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Causes of High Food Prices

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Abstract

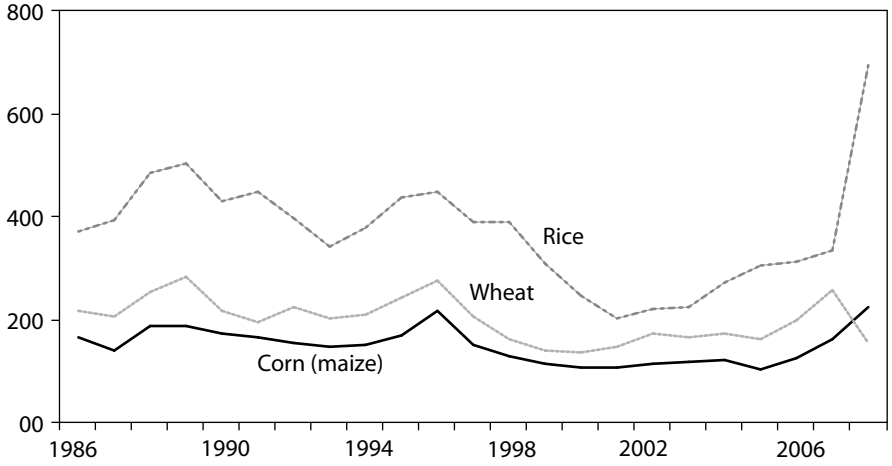
Since mid-2007 basic food prices have rocketed with disastrous consequences for poor consumers. The spike in international market prices through the first half of 2008 has now subsided. Still prices of rice, wheat, corn (maize), and edible oils remain well above the levels of just a year ago and are likely to remain elevated and volatile for years to come. Two separate dynamics need to be understood in order for countries to make necessary adjustments. A gradual rise in food prices has been under way since at least 2004 with three general and fundamental factors at work: rapid economic growth in the People's Republic of China and India especially put upward pressure on prices as demand simply outpaced supply; a sustained decline in the United States dollar since mid-decade added to the pressures on dollar-denominated international market prices; and a combination of high and rising fuel prices coupled with legislative mandates to increase production of biofuels has established a firm link between petroleum prices and food prices. The causes of price spikes are crop-specific. Drought and disease in 2007 caused wheat prices to jump, and supplies of edible oil were reduced as farmers in the United States shifted acreage out of soybeans into corn for nonfood uses (ethanol). Rice is the clearest example of crop-specific causes—the price spike was driven by export bans that were aimed at helping contain domestic food price inflation in exporting countries, but had the unintended effect of setting off panic as supplies to the already thin world rice market were sharply reduced. Asia will need several years of good rice harvests in order to stabilize the situation and reduce the exposure of the poor to another shock in food prices. This will not be easy to achieve as input costs are driven higher by high energy prices. Thus, it seems unlikely that world food prices will return to the declining trend seen between the mid-1970s and the first few years of this century.

I. Introduction

Are food grain prices high? The answer depends on the commodity, the period of comparison, and whether the prices are in nominal or real terms. Even from the perspective of just two decades, deflated prices are not exceptionally high for corn (maize) and wheat—only rice seems to be going off the top end of the scale (Figure 1).

Figure 1: Short-Run Movements in Real Prices of World Grains

($ per metric ton)

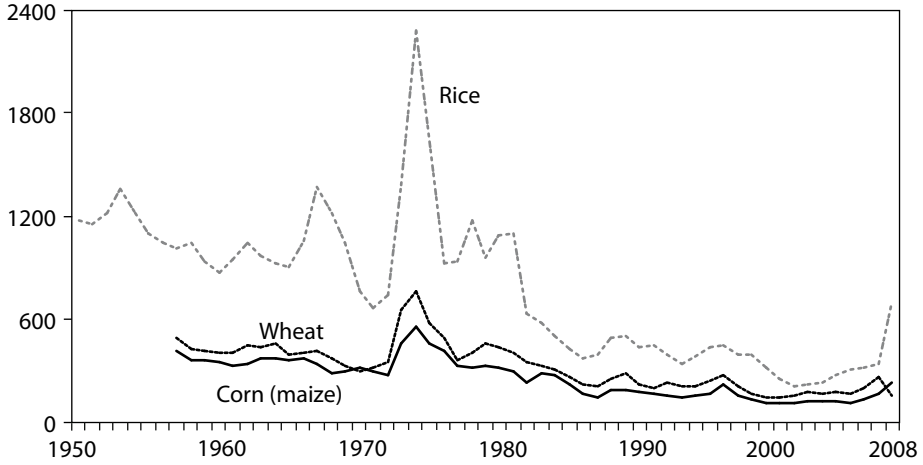


Note: 2008 represents data for the first 5 months. The world prices of corn (maize), rice, and wheat are based on US No. 2 Yellow, free on board Gulf of Mexico; Thailand white milled 5% broken, free on board Bangkok; and No. 1 Hard Red Winter, ordinary protein, free on board Gulf of Mexico, respectively. Prices were deflated by the US consumer price index, with 2007 prices as the base.

Source: International Monetary Fund website (imf.org/external/np/res/commod/index.asp), downloaded 15 August 2008.

A longer-run view, from 1950 to the present, is even more surprising. Price trends over more than half a century reveal that even the highest price levels experienced in 2007 and 2008 are substantially below the peaks in the previous world food crisis in 1973–1974. Indeed, real prices in mid-2008 for corn, wheat, and rice remain well below what was considered “normal” until the full impact of the green revolution was felt after 1980 (Figure 2).

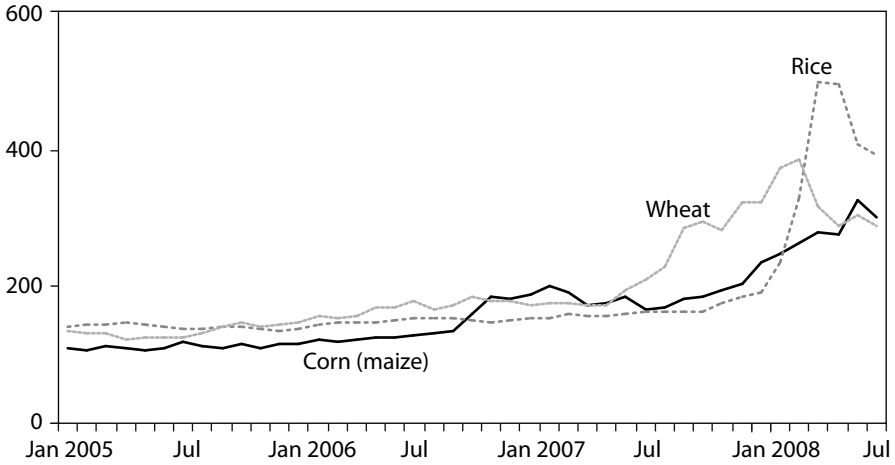
Figure 2: Long-Run Movements in Real Prices of World Grains
($ per metric ton)



Note: 2008 represents data for the first 5 months. The world prices of corn (maize), rice, and wheat are based on US No. 2 Yellow, free on board Gulf of Mexico; Thailand white milled 5% broken, free on board Bangkok; and No. 1 Hard Red Winter, ordinary protein, free on board Gulf of Mexico, respectively. Prices were deflated by the US consumer price index, with 2007 prices as the base.
Source: International Monetary Fund website (imf.org/external/np/res/commod/index.asp), downloaded 15 August 2008.

But most policy makers, consumers, and producers have shorter memories than implied by Figure 2. Recent price movements have been very sharp and disruptive, with an especially heavy impact on poor consumers and low-income food-importing countries. Rapid increases in food prices are adding to inflationary pressures in most of developing Asia, bringing into prospect monetary tightening and slower economic growth. After several decades of stability in world grain markets, and even steady price declines, the world looks very different in mid-2008 (Figure 3). Scarcity is back, hunger is growing, and rapid economic growth is threatened (ADB 2008b). These are difficult times.

Figure 3: Grain Price Indexes
(2000 = 100)



Note: The world prices of corn (maize), rice, and wheat are based on US No. 2 Yellow, free on board Gulf of Mexico; Thailand white milled 5% broken, free on board Bangkok; and No. 1 Hard Red Winter, ordinary protein, free on board Gulf of Mexico, respectively.
Source: International Monetary Fund, *International Financial Statistics* online, downloaded 15 August 2008.

These high food prices have attracted a great deal of attention in policy, media, and academic circles. The run-up in corn prices since mid-2007 has fueled a sharp debate over the ethanol subsidy program in the United States (US). High vegetable oil prices have raised similar questions over biodiesel mandates in Europe. High wheat and rice prices may significantly undermine the gains in poverty reduction in the past two decades. The world community has mobilized new resources to feed the poor, including a doubling of the budget for the World Food Program, from $3 billion a year to over $6 billion for 2008.

A combination of decent weather in most growing regions, vigorous response from farmers, and announcement of a small but timely release in May of imported rice stocks by Japan seem to have stopped the price panics seen early in 2008.[1] Market psychology has clearly turned negative (and Viet Nam has aggressively cut export prices for rice in an effort to regain market share from Thailand). But price levels remain well above long-run trends and significant micro- and macroeconomic adjustments are in the works. To understand these adjustments and to assess their impact, it is necessary to understand the causes of high food prices and their likely duration. That is the purpose of this paper.

The new price environment has now existed long enough to move beyond journalistic coverage (some of it quite insightful) and to have generated a preliminary flow of analysis and policy perspectives. These range from thoughtful essays that reflect on previous world food crises and the distinguishing features of this one (Naylor and Falcon 2008), to urgent appeals to ramp up food aid funding and support for agricultural research (von Braun 2008). The most useful and balanced assessment appeared in the Farm Foundation Issue Report (FFIR) in July 2008. Authored by three distinguished agricultural economists based at Purdue University, the report concludes that falling grain stocks since 2000 have gradually changed world commodity markets from surplus to deficit and have provided the supply–demand fundamentals for sharply higher prices (Abbot, Hurt, and Tyner 2008).

These changing fundamentals can be seen in an especially compelling way when one compares rates of population growth in Asia with rates of growth in rice yields (Figure 4). The green revolution produced a surge in rice production and rice surpluses, but the rate of growth has been on a falling trend for the last two decades.

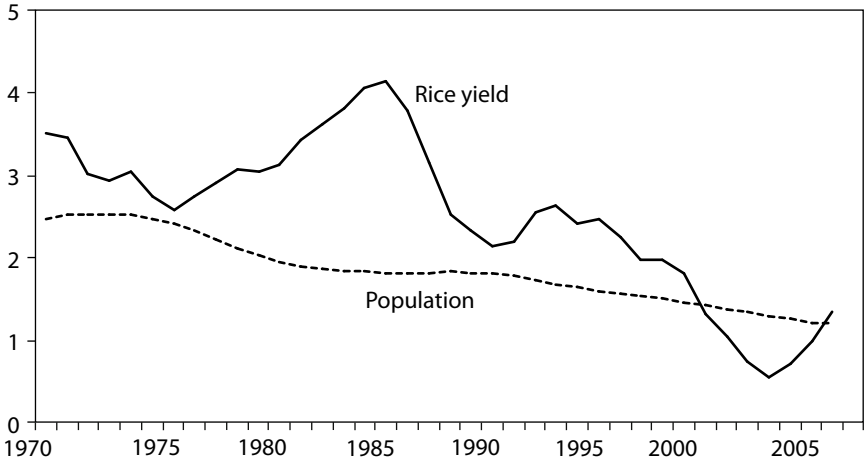
The trigger for the higher prices depends on individual commodities, but significant depreciation of the US dollar, high oil prices, and demand for biofuels have been the main drivers, although even these basic forces are interrelated. Because the FFIR covers the drivers of high food prices in detail, from both a macroeconomic and a commodity-specific perspective, it provides the basic foundation for the more specialized analysis here

[1] Interestingly, as of end-August, the rice had not actually been shipped from Japan to the Philippines, although the Japanese Ministry of Agriculture, Forestry, and Fisheries insists that it will be when all the details are agreed to by the Philippines. Obviously, what was important to the market in May was the signal that additional supplies would become available, at which point market psychology reversed.

(Abbot, Hurt, and Tyner 2008). In particular, the FFIR stresses the distinction between short- and long-term responses of supply and demand to a new price environment, and the pervasive impact of changes in exchange rates on commodity prices. Both these factors are investigated in some detail in this paper.

Figure 4: Growth of Rice Yield and Population

(percent)



Note: Growth is calculated using successive rolling 5-year period data on rice yield and population in 24 rice-producing developing Asian economies. For example, growth for 1970 is the change between 1966–1970 and 1961–1965.

Sources: Food and Agriculture Organization of the United Nations Statistics (FAOSTAT) website (faostat.fao.org/site/291/default.aspx); *World Development Indicators* online, both downloaded 3 September 2008.

A major policy issue has been the extent to which "outside" financial speculation—by pension and hedge funds, or newly created commodity index funds available to small investors—has been driving up prices for key staple foods (and petroleum). India, for example, has banned futures trading in important food staples. Nearly all economists and market analysts agree that financial speculation cannot drive up prices in the long run—over a decade or longer. Only the fundamentals of supply and demand can do that.

But there is much more controversy over the role of new speculative activity on price formation in the short run, and especially the potential for such speculation to create "spikes" in prices, or bubbles, that disconnect the market price from underlying fundamentals (OECD 2008). It is very difficult to explain the creation of such spikes across a wide range of commodities without a significant role for financial speculation based on expectations of higher prices. Indeed, the sharp sell-off in many commodity markets since mid-July 2008 has convinced many doubters that financial speculation played a significant role in the rapid price run-ups seen since mid-2007. This paper also brings to bear new empirical analysis that sheds light on this role.

The key results are as follows. First, the distinction between short-run responses of supply and demand to price changes and longer-run responses is crucial. This is a result familiar to agricultural economists, who have used Nerlovian-type distributed lag models of farmer and consumer behavior for half a century (Nerlove 1958). A simple model developed here that captures this distinction suggests that much of the recent gradual increase in the prices of food commodities—from 2002 to 2007—is a direct result of sharply declining prices a decade ago. We are paying a high price, literally, for the destocking of grains since the mid-1990s, a process that pushed down prices (see Appendix 1).

Simultaneously, this destocking was a rational response to falling grain prices. The simultaneity between stock levels and price expectations—emphasized in the theory of the supply of storage (Brennan 1958, Williams and Wright 1991)—is another neglected aspect of most analyses of current high food prices (see Appendix 2). Considerable insight comes from remedying that neglect, simply by recognizing that in market economies, stock changes do not happen "exogenously" from price formation.

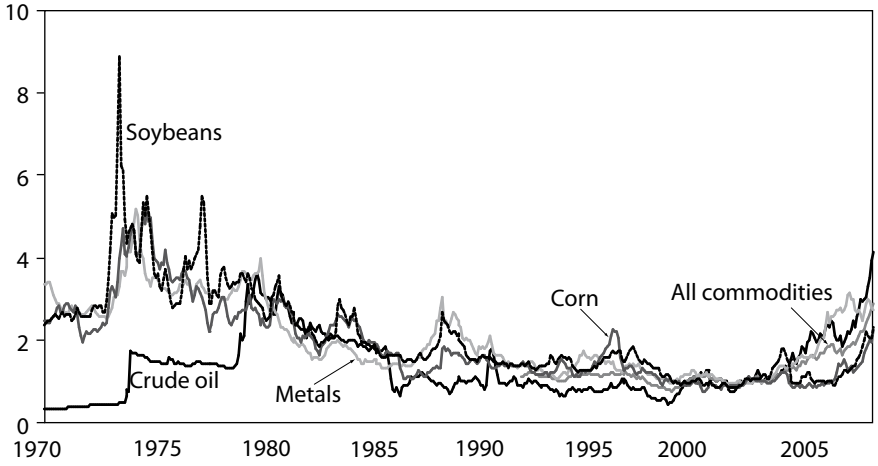
Second, the pervasive impact of exchange rates on commodity prices is confirmed even in the very short run (a result compatible with the FFIR perspective but additional to it). It is important to remember, as the report stresses, that exchange rates are financial variables conditioned by their macroeconomic and trade context. Almost inherently, then, commodity prices will be linked to financial markets, even in the long run (Frankel 2006). Price formation in organized commodity markets depends on financial factors as well as "real" supply and demand factors.

