubt been reduced by recent diversion to animal feed and biofuels, the direct effects on consumption of rice are unlikely to have been great. When corn and other feed grain supplies are scarce, diversion of one major food grain, wheat, to feed use occurs. But rice, the other major food grain in most of the world, has no significant feed use. Increasing meat demand does not substantially increase demand for rice as feed for animals. Furthermore, neither wheat nor rice has any significant use as a biofuel feedstock.

In addition to causing diversion of wheat and other food grains to animal feed uses and, consequently, of rice to food, income increases and biofuel demands might have affected rice production indirectly by diverting inputs to feed grain production. Some rice land might have been diverted to production of corn or soybeans, but this is unlikely to have had a strong impact on overall rice production; the best rice land tends to be ill-suited to corn or soy production in the temperate zones where much of the world's corn and soybeans are grown. However, on Asian croplands where two or three crops are grown in succession each year, wheat can be substituted for rice as a dry-season irrigated crop when its relative price increases. In the last few years, larger effects on rice supply might have come through competition for fertilizer and other scarce inputs; indeed the price of some fertilizers rose faster than any agricultural commodity in the last few years.

Figure 2. Thai Rice Prices



Rice (Thai), 5% broken, white rice (WR), milled; indicative price based on weekly surveys of export transactions, government standard, f.o.b. Bangkok
Source: World Bank, Propects Group.

Reality Check

There is one large problem with supply-side arguments linking diversion of land and other inputs induced by surges in feed and biofuel demand to recent high rice prices. In the aggregate, recent reports indicate that global rice production has increased about 2 percent in 2008.

Is It a Bubble?

The reality that overall rice availability increased this year has prompted a quite different rationalization of the crisis in the rice market: there was an "irrational" bubble attributable to "greedy" speculators that burst in the summer. In 2007, one story goes, prices got out of line in the rice market and supplies were withheld in anticipation of greater profits later. A new enthusiasm for investment in commodity futures by

hedge funds was purported to be fanning the speculative flames. The very recent sharp reversal of the rice price trend is viewed as confirmation of this interpretation: the "bubble" proved unsustainable, as bubbles always are.

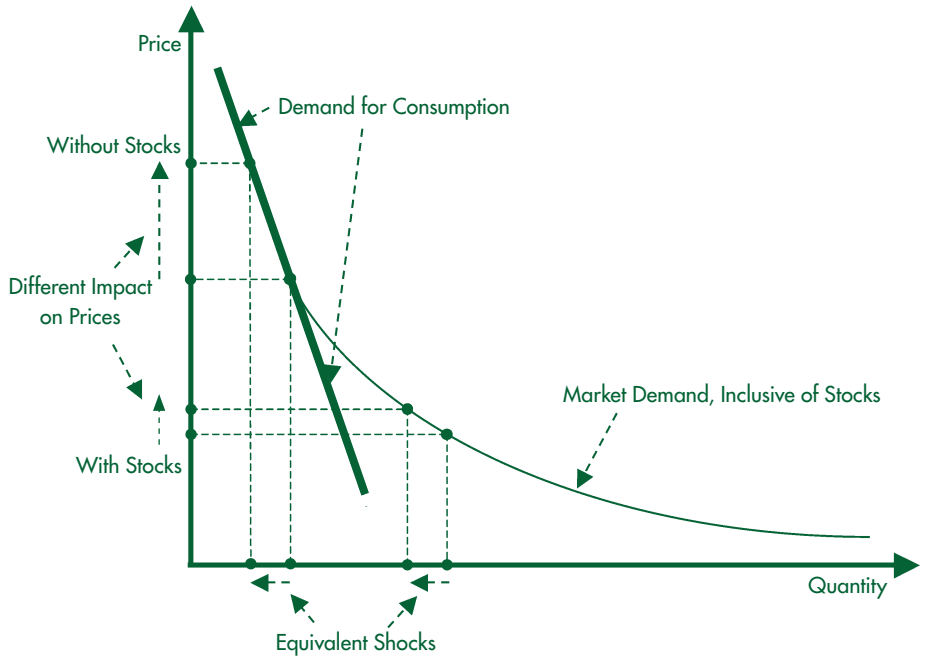
One problem with application of this notion to rice is that futures markets are less prevalent, and less important, for rice than for other major crops. Rice is a highly differentiated crop and most types are not traded on futures markets. Another problem is that any effect via futures trading must be manifest in increased stocks; how, otherwise, can consumption and prices be influenced? No serious claim of increased speculative rice stocks has been advanced recently. Similarly, a related argument that commodity price increases are caused by falls in interest rates must rest on an effect on speculative stocks that has not been empirically verified. This is not to rule out these causal links entirely; world stocks are notoriously difficult to determine, and this is particularly true of rice.

In any case, attribution of recent price rises to shortfalls in available supply, whether attributable to substitution in production, diversion to feed, or hoarding by speculators, must confront the reality that, of all the major grains, rice consumption appears to have been the steadiest—rising slowly with minor fluctuations (Figure 1). Assuming the data are reliable, modest shortfalls occurred in 2002 and 2004 but there is none to explain a price run-up after 2005.

Panic in a Fragile Market

In reality, the root cause of the problems in the rice market was not an irrational bubble. A key decision in generating the crisis in prices was made one year ago when India announced on October 9, 2007, a ban on rice exports other than basmati. This, it appears, reflected the wish of the unpopular government to reduce inflation in anticipation of the next national election. Immediately the rice price (outside of India) began to rise along an upward trend that accelerated into last summer (Figure 2). Production problems in some countries encouraged other rice exporters to follow India's lead and ban exports. It also became clear that China, apparently adequately supplied, would not act as supplier of last resort.

Figure 3: The Role of Stocks in Buffering Shocks



Countries that relied on imports for an important share of their food became increasingly anxious to secure foreign supplies adequate for their needs so they could satisfy politically powerful urban consumers concerned about food security. By April 2008, as reports of production problems in some countries surfaced, developing countries that export rice were also being pressured by their own urban consumers to act to reduce rice prices. These pressures dominated the interests of producers and traders. One by one, they chose to impose their own export bans, including, in March 2008, Vietnam, an important supplier. Thailand was still in the market as the major supplier, but the Thais were reportedly discussing formation of a "rice OPEC." The crisis was resolved only when it became clear, in the late Northern summer, that the current harvest was good and that, overall, 2008 rice production would be close to its trendline.

Why Volatility Soars When Stocks Are Low

The whole episode can be understood only when we realize that, when available stocks are low or of uncertain dependability, the price of rice is extraordinarily sensitive to fluctuations in excess supply. The market demand for rice is the aggregate of two demands. One is the demand for consumption in the current period, *t*; the other is the demand for rice to store for later consumption. This storage demand will be positive (in excess of minimal working stock levels) only if the rice price, *P(t),* is expected to rise at a rate that will cover the cost of storage and the interest charge at rate *r* on the value of the stocks placed in storage.

$$P(t) + \text{cost of storage} = E[P(t+1)]/(1+r), \text{ if stocks} > 0;$$

$$P(t) + \text{cost of storage} \geq E[P(t+1)]/(1+r)^{-}, \text{ if stocks} = 0.$$

This demand for stocks is added horizontally to consumption demand to form total market demand, as shown in Figure 3. When the price is high

and stocks are low, market demand is dominated by consumption demand. Rice consumers are dominated by those who eat it as their staple food. They will give up other expenditures (including health and education) to continue to eat rice. In other words, the consumption is highly inelastic, that is, very unresponsive to price. When stocks are substantial, their demand, added to consumption demand, makes market demand much more elastic, or responsive to price. The price effect of a modest reduction in available supply depends crucially on whether stocks are plentiful or scarce. In 1972/73, for example, a decline in world wheat production of less than 2 percent at a time when stocks were low caused the annual price to more than double. Figure 3 shows two equivalent supply shocks. In one case, when stocks are high, the impact on price is minor. In the other case, stocks are low and the price impact is large.

