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Rethinking the Global Food Crisis

The Role of Trade Shocks

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INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE

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ABSTRACT

From 2003 to their peak in mid 2008, the nominal prices of maize and wheat roughly doubled, while those of rice tripled in a matter of months rather than years. Although fundamental factors were clearly responsible for shifting the world to a higher equilibrium price during this time, there is little doubt that when food prices peaked in June 2008, they soared well above the new equilibrium price. Numerous arguments have been proposed to explain overshooting, including financial speculation, depreciation of the United States (U.S.) dollar, low interest rates, and reductions in grain stocks. However, observations that international rice prices surged in response to export restrictions by India and Vietnam suggested that trade-related factors could be an important basis for overshooting, especially given the very tangible link between export volumes and export prices. In this paper, we revisit the trade story by closely examining monthly data from the largest export markets for rice (Thailand), wheat, maize and soybeans (the United States). In each case, we find that large surges in export volumes preceded the price surges. The presence of these demand surges, together with back-of-the-envelope estimates of their price impacts, suggest that trade events played a much larger and more pervasive role than previously thought. This further implies that improving the international grain markets should be a central focus of the international policy agenda going forward.

Keywords: world food crisis, international grain trade, export restrictions, panic purchases

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1. BACKGROUND

"Since the market events of 1972, most market observers consider exports to be the great uncertainty underlying commodity supply, demand, and price forecasts.31 In 1972, the Soviet Union made unexpected purchases of large amounts of U.S. grain. Prices for corn, wheat, and soybeans climbed to record-levels in 1973, then to still higher levels in 1974. Congress responded by mandating export sales reporting by USDA beginning in 1973." From Ronald Schepf's (2006) Congressional Research Services Report for Congress, entitled "Price Determination in Agricultural Commodity Markets: A Primer".

The surge in international cereal prices over 2007 and 2008 was truly a crisis. From 2003 to their peak in mid 2008, the international prices of maize and wheat roughly doubled, while rice prices tripled in a matter of months rather than years (Figure 1). Yet while the scale of the crisis was on par with the 1973-74 crisis, the most popular explanations of the recent food crisis seem inconsistent with the quote above in that they are largely unrelated to exports or trade. This laundry list of popular explanations includes rising oil prices, growing biofuels demand, evolving Asian diets, declining research and development in agriculture, slowing yield growth, low stocks, macroeconomic imbalances, droughts, and export restrictions. Of these, it is evident that only macroeconomic factors (including exchange rate movements), droughts and export restrictions can be directly categorized under trade shocks (rising oil prices are another possible link, but more indirect). However, few if any observers have emphasized trade shocks as "the great uncertainty" underlying the most recent volatility in food prices. Was this most recent crisis fundamentally different form earlier food crises, or are trade events still a central feature of international price volatility?[1]

Of course, many early analyses of the food crisis were hastily conducted in response to the pressing demands of policymakers and the media, and some of the factors listed above were independent research interests for many years prior to the food crisis (such as evolving Asian diets, declining research expenditures on agriculture, and slowing yield growth) that were then called upon when the crisis hit. Subsequent and more thorough analyses of the crisis eventually did a better job of sorting the wheat from the chaff, albeit with few formal methods and quantitative estimates, and with ongoing debates regarding certain channels of impact (Abbott, Hurt and Tyner 2008, 2009, Headey and Fan 2008, Mitchell 2008, Piesse and Thirtle 2009, Schepf 2008). Importantly, these subsequent studies distinguished between long-run drivers of food prices (meaning those that appeared to be moving the world from a lower to higher food-price regime) and short-run factors that led to the so-called "overshooting" of food prices in late 2007 and the first half of 2008.

Topping the list of long-run drivers is the biofuels demand that has emerged over the past decade. This entirely new demand source consumed as much as 30 percent of the U.S. maize crop in 2007/2008, presenting a very tangible explanation for the switch to a higher food-price regime. Rising oil prices, which have been driven by long-run demand and supply factors as well as by short-run overshooting forces, are also estimated to have substantially increased the cost of agricultural production and trade, even beyond their impacts on the demand for biofuels. Another hypothesis (albeit one that has raised some debate) is that diet changes in fast-growing Asia helped drive the price surge. Virtually all of the abovementioned studies rejected this hypothesis on the grounds that China and India are essentially self-sufficient in cereals, while Indonesia (which is often a large cereal importer) has actually decreased its cereal imports in recent years. However, for a number of years now China and India have significantly contributed to the surging demand for oil (Headey and Fan 2008), and in more recent times substantially decreased their grain stocks (largely because of policy choices rather than surging demand), and imposed export restrictions that had large impacts on the grain markets (see below).

On the supply side, Timmer (2009), Abbott, Hurt, and Tyner (2009), and Piesse and Thirtle (2009) have all argued that the long period of low real food prices in the 1980s and 1990s led to under-

[1] See Abbott, Hurt, and Tyner (2008) for a summary of publications on the food crisis.

investment in agricultural production. Consistent with this hypothesis, global food demand outstripped production for a number of years prior to the food crisis. Because of the buffer provided by the depletion of stocks, however, prices did not rise and farmers failed to increase production. However, Headey and Fan (forthcoming) reject the notion that there was any crisis in global grain production. Instead, their examination of grain production data show that the global-level decline seen from the 1980s to 2006 was chiefly due to decreased grain production in the former Union of Soviet Socialist Republics (USSR). However, the former USSR countries have actually increased their exports since the end of the Cold War, suggesting that: (a) their decline in production did not contribute to rising export prices; and (b) the region was engaged in over-production under central planning. Fuglie (2008) also reported that although he found strong regional variations, there was no evidence of a productivity slowdown in global agriculture.

Perhaps more pertinent than production trends is the aforementioned role of stocks, which constitute an important buffer against the various shocks that inevitably hit agricultural markets. Writers such as Abbott, Hurt, and Tyner (2009) and Piesse and Thirtle (2009) saw stock declines as a major factor, but acknowledged that stocks (being a residual factor) were depleted because of deeper factors (such as surging demand for biofuels and strong economic growth) and conscious policy decisions. Headey and Fan (2008) stressed the importance of deeper factors, particularly the Chinese government's decision to reduce excessive stocks at the start of the decade. When the data from China were excluded, global stock declines were still evident, but they were far less stark (Headey and Fan 2008). Nevertheless, since stocks act as a price buffer, the reduction of major grain stocks could help explain the overshooting of food prices in 2007/2008. The logic here is that relatively ordinary factors, such as droughts in one or two major grain producers (for example, Australia and the Ukraine), can have an amplified effect when stocks are low. Piesse and Thirtle (2009) also argue that the decline in stocks encouraged speculation. However, most other independent researchers, save for Robles and Cooke (2009), have failed to identify financial market speculation as a leading factor. In the case of rice, Timmer (2009) argued that the large number of small producers and traders meant that the information available on the true level of stocks was unreliable, thus encouraging speculation, hoarding and panic purchases. Indeed, nearly all writers on this issue have identified export restrictions as significant determinants of price overshooting in late 2007 and 2008, especially in the relatively thin international rice market.

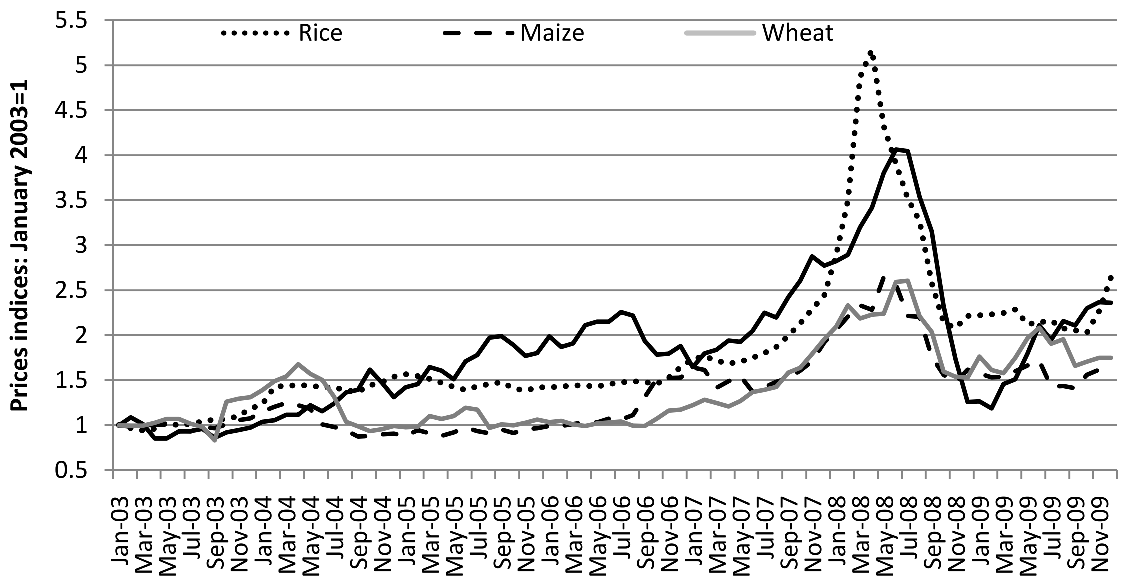
Finally, macroeconomic imbalances have long been regarded as a significant channel of overshooting in commodity markets (Frankel 1984, Schuh 1974). Low real interest rates and crises in the housing and stock markets, especially in the United States, could have caused money to flow out of interest-bearing instruments and into foreign currencies, emerging market stocks, other securities, and commodities (for example, food commodities). This portfolio shift would be projected to drive the prices of these assets higher and higher until they reached a level where people perceived that they lay "sufficiently" above their future long-run equilibrium levels. Monetary policy therefore could cause real commodity prices to increase more than other prices that are "sticky" relative to commodities. Thus, because of differences in price-adjustment speeds and arbitrage conditions regarding price expectations and interest rates, commodity prices and other asset prices overshoot in real (and often in monetary) terms.

This hypothesis is consistent with the general increases seen in both food and non-food commodities. In addition, Frankel (2006) provided econometric evidence supporting the inverse relationship between commodity prices and real interest rates in the United States dating back to the 1950, and subsequently argued that more recent data (before and after the commodity price peak in mid 2008) were consistent with both the historical evidence and the overshooting hypothesis (Frankel 2008). However, this theory predicts that commodity stocks should be high when interest rates are low, which would seem to be contradicted by the available data.

Perhaps the more important effect of low real interest rates and the large U.S. trade deficit was the depreciation of the U.S. dollar. Since the United States is a large grain exporter, depreciation of the dollar could have significantly boosted U.S. agricultural exports, leading to higher prices in the United States and lower price increases elsewhere (all else being equal). Previous research has indicated that depreciation of the dollar increases commodity prices with an elasticity of between 0.5 and 1.0 (Gilbert

1989). Taking 0.75 as a midpoint elasticity, Mitchell (2008) calculated that the depreciation of the dollar increased food prices by around 20 percent during the recent crisis. Comparing the recent spike in food prices with historical episodes, Abbott, Hurt, and Tyner (2009) argued that the weak dollar accounted for closer to 50 percent of the recent spike. However, the econometric evidence regarding the impact of dollar movements on commodity prices has so far failed to provide a consensus on the importance of exchange rate movements (Orden and Cheng 2007, Piesse and Thirtle 2009).