Finally, the short-run price linkages among exchange rates, oil prices, and the prices of important food commodities are tested with Granger causality techniques (see Appendix 3). These linkages are almost certainly driven by the intermediation of financial markets, i.e., speculators engaged in commodity futures (and other derivatives) markets who have no physical connection to the commodity businesses themselves. These results provide tantalizing, but preliminary, evidence of the role of financial speculation in short-run price behavior, but the role is not nearly as uniform and pervasive as most critics seem to think. Speculative pressures come and go, for reasons not yet apparent from the data. Understanding these reasons—which are perhaps no more than "animal spirits"—is the next goal of the research reported here. Any progress in such understanding will move the discussion forward a great deal.

II. What has Caused Commodity Prices to Increase since 2000?

When compared with the long-run decline in most commodity prices visible in Figure 5, the run-up in prices since 2000 appears to be a reversal of historical trends. The timing of the rise varies by commodity, so some commodity-specific stories will be needed to explain the patterns. But there seem to be common elements to the rise as well. This section will attempt to assess the role both of the general drivers and of the commodity-specific dimensions of the commodity price boom. A formal model is developed in Appendix 1 that attempts to illustrate how the general drivers and commodity-specific dimensions of price formation are related.

Figure 5: Long-Run Real Commodity Price Movements since 1970 (2002 = 1)

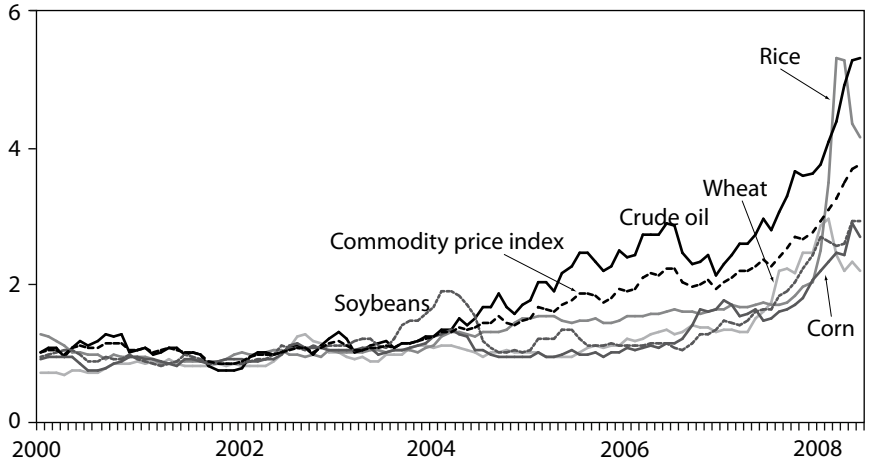


Note: The commodity price index includes both fuel and nonfuel price indices. The oil price index is the simple average of the spot prices of dated Brent, West Texas Intermediate, and Dubai. Corn (maize) and soybeans, respectively, refer to US No. 2 Yellow, free on board Gulf of Mexico; and US No. 2 yellow, Chicago Soybean futures contract (first contract forward). The metals price index comprises copper, aluminum, iron ore, tin, nickel, zinc, lead, and uranium price indexes. Prices were deflated using the US consumer price index, with 2000 prices as the base.

Source: International Monetary Fund, *International Financial Statistics* online, downloaded 1 September 2008.

The general patterns since 2000 are clear enough in Figure 6. From 2000 to 2004 all the tracked commodities moved more or less in tandem, and by relatively small amounts. Soybean prices spurted in 2004 after production problems in the US, but returned to normal levels in 2005. From then until early 2007 prices of wheat, corn, and soybeans remained flat, but rice prices had already started a steady rise from their historical low in 2001. Crude oil prices and metals—which together make up a large share of the International Monetary Fund commodity price index—had also started a steady rise by 2004. Clearly, by the mid-2000s, commodity prices were beginning to show signs of life not seen for a decade. Something had changed.

Figure 6: Short-Run Nominal Commodity Price Movements since 2000
(2002 = 1)



Note: The commodity price index includes both fuel and nonfuel price indices. The oil price index is the simple average of the spot prices of dated Brent, West Texas Intermediate, and Dubai. The bases for the price of maize, rice, soybeans, and wheat, respectively, are as follows: US No. 2 Yellow, free on board Gulf of Mexico; Thailand white milled 5% broken, free on board Bangkok; US No. 2 yellow, Chicago Soybean futures contract (first contract forward); and No. 1 Hard Red Winter, ordinary protein, free on board Gulf of Mexico.

Source: International Monetary Fund, *International Financial Statistics* online, downloaded 29 August 2008.

The change is most apparent in crude oil and the metals-heavy International Monetary Fund index. Food staples, except rice, remained stable until 2007. Such a pattern is best explained by the accelerating demands for industrial raw materials and energy as the economies of the People's Republic of China (PRC) and India consolidated their momentum of very rapid growth after the turn of the millennium. As the authors of FFIR point out, however, the PRC and India are not large factors in global grain markets, and their rapid economic growth did not spill over directly into higher prices for wheat, corn, and soybeans. The rising prices for rice need a special explanation, detailed below. By 2006, however, it was clear that rapid growth in the developing world, especially the PRC and India, could move global commodity markets. This realization set the stage for new expectations among commodity traders in particular and the broader investment community in general. By 2006, expectations of higher commodity prices were well established.

A. Layers of Causation

It is useful to think about the factors causing high food prices in terms of cumulative layers of causation (Timmer 2008a). Five basic drivers seem to be stimulating rapid growth in demand for food commodities:

(i) Rising living standards in PRC, India, and other rapidly growing developing countries lead to increased demand for improved diets, especially greater consumption of vegetable oils and livestock products (and the feedstuffs to produce them). The PRC is a major importer of soybeans for both meal and oil and India is a significant importer of vegetable oils. However, wheat and rice consumption in the PRC and India are not rising significantly and both countries are largely self-sufficient in both commodities.

(ii) The rapid depreciation of the dollar against the euro and some other important currencies drives up the price of commodities quoted in dollars for both supply and demand reasons (see below). The depreciation of the dollar also causes investors "long" in dollars (i.e., most US-based investors, but holders of dollars globally as well) to seek hedges against this loss of value, with commodities being one attractive option.

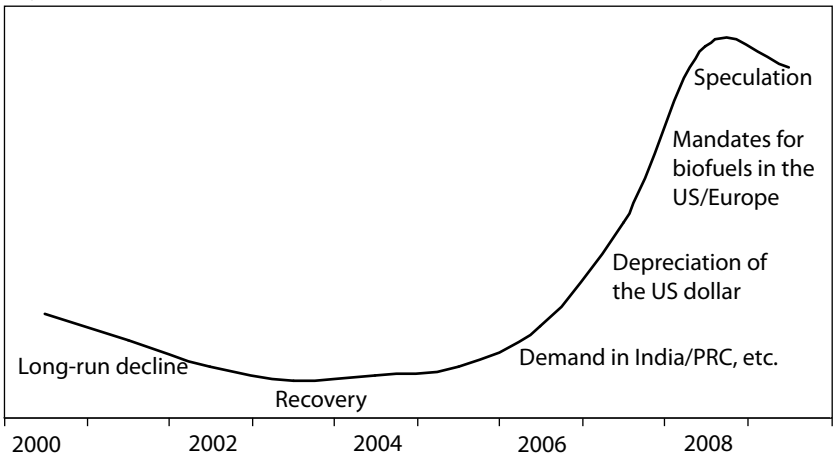
(iii) Mandates for corn-based ethanol in the US (and biodiesel fuels from vegetable oils in Europe) cause ripple effects beyond the corn economy, which are stimulated by inter-commodity linkages (Naylor et al. 2007; Timmer, Falcon, and Pearson 1983). There is active debate about whether legislative mandates or high oil prices are driving investments in biofuel capacity (Abbot, Hurt, and Tyner 2008), but no doubt about the increasing quantities of corn and vegetable oil being used as biofuel feedstocks (Elliott 2008).

(iv) Massive speculation from new financial players searching for better returns than in stocks or real estate has flooded into commodity markets. The economics and finance communities are unable to say with any confidence what the price impact of this speculation has been, but virtually all of it has been a bet on higher prices.

(v) Underneath all these demand drivers is the high price of petroleum and other fossil fuels.

Figure 7 provides a graphical representation of how the first four factors listed above have contributed to the recent escalation in food prices. The figure also illustrates the tail end of the long-run declining trend in prices that prevailed over the last 200 years or so. A moderate recovery from the trough earlier in this decade was motivated by long-run demand and supply responses to the protracted period of falling prices (i.e., a huge expansion in demand and limited additions in supply in reaction to declining prices gradually bid prices back up again; see Appendix 1). Nevertheless, the sharp acceleration in food prices generally began in late 2006, but the appeal of food commodities to speculative investors seems to have begun only toward the middle of 2007 (Timmer 2008a).

Figure 7: Factors Contributing to Food Price Formation since 2000



Source: Based on Timmer (2008a).

Each of the four demand-driven causes is a little different for each basic commodity, but the "structural" forces—rapid demand growth in developing countries and depreciation of the dollar—are similar for all the commodities of interest here (again, with rising oil prices as a foundation). These factors have been in play for years and have been fairly predictable, driven as they are by macroeconomic fundamentals. The two "top" layers, however, have come on the scene much more recently and have the potential to change the price formation equation rapidly and unexpectedly. Table 1 summarizes this perspective for supply and demand drivers according to their "predictability," i.e., whether the drivers are low variance (and easy to predict) or high variance (and very difficult to predict).

Table 1: External Drivers of Food Prices

	Supply	Demand
Low variance	Seed technology	Population growth
	Irrigation	Income growth
	Total harvested area	Dietary changes and tastes
	Climate change	Meat and livestock economy
	Knowledge and management skills	
High variance	Weather	Exchange rates
	Diseases	Speculation
	Crop-specific harvested area	Biofuels (but predictable from mandates; not predictable from oil prices)
	Fuel costs	Panic or hoarding
	Fertilizer costs	Government trade and inventory policies

Source: Author.

B. The Biofuel Debate

Biofuels are enormously controversial, and this paper is not the place to review the debate over their full economic and environmental impact (see Elliott 2008, Collins 2008, and Runge and Johnson 2008 for useful, if sobering, reviews). Very senior and experienced commodity analysts place the share of biofuels' contribution to the run-up in grain prices since mid-2007 at between 60% (Collins, the former chief economist for the United States Department of Agriculture, analyzing only corn) and 75% (Mitchell 2008, the senior commodity economist at the World Bank, analyzing all grain markets). More academic analysts relying on large-scale models tend to place the share at between 25% and 35%—the latter figure from Rosegrant's (2008) use of the International Model for Policy Analysis of Agricultural Commodities and Trade or IMPACT developed by the International Food Policy Research Institute. FFIR agrees that biofuel demand for corn was a main driver of higher corn prices, but argues that most of this demand was driven by high oil prices, not Congressional mandates.

The problem is that none of the formal models fully capture the cross-commodity supply and demand linkages between corn—the primary grain used to make ethanol—and other commodities such as soybeans, wheat, and other feed grains. As a simple example, increased planting of corn led to reductions in soybean acreage in 2007 in the US. The reduced output of soybeans meant that soy oil production was also lower, which caused increased demand for palm oil in Asia, and a spike in prices. Although the PRC is not a significant importer of corn, it is a huge importer of soybeans to crush for both soymeal and soy oil. With reduced supplies of soybeans available—a ripple effect of the increased acreage devoted to corn—the PRC turned to Asian-produced palm oil to meet its growing demand for vegetable oils (Naylor et al. 2007). India, too, is a substantial importer of vegetable oils and of palm oil, in particular.

Corn is the quintessential "multi-end-use" commodity, and the economics of which end use is "driving" market prices depends on the supply and demand structure of all the alternative commodities, as well as on macroeconomic conditions and trade policies in importing and exporting countries. Modeling this is difficult. In the precise language of Chen, Rogoff, and Rossi (2008), the multiple end uses lead to "parameter instability" in the relationship between supply, demand, and price.

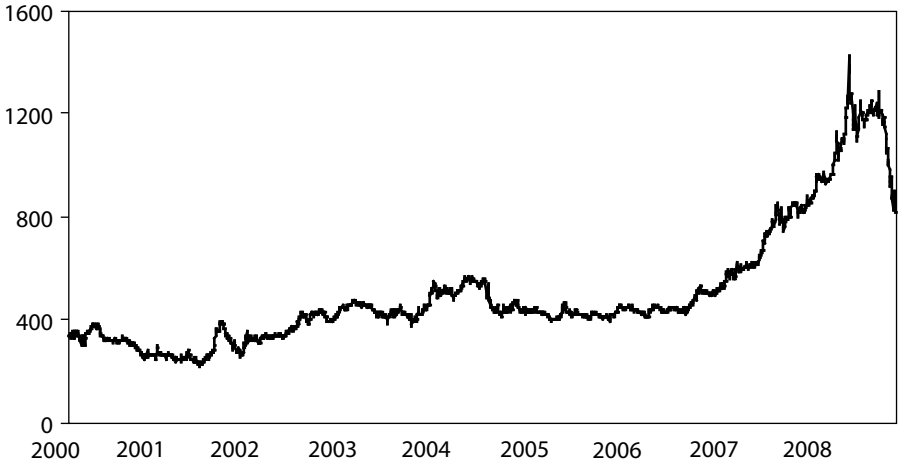
It is entirely possible that in one month demand for corn to make ethanol is driving up the price of corn, soybeans, and palm oil, whereas in another month price formation across these commodities can be completely delinked, depending simply on each commodity's own supply and demand situation (or on other forces). Thus not only would the parameters of a "multi-end-use commodity price model" vary from period to period, so too would the entire structure of the model. Perhaps it is not surprising that different analysts and different models produce very different estimates of what is causing high food prices. Parameter instability is the fundamental reason that careful analysts, such as Abbot, Hurt,

and Tyner (2008), argue that it is impossible to place quantitative weights on the causes of higher food prices, or at least weights that would have continuing validity over time and across commodities.

It is possible actually to "see" this parameter instability and changing structure if price data are available with sufficiently high frequency. Appendix 3 uses daily price data from 31 December 1999 to 2 July 2008 to test the structure of price interaction across exchange rates and commodities, and the structure clearly changes frequently. As one example of such data, Figure 8 plots daily prices of palm oil for 31 December 1999 to 2 July 2008. The sudden take-off around mid-2006, when corn prices also started to increase, suggests a new set of drivers in the formation of palm oil prices.

Figure 8: Palm Oil Price Movements

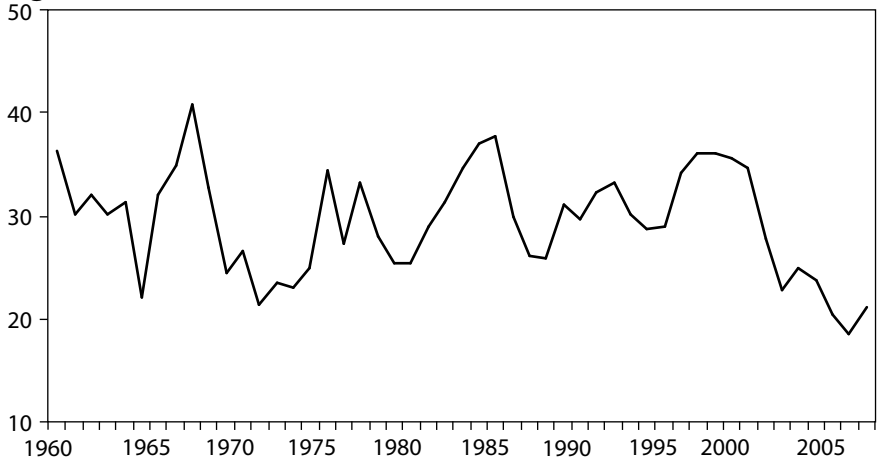
($ per metric ton)



Note: Price refers to Malaysian oil palm (Rotterdam).
Source: Datastream, downloaded 28 August 2008.

