Fighting Global Food Price Rises in the Developing World: The Response of China and Its Effect on Domestic and World Markets[1]

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Abstract

This paper addresses how China is being affected by and is responding to the world food crisis. So far, Chinese officials have responded to higher world prices by drawing down stocks and limiting exports of major grains. These policy instruments were not available for soybeans, so domestic prices of soy and other oilseeds have risen with international prices. Using a global CGE model we show that the initial world price rise was largely due to higher world oil prices and demand for biofuels as opposed to other factors, especially in maize and soybeans. China's response to this shock has kept domestic grain prices low relative to world grain markets and to domestic soybean prices. As grain stocks are depleted, however, demand growth will push domestic prices back into alignment. Anticipating this pressure on consumers and accelerating supply response through public investment will facilitate adjustment.

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I. Introduction

We are now facing the first world food crisis of the 21st century. Rising food prices have raised concerns everywhere, in developed countries (e.g. Low and Isserman., 2008; O'Brien and Woolverton, 2008), and especially in developing nations. Price rises in the developing world affect millions of poor people, contribute to inflation and induce political unrest (Diouf, 2008; Rosegrant, 2008). From Mexico to Egypt policy makers and other concerned citizens and academics are raising concerns about the seriousness of the current crisis and whether it will abate like past price spikes (FAO, 2008).

China's response to the crisis is of particular importance, because of its large size and significance in world markets. Rising food prices have driven continuing increases in Chinese consumer prices since the middle of 2007 (Huang et al., 2008). Many actions were taken immediately (Wen, 2008) and there is still a lot of discussion about what caused the recent price rises and whether or not the counter measures that were taken were successful.

There is a dearth of information inside China and elsewhere about what is behind the crisis and what are the impacts of different policy responses. This paper addresses the problem in three specific ways. First, we will describe how China reacted to rising international prices and threats to domestic food price stability. Second, we will compare prices inside China and on global markets before and after the government's response, and discuss their implications for the short and long run. Third, we will decompose—using models of the world food economy and China's own domestic economy—the changes in prices of key agricultural commodities into their component sources, including the impact of the rise in world crude oil prices, the emergence of biofuels and the net effect of China's domestic policy intervention. Our decomposition analysis is used to analyze the determinants of food prices both in China and on global markets, and to discuss China's response and alternative strategies for managing food economies in the developing world.

II. The Threat—Rising Prices in World Food Markets

Like food crises in the past, the current food crisis came on fast. After more than 10 years of low and falling prices, prices began to rise in 2006 (Figure 1).

Wheat began to trend up first, rising about 25 percent between January 2006 and June 2007. This modest rise, however, was followed another rise in mid-2007 and early 2008. The price of wheat on international markets was 150 percent higher in mid-2008 than in 2005. Notably, prices have backed off a bit in recent months but are still considerably above the 2005 level. On average, the international price of wheat rose by 149 percent between 2005 (the average of monthly prices in 2005) and 2008 (the average of monthly prices in 2008).

Although maize prices began to rise slower, the upward trend was more steady (Figure 1). Between mid-2006 and mid-2007 maize prices rose by more than 50 percent. After a leveling off of prices in mid-2007, they resumed rising towards the end of the year. By June 2008 international maize prices on average were 143 percent above the level they were in 2005.

The trend in soybean prices is similar, although the rise started a bit later. Because the international price of soybeans rose (and then fell) in 2005, the average increase in soybean prices between 2005 and 2008 was 123 percent.

The rise in the price of rice, while reaching a level of increase similar to that of wheat, maize and soybeans, increased more sharply (Figure 1). The price of rice did not begin to increase rapidly until the beginning of 2008. By May 2008 the price of rice had increased by 200 percent. Like wheat, the international price of rice fell during the early summer months. However, on average, the price of rice in 2008 was still nearly 155 percent above the 2005 price.

Internationally, the price of pork did not rise (Figure 1). The price of pork was the nearly same in 2008 as it was in 2005, and during the intervening years was even lower.

Integrated markets/high food shares/threat of higher food prices

As the prices of key commodities in world markets rose, two aspects of China's food economy became increasingly important.

First, food accounts for a large share of China's total expenditures. It makes up nearly 36 percent of urban budgets and more than 43 percent of rural budgets (NBSC, 2007). Therefore, any substantial price increase in food would almost certainly have implications for overall price stability.