Figure 1. Trends in the nominal prices of cereals and oil: January 2003 to May 2009



Source: calculated by the authors from IMF (2009). All prices are deflated by the US Bureau of Economic Analysis gross domestic product (GDP) deflator, available at http://www.bea.gov/national/index.htm#gdp

In summary, the food crisis was clearly a complex phenomenon with multiple (often interacting) causes. Given the very sharp food-price drop seen in July of 2008 (Figure 1), it seems that there is a legitimate dichotomy between long-run price shifters and the factors responsible for overshooting. Here, we chiefly focus on the overshooting effect; our goal is to explore the notion that trade events significantly contributed to the overshooting of grain prices. Although we believe that trade events have been somewhat discounted as a cause of the food crisis, this was not the case in the rice markets, where export restrictions by India, Vietnam and others have been widely viewed as the main culprit. In addition, Dollive (2008) highlighted the importance of export restrictions in the wheat and maize markets, and various works have noted large panic purchases of rice by the Philippines in the first quarter of 2008, when prices were already high.

In this paper, we go one step further by actually tracking monthly trade volumes in the world's largest grain markets: the United States for maize and wheat, and Thailand, Vietnam and India for rice. Since export volumes are presumably the most direct determinant of export prices, the detection of export-volume surges preceding price surges is taken as providing a strong indication that trade events were important to the overshooting of world food prices. A second objective of this paper is to estimate the importance of trade events in determining food price movements. Although this is difficult to assess in the absence of reliable econometric or modeling evidence (Section 2), we use back-of-the-envelope calculations similar to those reported by Mitchell (2008) and Timmer (2009) to provide ballpark estimates. Our third and final objective is to shed some light on the behaviors that have driven trade events over the past few years, including the importance of political-economy factors. Although the broad range of countries involved make it difficult for us to strictly define these behaviors, we identify events in the rice market that clearly point to the importance of governments in determining trade outcomes through export restrictions and government-to-government panic purchases (although we use the more general terms of “demand surges” or “import surges”). Both export restrictions and import surges effectively served to restrict grain supplies to the rest of the world at a time when larger supplies were needed. Hence, we find that trade events potentially provide an explanation for how a tightening of the world food situation rapidly turned into a full-blown crisis.

2. A SHORT NOTE ON METHODS

As we noted above, most of the prior studies on the crisis lack formal analyses such as simulation models or time-series econometric analyses. In fact, the very nature of the crisis revealed the limitations of existing methods.

Let us take the case of simulation models. Organizations such as the Food and Agricultural Organization, OECD, USDA, and IFPRI all have global simulation models that predict (among other things) the effects of various economic trends and policy actions on food prices. However, although these models gave some indications that food prices would increase (von Braun, et al. 2005), they are largely used to forecast prices 10-15 years in the future, and none of them really predicted the food crises observed in 1974 and again in 2008.

Indeed, we doubt that these models could have predicted the scale of the recent crisis, even retrospectively. For one thing, these models rely on crucial supply and demand elasticities that are typically derived from econometric estimates relating to the behavior of individual agents (consumers and producers) acting under normal conditions (including normal policy conditions). However, prices rose abnormally fast during the food crisis, thus encouraging panic buying, precautionary purchases, hoarding, and so on. This meant that the effective short-run demand and supply elasticities experienced value changes and even sign switching. This was largely because of government policies; there were numerous export restrictions and government-to-government purchases, and some governments (for example, Argentina) changed their export policies every few months throughout 2007 and 2008 (see below for more detail).

We do not mean to imply that the existing simulation models are useless, however. They successfully gave some early warning that biofuels might be a problem for food prices, and the recent OECD-FAO (2009) model has yielded interesting quantitative estimates on the current drivers of world food prices. Here, we are simply saying that the timeframes and research questions addressed by the existing models are imperfectly suited for studies aimed at fully understanding the food crisis.[2]

Given this, one might be tempted to think that time-series econometric techniques could be a more promising approach, especially since they can utilize monthly or even weekly data, as in the commendable effort of Robles and Cooke (2009). This might be true in principle, but in practice we are highly skeptical of the capacity of time-series techniques to really unravel the drivers of short-run price movements. For example, if supply and demand elasticities experiences changes in their sizes and signs during a crisis, then time-series data obtained before the crisis become irrelevant. However, since the price surges in question occurred over the space of a few months, restricting the sample to 2007 and 2008 would give us only twenty or so observations (that is, in the case of the monthly data used by Robles and Cooke).

A second set of problems relates to specification. In the absence of a theoretical structure, we have little guidance in structuring econometric commodity price models. Time-lag structures could be unstable, and one would typically expect a range of interaction effects (such as low stocks exacerbating the effects of all sorts of supply and demand shocks) or significant substitution effects between crops (such as maize and soybeans compete for land in the United States). However, Robles and Cooke did not find any significant substitution effects, nor did they model any interaction effects. Moreover, in even greater contrast to prior expectations, their estimates yielded some very anomalous results, such as oil prices having a significantly negative effect on maize prices, despite the contribution of oil prices to maize production costs and biofuels demand.

Finally, the identification of causality remains problematic, even with the use of Granger causality tests. This is especially true regarding tests of financial speculation, because expectations are

[2] We thank an anonymous reviewer of the discussion paper version of this manuscript for pointing out that a more sophisticated model of consumer and producer behavior (that is, where agents form price expectations based on recent price movements, stock-to-use ratios, and other market information) could potentially generate the kinds of hoarding and precautionary purchases witnessed during the crisis. However, it is inherently more difficult to model government behavior.

vitally important to both the futures market and the spot markets. Hence, justified expectations of higher prices could drive up activity in the futures market, which could in turn drive up spot-market prices. However, this would not necessarily signal that speculation was a cause of the crisis. Christmas cards may Granger-cause Christmas, but they are hardly a real cause of Christmas (Atukeren 2008).

In light of these problems with both simulation models and time-series econometrics, we are left with something of a methodological vacuum. Hence, our present analysis is more of an event analysis, in that we treat the crisis as a distinct event for which information from normal years can be treated as largely irrelevant.[3] Accordingly, we chiefly rely on descriptive data and a historical analysis of policy events, and use small bits of econometric analysis and back-of-the-envelope calculations to support specific arguments. Although we hope to persuade readers that this less technical approach yields some new and important insights into the crisis, we acknowledge that this lack of rigor is less than ideal. Future simulation and econometric work could perhaps improve on our relatively descriptive analysis by incorporating more flexible modeling techniques (for example, switching models time-varying parameters) or creating simulation models that account for more complex behavioral functions and political-economy factors (such as hoarding, precautionary purchases, and perhaps even "panic"). Indeed, we hope that our somewhat informal analysis will stimulate interest in such future work.

[3] Implicitly, we believe that other writers in this literature also engage in event analysis. Abbott, Hurt, and Tyner (2008), for example, compare dollar depreciations across previous food spikes (1995/96 and 1973/74) rather than examining data for all years.

3. RICE MARKETS

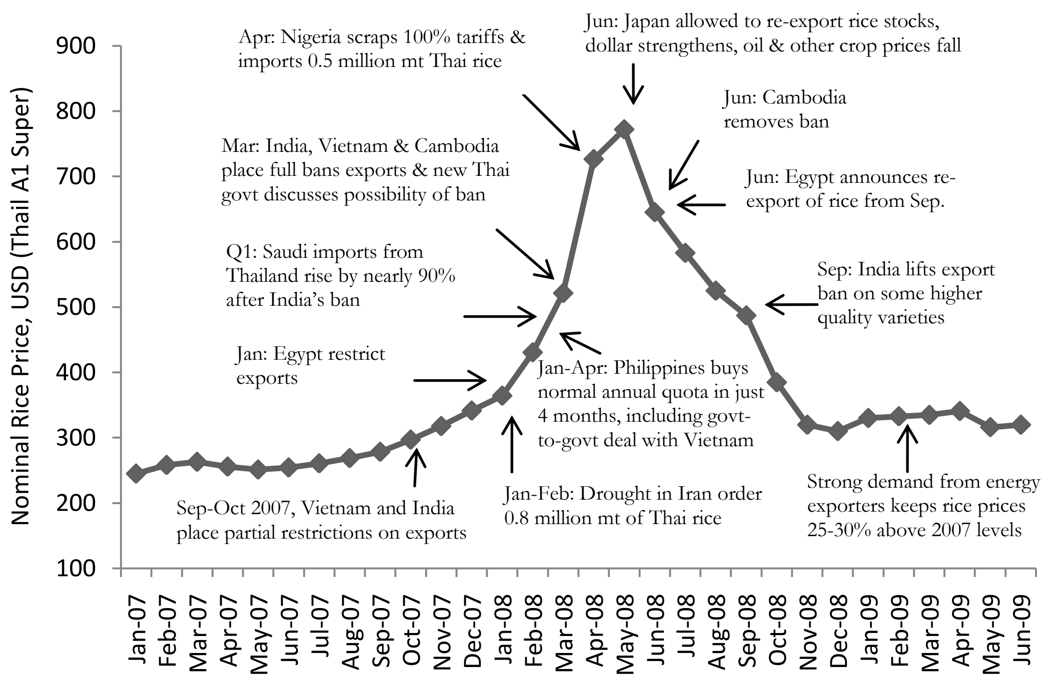
By beginning our work with an analysis of rice-market events, we intentionally begin at the end of the crisis rather than the beginning. As shown in Figure 1, rice prices started to rise in early 2007 (much later than maize prices and just after the first surge in wheat prices), and then surged dramatically beginning in December 2007. Rice is distinctive in that it is thinly traded; only around 25 million metric tons (mmt) have typically been traded in recent years, or about 7 percent of global production. Rice is also heavily dominated by Asian exporters (Thailand, India and Vietnam account for 60 percent of global exports), mostly produced by smallholders, and forms a large proportion of the diets of millions of people (Timmer 2009). Thus, rice is very important to numerous Asian governments, and is subject to a variety of trade distortions even in normal times. In addition, rice prices are highly sensitive to hoarding, precautionary (or panic) purchases, and export restrictions. Overall, this commodity is widely acknowledged to be a special case relative to other grains. Therefore, it should be neither difficult nor controversial to demonstrate that discretionary trade actions caused a surge in rice prices. However, we herein show that the story is perhaps even stronger than previously thought, and that there is an important link between wheat and rice prices.

The usual story told about rice markets is demonstrated in Figure 2 (see, for example, Headey and Fan 2008; World Bank (2008). The beginning of the surge in rice prices coincided with the October 2007 decisions of Vietnam and India to restrict rice exports. According to the United States Department of Agriculture (USDA),[4] Vietnam placed a partial ban on new sales because it had over-sold in the global market, and the government was concerned about rising domestic food prices. India announced a minimum export price in response to rapid increases in domestic food prices; these were due, not to rapid economic growth, but rather to a severe drought that dramatically affected wheat production. In fact, India had already banned wheat exports earlier in the year, and both wheat and rice are the staple grains of the government's Public Distribution Scheme (PDS) (see below).