Not all the action has been on the demand side. Supplies of some food commodities have generally been marked by shocks from adverse weather conditions and crop disease. Wheat is a clear example. A shock on wheat supplies would usually trigger some price increase, but would be quickly addressed by stock drawdowns and increased production that would damp the upward price movements. However, the bad harvest in 2007 happened at a time of extremely low wheat stocks (Figure 9). As a result, the price response was exaggerated. In the same vein, the rebound in Australia's wheat harvest in 2008 brought about a marked drop in wheat prices after April (Figure 3 above).

Figure 9: World Wheat Stock-to-Use Ratio

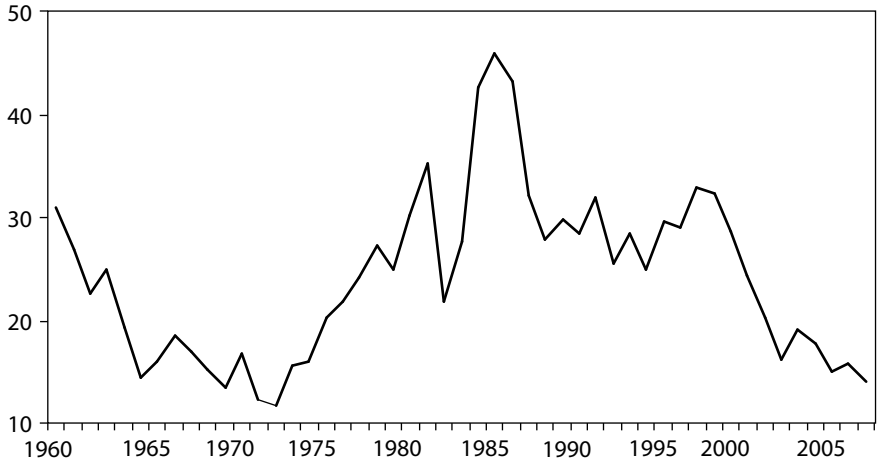


Note: The stock-to-use ratio indicates the level of stocks held at the end of the period as a share of total use.

Source: Foreign Agricultural Service, United States Department of Agriculture, *Production, Supply and Distribution* online (fas.usda.gov/psdonline/psdHome.aspx), downloaded 2 September 2008.

Declining stock-to-use ratios for corn since the late 1990s are the main rationale offered by analysts who see corn-based ethanol demand as the main driver of higher prices for staple food grains (Figure 10). Because corn has multiple end uses that are economically efficient at normal prices, a shift in demand from one of the end uses (e.g., biofuels) can create ripple effects throughout many other commodity markets. Corn is a primary feedstuff for livestock, but competes in this end use with wheat. But wheat and rice are consumption substitutes in many parts of Asia. In another direction, corn oil competes with soy oil and palm oil. Rapid growth in vegetable oil demand in Asia can indirectly stimulate corn production in the US.

Figure 10: World Corn Stock-to-Use Ratio



Note: The stock-to-use ratio indicates the level of stocks held at the end of the period as a share of total use.

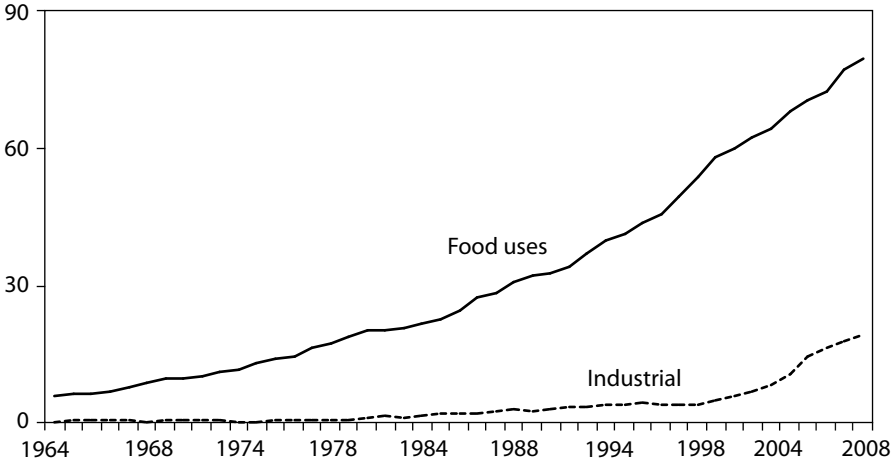
Source: Foreign Agricultural Service, United States Department of Agriculture, *Production, Supply and Distribution* online (fas.usda.gov/psdonline/psdHome.aspx), downloaded 2 September 2008.

Competition and substitution can also take place on the supply side. Corn and soybeans compete directly for acreage in much of the US. Increased demand for corn for biofuel production can reduce soybean acreage, causing soymeal and soy oil prices to rise. Thus there are many mechanisms by which higher demand for corn to convert into ethanol might have an impact on a wide range of food commodity prices around the world. With stock-to-use levels for corn so low in the mid-2000s (Figure 10), it was these mechanisms that led analysts such as Mitchell (2008) and Collins (2008) to single out rising demand for ethanol in the US as the trigger for higher food prices across the board.

Whether the demand was from Congressional mandates or from high gasoline prices, establishing a direct link between energy prices and food prices is a "game changer" in global commodity markets. The outlook for continued high crude oil prices (*Asian Development Outlook* Part 2 in ADB 2008a) thus has direct implications for the outlook for staple food prices. Most knowledgeable analysts of the US biofuel industry feel that corn-based ethanol will be economically competitive if crude oil stays above $80 a barrel (in 2008 prices) and if corn is available to local refiners at less than $5–6 a bushel. As noted, because of its multiple end uses in consumption, and area competition with soybeans (and to a lesser extent, with wheat) in the US, high-priced corn (specifically) means high-priced food (generally), including even rice in the long run.

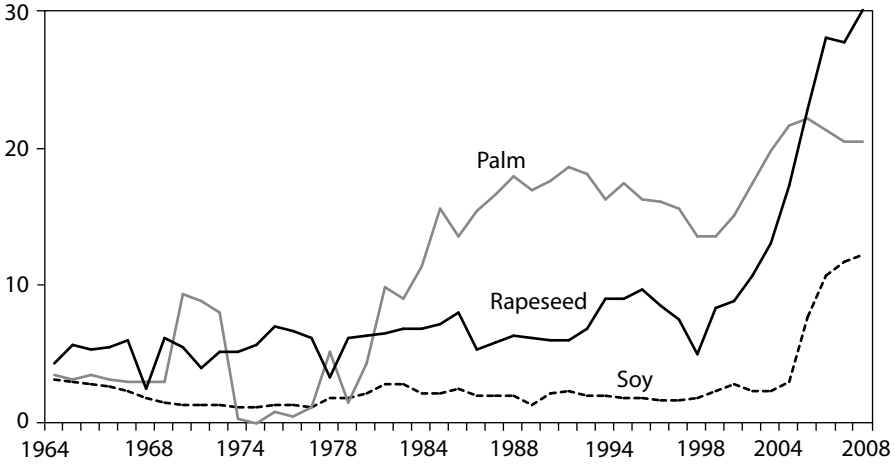
The price trajectory for vegetable oils is similar to the basic path for staple food grains (see Figure 8 for palm oil prices since 2000). The connections are established from both their food uses and their industrial uses. Figure 11 shows food uses of vegetable oils on an exponentially increasing path, led especially by rapid growth in demand in the developing world. But industrial use, after growing very slowly for decades, has also started an exponential increase since 2000. This growth is almost entirely due to the use of vegetable oils to make biodiesel fuels. Rapeseed oil and palm oil are used for this purpose in Europe and some soy oil is used for biodiesel in the US (Figure 12). Again, once a price connection is established between vegetable oils and liquid fuels, the price dynamics for vegetable oils will be driven largely by the world market for petroleum. All the evidence suggests that these connections are well established at petroleum prices over $80 per barrel and thus are likely to be permanent features of vegetable oil price dynamics for the foreseeable future, whatever happens to legislative mandates (Elliott 2008; Abbot, Hurt, and Tyner 2008).

Figure 11: World Vegetable Oils—Food versus Industrial Uses (million metric tons)



Note: Vegetable oil use refers to soy, palm, and rapeseed oil consumption.
Source: Foreign Agricultural Service, United States Department of Agriculture, *Production, Supply and Distribution* online (fas.usda.gov/psdonline/psdHome.aspx), downloaded 2 September 2008.

Figure 12: World Vegetable Oils—Industrial Use as Share of Total (percent)



Note: Vegetable oil refers to soy, palm, and rapeseed oil. Total use is the sum of industrial, food, and feedwaste uses.
Source: Foreign Agricultural Service, United States Department of Agriculture, *Production, Supply and Distribution* online (fas.usda.gov/psdonline/psdHome.aspx), downloaded 2 September 2008.

C. The Rice Difference

For rice, the story is more complicated. The actual production–consumption balance for rice has been relatively favorable since 2005, with rice stock-to-use ratios improving slightly. This stock buildup was a rational response to the very low stocks seen in the middle of the decade and to gradually rising rice prices. Short-run substitutions in both production and consumption between rice and other food commodities are limited, and until late 2007 it seemed that the rice market might "dodge the bullet" of price spikes seen in the wheat, corn, and vegetable oil markets. The lack of a deeply traded futures market for rice also made financial speculation less attractive.

But the world rice market is very thin, trading just 6–7% of global production. While this is a significant improvement over the 4–5% traded in the 1960s and 1970s, it still leaves the global market subject to large price moves from relatively small quantity moves.

The global rice market is also relatively concentrated, with Thailand, Viet Nam, India, US, and Pakistan (in order of their share of rice exports) routinely providing nearly four fifths of available supplies. Only in the US is rice not a political commodity from a consumer's perspective (although it certainly is a political commodity for producers there). All Asian countries show understandable concern over access of their citizens to daily rice supplies. Both importing and exporting countries watch the world market carefully for signals about changing scarcity, while simultaneously trying to keep their domestic rice economy stable.

As concerns grew in 2007 that world food supplies were limited and prices for wheat, corn, and vegetable oils were rising, several Asian countries reconsidered the wisdom of maintaining low domestic stocks of rice. The Philippines, in particular, tried to build up stocks to protect itself against shortages in the future. If every other country, household, or individual does the same thing, panic will grip the market. This will lead to commodity shortages and subsequent price surges. Such price panics have been fairly common over the past 50 years, but the hope was that deeper markets, more open trading regimes, and wealthier consumers able to adjust more flexibly to price changes had made markets more stable. This was wishful thinking, as the price record for rice shows (Figures 1–3 above).

After the acceleration in the gradual price increases that had been seen for half a decade started in September 2007, concern over the impact of higher rice prices in exporting countries, especially India, Thailand, and Viet Nam, started to translate into talk, and then action, on export controls.[2] Importing countries, especially the Philippines, started

[2] It is almost amusing that Indonesia announced a ban on rice exports early in 2008, before its main rice harvest started in March. Historically, Indonesia has been the world's largest rice importer, surpassed only recently by the Philippines, and no one in the world rice trade was looking to Indonesia for export supplies. But there was a rationale to the announcement by the minister of trade—it signaled that Indonesia would not be needing imports and was thus not vulnerable to the skyrocketing prices in world markets. The calming effect on domestic rice market participants meant that little of the hoarding behavior seen in the Philippines and Viet Nam was evident in Indonesia.

to scramble for supplies. Fears of shortages spread and a cumulative price spiral started that fed on the fear itself.

The panic was set off by the complex interlinkages among certain commodities. In 2007, wheat harvests in India, as in other parts of the globe, were damaged by drought and disease. This left the Food Corporation of India with inadequate wheat supplies for its public distribution system. The Government of India could have imported as much wheat as it did in 2006 (about 7 million metric tons) to meet the shortfall, but while importing was an option, it would have been too costly (both economically and politically), as wheat prices were already elevated at the time. The Food Corporation of India instead decided to substitute rice for wheat and announced increased procurement of rice from domestic producers. Restrictions were imposed on rice exports in September 2007, and by February 2008, an outright ban on non-basmati rice exports was in place. (India is the world's third-largest rice exporter, supplying 4.1 million metric tons in 2007.)

As rice prices picked up, other rice-exporting countries followed India's actions. Thailand's newly elected populist government, for instance, openly discussed similar export restraints on rice to avoid a sharp increase in domestic retail prices. (Thailand is the world's top rice exporter, supplying 10.0 million tons in 2007.)

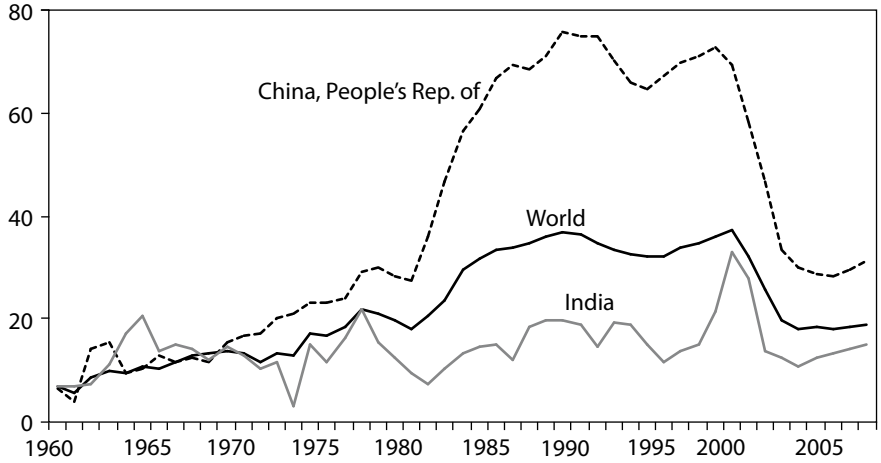
These actions by two large rice exporters caused rice prices to jump to $750 per metric ton on 28 March 2008. Prices continued to surge, breaching $1,100 per metric ton in April. All because of panic.

Dwindling global stocks have generally been recognized as the major trigger for the rise in prices, and indeed rice consumption has been significantly outstripping production since 2000 (Figure 13). Over the past decade, rice stocks in the PRC have been shrinking in response to declining world prices and to increased reliance on trade for a ready supply. However, in the rest of the world, there has been relatively little change in rice stocks—just small increases in the stock-to-use ratio since 2005. Since holding large stocks of rice in tropical conditions is extremely costly, a dependable flow of rice in international trade can sharply reduce outlays. With the recent experience of exporting countries readily putting bans on rice exports to protect their own consumers, importing countries will now be forced to accumulate significant domestic stockpiles. That is a tragedy for poor consumers and takes a toll on economic growth, since capital is used to fund large inventories rather than being allocated to investment that would foster productivity and growth.

The psychology of hoarding behavior is important in explaining why rice prices suddenly shot up from late 2007. Financial speculation seems to have played only a small role (partly because futures markets for rice are very thinly traded). Instead, decisions by millions of households, farmers, traders, and some governments sparked a sudden surge in demand for rice and changed the gradual increase in rice prices from 2002

to 2007 into an explosion: this was “precautionary” demand even if not “speculative” demand (see Appendix 2).

Figure 13: Rice Stock-to-Use Ratio



Note: The stock-to-use ratio indicates the level of stocks held at the end of the period as a share of total use.
Source: Foreign Agricultural Service, United States Department of Agriculture, *Production, Supply and Distribution* online (fas.usda.gov/psdonline/psdHome.aspx), downloaded 2 September 2008.

A rough calculation of the effect of household hoarding of rice shows the potential. Assume that 1 billion households each consumes 1 kilogram of rice a day (for a total consumption of 365 million metric tons, for the year, which is the right order of magnitude).

Assume that they keep a 1-week supply in their pantry, or 7 kilograms per household, which is 7 million metric tons of household stocks in total. This quantity probably varies by income class, with the very poor buying hand to mouth, and better off households storing more just for convenience. When prices start to rise, or the media start talking about shortages of rice, each household, acting independently, decides to double its own storage, thus buying an additional 7 kilograms. This means that the world rice market—the source of marginal supplies (and demand) for many countries—needs to supply an additional 7 million metric tons of rice over a short period (perhaps a few weeks). But this quantity is about one quarter of total annual international trade in rice (recent levels have been 27–30 million metric tons per year).