In the first half of 2008, rice stocks available to the world market (admittedly a quantity very difficult to measure) apparently were very low. If the mid-summer harvests of rice had been disappointing (reducing available supply for the year by, say, 2–3 percent from trend), then the principal exporter, Thailand, might well have restricted exports, in which case the international rice market might have completely collapsed, with grave consequences for poor importing countries. How can such a catastrophe be avoided if we are not so lucky next time?

What's Needed: Cooperation and Transparency

Obviously, in restricting exports in the first half of 2008, governments of major rice exporters were most likely acting in their own best interests, given that they anticipated others would act similarly. However, if they had all acted cooperatively, guaranteeing continued export supplies, prices for rice exports would have risen less sharply, relieving pressure from domestic consumers to ban exports, and domestic rice producers would have exported more rice. Exporting countries all have a long-run interest in assuring their consumers that they will be able to import in years when supplies are tight. If they all agree to keep markets open, all can continue to gain from exploiting comparative advantage; the North Korean model of autarky is not attractive.

Two international initiatives should be pursued immediately to encourage cooperation. One is to make a concerted effort to improve the accuracy and timeliness of reporting of stocks from each country to minimize uncertainty about the state of supplies at any particular time. In the global petroleum market, the International Energy Agency receives and reports on public and private petroleum stocks. It also has developed protocols for international collaboration in assuring supplies to a member country for which the import market has been disrupted. Cereal importers should study this model seriously.

Mutual assurance in maintenance of open markets in rice could also be facilitated by inception of disciplines at the World Trade Organization (WTO) with respect to food export quotas and bans, to complement the WTO's current focus on import restrictions. WTO leadership could go a long way in preventing the kind of disruption seen in the global rice market this summer.

Buffer Stock: Proceed with Caution

There has been talk of establishing a regional rice reserve in Asia to improve market stability. This idea might have some merit but deserves study before deciding on implementation. Previous experience with public buffer stock schemes shows that they have often been disruptive rather than stabilizing, especially when they finally collapse. At this stage, it is not clear whether we know enough about the optimal operation of rice stockpiles to be sure that such initiatives are desirable on a multilateral basis. A careful study of the structure and performance of the U.S. Strategic Petroleum Reserve that emphasizes the interplay between public and private stocks and its affect on international cooperation in market stabilization would be useful. Complications due to the differentiated nature of the rice market and the challenges of multilateral control must be taken into account in considering the design and implementation of any international buffer stock.

Summary

The recent sharp rise in rice export prices has been reversed. But the experience offers a lesson we should not misinterpret or ignore. Given what market participants knew as events unfolded, there is no convincing evidence of an irrational or manipulative bubble. Nor was increased demand from India and China, either directly or indirectly via demand for animal products, a major disruptive influence. While biofuels demand was an important factor in some grain markets, its influence on recent rice market behavior seems to have been tangential at best.

The record over the last year shows the importance of greater transparency in price, production, and stock data and of a collective commitment by exporters to maintain market access when supplies are tight, stocks are low, and the market is fragile. We were lucky last summer to find that harvests turned out to be good in aggregate. Had they been a few percent lower, the export trade might have collapsed completely into autarky, threatening the food security of importing countries and the long-run interests of exporters.

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Agricultural Research, Productivity, and Food Commodity Prices

Julian M. Alston, Jason M. Beddow, and Philip G. Pardey

The long-term downward trend in real food prices reflects agricultural productivity growth fueled by public and private investments in agricultural R&D, among other things. Slower rates of agricultural productivity growth since 1990 imply a slower rate of decline in real food prices. An acceleration in agricultural R&D spending may be required to restore productivity growth rates and prevent a longer-term food price crisis.

Over the past 50 years and longer, growth in the supply of food commodities has outpaced the growth in the effective market demand, driven by substantial increases in population and per capita incomes. Consequently, the real (deflated) prices of food commodities have steadily trended down. The past increases in agricultural productivity and production, and the resulting real price trends, are attributable in large part to technological changes enabled by investments in agricultural research and development (R&D). Evidence is beginning to emerge of a slowdown in the long-term path of agricultural productivity growth. This mirrors a progressive slowing down in the growth rate of total spending on agricultural R&D and a redirection of the funds away from farm productivity that began 20–30 years ago. In this short article we document the slowdown in growth of agricultural productivity and grain yields and thus a slowdown in the long-term downward trend of real food commodity prices, and we link those developments back to shifts in funding for agricultural R&D.

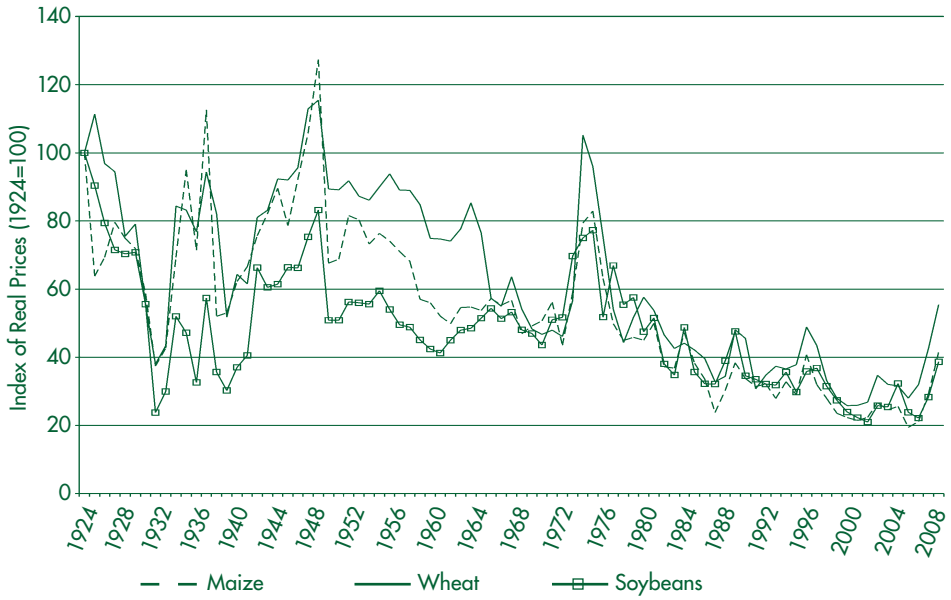
Price Trends and Their Possible Causes

Using U.S. commodity price indexes as indicators of world market prices, Figure 1 shows the price indexes for wheat, maize, and soybeans over the period 1929 to 2007, expressed in real terms by deflating by the index of prices paid by farmers. (Rice was omitted to improve the clarity of the plots. The rice prices follow a similar overall pattern to the commodity prices shown here.) In real terms, grain prices trended up generally (albeit with some major fluctuations during and after the Great Depression) from 1929 through the end of World War II, after which they trended generally down.

The period since World War II includes three distinct sub-periods. First, over the 20 years 1950–1970, prices for rice, maize, and soybeans declined relatively slowly while wheat prices declined fairly rapidly. Next, following the price spike of the early 1970s, over the years 1975–1989, prices for all four grains declined relatively rapidly. Finally, over the years 1990–2005, the rate of price decline slowed for all four grains. Toward the end of the period, but still before the onset of the recent price spike that became evident after 2005, the rate of decline of real prices slowed even more—in fact, from 2000 forward, prices increased in real terms for rice, soybeans, and wheat.

Figure 2 shows some comparable price indexes for U.S. field crops, specialty crops, and livestock products over the period 1949–2004. Panel a shows the nominal indexes, and panel b shows the same price series deflated by an index of prices paid by farmers for inputs. Real prices received by farmers for all crop categories trended down, but at different rates. Over the period 1949–2004, in real terms prices for field crops fell by 64.5 percent, prices for livestock fell by 42.7 percent, and prices for specialty crops fell by 5.3 percent

Figure 1. Real U.S. Prices of Maize, Soybeans, and Wheat, 1924–2008



Source: Compiled by the authors as described in Alston, Beddow, and Pardey (2009).