Wheat and maize prices had already risen sharply in 2006 and early 2007. Since India and Vietnam each accounted for around 15 percent of global exports, their decisions spread further panic into the world cereal markets. Figure 2 also shows that in early 2008, full export restrictions were imposed by Egypt in January, and by Cambodia, India, and Vietnam in March. These restrictions seemed to coincide with widespread panic among major rice importers. One of the largest net importers of rice, the Philippines, engaged in panic buying, importing 1.3 mmt of rice in just the first four months of 2008; this amount exceeded their entire import bill of 2007. Most of these imports were sourced from Vietnam in a government-to-government deal. Nigeria, also among the largest importers of rice, waived its 100 percent tariff on rice in early 2008 and procured 0.5 mmt from Thailand. Anecdotal evidence suggests that Saudi imports from Thailand rose by nearly 90 percent after India's export ban. A drought plus high inflation also caused concern in Iran, which ordered 0.8 mmt from Thailand.

[4] See http://www.ers.usda.gov/news/ricecoverage.htm.

Figure 2. The effects of export restrictions on rice prices



Source: Authors' construction based on the collation of various media articles and USDA Foreign Agricultural Service reports.

Granted, the run in rice prices couldn't last forever. Rice prices were so high in May 2008 that even cashed-up oil exporters were reluctant to buy at such inflated prices. In May, Japan was permitted to re-export some of its rice stocks, and although it has been reported that these re-exports never actually took place, the announcements probably helped calm the markets(Nakamoto and Landingin 2008).[5] In any event, the turnaround in late May was followed by further price declines after Cambodia and Egypt eased their exported restrictions in subsequent months, and India started allowing some exports of higher-quality varieties. The prices of oil and other cereals began to drop from June 2008 onwards, and the U.S. dollar re-appreciated. If speculative hoarding were also at play (Timmer 2009), then it would have petered out as speculators realized that prices could not continue to rise. No doubt all of these factors contributed to the fall in prices.

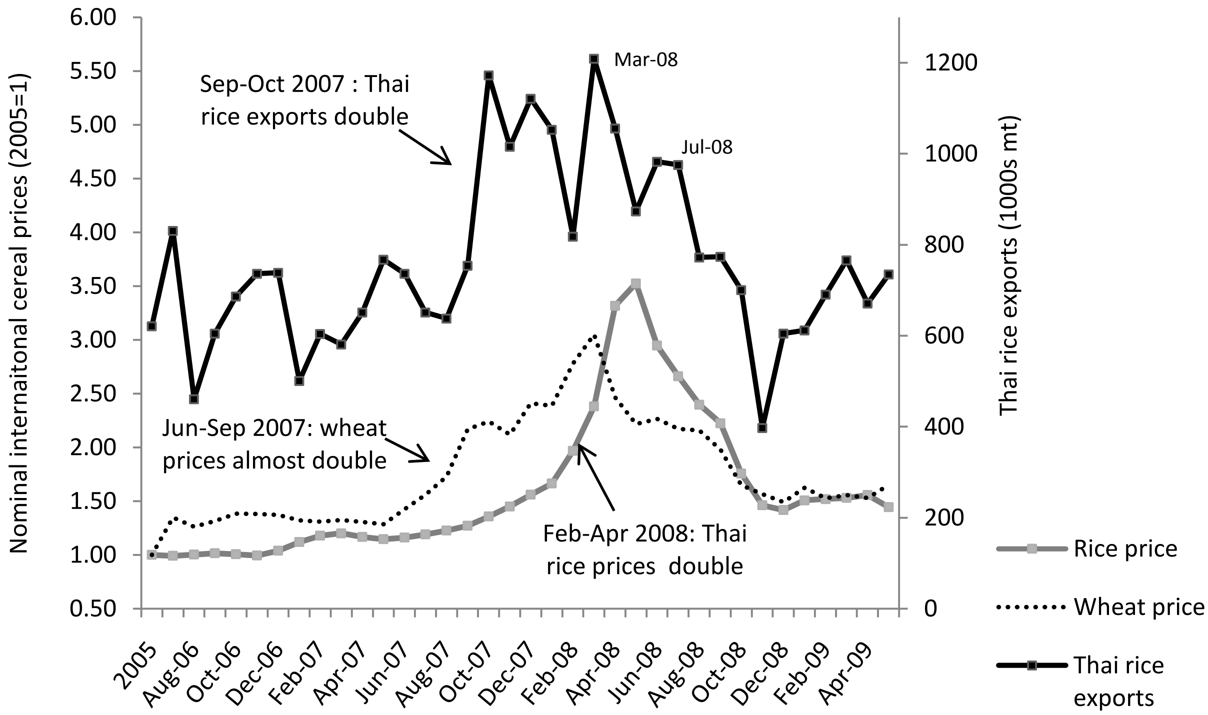
The above account of events in the rice market is conventional; similar stories are told in several other studies (Abbott, Hurt and Tyner 2008, 2009, Headey and Fan 2008, Mitchell 2008, World-Bank 2008). However, the Vietnamese and Indian governments' decisions to restrict rice exports cannot be treated as exogenous events. In fact, the major rice export markets were under tremendous pressure prior to these restrictions, and we argue that much of this pressure was a spillover effect from the wheat markets. This is demonstrated in Figure 3, which shows international wheat prices, Thai rice export prices, and monthly Thai export volumes. Here, Thailand's export market is particularly important because Thailand is the largest rice exporter in the world (comprising around 30 percent of global exports), and Thai export data are not biased by export restrictions. Hence, they can be used as a good indicator of demand patterns, including trade-diversion effects and precautionary purchases.

The chronology of Figure 3 is as follows. First, wheat prices almost doubled from June to September 2007. In September and October, the demand for Thai rice exports doubled within virtually a single month. These levels stayed high well into 2008, even as rice prices surged. A similar surge in mid 2007 is also evident in the Indian rice export data (Figure 4). From April 2007 until the ban on rice

[5] This is anecdotal information, but the USDA data do not indicate any increase in Japanese rice exports.

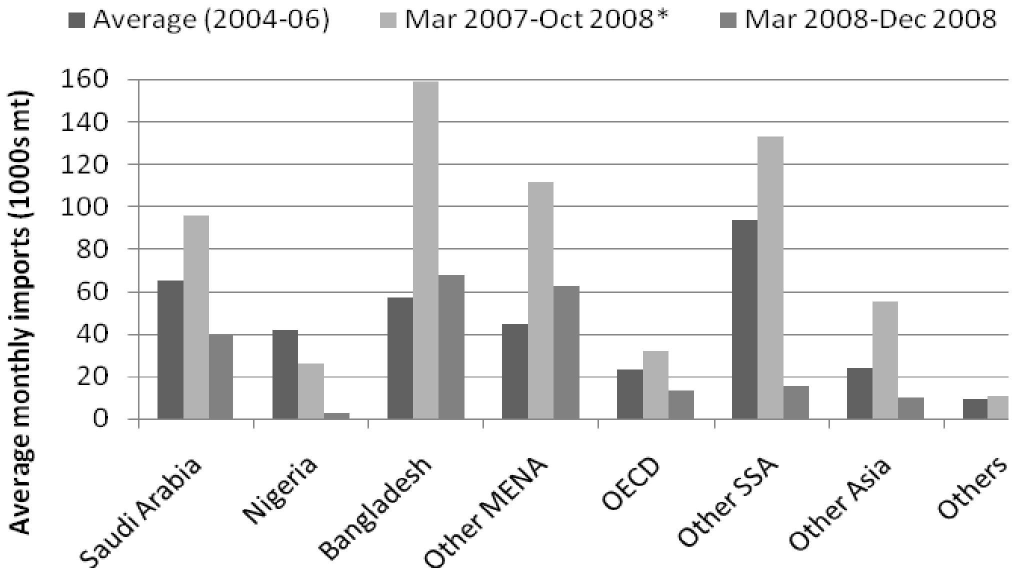
exports in November 2008, there was a large surge in demand for India's rice exports from Bangladesh, the African countries, the Middle East and North Africa (MENA), and several Asian countries. The Vietnamese export data also demonstrate that there was a strong demand for their rice exports prior to the first export restriction in October; indeed, the government pointed to over-selling in international markets as a rationale for the export restriction. The surge was milder in Vietnam, where rice exports were only 8 percent higher in the first nine months of 2007 than they were in the corresponding period of 2006.

Figure 3. Wheat prices, rice prices, and the surge in demand for Thai rice exports



Source: Thai rice export data are from the Bank of Thailand (2009) while rice and cereal prices are from FAO (2009a).
Abbreviation: mt, metric tons.

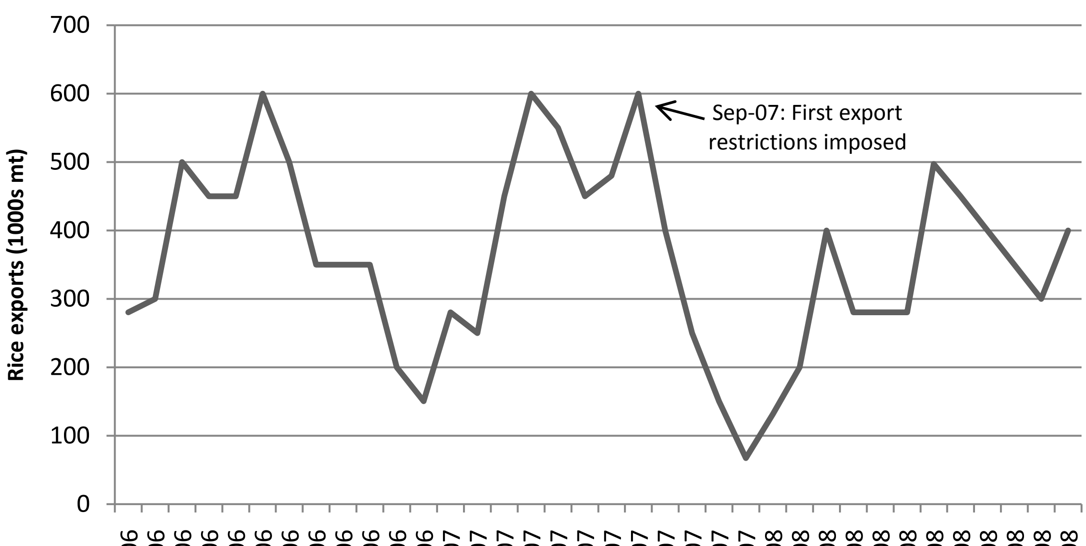
Figure 4. Average monthly Indian rice exports by destination: 2004-2008



Source: Department of Commerce, Government of India. http://commerce.nic.in/eidb/Default.asp

Notes: Abbreviations: MENA=Middle East and North Africa; SSA=Sub-Saharan Africa. *We were only able to obtain annual figures for the year running from March to February. Since annual figures disguise the surge in Indian rice exports from March 2007 to October 2007 (due to the rice export ban from November onwards), we obtained an estimate of monthly rice exports for March 2007 to February 2007 by dividing the annual figure (March 2007 to February 2007) by eight months instead of 12. Bangladesh, Bhutan and 'Other SSA' countries were the exception here; these countries were excluded from the export ban, so their annual figures were divided by 12.