And this is just the added demand from households. Farmers, traders, rice millers, and even governments will also want to hold more stocks in these circumstances. As an example, the Government of Malaysia announced in July that it was doubling the size of the national buffer stock held by Padiberas Nasional Berhad, even though it had to pay extremely high prices to do so. The Philippines is seeking to increase its government-

held stocks. Indonesia has announced plans to triple its level of buffer stocks to 3 million metric tons.

Now, put realistic short-run supply and demand parameters (from the analytical model developed in Appendix 1) into the price determination mechanism: –0.1 for demand and 0.05 for supply. With a 25% (sudden) increase in short-run demand on the world market, the world price will have to rise by 167% to get a new equilibrium. That is close to what happened—panicked hoarding caused the rice price spike.

Fortunately, a speculative run can be ended by "pricking the bubble" and deflating expectations. Once the price starts to drop, the psychology reverses on hoarding behavior by households, farmers, traders, and even governments. When the Government of Japan announced in May, after considerable international urging, that it would sell 300,000 tons of its surplus "World Trade Organization" rice stocks to the Philippines, prices in world rice markets started to fall immediately (Slayton and Timmer 2008, Mallaby 2008). By late August, medium-quality rice for export from Viet Nam was available for half what it sold for in late April.

D. Summing up the Factors Causing High Food Prices

Three fundamental factors, all interrelated, combined to drive up food prices. First, rapid economic growth, especially in the PRC and India, put pressure on a variety of natural resources such as oil, metals, timber, and fertilizers. Demand simply increased faster than supply for these commodities.

Second, a sustained decline in the dollar since mid-decade added to the upward price pressure on dollar-denominated commodity prices directly, and indirectly fueled a search for speculative hedges against the declining dollar. Increasingly from 2006, these hedges were found first in petroleum, then in other widely traded commodities, including wheat, corn, and vegetable oils.

Third, the combination of high fuel prices and legislative mandates to increase production of biofuels established a price link between fuel prices and ethanol/biodiesel feed stocks—corn in the US and vegetable oils in Europe. Because of intercommodity linkages in both supply and demand, food prices now have a floor established by their potential conversion into biofuel. These linkages are not always tight or effective in the short run—rice and corn prices can be disconnected for some time, as the discussion above indicated (and as the Granger causality results in Appendix 3 demonstrate quantitatively). But the long-run forces for substitution in both production and consumption are very powerful. If high fuel prices are here to stay, high food prices are, too.

To complicate matters, in the short to medium run, the specifics of individual commodity dynamics can produce divergent price paths. Rice is the clearest example, as large

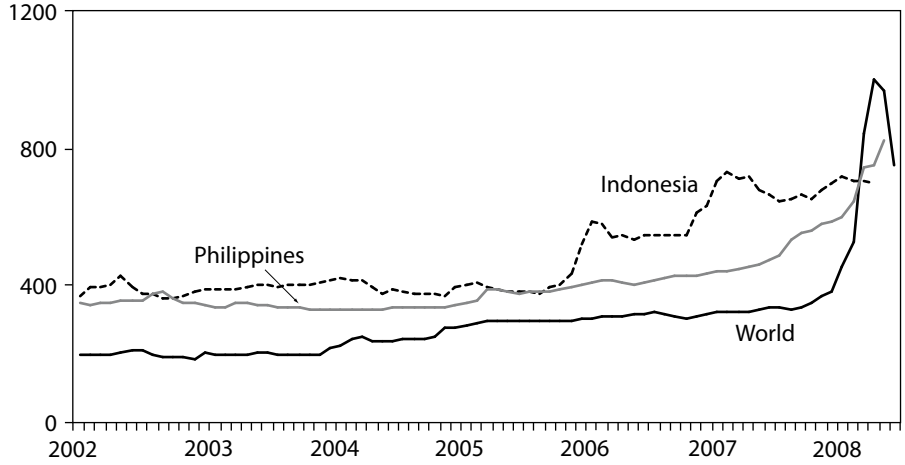
Asian countries act for their own short-run political interests with little or no regard to consequences for the international market or traditional trading partners. Without significant hope for binding international agreements between rice exporters and importers, this source of unique instability seems likely to last a long time.

III. Transmission of World Commodity Prices into Domestic Economies[3]

A key question is the extent to which changes in world market prices have been transmitted to domestic economies in recent years, especially for cereals. The extent of transmission is important for two reasons. First, domestic prices affect the welfare of poor consumers and farmers, not world prices. Second, the magnitude of price transmission will influence the extent to which adjustments by producers and consumers help stabilize world price movements. These adjustments (reduced consumption, increased production) will only take place if world prices are transmitted to domestic prices (see also Imai, Gaiha, and Thapa 2008). It is obvious from Figure 14 that world rice prices are not immediately transmitted into Indonesia and the Philippines, two important rice importers. Figure 15, however, shows that price transmission for exporters is quicker and more complete, despite Viet Nam's efforts to insulate domestic rice prices from the run-up in world prices.

Figure 14: World versus Domestic Rice Prices of Importers

($ per metric ton)

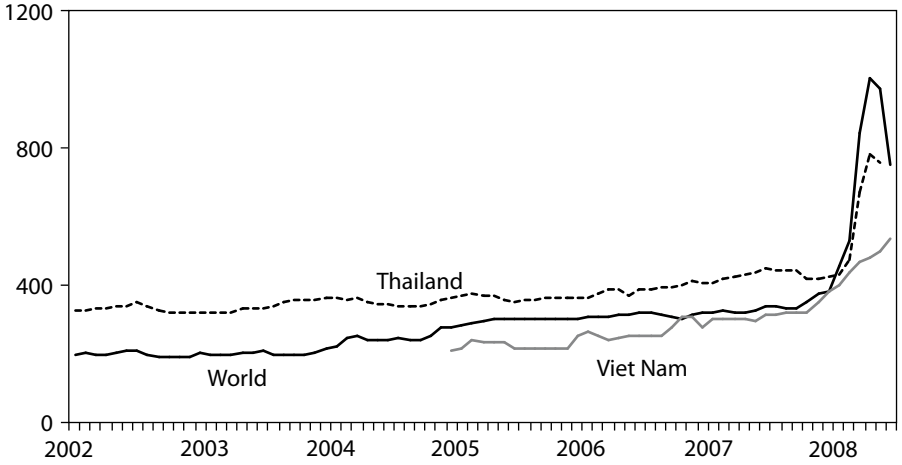


Note: World rice refers to Thailand 100% grade B; Indonesian rice refers to the retail price in Jakarta; and Philippine rice refers to ordinary (C-4) rice.

Sources: CEIC Data Company Ltd.; International Monetary Fund, *International Financial Statistics* online, both downloaded 22 August 2008.

[3] This section relies heavily on Dawe (2008a).

Figure 15: World versus Domestic Rice Prices of Exporters
($ per metric ton)



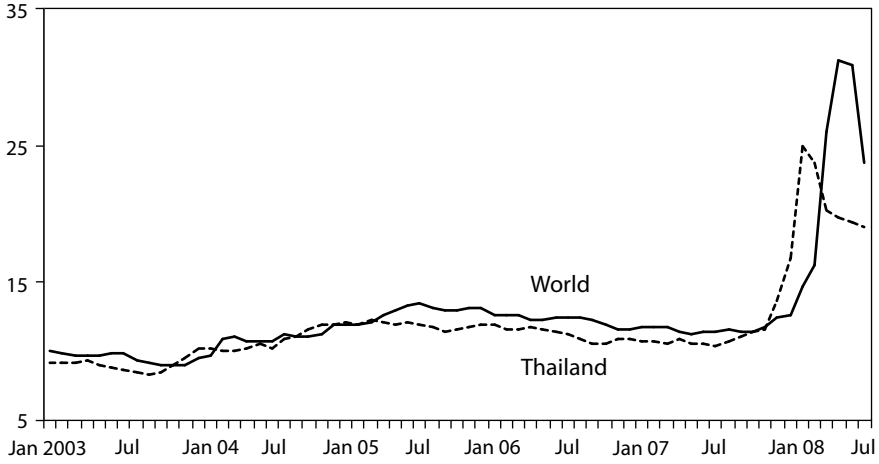
Note: World rice refers to Thailand 100% grade B; Thailand rice refers to the retail price of white rice 5%; and Viet Nam rice refers to the retail price of ordinary rice in An Giang province.
Sources: CEIC Data Company Ltd.; International Monetary Fund, *International Financial Statistics* online, both downloaded 22 August 2008; Information Center for Agricultural and Rural development, Institute of Policy and Strategy for Agricultural and Rural Development website (agro.gov.vn).

The extent of price transmission is a function of three key variables: the exchange rate at which dollar prices are converted to domestic currency prices; trade policy barriers at the border, which restrict (or enhance) the flow of commodities across the border; and the time horizon of adjustment. Normal marketing lags as well as policy interventions delay the immediate transmittal of international prices into domestic economies, but the longer there is a substantial difference between the two prices, the more pressure there is for convergence. Accordingly, Imai, Gaiha, and Thapa use an error-correction model (to allow for lags in price convergence) to test for price transmission of important foodstuffs into the PRC and India. They summarize their findings as follows (Imai et al. 2008, 1):

> This paper examines the extent to which changes in global agricultural commodity price[s] are transmitted to domestic prices in India and PRC. The focus is on short and medium-run adjustment processes using an error correction specification. In particular, we show that the extent of adjustment in the short and medium-run (from 0 to 3 years) is generally larger in PRC than in India. Second, the adjustment is larger for wheat, maize and rice than for fruits and vegetables in both India and PRC. In fact, the adjustment is the weakest for vegetables in both countries. Third, while most of the domestic commodity prices co-move with global prices, the transmission is incomplete presumably because of distortionary government interventions (e.g., subsidies for agricultural commodities) and failure to exploit spatial arbitrage. So potential benefits to farmers of higher food prices —especially in India—may be restricted, as also the supply response.

Figure 16 shows that Thai wholesale prices for rice adjust very quickly to world prices. The core of the analysis carried out by Dawe (2008a) is a very basic calculation of cumulative changes in international and domestic prices in real (inflation-adjusted) terms between various points in time. A base year of 2003 is used because international oil, cereal, and fertilizer prices were relatively stable during the course of that year.

Figure 16: Real Price Movements of Rice: World versus Wholesale Price in Thailand (Baht per kilogram)



Note: World rice refers to Thailand 100% grade B, while the wholesale price of rice for Thailand refers to white rice 5% new. Prices were deflated by the US consumer price index, with December 2007 prices as base.

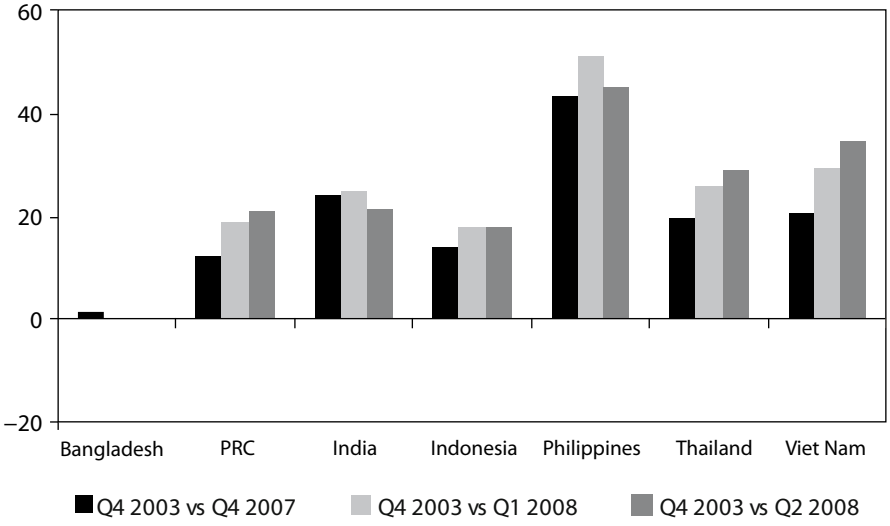
Sources: CEIC Data Company Ltd; International Monetary Fund, *International Financial Statistics* online, both downloaded 28 August 2008.

A. Exchange Rates

Even before the dramatic surge in prices in 2008, world market prices had increased substantially in real dollar terms in recent years. Comparing Q4 2007 with Q4 2003, world market prices increased by 56% for rice, 91% for wheat, 40% for corn, and 107% for urea (a source of nitrogen and the main fertilizer used by Asian farmers). During that time, however, the dollar depreciated substantially against many currencies.[4] Figure 17 shows the percentage appreciation of the real exchange rate for the seven countries included in the analysis.

[4] In fact, this depreciation is one cause of the recent high commodity prices.

Figure 17: Real Exchange Rate Appreciation of Domestic Currencies versus US Dollar (percent)



Sources: CEIC Data Company Ltd.; International Monetary Fund, *International Financial Statistics* online, both downloaded 29 August 2008.

Real exchange rate appreciation vis-à-vis the dollar, to the extent that it occurs, will neutralize some of the impact of increased prices in dollar terms. Because the magnitude of real exchange rate appreciation varies from country to country, changes in world market prices in real domestic currency (DC) terms will also vary from country to country, even for the same commodity. A comparison of columns 1 and 2 of Table 2 shows that, for a substantial group of Asian countries, world market rice prices did not in effect increase by as much as was commonly believed (the figure in column 1). For some countries, however, such as Bangladesh, world price increases were substantial because the real exchange rate was approximately constant.[5]

B. Transmission to Domestic Economies

The extent to which international prices of rice have been transmitted into domestic markets in developing Asia has been influenced by movements of exchange rates. This can readily be seen by comparing columns 1 and 2 in Table 2. The appreciation of Asian currencies against the US dollar (the currency in which international prices are set) means that, in domestic currency terms, the percentage increase is less than in US dollar terms.

[5] In some countries, the exchange rate may be partially determined by world commodity price movements when the commodity in question is a major share of that country's international trade, as is the case for oil in some African countries. The value of international cereal trade in the Asian countries analyzed here is relatively small, however, compared with the size of their foreign exchange markets and compared with total exports and imports (this is true even at current high price levels). Thus, exchange rate changes in these countries are taken as exogenous for the purposes of discussing commodity price transmission.

C. Consumer Prices of Rice: Pass-Through is Incomplete

Table 2 column 3 shows that not all the change in the international price of rice measured in domestic currency was passed through to domestic markets. Dawe (2008a) uses wholesale prices rather than retail prices to measure pass-through. This seems a valid procedure because rice at the wholesale level is milled and packaged and is quite close to that sold in the retail market.

Table 2: Cumulative Changes in Real Rice Prices, Q4 2003 to Q4 2007 (percent)

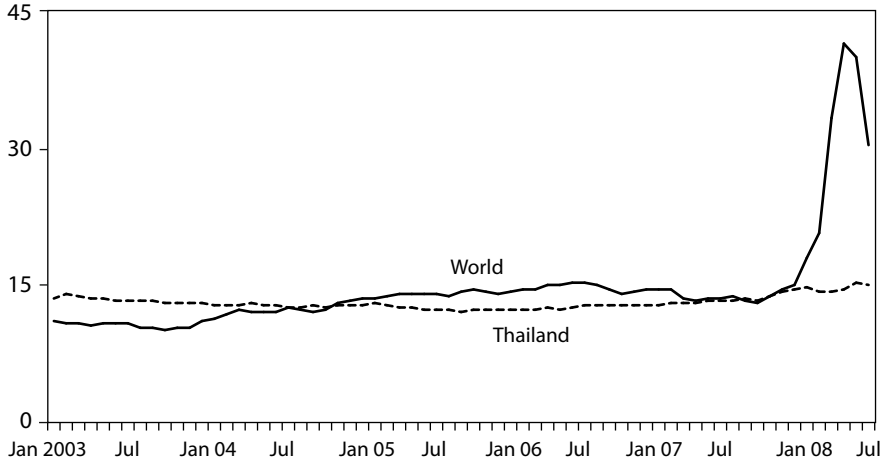
Country	World Price (US$) (1)	World Price (DC) (2)	Domestic Price (DC) (3)	DC Pass through (%) = (3)/(2) (4)
Bangladesh	56	55	24	44[a]
China, People's Rep. of	56	34	30	88[b]
India	56	25	5	20[a]
Indonesia	56	36	23	64
Philippines	56	10	3	30[a]
Thailand	56	30	30	100[b]
Viet Nam	56	25	3	12[a]

DC = domestic currency.
[a] "Stabilizers."
[b] "Free traders."
Sources: Dawe (2008a), author's calculations.