Second, food trade across China's borders was not restricted, so that rising international prices would lead to higher prices domestically. According to Huang et al. (2004); Huang et al. (2008); and Rosen et al. (2004), domestic prices of rice, wheat, maize and soybeans followed closely their border prices, especially in China's port cities. Indeed, in Rozelle and Huang (2003) and Rozelle and Huang (2004) it is shown that China's domestic maize and soybean prices are quite integrated with international prices.

Given Chinese officials' longstanding fear of unstable prices for food and other commodities, it is easy to see why the importance of food in the budgets of much of its population and the prospects of having domestic food prices be pushed up by rising international prices raised serious concerns. As early as mid-2007 government officials were already signaling that they believed rising prices were becoming a problem (Wen, 2008). In a policy brief written for a government conference in early 2008, Huang et al. (2008) clearly trace out the possible linkages among international food price increases and rising domestic food price instability.

III. China's Leaders Respond

Recognizing the threat, China took a series of steps between late 2007 and mid-2008 to try to counter the rising food prices. The first action came in 2007, as the government began to tap into its sizeable rice, wheat and maize reserves that had been stored mainly as a precaution against natural disasters. These sales, which are usually executed by directing the grain bureaus in designated counties to sell a certain quantity of stocks to free market traders, increases local supply and dampens upward pressure on prices. Although little information has ever been publically available on the size of China's stocks, even in March 2008 after a number of months of grain sales, Premier Wen Jiabao stated to the press that China still had between 150 and 200 million tons of grain stocks that were available for stabilizing domestic grain prices (Xinhuanews, 2008).

Officials also were authorized to sign long terms futures and forward contracts with grain (and meat) trading firms in exporting countries. Domestic concerns of higher pork prices triggered a policy response inside China to provide production subsidies (and insurance) to pork producers. The actions taken by the government in mid-to-late

2007 were focused on increasing domestic supplies, trying to hold down domestic prices when it became clear China would not be able to import large volumes of food since world prices were so high.

In late 2007 as world prices continued to rise, the government began to take a series of increasingly strong actions in order to try to keep the gains that it was earning by releasing domestic stocks. The problem that they were facing was that international prices had risen so high that grain traders were beginning to see arbitrage opportunities by exporting China's relative low priced food into global markets. The initial strategy adopted by China's government was to make it increasingly expensive for exporters to trade China's grain in world markets (Ministry of Finance and General Administration of Customs of China, 2008; interviews with officials from the State Grain Administration, September 9, 2008). The first target was maize, which China has historically exported in large volumes. In November 2008, subsidies for storage and transport of maize destined for export markets (described in Rozelle and Huang, 2003) were suspended. This was supposed to reduce the incentive to export China's grain in order to keep domestic prices relatively low. When prices continued to rise through the first part of 2008, the government canceled the payment of VAT rebates.[1]

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[1] The payment of VAT rebates for maize has been a source of controversy (see Rozelle and Huang, 2003, for details). International trade rules allow countries that charge domestic producers, processors and traders a VAT tax (which raises the domestic price of the commodity) to rebate the VAT tax when the commodity is exported in order to allow the country's traders to compete on an equal footing with traders from countries without VATs. The issue in the case of China is that it is not clear if producers, processors, traders and exporters of maize have ever paid the VAT as the maize has moved from farm to port. If not, then the VAT rebate is really an export subsidy. It is difficult to prove whether or not VAT rebates are an export subsidy for Chinese agriculture, and the question has never been adjudicated. In this paper, we ignore the issue and note that the removal of the rebate (whether it was paid in the first place or not) serves to reduce the incentive to export, which in late 2007 and 2008 is the objective of the policy action.

At the same time that officials were trying to disincentivize maize exports they also began to become concerned about rice and wheat, the nation's two major food grains. Although there were no transport or storage subsidies paid for rice and wheat that were destined for export markets, when the government eliminated the VAT for maize, they did the same for rice and wheat. To reinforce the policies objective of trying to give traders less of an incentive to export food and feed grains only a month or so after the VAT rebate was cancelled, it was announced that a 5 percent export levy was to be assessed on all export shipments, except those bound for Hong Kong, Taiwan and Macao.

Even after stocks were released, export subsidies were cancelled and export levies were assessed, leaders were not convinced that their measures were enough to offset the continuing surge of prices in international commodity markets. Stronger actions were needed. Therefore, in late winter 2008, China's top leaders themselves announced that exports of food and feed commodities were not to be allowed at all. Wen Jiabao, China's premier, announced "in order to control rising food prices, China will strictly restrict the use of food by industry and for grain exports" (Wen, 2008). Chen Xiwen, one the chief architects of China's agricultural policies at the highest levels, reiterated the ban and emphasized that the restrictions were to be enforced in order to keep domestic supplies up and they were to be for 2008 only (Chen, 2008). Therefore, between summer 2007 and March 2008 China had moved from subsidizing exports to assessing levies to imposing quantitative restrictions on exports.