Figure 5. Monthly rice exports from Vietnam, 2006-2008



Source: General Statistics Office of Vietnam (GSO 2009); http://www.gso.gov.vn

The Thai and Indian export data demonstrate particularly well that the international demand for rice experienced a sharp increase directly after wheat prices rose. How can we explain this apparent connection between wheat and rice? We contend that the connection is twofold. First, India is a large producer and consumer of both wheat and rice. A poor wheat harvest in 2006/2007 put pressure on India's wheat stocks and the country's PDS (which keeps stocks of both wheat and rice). In 2006/07, the government's stocks of wheat fell short of buffer stock norms, and about 6 mmt of wheat was imported. Although rice was in surplus, and India exported more than 4.5 mmt of rice that year, the fear of a food shortage weighed heavily on policymakers, especially given that international wheat prices were surging sharply in early to mid 2007, and export restrictions on wheat were beginning to emerge. Thus, if we look at it purely from the Indian point of view, there was a very strong connection between events in the domestic wheat and rice markets.

However, there is also a strong but not widely recognized connection between wheat and rice on the international scale. Specifically, wheat prices can have a strong impact on rice prices, rather than vice versa. This is because:

(a) the demand side of the international rice markets is quite concentrated, whereas the wheat markets are large and much less concentrated; and
(b) many of the largest rice importers, who can substantially affect rice prices because the market is so thin, are also large wheat importers or consumers.

Table 1 lists wheat and rice consumption and trade data for the largest rice importers. All of the countries listed in Table 1 imported at least 0.7 mmt of rice per year prior to the crisis, and together they comprised around a quarter of the world's rice demand. Moreover, many of these countries were either large rice consumers (Iran, Iraq, Saudi Arabia, and the European Union (EU)) or large rice importers (the Philippines, Nigeria, Indonesia, and Japan). There is a strong correlation (around 0.40) between wheat and rice imports across countries, whereas rice and maize have a lower degree of correlation (0.20). Finally, using monthly data from 1957 to 2009, we find that wheat prices Granger-cause rice prices (but not vice-versa), with an elasticity of around 0.10. When wheat prices surged in early to mid 2007, it seems probable that many of these countries switched some of their cereal demands over to rice. Thus, it appears that the Indian government's decision to ban rice exports at the beginning of November 2007 was based on its own poor wheat harvest plus increased demand for its rice exports.

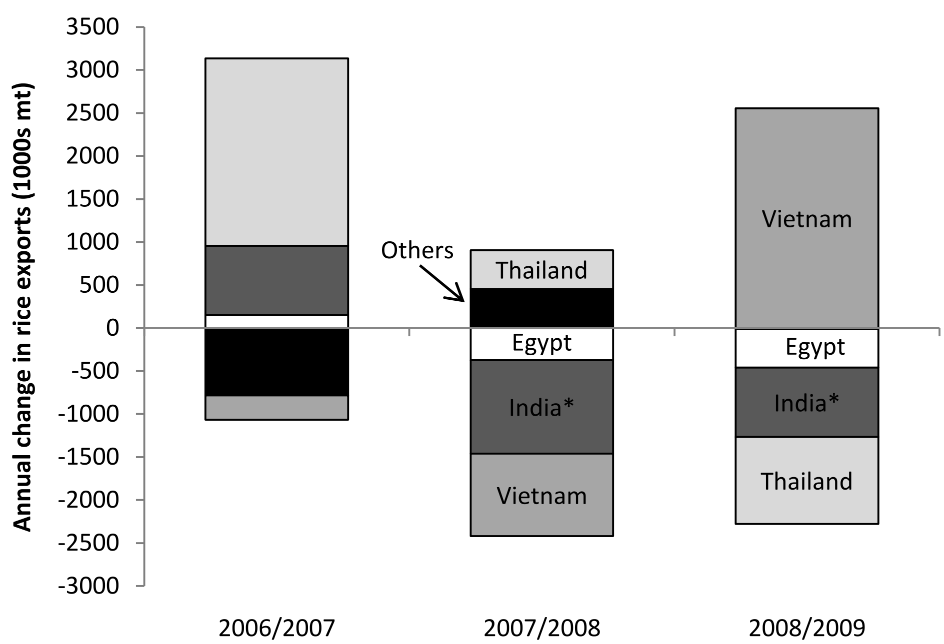
The next question we ask is: How much effect did these trade events have on international rice prices? In Figure 6, we decompose the changes in exports by the major net exporters, as well as the trend in world prices along with changes in world exports (lines). In calculating these world exports, we exclude India's exports to Bangladesh because India's export restrictions did not apply to Bangladesh (as well as its other, much smaller neighbor, Bhutan). When we treat such trade as "domestic," we find that world exports/imports declined by almost 1.9 mmt from June 2007 to July 2008. Furthermore, we see that India was almost solely responsible for the decline in global rice exports in 2007/2008 (bars). Egypt restricted exports in the second part of 2008, but given that it was a much smaller player, the decline in Egyptian rice exports is estimated to be fairly inconsequential. Although Vietnam restricted exports in September 2007, it made a large government-to-government contract with the Philippines for 1.5 mmt in March of 2008, so its exports in 2007/2008 actually rose slightly. These nuances, particularly the differences between the "direct" effects of trade shifts and their indirect psychological impacts, should remind us that the calculations given below are indicative at best.

Table 1. Connections among wheat consumption, wheat imports, and rice imports

	Dependence on wheat in diets & trade			Importance in rice trade	
Largest rice importers	Wheat consumption (% total calories)	Wheat imports (mmt)	Share in world imports (%)	Rice imports (mmt)	Share in world imports (%)
Philippines	8	8.3	2.5	1.6	3.1
Nigeria	5	10.0	3.0	1.5	2.8
Iran	45	1.7	0.5	1.4	2.6
Saudi Arabia	28	0.2	0.1	1.3	2.4
EU-27	20*	19.0	5.7	1.2	2.2
Indonesia	6	15.4	4.6	1.0	1.9
Iraq	45*	10.9	3.3	0.9	1.7
Cote d'Ivoire	5	0.9	0.3	0.8	1.5
South Africa	16	3.5	1.0	0.8	1.4
Malaysia	15	3.8	1.1	0.8	1.4
Japan	13	17.0	5.1	0.7	1.3

Source: Wheat consumption data are from the FAO (2009b). Trade data are from USDA (2009c). *Wheat consumption data for Iraq were not available and were approximated using data from Iran, which has a similar diet. Wheat consumption data for the EU were approximated by averaging data for Germany, France and Spain. Data relate to 2004-2006.

Figure 6. Decomposing annual changes in rice exports before and after the crisis



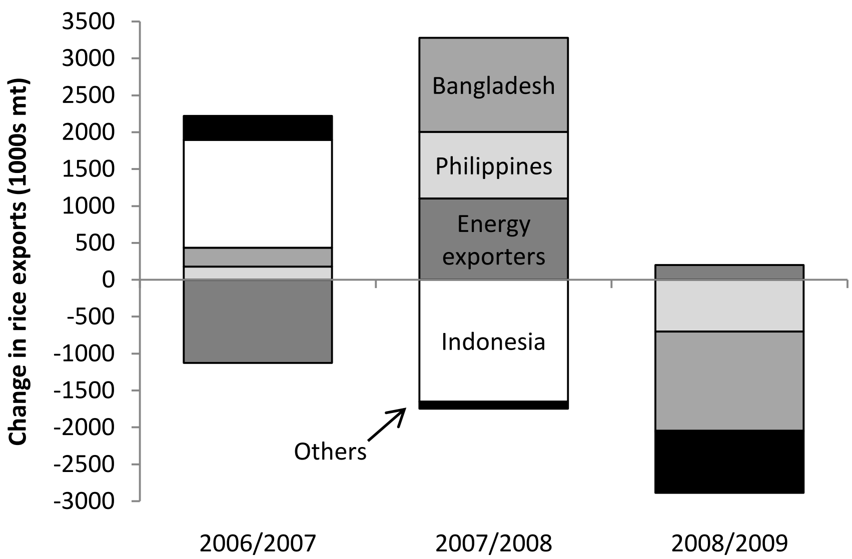
Source: Authors' calculations based on USDA (2009c) trade data, Vietnamese (GSO 2009) trade data and FAO (2009a) price data.

Figure 7 shows the demand side of the equation. Although this story is less dramatic, we see that rice imports still rose in 2007/2008 despite the surge in prices.[6] Some of the big players were still driving growth in imports through large purchases, including panic purchases by the Philippines, the surge in

[6] In Figures 5 and 6, the changes in "world exports" are not equal because we exclude Bangladesh from the world exports.

imports in Bangladesh following rice losses due to monsoon flooding and the impact of Cyclone Sidr (November 2007), and a surge in rice imports from energy-exporting countries that are generally large net importers of cereals (such as Saudi Arabia, other Persian Gulf states, and Nigeria). Fortunately, one of the large emerging economies that is regularly listed in the "changing diets" hypothesis, namely Indonesia, significantly cut its rice imports in 2007/2008, to the point that it was virtually self-sufficient that year.

Figure 7. Decomposing annual changes in rice imports before and after the crisis



Source: Authors' calculations based on USDA (2009c) trade data and FAO (2009a) price data.

Now that we have accounted for the sources of the observed changes in rice trade, we can use some back-of-the-envelope calculations to assess what kind of impacts trade actions might have had on world prices. To do so, we borrow the following model of cereal price transformation from Timmer's (2009) analysis of the crisis in global rice markets. For brevity, we omit the derivation and simply present the final model, which is:

$$p_t = (b_t - a_t)/SR + p_{t-n}(LR/SR) \quad (1)$$

where p is the percentage change in prices at time t or t-n; b and a are demand and supply *shifters* such as export restrictions or panic purchases (meaning we think of them as exogenous shifts in the supply and demand curves rather than normal responses); *SR* is the net short-run demand response (the difference between the short-run demand and supply elasticities, sr_d and sr_s, respectively); and *LR* is the net long-run demand response (the difference between the long-run demand and supply elasticities). For our purposes, we only need (b_t- a_t) and *SR*, because we are not interested in the long run (LR). We will be adjusting a_t and b_t based on our derivations of counterfactual situations in which exports were not reduced because of policy restrictions, and imports were not scaled up because of panic. The second assumption we must make is the value of SR, the net short-run demand response, which is equal to sr_d - sr_s. In the case of rice, which has a highly inelastic demand, Timmer (2009) assumes that the short-run demand-response parameter (sr_d) is -0.10. Since rice is mainly produced by smallholders, the supply response (sr_s) is also expected to be low at +0.05, especially given rapid surges in the price of fertilizers (upon which Asian farmers are heavily dependent), and the combination of rising prices for competing crops and quite severe land constraints. Hence, the short-run supply response is +0.05, implying that SR = -0.15.

Although some of these arguments would appear to justify relatively inelastic short-run demand and supply responses, we acknowledge that these assumptions are speculative. For example, although fertilizer prices rose, many Asian countries have highly insulated fertilizer markets, making a larger supply response quite feasible. Furthermore, although all food prices rose, they did so unevenly, such that there may have been important substitution effects. We must therefore examine precisely what we mean by “short run,” since this will affect our judgment as to whether the assumed elasticities are too high or too low. Timmer (2009) states: “The short-run elasticities assumed here are quite low, but realistic for annual responses.” However, since we are using monthly data, we may think of these short-run demand and supply responses as relating to the space of a few months rather than an entire year (of course, the instantaneous supply and demand responses will approach zero). In any case, one advantage of this back-of-the-envelope approach is that it makes sensitivity analysis exceptionally easy (see below).