There is quite a range of pass-through shown in column 4 of Table 2, and this indicates that some countries made a major effort to shield consumers from the spike in prices. The countries (indicated by "a" in column 4) with the low pass-through percentages are referred to by Dawe (2008a) as "stabilizers" while those for which pass-through exceeds 75% are called "free traders." Thus Bangladesh, India, Philippines, and Viet Nam are classified as "stabilizers" and the PRC and Thailand as "free traders." Implicitly this classification excludes the exchange rate policies of the countries and only considers commodity-specific policies, such as procurement, public distribution and subsidies, and international trade restrictions.

For "stabilizers," domestic prices should move with less volatility and variance than international prices. This turns out to be the case for Bangladesh, India, Philippines, and Viet Nam but not for Indonesia. Rice prices in India are representative of "stabilizer" behavior (Figure 18). Price signals from the international market are not getting through to consumers and farmers in these countries, but are being muted. This is likely to have costs in terms of supply responses and consumer behavior.

Figure 18: Real Price Movements of Rice—World versus Wholesale Price in India (Rupees per kilogram)



Note: World rice refers to Thailand 100% grade B, while the domestic price for India is the average retail price of rice in four large cities: Calcutta, Delhi, Bangalore, and Mumbai. Prices were deflated by the US consumer price index, with December 2007 prices as the base.

Sources: CEIC Data Company Ltd.; International Monetary Fund, *International Financial Statistics* online, both downloaded 28 August 2008.

In contrast, the PRC's and Thailand's rice prices have moved closely with international prices, and although there are some trade restrictions and government interventions, this means that consumers and producers are getting full price signals from the international market.

Indonesia has traditionally tried to stabilize domestic rice prices (Timmer 1986 and 1996) but this policy was abandoned in 2004 when imports were curtailed and domestic prices rose well above global prices. Since then, Indonesian rice prices have tended to be more volatile than international prices and thus the country cannot be classified as a "stabilizer."

The conclusion that emerges from the above discussion is that the real increase in domestic rice prices has averaged only about one third of the increase in international prices in real dollar terms. This indicates that the pass-through of international to domestic rice prices was muted though the end of 2007. Have things changed in 2008?

D. Price Movements in Early 2008

World market rice prices rose from 2003 to end-2007, but this increase was relatively steady and gradual. Thus in October 2007, prices were $335 per ton for Thai 100% grade B, just 5% higher in real terms than in October 2006. Prices began to increase more rapidly in November and December, but it was not until 2008 that prices surged, reaching a peak of more than $1,000 per ton in April and May (more than triple the level seen in the previous October). To what extent were these large price increases transmitted to domestic economies?

Table 3 shows that, again, less than half of these most recent price increases on world markets were transmitted to domestic economies, with the exception of Thailand and, barely, Viet Nam. The simple average pass-through of dollar prices to domestic prices, excluding Thailand and Viet Nam, was lower, at about 17%, than the average of 49% from Q4 2003 to Q4 2007. Given the much larger price increase on the world market, however, domestic prices increased substantially in several countries. In Bangladesh, Philippines, Thailand, and Viet Nam, real prices increased by nearly 50% or more in the span of 1 year, whereas prices did not increase more than 30% in any country in the 4 years between Q4 2003 and Q4 2007. Such large rises have serious repercussions for household food security, and often for domestic politics as well.

Table 3: Cumulative Changes in Real Rice Prices, "Early" 2007 to "Early" 2008 (percent)

Country	World Price (US$) (1)	World Price (DC) (2)	Domestic Price (DC) (3)	DC Pass through (%) = (3)/(2) (4)
Bangladesh	203	171	54	32
China, People's Rep. of	144	115	5	4
India	203	178	15	8
Indonesia	203	174	−5	−3
Philippines	144	104	46	44
Thailand	203	169	131	78
Viet Nam	202	158	85	54

DC = domestic currency.

Note: With regard to "early", all calculations compare a month in the first half of 2008 with the same month in 2007 to control for seasonality, although the months are different across countries. The chosen month for a given country is that month between April and June for which data are available, and where column 3 is largest (to capture different peak months in different countries). For Bangladesh, India, Indonesia, and Thailand, that month is April. For Viet Nam it is May, and for the PRC and the Philippines it is June.

Source: Author's calculations.

There have been substantial differences across countries during the past year with respect to the extent of price transmission, just as there were in 2003–2007. The obvious question is: Why did prices increase so much in some countries, but much less in others? There is no general answer: individual country analyses are required.

E. Summary of Price Transmission Results

There are two important reasons for wanting to understand the extent of price transmission from world markets to domestic markets. First is to understand the impact on consumers, especially those who must buy most of or all their staple foods from the market. Second is to understand the impact on incentives facing farmers. If high world prices are passed through to domestic producers, a more vigorous production result will be forthcoming than otherwise.

Working against a supply response, however, are increases in input prices, especially for fertilizer, fuel, and seeds (prices of the last input are likely to follow the same trend as output prices). Before the recent surge in prices, the value of these inputs accounted for perhaps one sixth of the value of gross output in Asian rice farming (labor, land, and returns to management usually account for well over half the gross value of production). The ratio of one sixth suggests that the negative effect on farmer incentives of a 60% increase in fertilizer prices will be offset by just a 10% increase in output prices.

If fuel and fertilizer are the only inputs whose prices have increased in real terms, even if they have doubled, it seems likely that incentives for farmers have improved on balance. Especially in rice-exporting countries where world prices have been transmitted to a substantial extent, even after the depressing effect of higher fertilizer prices is taken into account, farmers will have substantially enhanced incentives to expand production. If wages and land rents have also increased, incentives from higher output prices could be muted (although land-owning farmers providing most of their own labor will see these higher factor prices as higher incomes). Unfortunately, up-to-date data on prices for labor and land are not easily available. Early evidence from Asian rice harvests through August 2008—especially in India, Indonesia, Thailand, and Viet Nam—suggests that farmers are responding quite enthusiastically to higher rice prices.

Still, the magnitude of the improved incentives is much less than the price increases reported on world markets due to less than perfect transmission of world prices to domestic markets, and to increases in input prices. Thus, the ultimate supply response is still subject to a great deal of uncertainty in both the short and long run.

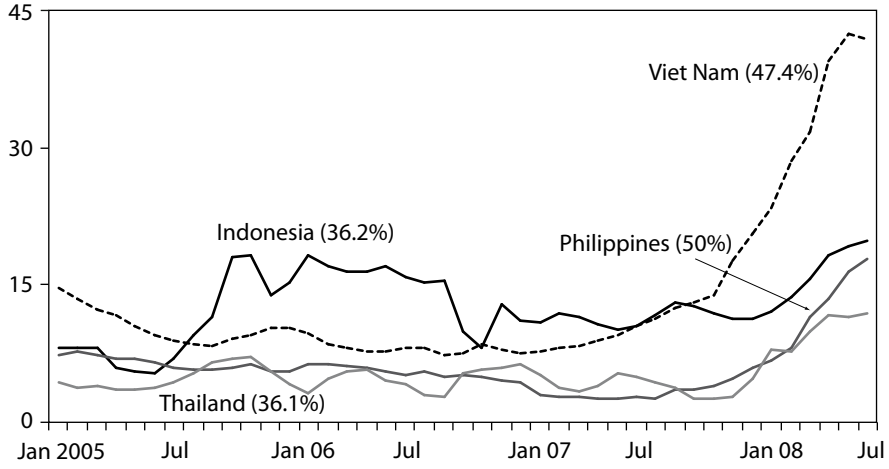
IV. Country Results: Contrasting Experiences of Rice Importers and Exporters

Policies are complex and differ from one country to another. The recent experiences of two exporters—Thailand and Viet Nam—and two importers—Indonesia and the Philippines—are discussed in this section to show the dramatic impact of diverse policy approaches.

In the broadest terms, there were three alternative policy approaches pursued by these four countries. Despite much internal political discussion after the new government was elected in early 2008, Thailand kept its border open and did not restrict rice exports. It did not release any of the 2.1 million metric tons of government-owned rice stocks that had accumulated since a farm-price support program began in 2005 (despite strong internal and external pressures), but it did not prevent private traders from selling into the world market.

At the other extreme, Indonesia stayed resolutely out of the world rice market. It had maintained very high rice prices since 2004, with sharp price run-ups late in 2005 and again in 2006 (Figure 19). These high prices were tolerated in the name of "food security", and the implied political support from rice farmers.

Figure 19: Food Price Inflation



Note: Figures in parentheses indicate the weights for food in overall inflation.
Sources: CEIC Data Company Ltd.; International Monetary Fund, *International Financial Statistics online*, both downloaded 28 August 2008.

The Philippines and Viet Nam seem to be tied at the waist by their mutual export-import relationship. Both countries sought to stabilize their domestic rice prices, and they engaged in very extensive rice trade with each other, on government account. Figure 14 above has already shown that rice prices increased rapidly in the Philippines, and Table 3

above has shown that domestic rice prices increased by 44% between early 2007 and early 2008.

Similarly, despite a ban on rice exports initiated early in 2008 and not lifted until July, Vietnamese rice prices shot up by 85% over the same period (Table 3 and Figure 15 above). What can explain such bizarrely unstable prices in the face of such active, and expensive, efforts to stabilize them? The only credible explanation is that price expectations changed on the part of key participants in the rice economy of both countries, partly because the two countries were so actively, and publicly, engaged with each other in the rice trade.[6]

These changed expectations then led to precautionary hoarding on the part of farmers, traders, and consumers. (A "run" on retail rice supplies in Ho Chi Minh City supermarkets in May showed how powerful this hoarding mentality could be.)

Neither the Philippines nor Viet Nam were short of supplies during this time. While government rice stocks were a bit on the low side in the Philippines, private sector stocks account for most of total stocks, and these stocks were ample. Domestic production in 2008 was forecast to be substantially above that in 2007, and there were no adverse climatic shocks at the time. Large import contracts were being negotiated, so domestic supplies were adequate in quantity terms. Viet Nam typically exports about 20% of domestic production and the export bans it put in place should have ensured ample local supplies.

Supplies were adequate in both countries and neither allows the private sector to arbitrage prices between domestic and international markets.[7] Thus the most likely explanation for the surge in domestic prices was speculation and panic on the part of domestic farmers, traders, and consumers in those two countries, who were well informed about the trades on the international market between the Philippines and Viet Nam in early 2008. Of course, once retail prices started to rise, this behavior became self-reinforcing.

The contrast with Indonesia and Thailand is striking. In the end, after much political debate—even talk of establishing a rice exporters' cartel like the Organization of the Petroleum Exporting Countries—Thailand allowed exports to continue and domestic prices to follow world prices. For several months Thailand was the only country with significant exportable supplies, and picked up customers from India and Viet Nam. Although domestic rice prices shot up—by 131% from early 2007 to early 2008—the

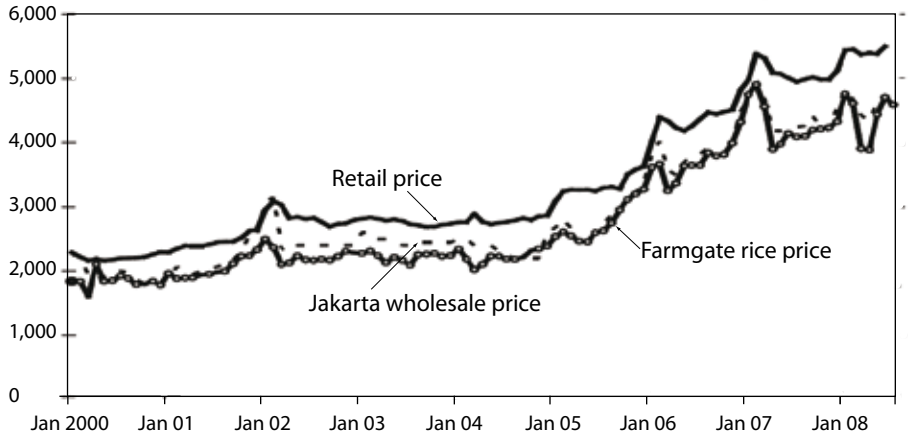
[6] The Office of the President in the Philippines routinely made public statements on the extent of necessary imports and the need to obtain them from Viet Nam.

[7] While the private sector does participate in international rice trade in both countries, it is the government that decides the quantities of imports or exports; private traders are not free to make this decision.

overall impact on the rate of inflation in Thailand was modest, as food and beverages make up only 36.1% of the overall consumer price index (Figure 20), and rice is a relatively small part of that. As Figure 21a shows, food price inflation surged to more than 10% early in 2008, but nonfood inflation also rose sharply. Inflation was more of a macroeconomic phenomenon than a food phenomenon in Thailand.

Partly because rice prices were already so high in Indonesia, none of the run-up in world prices was passed into domestic prices (indeed, Indonesian rice prices actually fell slightly between early 2007 and early 2008 in the wake of an excellent harvest, stimulated by high producer prices and very good rains from La Niña weather pattern—see Table 3 and Figure 19 above). Much of the food price inflation seen in Figure 21b was due to rising palm oil prices (despite efforts to stablize domestic palm oil prices through higher export taxes) and the cost of tahu and tempe, both derived mostly from imported soybeans, and a staple of Indonesian diets. However, food price inflation in early 2008 in Indonesia was roughly double the rate of that in Thailand, despite the radically different pass-through of rice prices from the world market to domestic consumers.

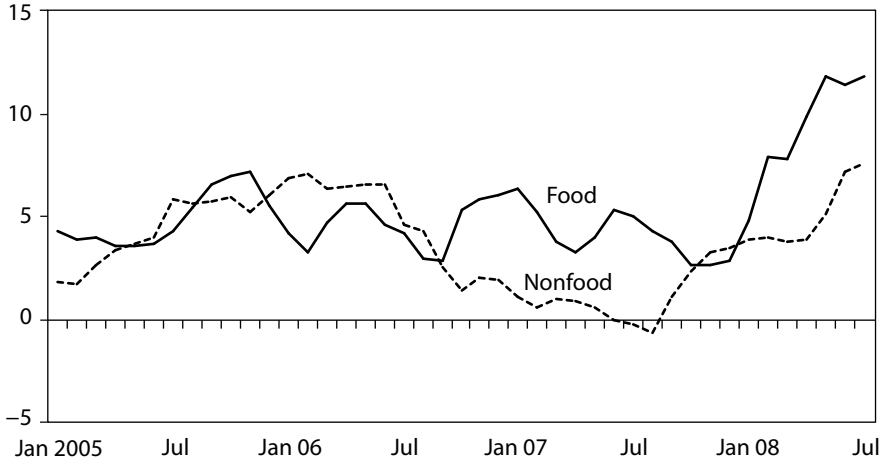
Figure 20: Rice Prices in Indonesia (Rupiah per kilogram)



Note: Farmgate rice prices are quoted in terms of wet paddy (*gabah kering panen*). After drying and milling, 100 kilograms of wet paddy produce roughly 55 kilograms of rice. Rp 2,500 per kilogram of wet paddy is therefore equivalent to Rp 4,545 per kilogram of rice.

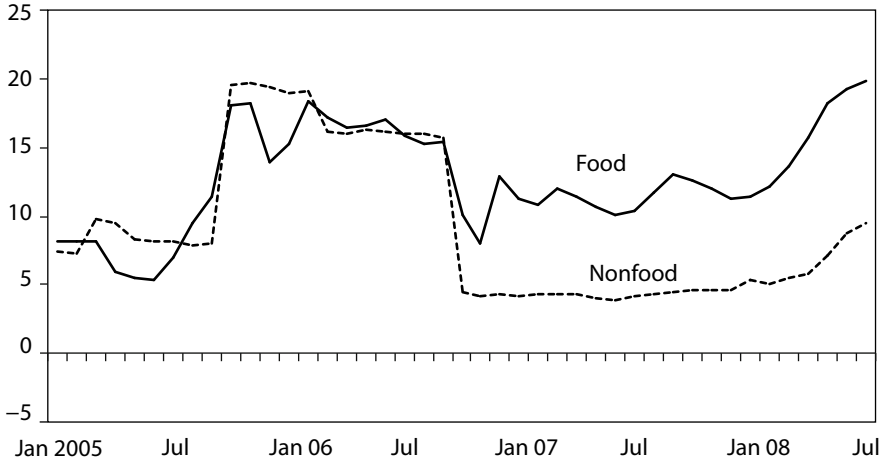
Sources: Retail price from Ministry of Trade of the Republic of Indonesia, wholesale price from PT Food Station, and farmgate price from Badan Pusat Statistik, Republic of Indonesia (adapted from Rosner 2008).