(8.6 percent for vegetables, 3.0 percent for fruits and nuts, and 0.2 percent for nursery and greenhouse products).

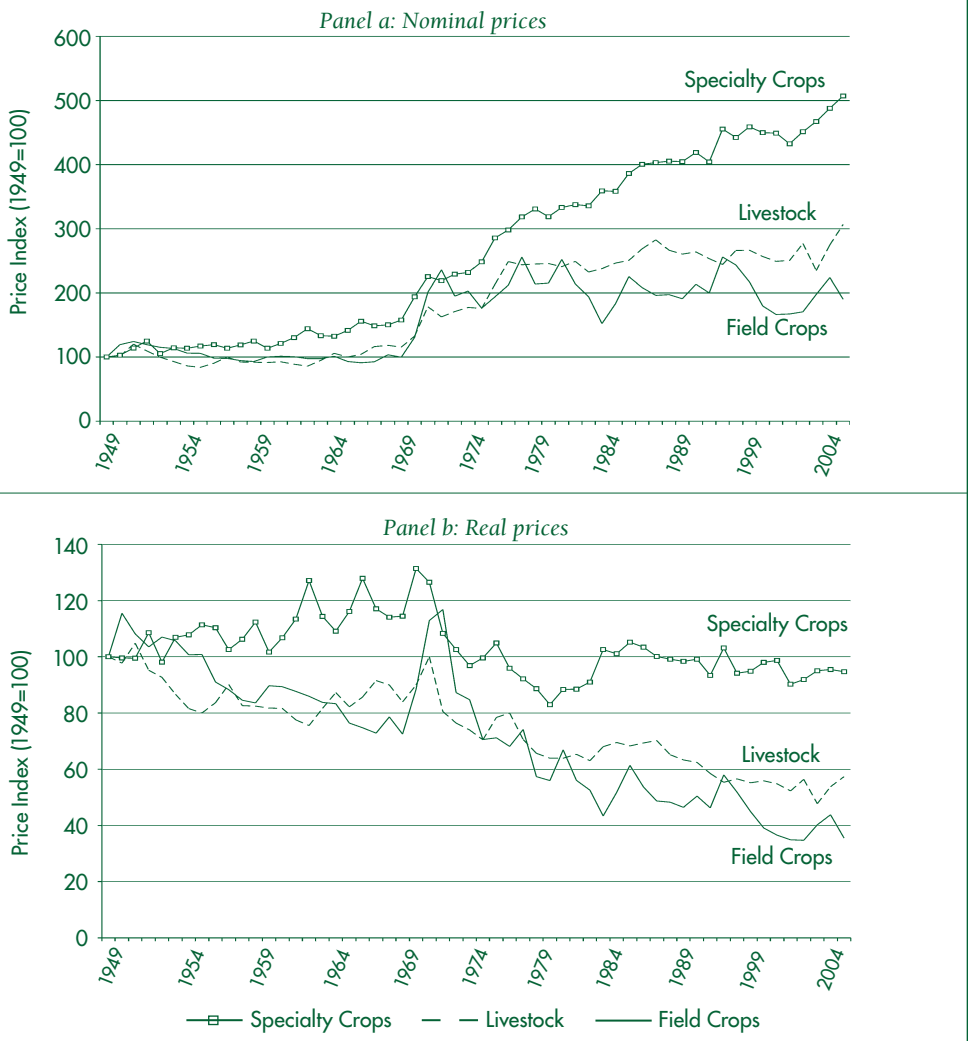
U.S. and Global Crop Yields

Various measures of agricultural productivity growth show some consistent patterns in terms of secular shifts, including indications of a recent slowdown in growth, that mirror the corresponding patterns in relative prices. Table 1 documents the remarkable growth in yields for selected U.S. crops over the long run—beginning in 1866 for wheat and corn, 1919 for rice, and 1924 for soybeans. Between 1866 and 2007 average yields of maize increased by a factor of six, while wheat yields increased by a factor of 3.5. Over the past 100 years, rice and soybean yields grew by a factor of 3.9. For all four crops, most of the yield gains occurred in the latter half of the 20th century. The annual average rates of growth for rice, wheat, and maize since 1950 were typically one to two percentage points greater than the previous longer-run rates of growth—which spanned the period 1866–1949 for wheat and maize and 1919–1949 for rice.

However, we see evidence of a slowdown in U.S. crop yield growth during the 1990s and the first decade of the 21st century. With the exception of soybeans, rates of yield growth during the 17 years, 1990–2007 were significantly below the rates that prevailed during the 40 years, 1950–1989: maize yields grew at an average rate of 1.50 percent per year over 1990–2007 compared with 2.85 percent for 1950–1889; wheat yields grew at an average rate of 0.15 percent per year during 1990–2007, compared with 1.75 percent for 1950–1989; and the rate of growth in rice yield was also substantially slower during 1990–2007 than during 1950–1989.

Table 2 reports average global yields for maize, rice, and wheat (in metric tons per harvested hectare) since 1961 (the earliest year for which global yield estimates are reported by the U.N. Food and Agriculture Organization, whence most of these data were drawn). Separate estimates of average growth rates of yields are reported for developing countries, developed countries, and the world as a whole, for two sub-periods: 1961–1989 and 1990–2006. For all three crops, in both developed and developing countries, average annual rates of yield growth were much lower in 1990–2006 than in 1961–1989. The growth of wheat yields slowed the most

Figure 2. U.S. Prices of Specialty Crops, Field Crops, and Livestock, 1949–2004



Source: Compiled by the authors as described in Alston, Beddow, and Pardey (2009).

Table 1. Rates of Growth of U.S. Average Yields for Selected Crops

Period	Crop Yield Growth			
	Maize	Wheat	Rice	Soybeans
	percent per year			
1866–2007	1.30	0.92	n/a	n/a
1900–2007[a]	1.58	1.12	1.55	1.60
1900–1949[a]	0.63	0.35	0.69	2.83
1950–2007	2.43	1.58	1.90	1.14
1950–1989	2.85	1.75	2.27	1.02
Post-1990	1.50	0.15	1.37	1.16

[a] *Rice yields start in 1919, soybeans in 1924.*
Source: Calculated by the authors as described in Alston, Beddow, and Pardey (2009).

Table 2. Rates of Growth of Global Average Yields for Selected Crops

Group	Maize		Wheat		Rice	
	1961–89	1990–06	1961–89	1990–06	1961–89	1990–06
	percent per year					
World	2.21	1.59	2.78	0.55	2.19	0.97
Developing	2.53	1.92	3.76	1.43	2.34	1.01
Developed	2.50	1.67	2.41	–0.13	0.77	0.73
Western Europe	3.65	1.74	3.25	0.86	0.33	0.53
Eastern Europe	2.62	2.45	3.29	–1.27	–0.61	3.63
North America	2.20	1.43	1.58	0.19	1.87	1.35

Source: Calculated by the authors as described in Alston, Beddow, and Pardey (2009).

and, for developed countries as a group, wheat yields actually declined over the 1990–2006 period. Global maize yields grew during 1990–2006 at an average rate of 1.59 percent per year compared with 2.21 percent per year for 1961– 1989. Likewise, rice yields grew at less than 1.0 percent per year after 1990, less than half the average growth rate for the pre-1990 period.