These back-of-the-envelope calculations regarding the impacts of trade events on rice prices are presented in Table 2 for 2007/2008. We begin with exports. Essentially, we recalculate world exports based on the assumption that Indian, Vietnamese and Egyptian rice exports were the same in 2007/2008 as they had been in the previous year. From this, we see that world exports in 2007/2008 would have been 4.1 percent higher if India had kept its exports unchanged from 2006/2007, and 3.6 percent higher if Vietnam had maintained its exports. As Egypt is a relatively small player in world trade, its ban appears to have had a limited effect. Using the above net short-run demand elasticity, we calculate that these three countries drove up rice prices by around 60 percent.

However, our results suggest that demand-side factors were even more important, particularly the large increases in purchases from the Philippines, a group of energy exporters, and Bangladesh.[7] Each of these large import surges could have increased rice prices by 20-30 percent. At the bottom of Table 2, we sum the individual changes to estimate the total change in rice prices that could plausibly be due to these export restrictions and import surges. We find that export restrictions and panic purchases appear to explain a 140 percent increase in world rice prices in 2007/2008. Since actual Thai export prices rose by around 115-145 percent over this period (depending on the variety), the examined export restrictions and import surges appear to account for the entire surge in rice prices. Notably, these results are broadly consistent with the more sophisticated counterfactual modeling exercise reported by Mitra and Josling (2009). Their model used econometrically derived elasticities and looked at potential price changes in India without the export ban. Their results suggested that rice prices increased about threefold because of the export ban; this approximates the actual price increase seen over the period in question, and is similar to our own results (Table 2).

That being said, our results should only be interpreted as indicative since they arise from an unsophisticated model that uses “best guess” assumptions. If, for instance, our short-run demand and supply elasticities were doubled (meaning our net short-run supply elasticity becomes -0.3), then the percentage of the total rice price increase we attribute to trade events would be exactly half of that derived in Table 2 (meaning 70 percent, or at least half of the actual price increases). This “sensitivity analysis” is instructive because even if we take it these alternative assumptions as a lower benchmark, it is quite clear that trade events were the dominating factor in the international rice price increase.

A final caveat is that Table 2 should not necessarily be used to apportion blame. The poor populations of India and Vietnam are many times larger than those in many of the countries that consume Indian rice (especially the Gulf states), so we can legitimately question the impact that these export restrictions had on global poverty. Moreover, countries such as China restrict rice exports in normal times. Had they lifted their restrictions, the crisis might have been averted (Slayton and Timmer 2008).

[7] One issue faced in constructing this table was that government-to-government transactions between India and Bangladesh and between Vietnam and the Philippines actually hid the full impact of the Indian and Vietnamese export restrictions. For example, if we exclude Indian exports to Bangladesh and recalculate the fall in world exports, the 30.3 percent increase in world prices due to Bangladesh’s import surge is added to the impact of India’s export ban. For clarity’s sake, however, we do not make such adjustments here.

Table 2. Estimating the contribution of export restrictions and import surges to changes in international rice prices in 2007/2008 based on a counterfactual of zero change from 2006/2007

	Quantity (1000s mt)	Change from actual exports	Change from actual prices
Actual world trade in 2007/2008	26,674		
Export-side counterfactual			
1. World trade if Egyptian exports were maintained	27,047	1.4%	-9.4 %
2. World trade if Indian exports were maintained	28,540	4.1%	-27.1 %
3. World trade if Vietnamese exports were maintained	27,636	3.6%	24.0%
Import-side counterfactual			
4. World trade if Philippine imports were maintained	25,774	-3.4%	-22.5 %
5. World trade if Bangladeshi imports were maintained	25,579	-4.1%	-27.4 %
6. World trade if energy exporters' imports were maintained	25,579	-4.1%	-30.3 %
Total price changes			
Change in prices due to export restrictions (1+2+3)			60.5 %
Change in prices due to import surges (4+5+6)			80.2 %
Change in prices from both (1+2+3+4+5+6)			*140.7 %*
*Actual change in prices: July 2007 to June 2008**			*115-145%*

Source: Authors' calculations from USDA (2009c) data on exports and imports. Rice prices are Thai export prices reported by the FAO (2009a), with price changes depending upon the variety (Thai A1 Super and Thai 100% B).
Notes: To calculate the potential change in rice prices, we assume a net short-run demand elasticity of -0.15, as in Timmer (2009).

4. WHEAT MARKETS

In this section, we continue to work our way backwards by investigating events in the wheat markets, which seem to have precipitated the rush on the rice markets. As with rice, we concentrate on the largest wheat export market, the U.S. market, which plays a significant benchmarking role in determining prices elsewhere. There are two good reasons why trade events could have been extremely important in determining U.S. wheat prices. First, exports accounted for around half of the total wheat usage in the United States (excluding restocking); over 2000-2008, wheat exports were around five times as volatile as domestic food use (which was highly stable). Second, although the U.S. wheat market is the world's largest, the United States only accounts for around 25 percent of world exports. Since the global wheat market has some other big players, there is a high likelihood of export restrictions having an influence on wheat prices. The top 10 wheat exporters are listed in Table 3, which also notes which of these exporters experienced drought and/or export restrictions. For example, a severe and rather long-term drought in Australia (which accounted for 12 percent of world exports over 2000-2009) put pressure on the world's wheat markets for several years. However, export restrictions were also imposed in a number of countries, which together account for 25 percent of world exports.

Table 3. Shares of world wheat exports: 2000-2009

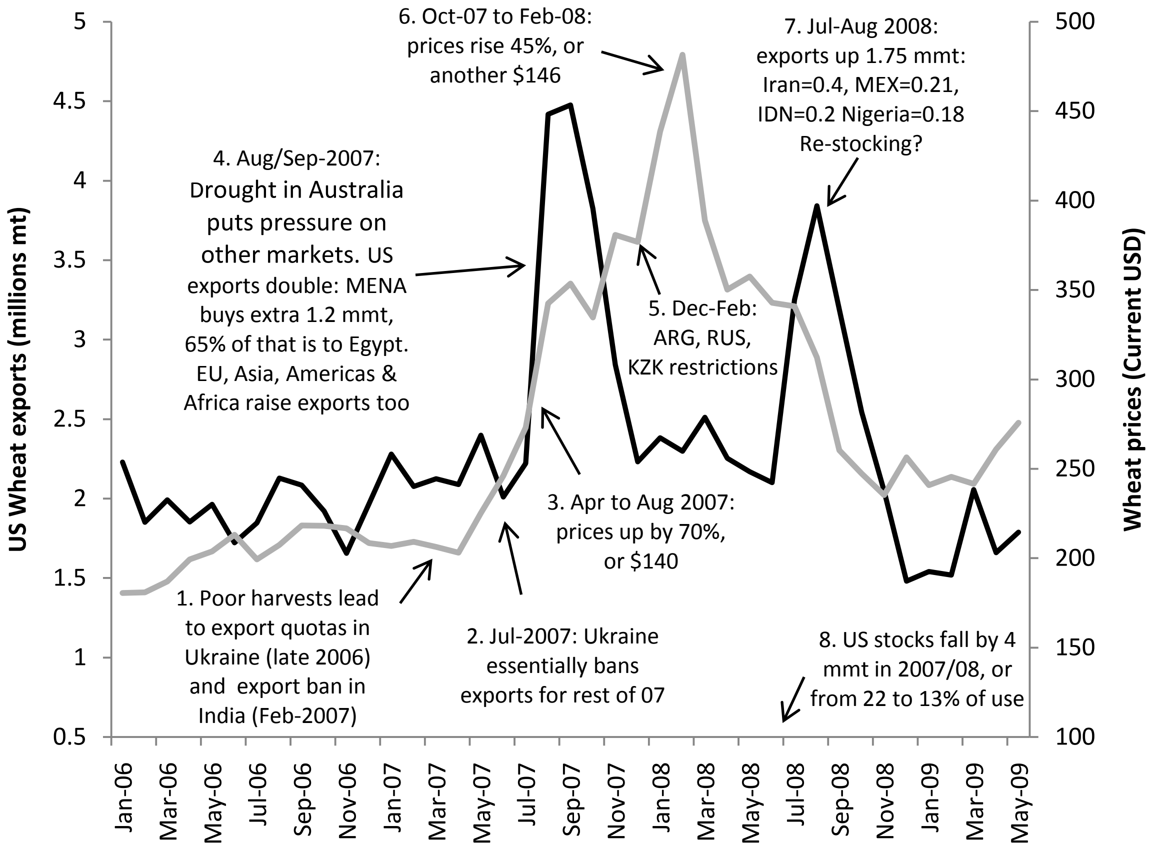
United States	25.0%	Russia (restrictions)	7.8%
Canada	14.1%	Ukraine (drought, restrictions)	3.8%
EU-27	13.5%	Kazakhstan (restrictions)	4.6%
Australia (drought)	12.0%	India (drought, restrictions)	1.9%
Argentina (restrictions)	8.6%	Others	8.7%

Source: Authors' calculations based on USDA (2009c) trade data.

Dollive (2008) regarded the Ukraine's export ban (later modified to an export restriction) as the most critical of these. He showed that Ukrainian grain exports in 2007 were 77 percent lower than those in 2006, and reported that many of the Ukraine's largest grain clients switched entirely to other grain markets, such as those of North America, France, Australia, Argentina, Russia and Kazakhstan. The last two countries are particularly relevant because the Ukraine's export ban increased demand for Russian and Kazakh grain exports, putting greater price pressure on these markets and halving their stock-to-use ratios. By early 2008, Russia and Kazakhstan had both implemented export restraints in an effort to protect prices in their domestic markets. Hence, as with rice, there was a clear contagion effect. Argentina also began to indirectly restrict exports by closing its export registry in March 2007, although this only really slowed exports later in the year when the existing registrations began to expire (Dollive 2008). In November 2007, the Argentine government raised its export taxes on wheat (to 28 percent), before re-opening and then re-closing the export registry in January and February of 2008, respectively.

The effects of these export restrictions in India, the Ukraine, Argentina, Russia and Kazakhstan are also apparent in the descriptive data (Figure 8, boxes 1, 2 and 4). The Ukraine imposed fairly tight export quotas as early as the second half of 2006, when monthly exports dropped by two-thirds (Grueninger and von Cramon 2008). India imposed an export ban in February 2007. Then, in late June, the Ukraine announced new export quotas that virtually imposed a complete export ban, such that from July 2007 to March 2008, the Ukraine exported almost no wheat. Coinciding with the Ukraine's effective ban on wheat exports, U.S. wheat prices rose by 70 percent from April to August of 2007. These initial price increases led to a rush of demand for U.S. wheat exports. U.S. wheat exports doubled from their July 2007 level of 2.2 mmt to 4.4 mmt in August and September of 2007 (Box 4). The August-September surge was principally fueled by an increase of 1.2 mmt of exports to the Middle East and North Africa (55 percent of the total surge); two-thirds of this 1.2 mmt went to Egypt alone. Other regions (South Asia, East Asia, South America, Africa, and the EU) increased their demands for U.S. wheat exports by around 0.15-0.22 mmt each.

Figure 8. A four-way relationship among droughts, export restrictions, price increases, and import surges?