Figure 21a: Food versus Nonfood Price Inflation, Thailand (percent)



Sources: CEIC Data Company Ltd., International Monetary Fund, *International Financial Statistics* online, all downloaded 28 August 2008.

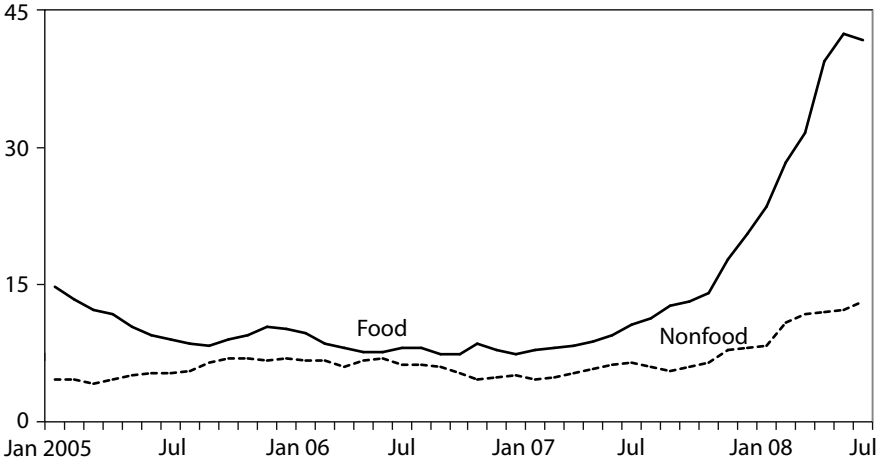
Figure 21b: Food versus Nonfood Price Inflation, Indonesia (percent)



Sources: CEIC Data Company Ltd., International Monetary Fund, *International Financial Statistics* online, all downloaded 28 August 2008.

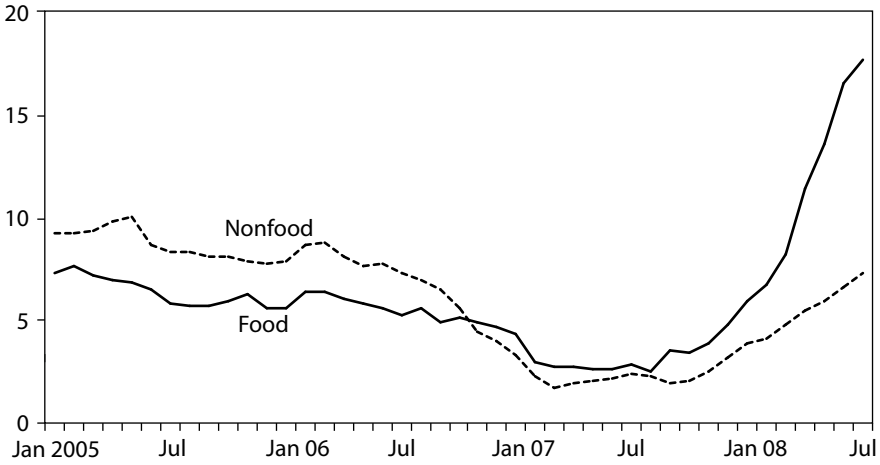
The parallels between Viet Nam and the Philippines can be seen in Figures 21c and 21d. In contrast to Thailand, both countries showed more than threefold increases in the rate of food price inflation (although from a much lower base in the Philippines than in Viet Nam). Efforts at food price stabilization in both countries clearly failed. By contrast, Indonesia managed to stabilize rice prices—at extremely high levels—but failed to contain food price inflation in other important commodities. Thailand, with the most open border and the biggest runup in rice prices, did best in overall food price stability. What a paradox, and also what a guideline to current and future trade policy makers!

Figure 21c: Food versus Nonfood Price Inflation, Viet Nam (percent)



Sources: CEIC Data Company Ltd., International Monetary Fund, *International Financial Statistics* online, all downloaded 28 August 2008.

Figure 21d: Food versus Nonfood Price Inflation, Philippines (percent)



Sources: CEIC Data Company Ltd., International Monetary Fund, *International Financial Statistics* online, all downloaded 28 August 2008.

V. Can Anything be Done about High Food Prices?

The main explanatory factors behind the gradual run-up in food prices from the early 2000s to mid-2007 were spillover from the broad resource demands generated by rapid demand growth, the declining dollar, and the lagged effect of earlier declines in real food prices and their (endogenous) impact on stock-to-use ratios. But these factors do not explain the sharp run-up in many staple food prices from mid-2007 to mid-2008. The explanation for this varies by commodity and period, but in addition to the broad factors affecting all commodity markets just noted—especially high oil prices and the declining dollar—new end uses for food grains and vegetable oils as biofuels, bad weather and diseases, and political decisions by food exporters to insulate their consumers from world prices led to the sharp increases in food prices. Panicked hoarding on the part of countries and individuals clearly played a role in the spike in rice prices, and financial speculation may have contributed to spikes in other commodities, especially oil, wheat, corn, and vegetable oils.

The longer-term issue is whether supply responses can meet the outlook for the rapid growth in demand. In the past, when food prices spiked and talk of an impending Malthusian crisis arose, output responded to bring world food prices to their long-run downward trend, though with a lag (Figure 2 above). This time, however, expectations are that such a benign output response may not be forthcoming, for the following reasons:

(i) Little additional high-quality agricultural land is now available for farming.

(ii) Yields of existing agricultural technologies have essentially been unchanged for decades because of the paucity of investment in research during this time. Thus raising yields from actual farmer practices to the present technology potential is the only source of increased output until new agricultural technologies are developed. New technologies, however, are at least a decade away. Moreover, the yield gap to full potential has largely been closed except for Africa,

(iii) The costs of essential inputs—fuel, fertilizer, and water—to obtain greater yields are both high and growing rapidly. In addition, prolonged periods of high grain prices could raise land rents and rural labor costs.

In view of these difficulties, it seems unlikely that basic food prices will return to their real long-run downward trend, seen so clearly in Figure 2 above. Instead, a return to the real average prices seen in 2007 would be considered a major accomplishment from the perspective of late August 2008. That is, when the panic subsides and the financial speculators move on to “greener pastures”, the new equilibrium price for rice, for example, is likely to be in the $500–600 range, not in the $300–400 range (in 2007 prices). Other basic food commodities are likely to exhibit similar patterns.

Should policy makers try to do anything about this new equilibrium? Clearly, it was appropriate to do everything possible to prick the speculative price bubbles, especially for rice, since reversing the dynamics of rising price expectations, and the private hoarding that exacerbated them, brought dramatic price relief in just a few months. It is unfortunate that the world does not have any internationally mandated mechanism for stabilizing grain prices, or for keeping large countries from destabilizing them. But that is the world we live in. Domestic policies will trump international cooperation whenever politicians see a short-run advantage in closing borders or subsidizing trade. The world was lucky that Japan had 1.5 million metric tons of unwanted rice imports in storage and received a World Trade Organization waiver from the US to reexport some of it to the Philippines. The deal marked the turning point in world rice prices (even though the rice has yet to be shipped as of early September—thus emphasizing again the importance of expectations in short-run price formation).

Equally, it was also appropriate for the international community to rally resources on behalf of increased food aid to the most affected populations. Safety nets for poor consumers are essential in a world of highly unstable food prices. But no one should be fooled into thinking that such safety nets are a solution to poverty, or even high food prices, in more than a transitory way. The only sustainable solution for these households is inclusive, or pro-poor, economic growth that provides reliable real incomes and stable access to food from home production or in local markets.

The appropriate policy response to high food prices, then, is to find ways to stimulate such growth. Much of the action is likely to be in the agriculture sector, especially in investments to raise productivity of basic food crops (see, for example, Brahmbatt and Christiaensen 2008). High food prices now provide plenty of incentives to make those investments, but many of those investments—especially in research and extension—would have paid off at the prices of a decade ago if donors and governments had recognized the full social value of rising agricultural productivity (Timmer 1995 and 2008b). These are political decisions that are driven only indirectly by market realities. Perhaps it is good news that the market is sending very clear signals on what to do.

Technical Appendix

Appendix 1. The Analytics of What Causes High Food Prices

Understanding causation implies an empirically refutable model of mechanisms of action. For food prices, this means an analytical model based on supply and demand mechanisms with equilibrium prices derived from basic competitive forces. There are many such models in existence (International Food Policy Research Institute, Food and Agricultural Policy Research Institute, Food and Agriculture Organization, United States Department of Agriculture, and World Organization for Agriculture), but none that address the specific issues in this paper (Munier 2008, Trostle 2008).

Here we seek to understand the contribution from a wide range of basic causes to high prices of important food commodities—rice, wheat, corn, and palm oil. Some of these causes may be exogenous, e.g., weather shocks or legislated mandates for biofuel usage. But many will be endogenous, e.g., responses of producers and consumers to prices themselves, perhaps even policy responses of governments to prices. Export bans for rice as a way to prevent domestic food price inflation are an obvious example (Brahmbhatt and Christiaensen 2008).

The model of price formation developed here attempts to incorporate all of these factors in a rigorous enough way to bring data to bear on answering the key question: what caused the recent run-up in world market prices for these basic commodities? For several of the factors, the answers remain more impressionistic than statistical, but we push the statistical approach as far as it will go (perhaps too far; see the Granger Causality tests in Appendix 3).

A Simple Model of Price Formation to Use as a Heuristic Device

Consider the most basic model of commodity price formation that is capable of illuminating our problem.

$$D_t = f(a_t, P_t, sr_d, P_{t-n}, lr_d) = a_t P_t^{sr_d} P_{t-n}^{lr_d}$$

$$S_t = g(b_t, P_t, sr_s, P_{t-n}, lr_s) = b_t P_t^{sr_s} P_{t-n}^{lr_s}$$

where D_t = demand for the commodity during time t; S_t = supply of the commodity during time t; f and g = functional forms for demand and supply functions, respectively; a_t = time-dependent shifters of the demand curve; b_t = time-dependent shifters of the supply curve; P_t = equilibrium market price during time t; P_{t-n} = market price during some previous time period t-n; and, sr_d, sr_s, lr_d and lr_s = indicators that demand and supply responses will vary depending on whether they are in the short run *sr* or long run *lr*. In the specification below, these will be short-run and long-run supply and demand elasticities.

In short run equilibrium, $D_t = S_t$. For simplicity (and the ability to work directly with supply and demand elasticities), assume the demand and supply functions are Cobb-Douglas. Then

$$\log a_t + sr_d \log P_t + lr_d \log P_{t-n} = \log b_t + sr_s \log P_t + lr_s \log P_{t-n}$$

Solving for the equilibrium price P,

$$\log P_t = [\log b_t - \log a_t]/[sr_d - sr_s] + \log P_{t-n}[lr_s - lr_d]/[sr_d - sr_s]$$

Taking first differences to see the factors that explain a change in price from *t-1* to *t* reveals a somewhat complicated result:

$$d\log P_t = \{[\log b_t - \log b_{t-1}] - [\log a_t - \log a_{t-1}]\}/[sr_d - sr_s] + [\log P_{t-n} - \log P_{t-(n+1)}][lr_s - lr_d]/[sr_d - sr_s],$$

where $d\log P_t$ = the percentage change in price from time period *t-1* to time period *t* (for relatively small changes). This is what we are trying to explain. What "causes" changes in $d\log P_t$? Why are food prices high?

To answer these questions, it helps to simplify the equation. Let *SR* = the net short-run supply and demand response $sr_d - sr_s$, which is always negative because $sr_d < 0$ and $sr_s > 0$. Let *LR* = the net long-run supply and demand response $lr_s - lr_d$, which is always positive, for similar reasons (note that the demand coefficient is subtracted from the supply coefficient in this case, the opposite from the short-run coefficients above). Let $d\log b_t = \log b_t - \log b_{t-1}$, which for small changes is the percentage change in the supply shifters. Let $d\log a_t = \log a_t - \log a_{t-1}$, which for small changes is the percentage change in the demand shifters. Finally, let $d\log P_{t-n} = \log P_{t-n} - \log P_{t-(n+1)}$, which for small changes is the percentage change in the commodity price for some specified number of time periods in the past, for example, 5 or 10 years (after which the long-run producer and consumer responses to price have been realized).

Combining all of these new definitions, we have a simpler equation explaining percentage changes in commodity prices:

Percent change in P_t = [percent change in b_t - percent change in a_t]/SR
+ [percent change in P_{t-n}] LR/SR

The "surprising" result is how simple the answer appears to be. There are four key drivers:

(i) the relative size of changes in a_t to b_t, i.e., factors shifting the demand curve relative to factors shifting the supply curve;

(ii) the relative size of short-run supply and demand elasticities (sr_s and sr_d);

(iii) the relative size of long-run supply and demand elasticities (lr_s and lr_d); and

(iv) how large the price change was in earlier time periods.

Why the Analytics Matter

A simple numerical example, with plausible parameters, shows the power of this "explanatory" equation. Assume the following numerical parameters for purposes of illustration:

sr_d = −0.10

sr_s = +0.05

lr_d = −0.30

lr_s = +0.50

These values imply that *SR* = −0.15 and *LR* =0.80.

The short-run elasticities assumed here are quite low, but realistic for annual responses. Demand responds 1% for a 10% change in price; supply only responds by half a percentage point to a similar 10% price change (the signs, of course, are negative for demand and positive for supply responses).

The long-run elasticities are also on the low side of econometric estimates, but again, seem realistic for a world facing increasing resource constraints. Although some estimates of long-run supply response are quite high—approaching unity or higher; these were estimated for time periods when acreage expansion was significant and fertilizer usage was just becoming widespread (Peterson 1979).

Assume, as seems to be the case since the early 2000s, that demand drivers have been larger than supply drivers, with demand shifting out by 3.0% per year and supply shifting out just 1.5% per year (an example of such a growing imbalance is shown in Figure 4). Finally, assume that prices in the past have been "low", so the change in P_{t-n} is –10.0%. What do all these parameters mean for current price change?

Plugging these values into the price change equation yields the following result:

$$\begin{aligned} \textit{Percent change in } P_t &= [1.5\% - 3.0\%]/-0.15 + [-10.0\%]0.80/-0.15 \\ &= [10.0\%] + [53.3\%] \\ &= 63.3\% \text{ higher.} \end{aligned}$$

This is a very dramatic result. The imbalance between "current" supply and demand drivers causes the price to rise by 10%, but the historically low prices (and "only" a 10% decline in the earlier period) cause current prices to be 53% higher, as the long-term, lagged response from producers and consumers to these earlier low prices has a very large quantitative impact. *Much of the slow run-up in food prices from 2003 to 2007 would seem to be caused by producers and consumers gradually responding (i.e., reflecting their "long-run" responses) to earlier episodes of low prices, especially from the late 1990s until about 2003.* For example, between 1996 and 2001 the real price of rice declined by 14.7% per year!

Over long periods of time, the first driver is clearly most important—how fast is the demand curve shifting relative to the supply curve? At the level of generality specified in this model, the actual underlying causes of these shifts do not matter. All that matters is the net result. If the demand

curve is shifting outward by 3% per year, and the supply curve is shifting out by just 1.5% per year, the difference of 1.5% per year will push prices higher, by an amount determined by net short-run supply and demand elasticities with respect to price. The "simple" fact is that commodity price changes are driven by the net of *aggregate* supply and demand trends, not their composition.

It is important to realize that the analytical model of price formation makes a sharp distinction between factors that shift the demand and supply curves (the a_t and b_t coefficients), and the responsiveness of farmers and consumers to changes in the market price (the sr_s and sr_d coefficients), which show up as movements along the supply and demand curve. Analytically, the distinction is very clear, but empirically it is often hard to tell the difference. If farmers use more fertilizer in response to higher grain prices, should this count as part of the supply response or as a supply shifter? If governments and donor agencies restrict their funding of agricultural research because of low grain prices, is the resulting lower productivity potential a smaller supply shifter a decade later or a long-run response to prices? Whatever the labels, it is important to understand the causes.