By February 2008 the government also turned their attention to fertilizer. In the same way that international grain prices rose in late 2007, the price of fertilizer also increased significantly. For example, chemical fertilizer prices rose by 42 percent between July 2007 and June 2008 (NBSC, 2008; China Monthly Economic Indicator).

In response, China's leaders began to levy export taxes on fertilizer in early 2008. The first target was phosphate fertilizers (Ministry of Finance, 2008). On February 15, the government announced that exports of phosphate fertilizers (or any fertilizer that contained phosphates) would be assessed an export levy. In April, exporters of triple super phosphates were forced to pay an addition levy of 30 percent. In May, a 35 percent levy was assessed on urea exporters. Finally, in an effort clearly designed to stop all fertilizer exports, all fertilizer products were assessed a 100 percent export levy in mid-May.

In short, China has used a number of different instruments to keep the prices of key commodities from rising or to try to dampen their rise. Most simply, the government has been drawing down stocks in order to increase the supply of key agricultural commodities inside the country. They also have taken measures at the border to in order to keep the domestically-produced grain (as well as the grain that was being stored) inside China's own markets. They have done the same for fertilizer.

China's biofuels policy: Big initial plans; second thoughts

While most of the world's attention is on big three players in the biofuels sphere—the US, Brazil and the EU, China's is still the third largest producer of ethanol in the world. In 2006 China's bioethanol production reached to 1.3 million tons. Maize is the primary feedstock, being used mostly in the plants in the Northeast. Wheat also is used as a feedstock in China's newest biofuels plant in Henan province. In total, in 2007 nearly 4 million tons were used in the production of biofuels.

Like many developed and developing countries, in 2005 and 2006 China began to chart out an even more ambitious biofuels development strategy, establishing high production and use targets for itself. According to China's "Middle and Long Term

Development Plan of Renewable Energy," annual bioethanol production was targeted to be 10 million tons by 2020. To encourage the expansion of the biofuels industry, a set of incentive policies was supposed to be implemented to support the biofuels development in China. First, requirements were promulgated requiring a mandatory mixing of 10 percent bioethanol in gasoline in nine provinces in order to promote the use of biofuels and the emergence of a market. Second, the 5 percent consumption tax on bioethanol was supposed to be waived and the 17 percent value added tax was supposed to be refunded to producers. Finally, a direct subsidy of 1370 yuan/ton was supposed to be given to biofuels plants. With such powerful incentives, there was a lot of interest in investing in biofuels by both large national corporations and aggressive local firms.

However, China's biofuels expansion plans never really got of the ground. At a time when there was a rapid development of biofuels worldwide, rising agricultural prices brought a quick end to the unrestrained growth of the industry in China. Concerns about rising prices and overall food security triggered a moratorium on the building of new biofuels plants. Later the policy was clarified. Biofuels production could continue as long as it did "not compete with grain over land;" did "not compete with consumers for food;" and did "not enter compete with livestock over feeds." While construction has continued on several plants that are supposed to use sweet sorghum, cassava and/or sweet potatoes as feedstocks, China has voluntarily dampened their biofuels ambitions—at least in the short run.

IV. Impacts of China's Countermoves

The first step in assessing the effect of China's countermeasures on domestic agricultural commodity prices involves the examining of price trends. To show how domestic prices have changed, Figure 2 traces prices for rice, wheat and maize on international markets and in China's domestic markets, in U.S. dollars at nominal exchange rates. These are the same price levels that are presented as index numbers in Figure 1. The graphical analysis appears to demonstrate that—at least in the case of China's major food and feed grains, rice, wheat and maize—the nation's responses to rising world food prices have succeeded (so far) in keeping domestic prices from rising as much as international prices. Between 2005 and 2008 the trajectories of domestic and foreign prices differ distinctly. Whereas world prices rise steeply beginning in 2007 (as discussed above in section II), China's prices only gradually trend up. For example, in the case of rice while, on average, the international price of rice rose by 155 percent between 2005 and 2008, inside China the price of rice only rose by 19 percent. The cases of wheat and maize are similar. In fact, as can be clearly seen, the changes of prices inside and outside of China are so different that whereas the domestic prices of all key commodities inside China were above world market prices during 2005, they were well below world market prices in 2008.