Source: Authors' construction from USDA (2009b) export data and FAO (2009a) price data.

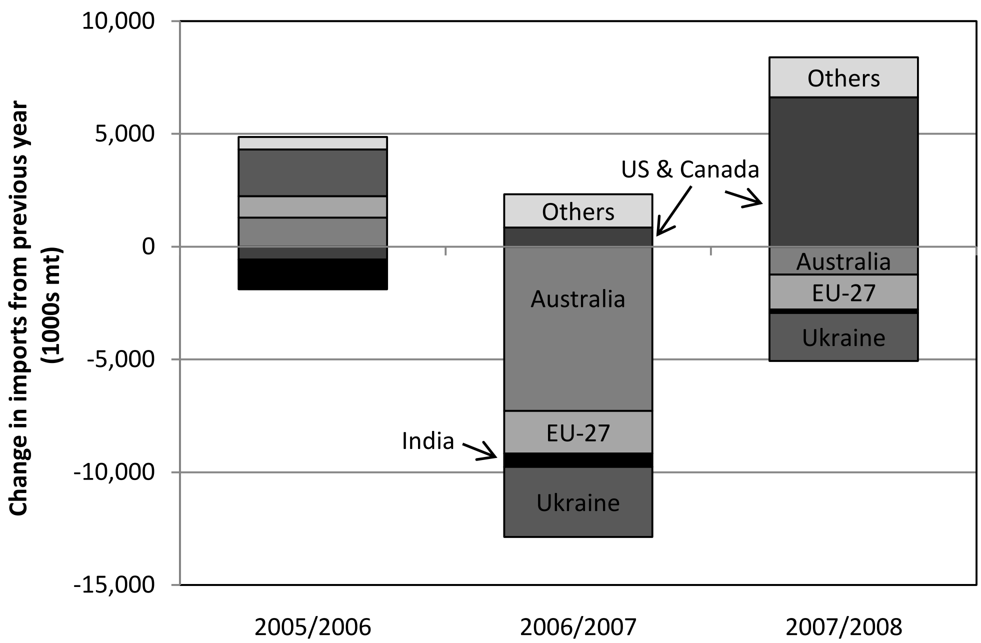
Notes: The wheat price relates to U.S. Wheat No. 2 Hard Red Winter, but the trends for the soft red were very similar. Abbreviations: mmt=million metric tons; MENA=Middle East and North Africa; ARG=Argentina; RUS=Russia; KZK=Kazakhstan; MEX=Mexico; IDN=Indonesia.

There are several interesting points of comparison with events in the Thai rice market. The major difference is that Thai rice exports stayed high after peaking, whereas U.S. wheat exports dropped within just two months. On these grounds, we might reasonably believe that wheat demand was more price-sensitive than rice demand, or that the effects of export restrictions and trade diversion were not as significant in wheat markets as they were in rice markets. Both hypotheses are probably correct, and it is also true that wheat prices rose less than rice prices. Nevertheless, a doubling of demand for U.S. wheat exports in two successive months should be considered significant, and it is notable that the surge in U.S. wheat exports preceded a second run-up in wheat prices, suggesting that the surge in foreign demand substantially contributed to the total rise in wheat prices. A second effect of the demand surge was to run down U.S. wheat stocks. The extra 4 mmt of exports in August-September of 2007 corresponded exactly to the decline in U.S. stocks from July 2007 to June 2008, when they reached just 13 percent of total use (domestic consumption plus exports). Insofar as wheat suppliers typically base their prices on existing stock levels, the stock run-down in 2007/2008 probably had a second-round effect on wheat prices.

Hence, the combination of low stocks and further export restrictions by Russia, Kazakhstan and Argentina no doubt significantly contributed to the price bubble seen in early 2008.

In summary, the message that can be drawn from Figure 8 is not a simple one, because there is arguably a four-way causality at work: Droughts and bad harvests caused some initial export bans; the export bans caused a first round of price increases; these price increases caused a run on U.S. wheat exports plus a second round of export restrictions; and this (along with other factors, such as surging oil prices) caused a second round of price increases in the U.S. markets. Figure 9 demonstrates the outcomes of these events more broadly by decomposing the year-by-year changes in exports for the entire world (black line) by the major wheat exporters. In 2006/2007, world wheat exports dropped by around 5 mmt, largely due to a 7.28-mmt drop in Australian exports, a 3.1-mmt drop in Ukrainian exports, and a 1.9-mmt drop in EU exports. Australian, EU and Ukrainian exports dropped even further in 2007/2008, while North American exports surged by 6.6 mmt. If we take the surge in North American exports as reflecting trade-diversion effects and precautionary/panic purchases, then we can use Timmer's (2009) model (with suitable adjustment for wheat markets) to broadly estimate the contribution of export restrictions, panic purchases, and drought to rising wheat prices.

Figure 9. Decomposing annual changes in wheat exports before and after the crisis



Source: Authors' calculations based on USDA (2009c) trade data.
Notes: Abbreviations: IND=India; AUS=Australia; EU-27=27 EU countries; UKR=Ukraine; US + CAN=USA + Canada; ROW=rest of world.

To do so, we first estimate the percentage change in total demand for U.S. wheat (U.S. exports and domestic consumption) for 2007/2008. Domestic consumption and exports typically each comprise 50 percent of the total demand for U.S. wheat. In 2007/2008, in contrast, exports grew by almost 40 percent while domestic consumption shrank by almost 8 percent. However, the total increase in demand for U.S. wheat was "only" 13.1 percent in 2007/2008. If, as in the case of rice, we think of this growth as resulting from a short-run demand shift, then we only need to divide this by a net short-run demand elasticity. Since wheat is mostly produced by largeholders in middle- or upper-income countries, however, the short-run supply response could be stronger; thus, we choose an elasticity of 0.10. As for the demand side, wheat demand is likely to be more elastic in rich countries, but it could still be quite high in low- and middle-income importing countries (such as in the Middle East and North Africa). If we again double this elasticity to -0.20, [8] we get a net short-run demand elasticity of -0.30, which is twice the equivalent elasticity that we used for rice markets. Simply dividing 13.1 percent by 0.30 suggests that the surge in U.S. exports would result in wheat prices being 44 percent higher in 2007/2008 than they were in 2006/2007. In actuality, wheat prices were 72 percent higher in 2007/2008, suggesting that the surge in U.S. exports accounted for around 60 percent of the price increase. However, this estimate is arguably a lower benchmark given that virtually the entire surge in U.S. exports took place in July and August of 2007. In addition, the caveats noted for the back-of-the-envelope calculations described in the previous section also apply.

The last remaining question is how much of this 44 percent price increase was due to export restrictions, the drought in Australia, or panic purchases aimed at securing supplies before the prices or restrictions increased further. This is very difficult to gauge, because it requires that we determine what the export response would have been if export restrictions had not been imposed (especially in the case of the Ukraine, which experienced both a drought and an export restriction). However, we can estimate that the global fall in wheat exports from July 2006 to June 2008 was mostly due to the Australian drought (48 percent), Ukraine's drought and export restrictions (29 percent), and the EU's more inexplicable drop in wheat exports (19 percent).[9] In any event, our analysis of wheat markets suggests that there is a large and tangible trade-based explanation for the surge in wheat prices seen during the second half of 2007.

[8] Since the 2007/2008 price increase was 74 percent and the decrease in US wheat consumption was 8 percent, this would imply a domestic short-run elasticity of -0.11. Thus, demand might more inelastic than the figure we assumed. Global imports stayed constant, however, implying they are very inelastic in the short run.

[9] These figures were calculated simply by assuming that each country's exports remained unchanged from their 2005/2006 levels.

5. MAIZE MARKETS

Despite the importance of trade events in the rice and wheat markets, there has been virtually no discussion of trade events being an important factor in maize markets. This omission is understandable in light of some important stylized facts regarding the global maize market. First, the United States heavily dominates the global maize trade, accounting for around 60 percent of world exports; thus, trade restrictions elsewhere have far less ability to influence international prices (this does not, however, rule them out entirely, nor does it preclude the possibility of import surges for reasons other than trade diversion). Second, U.S. maize production is heavily dependent on energy products as an input, so rising oil prices would seem to be an important explanation of increasing maize prices. Third, maize is used as livestock feed in much of the world, whereas rice and wheat are staple foods; therefore, the demand for wheat should be more inelastic, since meat is often a luxury good. This explains why export restrictions on maize were quite rare, but also suggests that the demand for maize feed should have fallen off as prices increased (although this is an empirical question). Last but not least, although the United States dominates global wheat trade, exports comprise less than 20 percent of U.S. maize use, with domestic feed use making up over 50 percent, and food and industrial use making up 20-25 percent. With biofuels use increasing steadily in recent years, trade shocks might seem relatively unimportant.

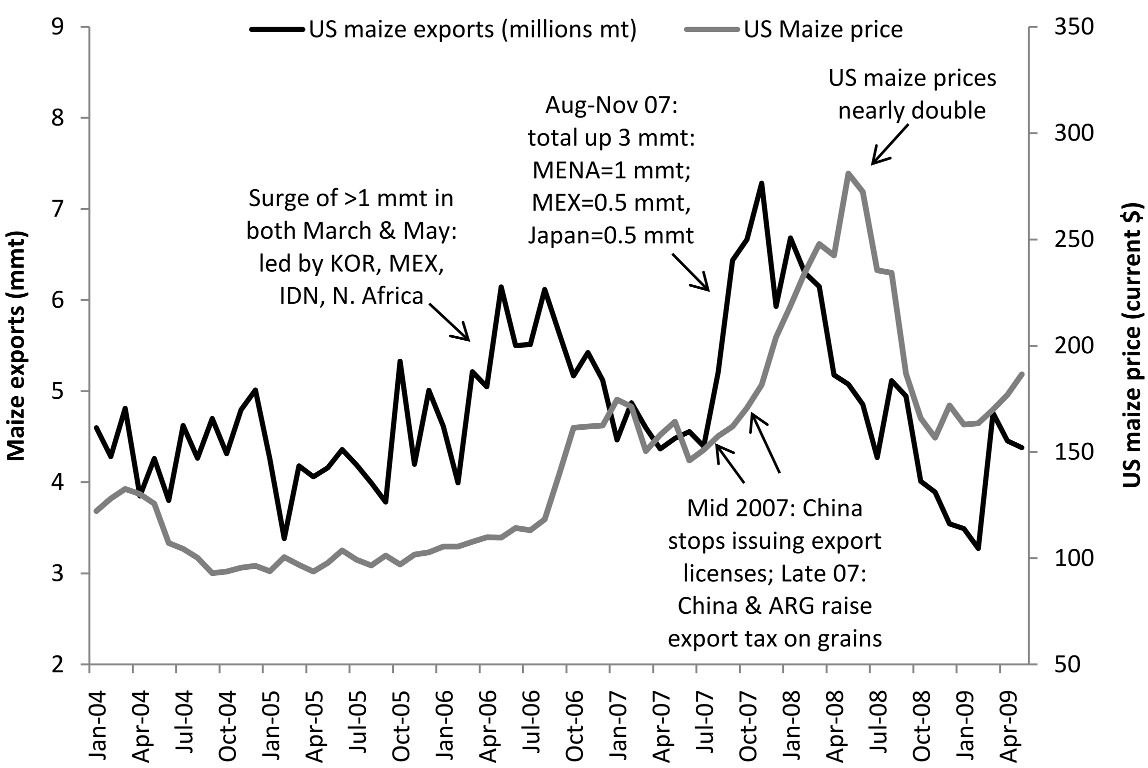
However, despite the intuitiveness of this *a priori* position, there is some existing basis for thinking that trade events might also impact the maize markets. For example, maize exports as a share of total maize use in the United States might be small, but this share is quite volatile relative to its use for feed or biofuels. Indeed, the steady increase in the use of maize for biofuels is widely known to have precipitated significant increases in maize production in the United States. Thus, the effect of biofuels on maize prices might be smaller than expected, and this pressure may be substantially diverted to soybeans (see below). It is also possible that the demand for maize is more inelastic that we think because some of the countries that use maize as an input into livestock production might have few feed alternatives in the short run (such as Egypt, Mexico). Lastly, several export restrictions were imposed by some of the largest maize exporters, including Serbia, Argentina and China. The latter two are the largest maize exporters after the United States, and Dollive demonstrated that the export restriction imposed by China could have diverted a significant amount of demand to the U.S. market, particularly that from South Korea, which is typically the second largest maize importer in the world (Dollive 2008). Our own calculations from USDA (2009c) data suggest that the Chinese restriction withdrew at least 5 mmt of maize from the world market, although countries such as India and the Ukraine picked up much of the slack (which is rather ironic, given that they had export bans on rice and wheat, respectively).