The Composition of Changing Demand and Supply Trends

This ambiguity can be a serious problem, because it is the composition of changing demand and supply trends that we are seeking to understand, even quantify, as a way to understand the causes of high food prices. The list of possible factors is long. For demand, it includes (in order of predictability):

1. Population (driven by demographic transition, fertility, mortality, famine)

2. Income growth (driven by economic policy, trade, technology, governance)
   (i) Direct consumption
   (ii) Indirect consumption through livestock feeding or industrial utilization

3. Income distribution (driven by globalization, food prices, agricultural growth, structural transformation)

4. Biofuel demands (driven by political mandates and the price of petroleum)
   (i) Direct demand for maize and vegetable oils
   (ii) Ripple effects on other commodities

5. US dollar depreciation (most commodities on world markets are priced in dollars)

6. Food prices (endogenous, driven by supply/demand balance and technical change; impact felt through the demand elasticities)

7. Private stockholding
   (i) Commercial (driven by price expectations and supply of storage)
   (ii) Household (driven by price panics and hoarding)

8. Public stockholding (driven by buffer stock policy)
   (i) Trade policy
   (ii) Procurement policy

9. Financial speculation
   (i) Futures/options markets and "sophisticated" speculators
   (ii) Role of commodity index funds available to general investors

For supply, the list is not so long, but the factors may be even more difficult to understand and quantify:

1. Area expansion
   (i) Irrigation and cost of water
   (ii) Deforestation and environmental costs
   (iii) "Benign" area expansion in Africa and Latin America?

2. Yield growth
   (i) Availability and costs of inputs
      (a) Fertilizer costs
      (b) Energy costs
      (c) Sustainability issues
   (ii) Seed technology and the GMO debate
   (iii) Management improvements/farmer knowledge

3. Variability
   (i) Weather
   (ii) Climate change

The original goal of this paper was to put quantitative weights on each of the supply and demand factors in terms of their role in causing the current high levels of food prices for key commodities in developing Asia: rice, wheat, corn, and palm oil. Other researchers are attempting to do the same thing for other regions or for global markets. The main debates have been over how much biofuels and financial speculation have caused the run-up in food and oil prices. A paper by Mitchell (2008), for example, caused a furor when it was "leaked" to the press in July: his finding was that perhaps three quarters of the run-up in grain prices was caused by US policy toward ethanol production from corn. At the same time, the US Secretary of Agriculture was arguing publicly, at the FAO Food Summit in June, that biofuel production played only a minor role in high food prices: 2–3%. Somebody is wrong.

The point is that these are contentious issues with no clearly accepted methodology for resolving them, a point also stressed by Abbot, Hurt, and Tyner (2008):

> The factors driving current food price increases are complex. We make no attempt to calculate what percentage of price changes are attributable to the many disparate causes, and, indeed, *think it is impossible to do so* (Abbot et al. 2008, 8; emphasis added).

The simple model here reveals why. If, for example, population growth is adding 1.5% per year to demand for a staple food grain, income growth is adding 0.5% per year to direct demand for that grain, and indirect demand via livestock feeding is adding 1.0 % per year, demand is growing by 3% per year. If, at the same time, supply is growing by 1.5% per year (0.5 % from area expansion and 1.0% from annual yield growth, for example), the net result is that aggregate demand growth exceeds aggregate supply growth by 1.5% per year, putting upward pressure on the equilibrium price of this food grain. Even if lagged prices had been in long-run equilibrium until demand shifters started to outstrip supply shifters, just this imbalance of 1.5% per year leads to price increases of 10% per year with the assumed short-run supply and demand elasticities.

Conclusion

There is no meaningful way to say what element of demand is growing "too fast" so long as each of the components of demand growth is growing relatively steadily. Indeed, the "blame" for the rising grain price can equally be laid at supply growth that is "too slow." Market clearing prices are driven by the aggregate of supply and demand in that market at a point in time. Prices themselves cannot reveal the underlying composition of those supplies and demands (the origin of the classical "identification problem").

This perspective on formation of market prices presents a conundrum. The "slow and steady" shifters of both supply and demand can explain gradual increases in prices, such as seen from the mid-2000s until late 2007 (see Figure 3). The lagged response to earlier periods of low prices can explain some acceleration in these prices, especially for rice and wheat. But the explosion in food prices late in 2007 and in the first half of 2008 clearly requires additional explanation involving factors not incorporated in the simple model of price formation just outlined. Much of the additional "analytical" explanation of short-run price movements will be provided from the supply of storage model, with its focus on links between inventory movements and price expectations in futures markets.

Appendix 2. The Supply of Storage Model and Short-run Price Behavior

The link between the supply of grain held in storage and prices in both spot and futures markets has long been the subject of analytical attention (Working 1933, 1948, 1949; Keynes 1936; Kaldor 1939; Telser 1958, Brennan 1958; Cootner 1960, 1961; Weymar 1968; Williams and Wright 1991). The basic "supply of storage" model that has emerged from this theoretical and empirical work is the foundation for understanding short-run price behavior for storable commodities (Houthakker 1987). It stresses the interrelated behavior of speculators and hedgers as they judge inventory levels in relation to use. The formation of price expectations is the key to this behavior.

The basic supply of storage model is a simple extension of the supply/demand model already used here. The formulation here follows Weymar's presentation, with three behavioral equations and one identity (error terms are omitted for simplicity):

$$C_t = f_c(P_t, P_t^L) \tag{1}$$

$$H_t = f_h(P_t, P_t^L) \tag{2}$$

$$(P_t^* - P_t) = f_p(I_t) \tag{3}$$

$$I_t = I_{t-1} + H_t - C_t \tag{4}$$

where C = consumption, P = price, P^L = lagged price, H = production (harvest), I = inventory, and P^*= expected price at some point in the future.

> The first two equations, indicating the dependency of consumption and production on current and/or lagged price, reflect traditional micro economic theory. While other variables may appear in these relationships (e.g., consumer income, government support levels), their exclusion here will not affect the discussion that follows. [The third equation] represents the "supply of storage" curve … and reflects the notion that the amount of a commodity that people are willing to carry in inventory depends on their expectations as to future price behavior. If they feel that the price will increase substantially, they will be willing to carry heavier inventories (supply more storage) than would otherwise be the case. Because the inventory level is in fact determined by the identity expressed in [the fourth equation], the supply of storage function can be used to explain the gap between the current price and price expectations in terms of the current inventory level (Weymar 1968, 28; emphasis added).

Thus the relationship between current inventories and current price helps explain price expectations, and vice versa. These price expectations can then be expressed in prices on futures markets. The actual working out of this theory empirically requires a close understanding of the behavior of market participants—farmers, traders, processors, and end users (consumers)—in their role as hedgers or speculators. The current controversy over the role of "outside" speculators—investors who are not active participants in the commodity system—has many precursors in the history and analysis of commodity price formation on futures markets (see, for example, the Telser-Kaldor debate reviewed by Cootner 1960).

The empirical difficulty in using the supply of storage model to understand short-run price behavior is having current information on inventory levels. This is not such a severe problem when virtually all the commodity storage is in commercial hands, as with cocoa or wheat, and stock levels for such commodities can be estimated fairly accurately. For a commodity such as rice however—which is mostly grown by smallholders, is marketed by a dense network of small traders and processors, and is purchased by consumers in a readily storable form (milled rice)—stock levels can change at any or all levels of the supply chain, and there is virtually no data available on these inventory levels.

For the purposes here, then, the main advantage of the supply of storage model is its ability to build conceptual links between long-run supply and demand trends, where basic models of producers and consumers provide operational guidelines to decision making and price formation, and very short-run movements in prices that often seem totally divorced from supply and demand fundamentals. Because long-run trends are gradually built up from short-run observations, these links are crucial for understanding price behavior even in the long run.

The key, then, to making the supply of the storage model operational in the short run, is to use it to gain insight on formation of price expectations. In the very short run, from day-to-day or week-to-week, these expectations seem to be driven by a combination of price behavior for commodities broadly, and by the specifics of individual commodities. Broad commodity price trends are captured by the International Monetary Fund commodity price index, the *Economist* price index, or the Goldman-Sachs commodity price index, for example. Thus, traders operating in any one specific commodity market, such as oil, corn or wheat, will be following closely the broader price movements for all commodities (Sanders and Irwin 2008). As the main body of this report stresses, these broad price movements seem to be driven by basic macroeconomic forces such as rates of economic growth, the value of international currencies, especially the US dollar, and relative inflation rates.

But traders are also following closely the specifics of the commodity as well. Here inventories (especially relative to actual use for consumption) are the key to price formation, once the harvest/supply situation for the crop is established. Clearly, the analytics of price behavior for oil or metals begin to look quite different from the analytics of food commodities at this stage, as seasonal production and the inherent need to store the commodity for daily use throughout the year drive inventory behavior via the supply of storage.

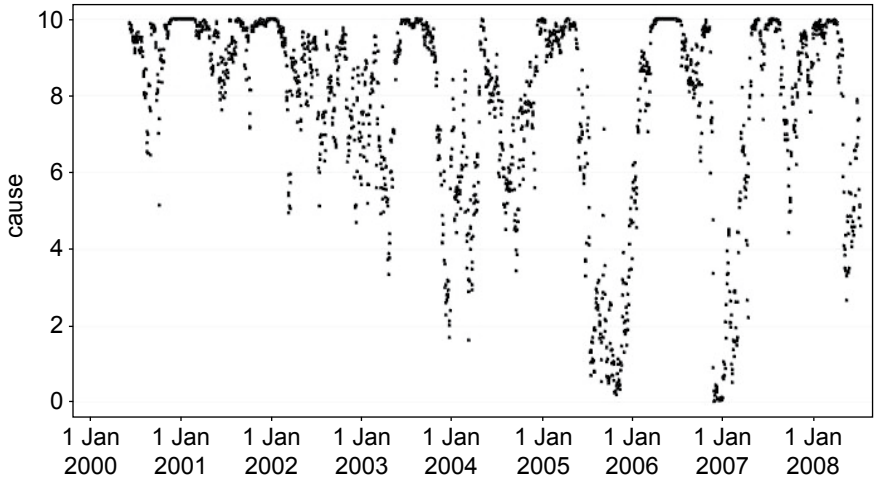
Typically, commodities for which inventory data are reasonably reliable tend to have their prices driven by unexpected supply behavior, whereas commodities with poor data on inventories, especially where significant inventories can be in the hands of millions of small agents—farmers, traders, consumers—tend to have their extremes in price behavior generated by rapidly changing price expectations themselves, and consequent hoarding or dishoarding. The short-run price dynamics for rice thus look significantly different from wheat or corn, partly because of the different industrial organization of the respective commodity systems. There are surprisingly few studies of individual commodity systems that are set within this broader macroeconomic and organizational framework (see Timmer 1987 for an exception). The world food crisis in 2008 provides ample rationale for major new studies within this framework for all of the major food commodities.

Appendix 3. Testing for Granger Causality across Exchange Rates and Commodities[8]

It is possible to examine the changing relationships for price formation across commodities in a formal way using the methodology of Granger Causality. Simply put, variable *X* is said to "Granger Cause" variable *Y* if time series information on variable *X* adds to the explanation of variable *Y* over and above the ability of past values of variable *Y* to explain the current value. Econometrically, vector autoregressive (VAR) techniques are used to determine how much of variable *Y* can be explained using just lagged values of variable *Y* itself, after which lagged values of variable *X* are added to the regression. If these lagged values are statistically significant in contributing additional explanatory power to variable *X*, then variable *X* is said to "Granger cause" variable *Y*. Reverse causation is routinely tested as well, and with many macroeconomic variables, direct and reverse causality are often found simultaneously.

A plausible interpretation of the visual model in Figure 7 would suggest that the depreciating US dollar might cause oil prices to rise. Through a biofuels connection, higher oil prices might then cause corn (maize) prices to rise (the main mechanism analyzed in the Farm Foundation report; see Abbot, Hurt, and Tyner, 2008). Higher corn prices might then spill over to other commodities through both supply and demand linkages, thus causing wheat, rice, or palm oil prices to rise. Using Granger causality methods, it is possible to test certain elements of this interpretation. In the first instance we are seeking very short-run linkages that are most likely mediated through futures and other financial markets, so daily price movements are required to observe such short-run effects. Indeed, given the split-second decision making on most trading floors where these "investments" are being made, even daily prices might aggregate away some of the effects we wish to observe.

Appendix Figure 3.1: Euro/US$⇒Brent Crude



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

[8] This part of the Technical Appendix is very much research in progress and thus raises far more questions than it answers.

Appendix Figure 3.1 shows a startling result for the Granger test that the exchange rate between the Euro and the US dollar "causes" the price of oil (Brent). A 15-day lag is specified and the model is run on (daily) rolling 6-month horizons, starting on 31 December 1999 and ending on 2 July 2008. Each observation in Appendix Figure 3.1 is thus the outcome of a Granger regression on 6 months of price data, resulting in 2090 regressions. The vertical axis is the probability that the null hypthosis of no Granger causation is rejected. Values between 0.95 and 1.00 reflect a very high probability that Granger causation in the direction specified is significant.

As Appendix Figure 3.1 demonstrates, there are several lengthy intervals when the exchange rate seems to be "causing" the price of oil (which was shown in Figures 5 and 6)—at least seven intervals of more than 2 months just between 2000 and 2008. But there are also many intervals when there seem to be no linkages at all between the two markets. If the question is, "did the depreciation of the US dollar cause high oil prices", the answer seems to be, "it depends on when you look." No model that assumes a stable relationship between the two variables can possibly capture this behavior. To understand it, we almost certainly need to understand behavior in financial markets and especially the formation of price expectations on the part of traders in these markets, including markets for commodities.

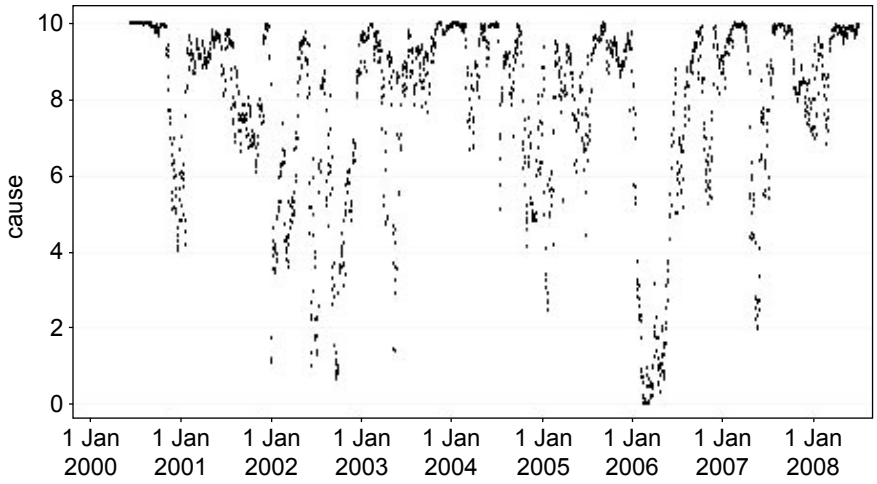
From this perspective, the most volatile element in the sudden and sharp run-up in food commodity prices is likely to be the "hot money" in search of the next investment boom, after the crash in tech stocks and then real estate derivatives. The source of this hot money is the massive liquidity infusion provided by the US Federal Reserve System as it seeks to stave off a recession caused by collapsing real estate values and subsequent threats to the nation's financial system itself (see Frankel 2006). This money has to go somewhere. Thus the real trigger for the recent spike in food prices seems to be speculative behavior on the part of large investment/ hedge funds with hundreds of billions of dollars looking for the next price bubble. The combination of a rapidly falling dollar, movement of investment funds into commodities, especially petroleum, and then on to other commodities is the trigger needed for the food market to explode. The Bank of International Settlements in Basel estimates that hundreds of billions of dollars are now invested in commodity funds, and until recently, they all were betting on higher prices.