Land, Labor, and Multi-factor Productivity

In 2002, in aggregate terms, U.S. agriculture produced more than five times the quantity of agricultural output produced in 1910. The 1.82 percent per year increase in output over 1910–2002 was achieved with only a 0.36 percent per year increase in the total quantity of inputs. Consequently, between 1911 and 2002, U.S. agricultural land productivity (output per unit of land) increased by a factor of 4.4, labor productivity increased by a factor of 15.3 and, accounting for all measurable inputs, multi-factor productivity increased by a factor of 4.1. Impressive as the long-run productivity gains undoubtedly are, they mask a more recent slowdown in the rates of productivity increase. Prior to the 1950s, U.S. land, labor, and multi-factor productivity grew comparatively slowly (Table 3). The average rates of productivity growth picked up considerably during the subsequent four decades 1950–1989, averaging 4.11 percent per year for labor productivity, 1.88 percent per year for land productivity, and 2.11 percent per year for multi-factor productivity. A third phase, beginning in 1990 (and, in this instance, running to 2002, the last year for which our productivity estimates are currently available), saw a sharp downturn in the rates of growth of all three productivity measures. Notably, during the period 1990–2002 labor productivity and multi-factor productivity grew at half, or less than half, the corresponding rate for the period 1950–1989.

A similar slowdown is evident in global measures of land and labor productivity growth during the post-1989 period compared with the preceding three decades. Among the world's top 20 producers (according to their 2005 value of agricultural output) after setting aside the large and in many respects exceptional case of China, land and labor productivity growth slowed significantly in the post-1989 period (Table 4). Across the rest of the world (i.e., after setting aside the top 20 producing countries), on average, the slowdown is even more pronounced. For this group of countries, land productivity grew by 1.83 percent per year during the period 1961–1989 but only 0.88 percent per year thereafter; labor productivity grew by 1.08 percent per year prior to 1990 but barely budged during the period 1990–2005.

Research Spending

The increases in agricultural production and the resulting real price trends over the past 50 years and longer are attributable in large part to improvements in agricultural productivity achieved through technological changes enabled by investments in agricultural R&D. Similarly, the recent slowdown in productivity growth reflects an earlier slowdown in the growth rate of total spending on agricultural R&D and a redirection of the funds away from farm productivity. From 1951 to 2006, in inflation-adjusted terms, total U.S. public spending on agricultural research grew by 1.84 percent per year; but from 1981 to 2006, spending growth slowed to only 0.45 percent per year. Similar shifts in agricultural research spending have been observed in at least some other countries.

Worldwide, public investment in agricultural R&D increased by 35 percent in inflation-adjusted terms between 1981 and 2000—from an estimated $14.2 billion to $20.3 billion in real (year 2000) international dollars. It grew faster in less-developed countries and the developing world now accounts for about half of global public-sector spending—up from an estimated 41 percent share in 1980. However, developing countries account for only about one-third of the world's total agricultural R&D spending when private investments are included, and agricultural research intensities (expressing agricultural R&D spending as a percentage of agricultural gross domestic

Table 3. U.S Agricultural Productivity Growth Rate by Period, 1911-2002

Period	Productivity		
	Labor	Land	Multi-Factor
	percent per year		
1911–2002	3.00	1.64	1.56
1911–1949	2.38	1.42	1.24
1950–2002	3.50	1.87	1.86
1950–1989	4.11	1.88	2.11
Post-1990	1.59	1.58	1.01

Source: Alston, Anderson, James, and Pardey (2009).

product) in developing countries are generally static and remain much lower than in the developed countries.

A notable feature of the trends was the contraction in growth of support for public agricultural R&D among developed countries. While spending in the United States increased in the latter half of the 1990s, albeit more slowly than in preceding decades, public agricultural R&D was massively reduced in Japan (and also, to a lesser degree, in several European countries) towards the end of the 1990s, leading to a reduction in the rate of increase in developed-country spending as a whole for the decade. More recent data, where available, reinforce the longer-term trends. Specifically, support for publicly performed agricultural R&D among developed countries is being scaled back, or growing more slowly, and R&D agendas have drifted away from productivity gains in food staples towards concerns for the environmental effects of agriculture, food safety and other aspects of food quality, and the medical, energy, and industrial uses of agricultural commodities. Given the role of international spillovers of agricultural technology, a continuation of the recent trends in funding, policy, and markets is likely to have significant effects on the long-term productivity path for food staples in developed and developing countries alike.

Assessment

The hundreds of country-specific studies reported in the professional agricultural economics literature reveal a strong association between agricultural productivity improvements in a given year and spending on agricultural research and extension over the previous 30 years and more. We suspect that substantial shares of the slowdown in productivity growth observed during the past decade or so are attributable in significant part to a slowdown in the rate of growth in spending on agricultural R&D during the previous decade or two. The observed shifts in that research spending away from productivity-oriented research would serve to amplify the slowdown in productivity growth. Thus, the slowdown in R&D spending is likely to have contributed to the current high commodity prices, though other factors were responsible for most of the recent rapid increases. An implication of our analysis is that a restoration of the growth in spending on agricultural R&D may be necessary to prevent a longer-term food price crisis of a more enduring nature.

Table 4. Growth in Agricultural Land and Labor Productivity Worldwide, 1961–2005

	Land Productivity		Labor Productivity	
Group	1961–1989	1990–2005	1961–1989	1990–2005
Developing Countries	2.60	3.00	1.60	2.56
excl. China	2.47	2.29	1.49	1.49
Developed Countries	1.71	0.27	3.81	2.89
World	2.04	1.84	1.12	1.37
excl. China	1.93	1.20	1.23	0.42
excl. China & USSR	1.93	1.58	1.14	0.73
Top 20 Producers	2.08	2.18	1.14	1.78
excl. China	1.98	1.38	1.32	0.63
Other Producers	1.83	0.88	1.08	0.07

Source: Calculated by the authors as described in Alston, Beddow, and Pardey (2009).

For additional information, the authors recommend:

Alston, J.M., M.C. Marra, P.G. Pardey, and T.J. Wyatt. *A Meta Analysis of Rates of Return to Agricultural R&D: Ex Pede Herculem?* Washington DC: IFPRI Research Report No 113, 2000.

Alston, J.M., M.A. Andersen, J.S. James, and P.G. Pardey. "Persistence Pays: U.S. Agricultural Productivity Growth and the Benefits from Public R&D Spending." InSTePP Monograph. St Paul: University of Minnesota, 2009 (in preparation).

Alston, J.M., J. Beddow, and P.G. Pardey. "Mendel versus Malthus: Research, Productivity, and Food Prices in the Long Run." InSTePP Working Paper. St Paul: University of Minnesota, January 2009.

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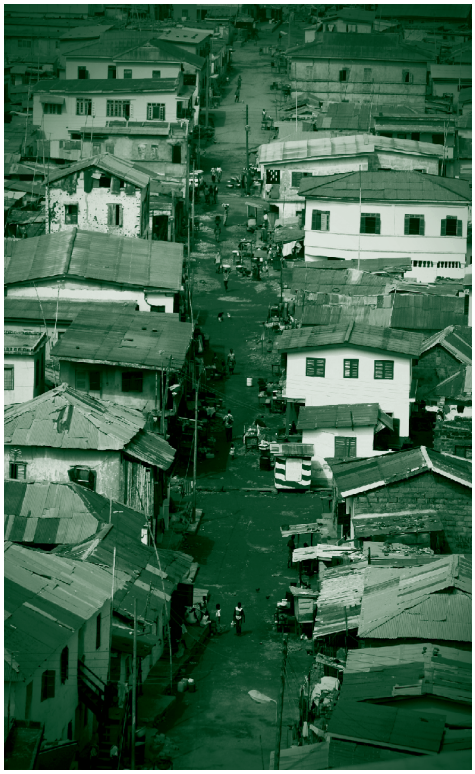
Food Prices and the Welfare of Poor Consumers

Ethan Ligon

Increases in food prices will increase the number of the world's poor and will have the greatest impact on the very poorest. But the most visible impact will not be to nutrition.