How could two sets of prices—those inside China and those outside of China—differ so much? One of the most straightforward interpretations is that China's policy responses have been effective. Although during the past decade or so China's open borders have ensured that its domestic prices mostly follow those of international prices (Huang et al., 2004; Huang et al., 2008; and Rosen et al., 2004), when it released grain stocks onto domestic markets and closed its borders it broke that pattern and—at least in the short run—has forced its own domestic prices below world market prices. Of course, both policies—releasing stocks and assessing export levies—need to be implemented together. If China had not restricted exports, stock releases would have been sold onto world markets and had a much smaller impact. Likewise, if China had not released its stocks, export restrictions would have reduced prices much less than their combined effect.

The contrast between grain and soybeans is informative. Figure 3 shows how China's soybean prices rose with world market prices throughout the 2005 to 2008 period. For soybeans, unlike grains, China is a large importer and has not invested in public stocks, so officials had no means (apart from going onto international markets, importing, and selling into the domestic at below market levels, which would have to be supported by large subsidies) for trying to force down prices—at least in the short run.[2] In China today, more than 60 percent of the domestic consumption of soybeans is from imported soybeans. China's importers buy about 40 percent of the world traded soybeans in volume terms. Because of this, there is no real way to insulate the domestic soybean economy inside China from the rises in the prices of international soybeans without resorting to subsidized imports.

The case of pork is a third and, again, different story (Figure 4). In fact, historically, unlike the key traded commodities (rice, wheat and maize and soybeans), China's pork prices are far under world market prices and have not historically moved together with them. One reason is that such a small share of the total consumption (production) of China's pork is traded. In addition, because of concerns by China's trading partners about hoof and mouth disease and other sanitary/phyto-sanitary factors, traders in China export relatively little pork—despite the fact that China price has almost always been lower than the world market price.

So why is it that China's pork price increased while the international price of pork stayed relatively even? In this case, the price rises of pork at least mostly (and so

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[2] China could also have removed the VAT that it charges on imported soybeans. This would have reduced the landed price of soybeans. Trade economists (and policy officials) often do not advocate this policy since the VAT should be a stable tax.

far) have been limited to China and have not spread to the rest of the world. One explanation is that the rise of China's pork price was mainly related to a domestic supply shock (an outbreak of a disease that reduced China's hog population significantly). According to this explanation, international market prices were not driving China's domestic price trends—at least not yet.

In summary, then, we find that in the cases of the major food and feed grains—rice, wheat and maize—China had the means and will to effectively implement a set of policies that—at least in the short run—has kept China's grain economy isolated from the rapid price rises internationally. Grain prices inside China have grown significantly slower. Using the nation's grain storage system and a series of export levies and quantitative restrictions, while the rest of the world was trying to deal with high prices, China was releasing enough grain from its national stocks into the local markets and then successfully kept traders from selling the lower priced grain into international markets and keeping the grain inside the country.

Explaining the sources of price rises and effectiveness of China's policies

While the graphical analysis is instructive, in fact, there are many different things going on simultaneously which are lumped into a single net effect on prices in Figures 2, 3 and 4. In fact, we are interested not only if policies are effective or not, but whether or not (and, if so, how) international forces have affected China. If we can first measure what prices would have been without the nation's response, we can then figure out if its policy responses as a whole has had any collective effect.

To do this, we need a model that can decompose the recent price rises into several key sources. Therefore, in this section, to identify the sources of the changes in prices and measure the full impact of China's policy responses, we first describe our methodological approach. Next, we explain the scenarios that will be used to isolate the impact of international forces—including the rise in the price of oil and the emergence of biofuels—on China's domestic price of grain (and soybeans and pork). We then discuss our findings, decomposing the actual change in China's domestic price into three components—the effect of oil price rises; the effect of the emergence of biofuels and the net sum of all other factors, including China's policy responses. In the next section, we decompose the change in the world price of major commodities into its component parts.

Methodology and Scenarios

To understanding the impacts of the increase in world oil prices and the emergence of biofuels production on the price of China's agricultural commodities, we have built our modeling framework on the Global Trade Analysis Project (GTAP) platform.[3] As it is a model that allows multi-features (i.e., multiple commodities and multiple countries), the GTAP model makes it possible to model the linkages among biofuels production, energy and global agricultural markets. Since it is a global trade model, one can track the impacts from world markets into specific countries, including China (as well as track the effect on international prices).