Exchange Rates Driving Food Commodity Prices

Of course, the depreciating dollar can be reflected directly in prices of food commodities. In the medium run, both supply and demand adjustments by producers and consumers to changes in the value of the US dollar relative to their own domestic currency cause the US dollar price of most commodities to rise when the dollar falls. In the very short run, however, in daily price formation, a declining dollar seems likely to stimulate financial speculation into commodity markets, thus establishing a direct price link even before producers and consumers have had a chance to adjust. Appendix Figure 3.2 and Appendix Figure 3.3 show how these connections come and go between the Euro/US$ rate and corn and hard wheat prices, respectively. We still do not know why these short-run speculative connections get established for shorter or longer periods of time, and then disappear altogether for extended periods of time.

It is especially difficult to explain these short run price linkages for rice (see Appendix Figure 3.4). For long periods of time the Euro/US$ rate seems to drive the price of Thai rice. This may simply be a factor of the Thai baht being linked to the appreciation of the Euro, with the US dollar price of Thai rice being converted directly from the baht wholesale price.

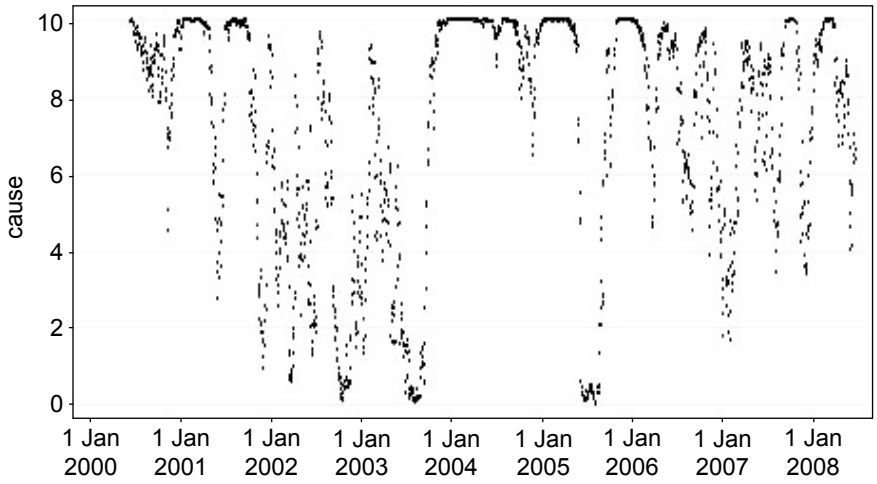
Appendix Figure 3.2: Euro/US$⇒Corn (Maize)



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

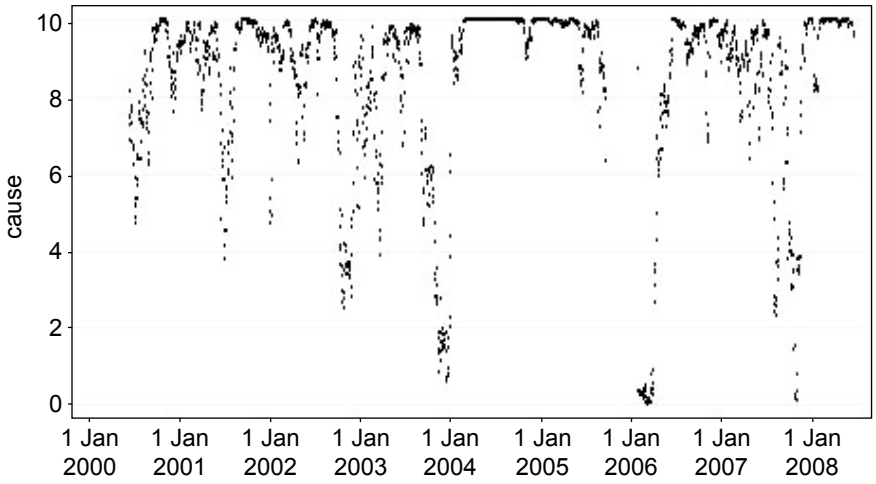
Appendix Figure 3.3: Euro/US$⇒Hard Wheat



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

Appendix Figure 3.4: Euro/US$⇒Rice



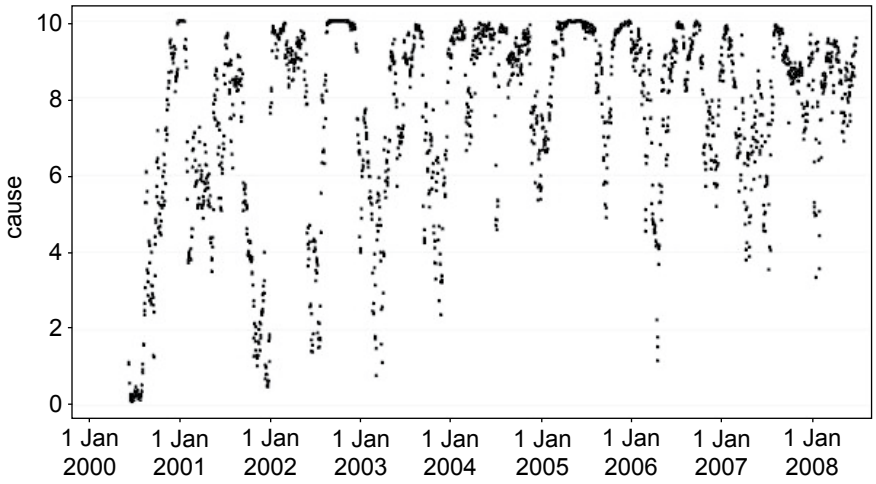
Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

Cross-Commodity Linkages

One broad hypothesis underlying the various explanations for sharply higher food prices on world markets has been the link between oil prices and food commodity prices. As the main body of the report puts it, if high oil prices are here to stay, high food prices are here to stay. The logic of this connection, through biofuel production, depends on medium- to long-run responses by producers and consumers to the profitability of converting corn or vegetable oils into ethanol or biodiesel. But again, financial speculators can see this longer-run potential and convert it into short-run price behavior by investing in futures markets (and other more exotic derivatives). Appendix Figure 3.5 and Appendix Figure 3.6 show how the oil price drives the daily formation of maize and palm oil prices. Again, we need to understand why the periods of strong price linkages come and go.

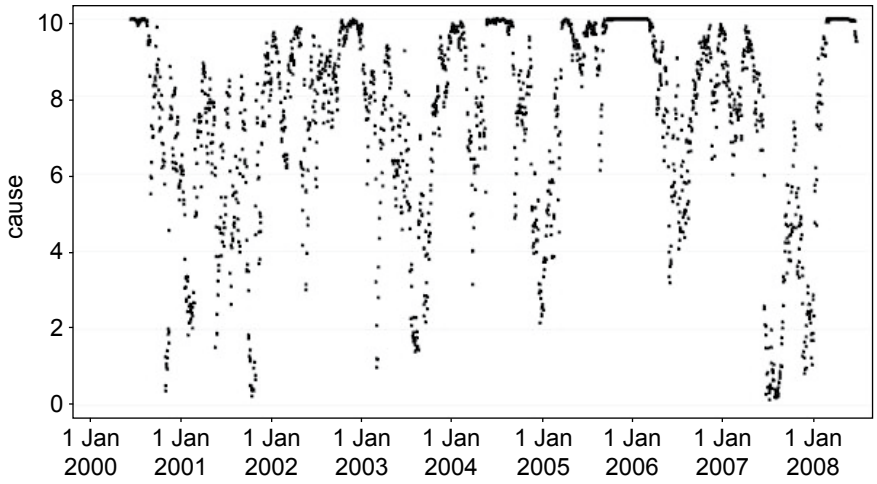
Appendix Figure 3.5: Oil (Brent)⇒Corn (Maize)



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

Appendix Figure 3.6: Oil (Brent)⇒Palm Oil

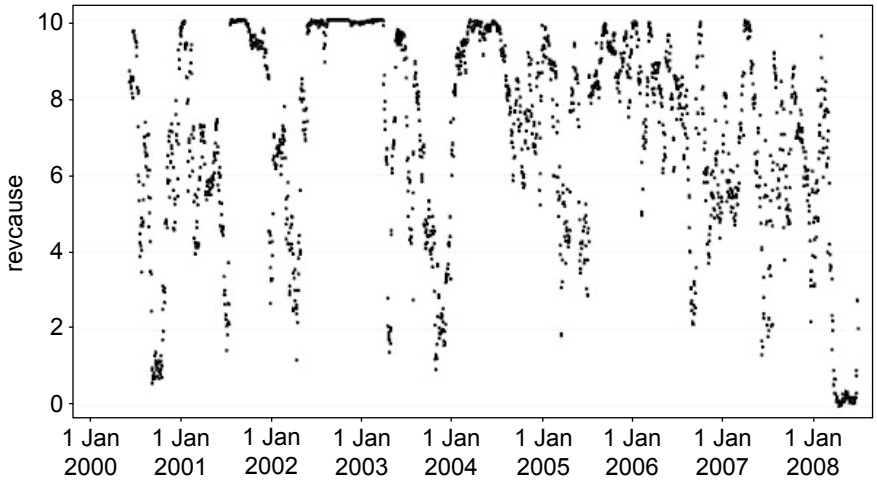


Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

Most commodity analysts think the main connection between the maize market and wheat market comes through livestock feeding, with soft wheat serving as a very close substitute for maize in many feed rations. Appendix Figure 3.7 and Appendix Figure 3.8 test which direction this linkage tends to run in the very short run. Visually, it seems like soft wheat had more of an impact on maize prices before 2004 (Appendix Figure 3.7), with maize having more of an impact on soft wheat after then (Appendix Figure 3.8). Such a change would be consistent with the argument that biofuel demand for maize in the US after 2005 became a much more important driver of maize prices. Formal confirmation of this hypothesis is part of the ongoing research.

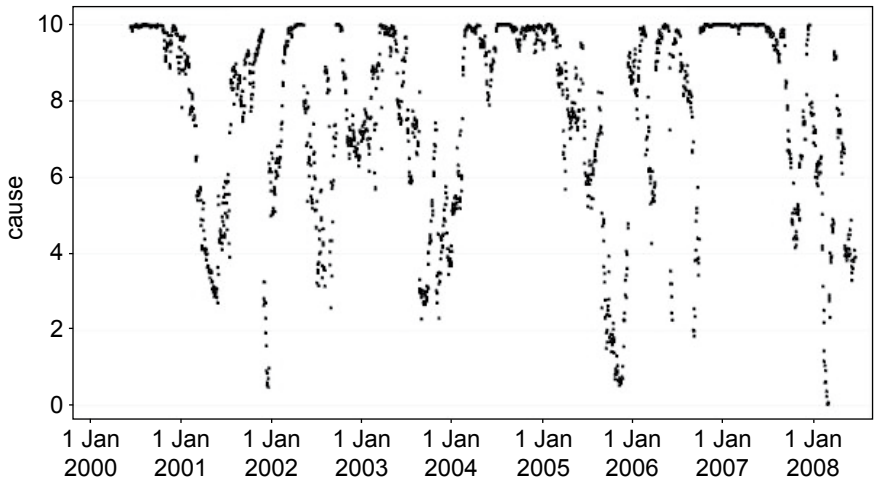
Appendix Figure 3.7: Soft Wheat⇐Corn (Maize)



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇐" indicates the direction of causality.

Source: Author's calculations.

Appendix Figure 3.8: Corn (Maize)⇒Soft Wheat



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

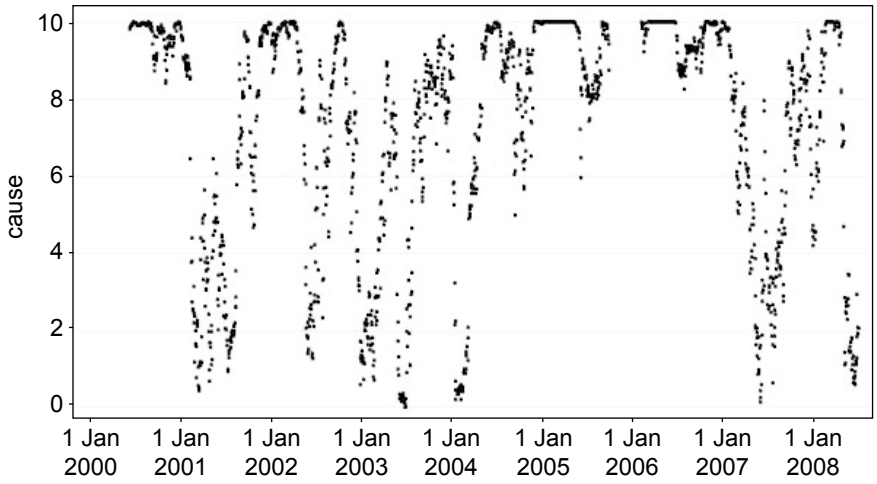
What explains rice price behavior, in terms of cross commodity linkages? Normally, rice behaves as a "special" commodity, driven mostly by national and international balances for the commodity itself, with relatively weak connections to other commodities (Dawe 2008b, c, d). Rice is not used for livestock feed or biofuel production, except in very unusual circumstances. The Japanese, for example, allow their imported rice required by WTO commitments to deteriorate in storage, and then feed it to livestock.

But there are substantial regions in Asia where rice competes with wheat in consumption. Over the long run, commodity analysts expect rice and wheat prices to reflect this substitution and exhibit a relationship that captures the opportunity cost of producing each commodity (at the long-run margin). Although this relationship is likely to be stable only in the long run, with very substantial divergences from year to year, it is apparently important enough for short-run commodity traders to factor wheat prices into expectations about rice prices, and vice versa. Appendix Figure 3.9 and Appendix Figure 3.10, respectively, show the episodes when short-run prices of hard wheat drive rice prices, and when rice prices are driving the prices of hard wheat.

Although the timing of the linkages across all these commodities is not yet understood, it is clear that financial markets must be the main integrator of these markets in the very short run, for daily price formation. The Granger Causality results already show that there are episodes when the rice market is connected to the hard wheat market (in both directions). The wheat market (mostly via the market for soft wheat, which competes at both the production and consumption margin with hard wheat) is connected to the maize market. All of these commodity markets are linked at times to the market for oil and to the rate of exchange between the Euro and the US dollar.

Understanding the timing of these linkages, and what causes their strength to come and go, is the purpose of the next stage of research.

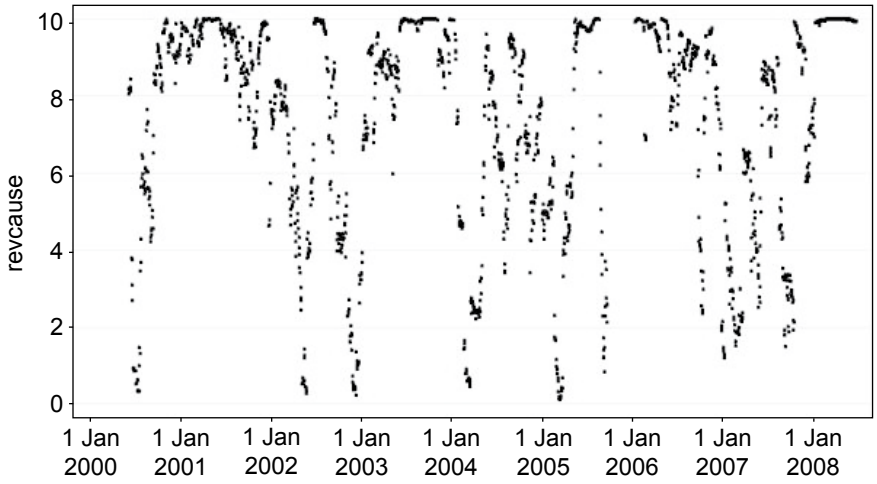
Appendix Figure 3.9: Hard Wheat⇒Rice



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇒" indicates the direction of causality.

Source: Author's calculations.

Appendix Figure 3.10: Hard Wheat⇐Rice



Note: The Granger Causality test is applied on a daily (with 15-day lag) rolling 6-month data starting from 31 December 1999 to 2 July 2008. The symbol "⇐" indicates the direction of causality.

Source: Author's calculations.

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About the Paper

C. Peter Timmer writes about the causes of high food prices, focusing on staple grains—rice in particular—and edible oils. He shows that although food prices have come down from the spikes of early 2008, they are likely to remain higher than they were in early 2007 for years to come. The paper explores the implications for policy and includes a technical appendix that provides the analytical framework of this analysis.

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