The most visible consequences of a large increase in food prices are likely to be decreases in schooling rates, health expenditures, and other similar investments as the need to purchase food—at higher prices—crowds out expenditures on other goods.

iStockphoto

How do increases in the cost of food affect the world's poor consumers? Standard demand theory tells us that there will be two important effects. First, there is a substitution effect: changes in the price of food relative to other goods will lead to a decrease in (compensated) demand for food. Second, there is an income effect: an increase in the price of food reduces the remaining budget available for purchases of all goods. This much is true for all consumers, rich and poor. But here we are guided by one of the oldest and most robust of empirical observations regarding consumer demand in economics: Engel's Law, derived from analysis of household budgets of working-class Belgians in the nineteenth century. Engel's statement of the eponymous law is sometimes translated as "The poorer the family, the greater the proportion of its total expenditure that must be devoted to the provision of food." The size of the income effect will be larger for poor consumers than for rich ones. Engel's Law is buttressed by common sense: at very low levels of income, the threat of starvation limits the consumer's ability to substitute away from food and so increases in food prices have a larger effect on poor households.

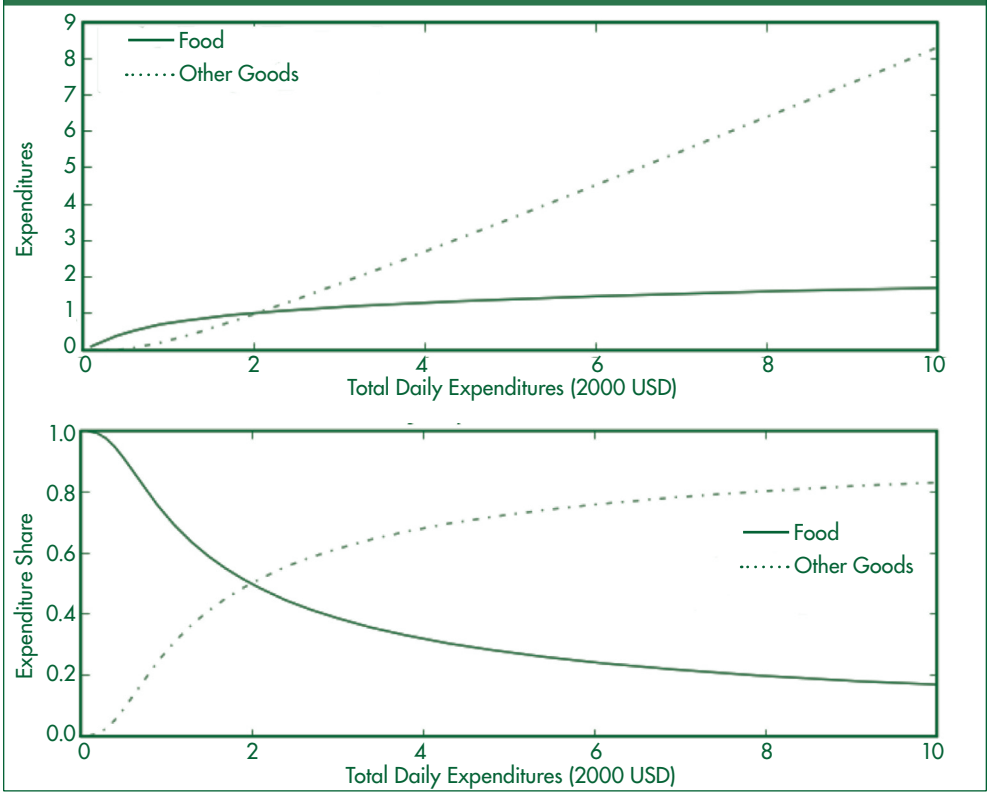
Engel noted an important corollary: the share of total expenditures devoted to food is "the best measure of the material standard of living." It follows, then, that it is the consumers with the lowest "material standard of living" that will be most harmed by an increase in food prices. This corollary goes beyond the general observation that increases in prices hurt poor households just because they are poor. Poorer households are more vulnerable to increases in food prices than they are to increases in other prices. This corollary may seem obvious, but it actually is not predicted by standard economic models, which generally assume that the budget share of food is constant.

It is not all about food! The main consequence of sharply increased prices for food staples is not that more poor people go hungry, or that we will see sharp increases in malnutrition. Indeed, nutrition may even improve—as households substitute from preferred diets to more basic foodstuffs, they may be less happy but better nourished. Instead, the main consequence of increased food prices is that poor consumers, forced to devote a larger share of their budgets to food, will have to reduce expenditures on other important things, including investments in health, education, and other nonfood items.

Modeling Consumer Behavior

To try to understand the effects of sharp increases in food prices for the welfare of the world's poor, it is useful to employ a simple economic model. The model is as standardized as possible, but must accommodate two important real-world features often missed by the simplest models. First, the share of food expenditures in the budget should fall as income increases. Second, the expenditure elasticity of food should fall below one for wealthy consumers. The expenditure elasticity can be thought of as the rate at which food expenditures increase relative to the rate at which total expenditures increase. In general, expenditure elasticities are one of the main tools that economists use to measure the way in which demand varies by wealth. In the specific case of food, it is well known that changes in the total expenditures

Figure 1. Wealth and Demand



of wealthy households result in much smaller changes in food expenditures for those same households.

I have chosen values of parameters to roughly match some features of the real world. Because we want the model to capture the fact that expenditure elasticities of food demand can vary with wealth, we use what I will term a "variable elasticity of substitution" system of demands. This system uses a slightly richer parameterization of utility functions than is usual in applied work.

A household's utility depends on its consumption of both food and nonfood goods. The approach adopted here differs from the usual approach in two ways. First, there is a (very small) subsistence level of food expenditure required to survive. Second (and much more important for the present exercise), people are assumed to be much more sensitive to variation in their food consumption than they are to variation in their consumption of other goods.

I use data on food expenditure elasticities and budget shares estimated from populations with very different levels of wealth and find values of preference parameters that allow the assumed demand system to match them. These include, on the poor end, data from rural households in the state of Maharashtra in India in 1983, estimates of food expenditure elasticities in the United Kingdom in 1983, and estimates for food shares from a large collection of poverty assessment surveys conducted by the World Bank. Choosing preference parameters to fit the different food-share expenditure elasticities reported by these sources, generates an estimate of a subsistence level of food consumption and an estimate that households are roughly four times more sensitive to variation in food consumption than they are to variation in nonfood consumption. The aim is to better model how (or whether) the poor become rich over time by making the model match data from both poor and rich populations.

I define a poor consumer as one whose expenditures on food exceed half of the total budget—at 2005 prices, a poor household has a total expenditure of less than about $2 per day, as shown in Figure 1. At such low levels of expenditure, one might suppose that there could not be a great deal of variation in the composition of budgets but, in fact, there is a great deal of variation in expenditure shares among the poor. For the very poorest (with total expenditures of pennies per day), the total share of food approaches one. But even slightly richer people have very different budgets, as expenditures on nonfood items (e.g., clothing, shelter, medicine) increase much more rapidly than do food expenditures as one crawls away from the barest subsistence.

When a consumer's expenditures fall, the shortfall will affect nonfood more than food, regardless of expenditure level. As shown in Figure 2, when a poor (less than $2 per day in expenditures) consumer suffers even a small reduction in income, there can be a very large impact on how the budget is allocated. In particular, the need for food can crowd out expenditures on other goods or investments.

A large increase in food prices would have a dramatic impact on the number of poor people worldwide. Figure 3 illustrates the effects of a 50 percent increase in food prices on expenditure shares for differently situated consumers. From the figure, we can see that an increase in food prices of this magnitude changes the level of total expenditures below which food shares are greater than one half from about $2.00 to about $2.50. Engel's corollary then suggests that, in the face of a 50 percent increase in food prices, the poverty line should also increase to $2.80. Combining this estimate with estimates of the cumulative distribution of world income indicates that this increase in food prices would yield an increase of roughly 30 percent in the total number of the world's poor.