In any event, since the United States is easily the largest maize exporter in the world, it is essential that we look at both U.S. exports and U.S. domestic consumption (since the latter comprises 80 percent of U.S. maize use). As in the previous sections, we plot monthly U.S. exports against U.S. prices, but here we also plot the domestic use of maize in the United States. Astonishingly, Figure 10 shows that U.S. maize exports have surged twice in recent years, from March to May of 2006 and August to November of 2007, and these two import surges were preceded by two large price surges. The first export surge involved a 2-mmt (or 54 percent) increase, which was followed by a 59 percent price increase. The second export surge, that of 3 mmt (65 percent; Aug-Nov 2007), was followed by a 75 percent price increase from September 2007 to May 2008. Therefore, as we saw in the rice and wheat markets, large export surges preceded the price surges. In fact, the export surges in the U.S. maize market so neatly precede the price increases that we are forced to question our *a priori* position that trade events were only a minor factor in maize markets.

Another puzzling question relates to which maize-importing countries contributed to this surge. As we indicate in Figure 10, although South Korea was a major part of the smaller surge in early 2006 (along with Mexico, Indonesia, and North African countries), the much larger 3-mmt surge from August to November of 2007 was driven by rapidly increasing demand from the Middle East and North Africa (MENA, which imported an extra 1 mmt over that period), as well as from Japan and Mexico (which each imported around an extra 0.5 mmt). Of these three regions, only Japan imported significant amounts of maize from China (430,000 mt), so China's export restrictions only seem to be a small part of the story. The situations in the other countries are something of a puzzle. Mexico basically imports U.S. maize for feed use, but given the importance of domestic maize in the Mexican diet, future research should look more closely at substitution effects. As for the MENA region, we have no particular evidence of panic, but we conjecture that demand could be quite inelastic there in the short run, because there are few available substitutes for maize feed and because meat consumption is important in the region (especially around Ramadan).

The remaining puzzle with regard to maize prices relates to the fact that exports are a relatively small proportion of total U.S. maize use. Feed demand is still the largest use of U.S. maize, typically accounting for around 50 percent. However, we faced a data problem when seeking to analyze feed demand, because the USDA groups feed with residual uses (such as restocking), meaning that the series on "feed and residual use" is highly seasonal. In the September-November period of 2006, however, the United States "feed and residual use" series was 13 percent (or 7.5 mmt) higher than in the same quarter of 2005. This suggests that there was some increased demand from either the livestock industry or the residual components.

Figure 10. Surges in demand for U.S. maize exports precede maize price surges



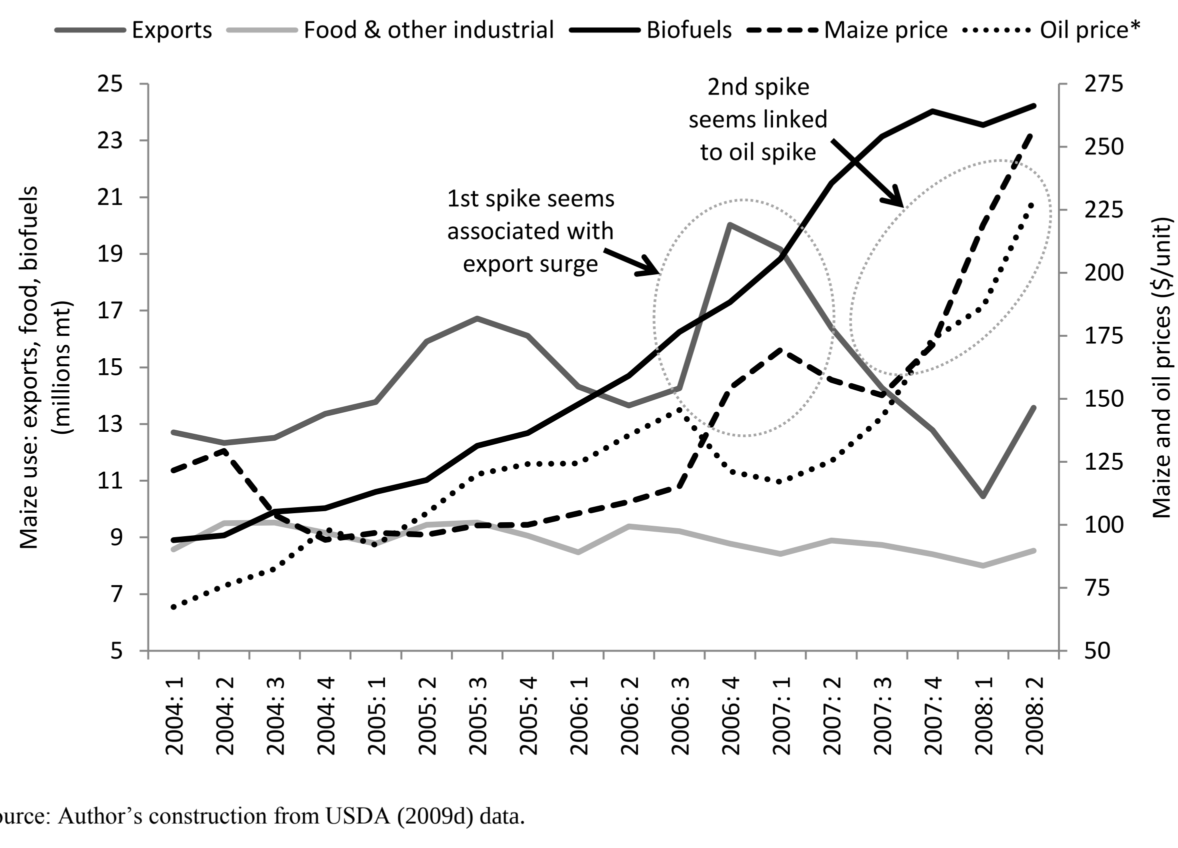
Source: Authors' construction from USDA (2009b) export data and FAO (2009a) price data.

Notes: The maize prices relate to that of U.S. No. 2, Yellow. Abbreviations: mmt=million metric tons; MENA=Middle East and North Africa; SSA=Sub-Saharan Africa; KOR=South Korea; MEX=Mexico; IDN=Indonesia; ARG=Argentina.

Nevertheless, the most likely alternative to a trade story is undoubtedly one that centers around biofuels, which comprised a major new source of demand. Figure 11 shows quarterly U.S. data for biofuels demand, U.S. food demand and foreign demand, with maize and oil price series given on the right axis. The black line shows that biofuels production more than doubled over 2004-2008, indicating that this was, indeed, an enormous new source of demand for U.S. maize and undoubtedly had profound effects on farm areas, land-use decisions, and the expectations of market players. Nevertheless, the presence of growth in biofuels does not rule out the importance of the maize trade. Biofuels demand increased quite smoothly and predictably, which in turn prompted an increase in the amount of land allocated to maize production. Hence, expansion of the maize supply would have at least partially offset the price effects of the demand surge. Granted, the seasonality of maize production means that lags in the supply response could still have induced price spikes in the short run. In particular, the 2006/2007 season (when prices first spiked) did not produce a large maize crop. However, Figure 11 shows that although the 2008 exports were lower than biofuels demand in absolute terms, exports were more volatile than biofuels demand. The first maize price spike in mid 2006 seems to be closely linked to its preceding export surge. Specifically, exports in the last quarter of 2006 were 6 mmt larger than those in the preceding quarter. Total U.S. maize use in the last quarter of 2006 was almost 16 mmt higher than it had been in the same quarter of the prior year; increased foreign demand accounted for 36 percent of this increase, while "feed and residual" accounted for 48 percent, and biofuels for 29 percent.

Lastly, Figure 11 suggests that the second maize price surge (from late 2007 to mid 2008) seems to more closely coincide with surges in the price of oil, which is a major determinant of U.S. maize production costs. Headey and Fan (2008) and Mitchell (2008), for example, suggested that rising oil prices could have added as much as 40 percent to the maize price increases seen in 2008. In any event, we conclude that while trade events were by no means the sole determinant of the increases seen in maize prices, they were a significant driver of U.S. maize prices over this period. This has not been recognized by most of the prior studies on the crisis.

Figure 11. Trends in different uses of U.S. maize production: 2004:Q1 to 2008:Q2



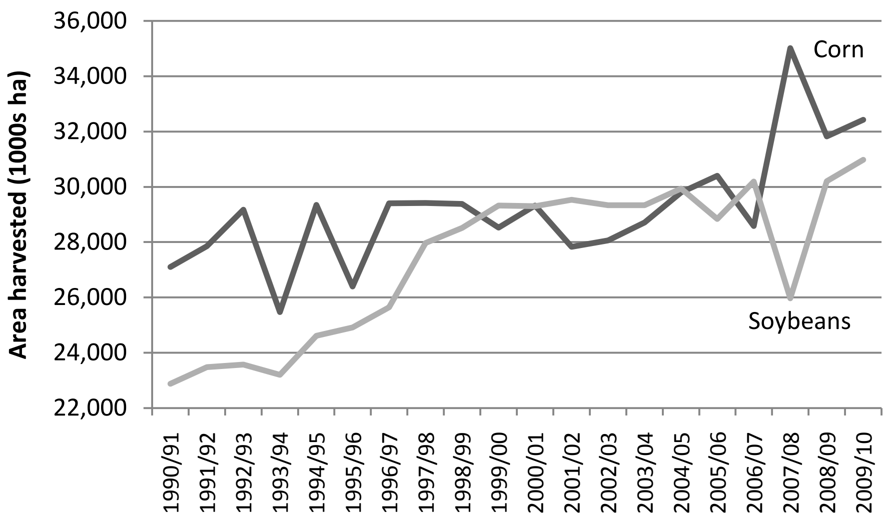
Source: Author's construction from USDA (2009d) data.