Yet noting that there would be a 30 percent increase in the number of poor only begins to get at the consequences of such a large increase in food prices. Not

Figure 2. Expenditure Elasticities for Food

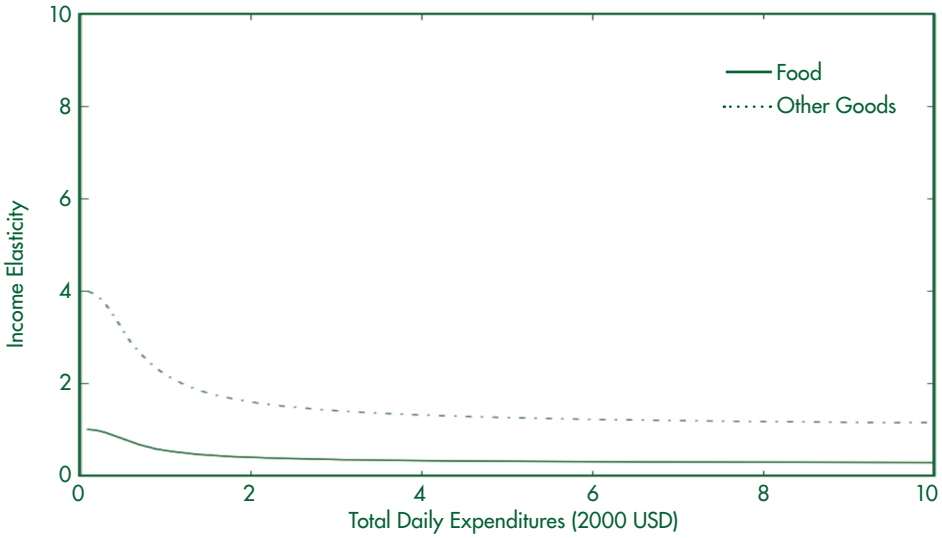
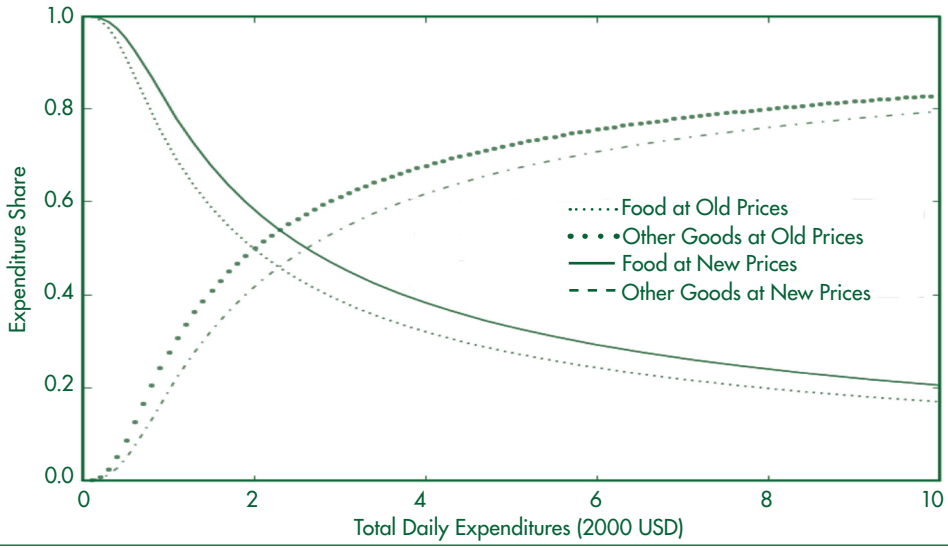


Figure 3. Consequences of a 50 Percent Food Price Increase for Expenditure Shares



only would there be many more poor, but the poorest would be most hurt. Wealthier consumers with low food expenditure shares are not much harmed by even quite large increases in food costs, but in the face of a 50 percent increase in food prices, a poor household will have to cut nonfood expenditures by more—for the poorest households, much more—than 50 percent. For example, the average rural Maharashtran household in 1983 spent 80 percent of its income on food. A 50 percent increase in food prices would cause this household to decrease its nonfood consumption by more than 80 percent and its food consumption by 44 percent.

Conclusion

Two simple facts about food demand—that the share of food expenditures in the consumer's budget falls as total expenditures increase, and that for wealthy households the expenditure elasticity of food demand is less than one—combined with estimates of household food expenditure elasticities imply enough of the structure of the demand system to draw some fairly robust conclusions about the effects of increases in food prices on poor households.

Taking a poor household to be one who spends more than half of its income on food, a 50 percent increase in food prices implies an increase in the poverty line from about $2.00 to about $2.80 and a global increase of roughly 30 percent in the total number of poor households. The poorest households, having the largest budget devoted to food, are harmed the most, and this harm is most visibly manifested not in reductions in food consumption and consequent malnutrition, but in reductions in nonfood expenditures and investments. The most visible consequences of a large increase in food prices are likely to be decreases in schooling rates, health expenditures, and other similar investments, as the need to purchase food at higher prices overwhelms the need to spend on other goods.

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Behrman, J.R. and A.B. Deolalikar. "Will Developing Country Nutrition Improve with Income? A Case Study for Rural South India." *The Journal of Political Economy* 95(3), 1987: 492–507.

Chen, S. and M. Ravallion. "Absolute Poverty Measures for the Developing World, 1981–2004." *Proceedings of the National Academy of Sciences* 104(43), 2007: 16757–16762.

Milanovic, B. "True World Income Distribution, 1988 and 1993: First Calculation Based on Household Surveys Alone." *The Economic Journal* 112(476), 2002: 51–92.

Ravallion, M., S. Chen, and P. Sangraula. "Dollar a Day Revisited." Policy Research Working Paper WPS4620, The World Bank Development Research Group, Washington DC, May 2008.

Subramanian, S. and A. Deaton. "The Demand for Food and Calories." *Journal of Political Economy* 104(1), 1996: 133.

The Global Food Crisis: Identification of the Vulnerable and Policy Responses

Alain de Janvry and Elisabeth Sadoulet

Seventy-five percent of the world poor are rural people. Half a billion of them are located in countries both vulnerable to rising food prices and with weak capacity to provide social safety nets. For them, agriculture must be the main instrument to respond to the food crisis and escape poverty.

The global food crisis has made the headlines for the last year. Governments and international organizations have shown concern and poor people have expressed discontent in the streets and in polling booths. The main symptom of the crisis has been sharply rising food prices on international commodity markets, reaching 120 percent for wheat, 140 percent for maize, and 150 percent for rice and soybean oil over the period extending from mid-2005 to mid-2008. The causes of the price increases have been extensively described, so we do not need to return to those here. We focus instead on the consequences. Because food is so important in poor people's consumption budgets, our concern has to be with (1) the impact of rising prices on vulnerable countries that have a weak capacity to protect against price increases on the international market and to organize policy responses to protect their poor, and (2) the impact within these countries on the vulnerable poor who are most exposed to price changes and least protected by policy interventions. We first characterize who these categories represent and how they are exposed to the food crisis. We then ask what has been done to respond to the food crisis, reviewing policy interventions already in place. We note that policy interventions, in spite of being extensively discussed, have been improperly defined and targeted relative to the nature of the problem to make them effective for the intended purpose. This takes us to the thesis of this paper—namely, that too much attention has been given to trade policy adjustments and targeted social safety nets and not enough to the role that agriculture can play in reducing the social costs of the food crisis, in both the short and the medium run. Agriculture has been neglected and poorly understood in the past as to what it can do for development. This neglect is among the factors contributing to the current food crisis. While the crisis has elevated concern about access to food for the poor, use of agriculture as the main instrument for policy response in the case of the most vulnerable countries and the most vulnerable people within these countries continues to be insufficient.

Uneven Pass-Through

There is no doubt that international market prices for major staple foods—wheat, rice, maize, and soybean oil—have increased sharply and are likely to remain high for the next 10–15 years in spite of the decline from peak prices in June 2008. What has been neglected is a look in greater detail at how much pass-through there has been from international to domestic retail prices. This is important because some countries have in fact been able to shelter their domestic markets from international commodity prices, avoiding a food crisis, while others have borne the full brunt of rising prices.

As an example of uneven transmission, we show in Figure 1 real border prices and real consumer prices for rice in Burkina Faso and India. We see strong pass-through in the first case but very limited in the second. In general, among importing countries, high- and middle-income countries have had more capacity to restrain pass-through than poor countries. This gives a sense that some countries are more vulnerable to international price movements than others.

The Vulnerable Countries

Countries are more vulnerable to rising international food prices if they meet three criteria:

1. High food dependency as measured by the share of cereal imports in total cereal consumption.
2. High food import burdens as measured by the share of cereal imports in total imports.
3. Low income as measured by a gross national income (GNI) per capita in 2006 of less than $905 or lower-middle-income with a GNI per capita between $906 and $3,595. With low income comes weaker policy, fiscal, and administrative capacities to respond to a crisis.

Countries are classified according to these criteria in Table 1. It shows that most of the poor vulnerable countries are in Sub-Saharan Africa and Central Asia, but also include Haiti, Mongolia, Papua New Guinea, Bangladesh, and Yemen. Together, these countries account for 900 million people, a rural population of 630 million representing 70 percent of the total population, a rural poverty rate of 84 percent with a $2 per day poverty line, and a poor rural population of 530 million representing 73 percent of the total number of poor. For countries for which data are available, fiscal revenues are very weak,

accounting for only 15 percent of GDP. Foreign aid is very important, accounting on average for 70 percent of central government expenditures. Policy space to reduce tariffs on imported foods is very limited, with a nominal rate of taxation on the order of only 10 percent for agriculture-based countries in the World Bank's World Development Report (WDR) for 2008. Reducing import tariffs on food is a nearly insignificant policy instrument in the face of price increases on the order of 150 percent.

The message here is that a very large number of world poor are located in countries vulnerable to international food price shocks. These countries have very little policy space to manipulate domestic prices. As a consequence, price transmission is high. They also have very limited fiscal and administrative capacity with which to organize safety nets to protect their poor from rising food prices. An overwhelming majority of these poor are rural and are the poorest of the poor. It is that population that should be of concern in organizing responses to the food crisis.

The Vulnerable Poor

Poor rural people can be landed or not, and if landed, they can be net sellers or net buyers of food. Poor smallholders who are net buyers will lose from a rise in the price of food. How many of the country's total poor are in that category? The answer is a surprisingly large percentage. We show in Table 2 data for two vulnerable low-income countries (Ethiopia and Bangladesh), two vulnerable lower-middle-income countries (Bolivia and Guatemala), and two nonvulnerable low-income countries (India and Vietnam). They show that smallholders tend to be a majority of a country's poor. They also show that a large share of these poor smallholders tend to be net buyers of food. In Bangladesh, for example, 80 percent of the poor are smallholders and 62

Figure 1. Price Transmission in Burkina Faso and India

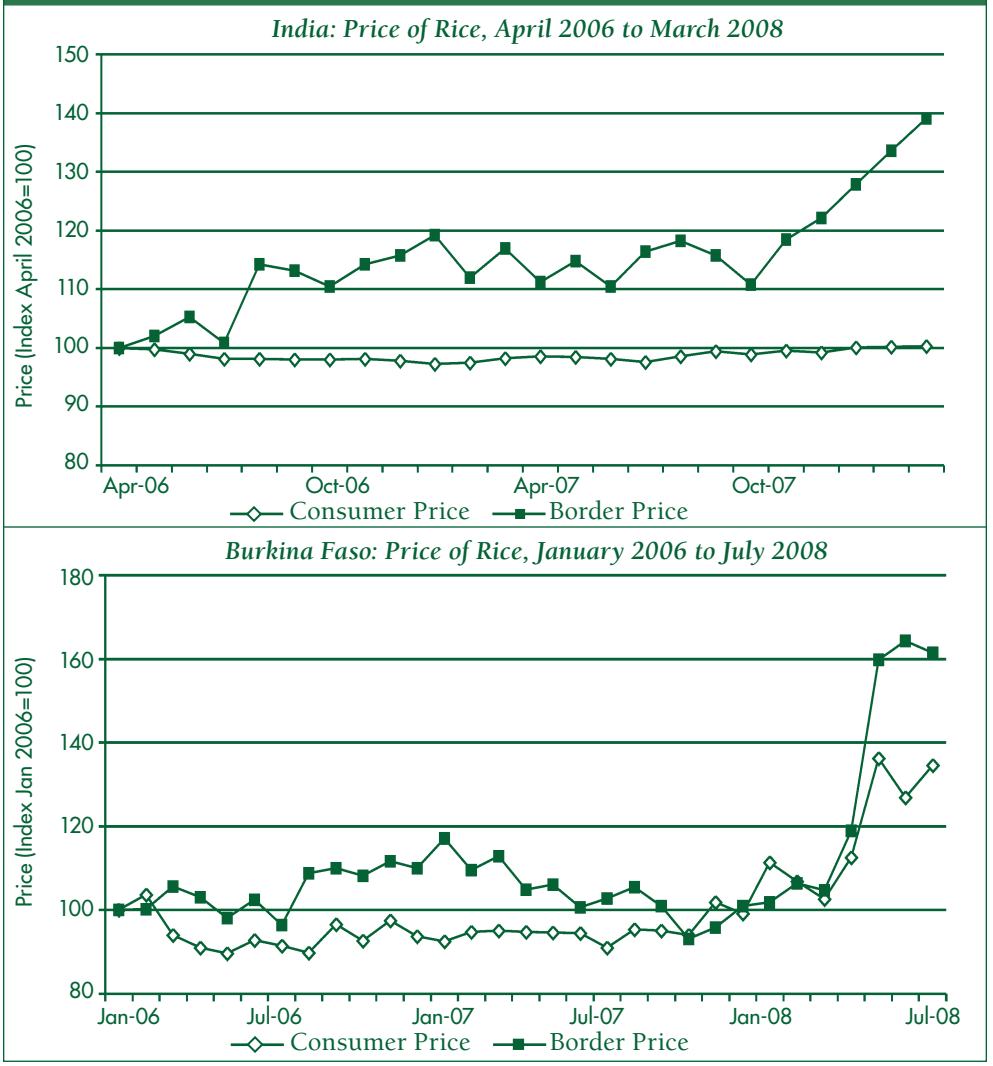

Table 1. Countries Vulnerable to an International Food Price Shock

Food Dependency	Food Import Burden			
Cereal Imports/Cereal Consumption	Cereal Imports/ Total Imports	Vulnerability to Food Crisis	Low-Income Countries (GNI per capita, in 2006 < $905)	Lower-Middle-Income Countries (GNI per capita, in 2006 $906–$3,595)
High	High	Most vulnerable	CongoDR, Cote d'Ivoire, Eritrea, Gambia, Guinea-Bissau, Haiti, Liberia, Mauritania, Mongolia, Papua New Guinea, Senegal, Tajikistan	Azerbajian, Egypt, Jamaica, Morocco, Peru, Swaziland, Tunisia
Low	High	Highly vulnerable	Afghanistan, Bangladesh, Benin, Burkina Faso, Burundi, Central Africa Rep, Ethiopia, Ghana, Guinea, Kenya, Kyrgyzstan, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Sierra Leone, Sudan, Tanzania, Togo, Uganda, Uzbekistan, Yemen, Zambia, Zimbabwe	Bhutan, Bolivia, Cameroon, Sri Lanka, Suriname, Syria
High	Low	Somewhat vulnerable	Somalia, Timor, Yemen	Angola, Cuba, Dominican Rep, El Salvador, Guatemala, Honduras, Jordan, Namibia

Table 2. Households Vulnerable to a Domestic Food Price Shock						
	Bolivia	Guatemala	Ethiopia	Bangladesh	India	Vietnam
Share of Smallholders in Total Poor (%)	60	48	64	80	81	88
Share of Net Buyers Among Poor Smallholders (%)	67	93	44	62	62	51

percent of the poor smallholders are net buyers of food. In the end, poor net-buyer smallholders thus represent 50 percent of the country's poor. They are poorer among the poor, as they are a higher share of the poor on the basis of a $1 rather than a $2 poverty line.