6. SOYBEAN MARKETS

Essentially, the increase in soybean prices was entirely driven by maize-market events and maize-price movements. Figure 1 showed us that soybean prices tracked maize prices very closely from 2003 onwards (more closely than any other pair of series), and typically with a small lag.[10] Two factors explain this. First, maize and soybeans are very close substitutes, as both are predominantly used for feed in the United States. Second, maize and soybeans compete for land in the United States. Indeed, Figure 12 shows that a massive 6.4-million hectare (ha) (22 percent) increase in maize area in 2007/2008 was accompanied by an equally impressive 4.2-million ha (14 percent) reduction in soybean area. On these grounds, there is probably not much mystery as to why soybean prices rose. Biofuels demand (in conjunction with surges in maize exports) greatly increased the attractiveness of maize production, with corresponding declines in the amount of land allotted to soybeans, and soybean production. This in turn meant that the U.S. stock-to-use ratio for soybeans declined to 4 percent, its lowest level ever, such that soybean prices became even more sensitive to changes in maize prices and soybean demand.

Consistent with this, we do not find any evidence of sudden surges in U.S. soybean exports over 2005-2009, with only the usual seasonal variation and some strong but perfectly normal demand in 2006 (Figure 13). However, because of the reduced area planted to soybeans in 2007/2008, U.S. production fell by 14 mmt that year, and the surge in oil prices would also have significantly added to production and trade costs. In any event, from July 2007 onwards, it is clear that soybean prices very closely tracked maize prices, typically with a short lag.

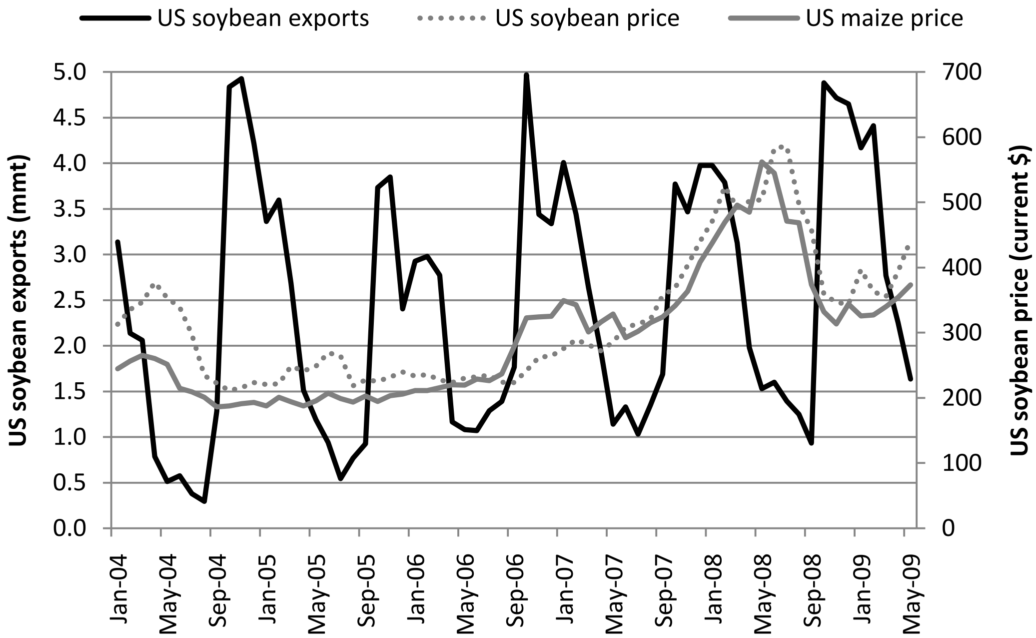
Figure 12. Trends in harvested areas for U.S. maize and soybeans: 1990-2009



Source: Authors' calculations based on USDA (2009c) trade data.

[10] The correlation between soybeans and maize prices is around 0.90 over 2003 to mid 2009, whereas it is 0.81 for soybeans and wheat prices. We also explored Granger-causality tests between variables, and although we found that maize prices Granger-often cause soybean prices, the results appear very sensitive to the utilized time frame. The results are not reported here but are available upon request.

Figure 13. Trends in demand for U.S. soybean exports, soybean prices and maize prices



Source: Authors' construction from USDA (2009b) export data and FAO (2009a) price data.

7. RESEARCH AND POLICY IMPLICATIONS

In most of the research and media reports on the food crisis, there has been very little emphasis on trade events; instead, the vast majority of the attention has focused on biofuels, oil prices, changing Asian diets, and financial speculation. However, the analysis herein suggests that trade events were pervasively important in all of the major grain markets and arguably provide the most tangible explanation for the overshooting dynamics apparent in price series data (Figure 1). In the rice markets, export restrictions and import surges had massive effects on rice prices, and there was apparently a strong link between earlier wheat prices and the initial pressure on the rice markets. Tracking back, we find indications of two-way causality between trade events and price movements in the wheat markets. Wheat prices rose first because of other factors (droughts in Australia and the Ukraine, oil prices, and so on), just before a major surge in demand for U.S. wheat exports. However, the surge in demand for U.S. wheat imports also appears to have triggered further price increases. Export restrictions were moderately important in the wheat markets, but their effect was no larger than that of the Australian drought. Quite remarkably, given the biofuels argument, we again find that sizeable demand surges for U.S. maize exports preceded sharp price increases. Of course, biofuels demand still remains a compelling explanation for maize-price movements, but our evidence suggests that this is not the whole story.

More generally, the deeper non-trade factors discussed in our introductory section (oil prices, biofuels, and a weak U.S. dollar) probably still played important roles in creating initial pressures in the grain markets, which in turn contributed to export restrictions and import surges. For one thing, a cheaper U.S. dollar and strong economic growth rates around the world made precautionary purchases more affordable. In addition, there was an interaction between depleted stock levels and surges in demand, although in some cases we found that the stock depletions were partly due to the demand surges (for example, in the U.S. wheat markets).

Although there is some complementarity with other explanations of the crisis, our interpretation of events is rather different from those found in the existing studies. First, previous explanations of commodity overshooting that relied solely on dollar depreciation or low interest rates do not plausible explain the size or timing of commodity price changes, whereas large trade shocks generally precede sharp price changes and provide a very tangible price explanation to boot.

Second, we strongly suggest that these initial pressures would not have resulted in a full-blown crisis had it not been for the trade restrictions and demand surges. Moreover, as we pointed out in our brief methodological discussion (Section 2), there are clearly serious deficiencies in our understanding of the way markets work (or don't work) in a crisis. Conventional economic theories and simulation models of agricultural markets do not seem to incorporate either the complex psychological responses of traders or the politically motivated decisions of policymakers. Where "hoarding," "panic," "animal spirits," and "herding behavior" are discussed in the context of the crisis, these discussions are usually in regard to the futures market (Timmer's (2009) analysis of rice markets is an exception). However, our results suggest that these responses may have been just as prevalent, and perhaps more important, in the spot markets.

This is not to say that such behaviors are individually irrational. One interpretation of trade events is that both exporters and importers of cereals were essentially trapped in a Prisoner's Dilemma. If all traders had kept to the implicit agreement to keep trade free then prices would only have risen far more modestly on the back of the underlying causes of the food crisis (oil prices, biofuels, exchange rate movements, and so on). But once one sizeable trading country defected from this "Gentleman's agreement" by imposing an export ban or buying up cereals before others did, it was perfectly rational for others to do so. In conjunction with the trade-diversion effects that arose from export restrictions, the Prisoner's Dilemma explanation quite credibly accounts for the cascade of export restrictions and panic purchases that ensued in 2007 and 2008. However, there is also an important political-economy aspect to these decisions. It is debatable whether the overall Indian economy benefited from the lower rice prices resulting from its export restriction, because rice farmers are generally poorer than their urban counterparts (Polaski, et al. 2008). From the government's perspective, however, urban constituents may have been regarded as more politically important, especially given that a national election was on the horizon at the time.

Given that our interpretation of events differs from those found in most other analyses of the food crisis, it is unsurprising that our policy recommendations are also different. If the crisis could have been prevented by a more functional world trade system, then obviously one means of preventing the next crisis would be to improve the system. Export restrictions and import surges were cross-commodity phenomena, although they had larger impacts on rice prices because of the thin world market. Therefore, while fixing highly distorted rice markets should be a priority, international efforts should also focus on more general multilateral efforts to draw up trade agreements that preclude export bans. We emphasize the preclusion of export bans rather than other export restrictions because the former clearly did more direct damage than the more infra-marginal actions (for example, raising export taxes), and also because bans increase fears that physical access to food imports may be threatened, whereas export taxes only indicate to importers that prices will rise.[11] Moreover, export taxes are arguably non-distortionary from the social planner's viewpoint; an export tax can eliminate the increasing wedge that exists between the private benefits accumulating to food producers and traders, and the social benefits that pertain to domestic food availability and affordability (such as poverty reduction and improved nutrition).

Unfortunately, however, most of the food-export restrictions that were actually imposed during the period in question would not be outlawed under current WTO agreements, nor would they be outlawed under the proposed agreements (Abbott and Borot de Battisti 2009). This is because the existing and proposed agreements are heavily geared towards opening up import markets rather than making sure the export markets stay open. New agreements, therefore, should place a much greater emphasis on keeping the export markets open (which will not be easy). Asia is unusual in that the vast majority of the population, particularly the poor population, is still highly dependent on rice consumption. The Indian, Chinese and other Asian governments are therefore deeply committed to feeding programs, price stabilization policies, and other food-security instruments. Most of these instruments are not explicit trade policies, but the Theory of Second Best tells us that, given one set of distortions (for example, feeding programs, price controls, and so on), the removal of another distortion (such as, trade distortions) could actually produce worse outcomes (Lipsey and Lancaster 1956). Indeed, it was the Indian government's commitment to the PDS that arguably locked them into defending domestic grain supplies through an export ban. These complexities lead us to suggest that new international agreements must be: (1) truly international and binding (because of the aforementioned Prisoner's Dilemma); but (2) flexible enough to leave policymakers the option of employing infra-marginal policy instruments (such as capped export taxes) that can keep their food prices sufficiently stable. Without this flexibility, it is highly likely that Asian countries (for example, India, Vietnam and China) will either refuse to sign the multilateral agreement, or will quickly defect from such an agreement when the next round of pressure emerges.

We conclude by stressing that we must reach such an agreement precisely *because* the global cereal markets will continue to face significant pressures in the not-too-distant future. Commodity prices rebounded in 2009, and USDA (2009a) and OECD-FAO (2009) food-price projections suggest that real food prices will be significantly higher in the next 10 years than they were before the food crisis (Headey, Fan and Malaiyandi 2009). Although such projections do not discuss volatility *per se*, the events of the past few years emphasize that even relatively modest price increases can quickly induce trade actions that can drive prices well above the long-run fundamentals. Suffice it to say that the world's poor can ill afford the next world food crisis.

[11] For example, a tax on Indian rice exports would still have resulted in increased demand for Thai exports, but only up to the point at which Thai prices had increased by the same amount as Indian export prices (at a maximum, this would be the amount of the tariff). Another (more marginal) option would have been to only allow exports after domestic needs (including grain reserve targets) had been met. A full analysis of these various options is beyond the scope of this paper, but there are good reasons to think that such alternatives would have been better than immediately announcing a full export ban.

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