Policy Responses

Policy responses follow three lines of action: use policy instruments to reduce consumer prices, set up safety nets to provide access to cheap food to the targeted poor, and/or focus on supply response in agriculture. These three types of interventions are the instruments used by the World Bank in its Global Food Crisis Response Program (Table 3).

1. Price policy to reduce consumer prices

Vulnerable countries are net importers. Policy instruments that allow for them to manipulate domestic food prices include reducing import tariffs and introducing food price subsidies. These instruments are basically ineffective. Tariffs that remain after years of pressure to liberalize trade are already very low and they do not have the fiscal resources necessary to subsidize food.

Because of weak fiscality, import tariffs are an important contribution to government tax revenues. For this reason, the World Bank's Global Food Crisis Response Program has focused on compensating governments for the loss of fiscal revenues when lowering tariffs on imported foods. As can be seen in Table 3, 32 percent of the participating countries receive this type of assistance. This is important to help governments maintain their expenditure programs. However, it can make only a marginal contribution to reducing the impact of the food crisis on the poor via lower prices for main staple foods.

2. Access to food: safety net programs

Middle-income countries such as Mexico and Brazil and low-income countries with strong administrative capacity such as India can organize extensive safety net programs to provide the poor with access to food. This can take the form of targeted food subsidies, targeted cash transfers, food-for-work or workfare programs, and targeted conditional cash transfers. These programs require not only fiscal resources but also strong administrative capacity, which is usually missing in low-income vulnerable countries. In such countries, safety net programs are implementable mainly in the urban environment or for children through schools, an institution already in place. Yet the majority of the poor are rural and hard to reach through these programs.

The main policy instrument used under the Global Food Response Program is to help countries introduce safety nets for those affected by the food crisis, with 68 percent of participating countries following this approach (Table 3). For the rural poor, school feeding programs are relatively easy to administer and make very important contributions in reducing the educational and health irreversibilities of a price shock on children. At the same time, they are not reaching the majority of the poor, especially those who are rural smallholders.

3. Supply response in agriculture

Given who the poor are in vulnerable countries—mainly rural people, a majority of them landed, even if endowed with only a small plot of land—and given the weakness of the policy instruments that would be effective in middle- and high-income countries to respond to the food crisis (lowering the price of food and establishing safety net programs), agriculture has to be the main instrument for a response in vulnerable countries and for vulnerable people. In a sense, the fact that the poor are so close to the land in these countries creates an opportunity to use agriculture effectively for that purpose. Two types of responses are available: (1) short-run next harvest responses that aim to reduce the gap in land productivity for smallholders who depend heavily on home production for family consumption, and (2) medium-run responses that restore the role of agriculture on development and succeed in bringing a Green Revolution to Africa, specific to its own conditions, as argued in the WDR 2008. Both require attention that agriculture has not received and more effective approaches than those used in the past. We take each in turn.

"Next Harvest" Food Security Programs

Simulations of the impact of rising food prices for India and Guatemala show that, among all of the poor suffering from the food crisis, smallholders represent as much as 82 percent of the total in India and 57 percent in Guatemala. These are smallholder farmers who have access to land yet must buy on the market to cover shortfalls in production relative to consumption. They lose from rising food prices, but have the capacity to respond by producing more for home consumption. Inspection of the levels of gross output per hectare they generate on the plots of land they control shows large gaps relative to potential. In Guatemala, for instance, gross production per hectare of farmers losing from the food crisis is about 30 percent of those gaining from the food crisis at equality of farm size. The expectation is that this is

due to very low levels of input use, especially new seeds and chemical fertilizers, among subsistence-oriented farmers.

A "next harvest" food security program would aim to reduce the land productivity gap in subsistence farming. For this, it would address the market failures that affect subsistence farmers, particularly in accessing seeds, fertilizers, and basic tools. It would offer subsidies for these inputs through vouchers redeemable in the private agro-dealer sector. It would complement access to these inputs with technical assistance provided by Non-Governmental Organizations (NGOs) that understand subsistence agriculture. These farming systems are quite different from more market-oriented agriculture as they are based on the principles of low external input use, diversity of crops and activities, and resilience to shocks to ensure food security. They take the form of the "milpa" in Mexico and the "conuco" in the Dominican Republic. Few extensionists in the public sector understand this type of agriculture, and it has been largely shunned by formal research institutions. Input subsidies are viewed with suspicion by most donors because they have so frequently been mismanaged and abused. Improving land productivity in subsistence farming is a road to production of a marketed surplus, adding to cash income. Diversification on the basis of comparative advantage, toward high-value crops and animal/fish activities in particular, can subsequently help increase monetary incomes. Improved production for home consumption is thus both a solution to the food crisis for the rural poor and a pathway out of poverty based on competitive smallholder farming.

The calculus of subsidies should not be made in terms of the opportunity cost of resources in alternative sources of growth, but in terms of the opportunity cost of providing food security to these households. The fact that they have access to plots of land and generally sub-utilized family labor likely makes it cheaper than approaches based on price subsidies or safety nets.

Table 3. Global Food Crisis Response Program in Low & Lower Middle-Income Countries

Number of Countries	Program Amount (million US$)	Number of Interventions			
		Price Policy	Safety Nets	Agriculture Short Run	Agriculture Medium Run
31	581	10	21	14	12

Agriculture for Development

In the medium run, agriculture has to be the anchor for the food security of the rural poor. Yet we should recall that agriculture has been badly neglected by governments and international donors over the last 25 years, in part precipitating the current food crisis. The share of agriculture in public expenditures in most Sub-Saharan African countries is on the order of 4 percent compared to the 10 percent provided by the New Partnership for African Development (www.nepad.org) objective. Overseas development assistance going to agriculture has fallen from 12 percent in 1990 to some 4 percent today, in spite of a non-declining 75 percent of world poverty remaining rural.

Will the alarm bell of the food crisis be sufficient to restore interest in using agriculture for development and, in so doing, address the food crisis and avoid the recurrence of such incidents? For Sub-Saharan Africa in particular, this requires engineering a unique Green Revolution able to significantly increase productivity in agriculture. Success will require: (1) developing participatory national agendas that strategically position agriculture in relation to the specificity of local opportunities and constraints; (2) reversing the neglect of agriculture by governments and donors; (3) adapting the Green Revolution methodology to the conditions of Africa characterized by heterogeneity, multiple constraints, small countries, and severe resource constraints; and (4) extending the Green Revolution beyond staple foods toward high-value crops and the rural nonfarm economy. It will be important to approach the problem as an opportunity to innovate and learn, not as a blueprint that can be drafted and implemented.

Conclusion

The world food crisis was man-made and it requires a broad effort to be overcome and avoided in the future. Given the nature of world poverty, the main solution to the food crisis for the most vulnerable countries and the most vulnerable people has to come from agriculture, both through short- and medium-run responses. For this to happen, serious efforts must be made on four fronts:

1. Increase awareness of what agriculture can do to reduce hunger and poverty.
2. Identify options for effective investments in agriculture-based projects.
3. Develop capacities in using agriculture for development at the individual, collective, national, and international level.
4. Mobilize political support to elevate agriculture in government and donor priorities.

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For futher reading, the authors recommend the following sources:

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

World Bank. Commodity Markets Review. November 12. Washington DC: DECPG, The World Bank, 2008.

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