[3] GTAP is a well known multi-country, multi-sector computable general equilibrium model (Hertel, 1997). The model is based on the assumptions that producers minimize their production costs and consumers maximize their utilities subject to a set of certain common constraints. Supplies and demands of all commodities clear by adjusting prices in perfectly competitive markets. Representative consumers of each country or region are modelled as having non-homothetic Constant Difference of Elasticity (CDE) demand functions. On the production side, firms combine intermediate inputs and primary factors (e.g., land, labor, and capital) to produce commodities with constant-return-to-scale technology. Intermediate inputs are composites of domestic and foreign components with the foreign component differentiated by region of origin (the Armington assumption). Regional endowments of natural resources, labour and capital are fixed. Labour and capital are perfectly mobile across domestic sectors. Agricultural land, on the other hand, is imperfectly mobile across alternative agricultural uses, hence sustaining rent differentials.

In order to make the standard GTAP modeling platform more suitable for our analysis, several modifications are made. First, we update the parameters that allow for the substitution between capital and energy (that are embodied in GTAP-E(nergy) model).[4] Second, we need to add a set of parameters to capture the substitution between biofuels and gasoline. Third elasticities of substitution are needed to understand the tradeoffs in land allocation among different crops—those that produce biofuels (e.g., maize) and those that do not (e.g., soybeans). Since the GTAP database does not have a biofuels sector, the production activities that produce biofuels need to be created and added into the database.

Linkages between agricultural and energy markets

In order to accurately capture the effects of changes in the world price of oil and the emergence of biofuels production, the standard GTAP model is extended by introducing the energy-capital substitution relationships that are described in the GTAP-E model (Burniaux and Truong, 2002). In addition to the standard assumptions, we also account for the substitutions between biofuels and petroleum products. To introduce the possible substitution of biofuels and petroleum products, a nested CES function between biofuels (bioethanol and biodiesel) and petroleum products is incorporated into the GTAP-E capital-energy commodity nested structure. Such a method is carried out in a way that is similar to the approaches taken by others who also add this sector to the GTAP-E model (e.g., Birur et al., 2007; Hertel et al., 2008). The elasticity of substitution between crude oil and biofuels is crucial in our research since it will be an important element that ties the price of energy to the price of food. Interestingly, in past research on biofuels in the US, EU and Brazil, the values of the

[4] GTAP-E model introduces energy-capital substitution to the standard GTAP model and is widely used for the analysis of energy and climate change policy.

elasticity of substitution are almost all similar to those used by Hertel *et al.* (2008), who set their substitution parameters (for the US, EU and Brazil) equal to 3.0, 2.75 and 1.0 respectively. In this work we use the default value of 2.0 (in other regions), the value of the parameter that is used in Birur (2007).

Allocation of agricultural land

The biofuels boom (especially, the first-generation of biofuels) will increase the demand on feedstock crops. However, the feasibility of changing land use from one crop to another may differ significantly by type of land. The standard version of GTAP allocates land using a constant elasticity of transformation (CET) structure. While this assumption means that different types of land use are imperfect substitutes for each other (a plausible assumption), all uses have the same degree of substitutability. This land-use structure makes it difficult to capture differences in substitutability that will almost surely emerge when we see a rapid expansion of feedstock crops.

To overcome this problem, different types of new land-use modules are being incorporated into the standard GTAP model. One way to do it is explored in Hertel *et al.* (2008) who uses different agro-ecological zones (AEZs). The authors of the Hertal et al. (2008) paper follow the methodology outlined in Lee *et al.*, 2005. Banse (2008) developed a stylized demand structure for land by producers of different crops that allows for different degrees of substitutability among the cultivated land for different crops. To implement this, inside the GTAP framework they embed a land supply curve equation that allows for the expansion of land. In our paper, we also use the same approach of modeling the land-use structure as Banse (2008). This approach helps capture the different degrees of substitutability between agricultural land uses. In our paper land use allocation structure is created by adding a three-level CET, nested structure to the standard GTAP model which takes into account the different degrees of substitutability among different land use types (Huang *et al.*, 2004). Unlike the Banse study, however, we do not allow for an endogenous adjustment of total land supply. In this application, this does not entail much of a cost because our study is trying to explain the past effects of the expansion of biofuels over a three year time horizon. Because the expansion of land over such a short time horizon is less important (in reality), we model the increase in the total supply of land using exogenously-determined shocks.

Introducing biofuels into the GTAP database

We use version 6 of the GTAP database in this study. The standard GTAP database has 57 sectors. Of this total number of industrial sectors, 20 represent agricultural and processed food sectors. Despite this level of disaggregation, many of the biofuels feedstock crops are aggregated with non-feedstock crops. There also is no biofuels industrial sector.

Our model modifies the standard database in two ways. First, we disaggregate the key biofuels feedstock crops and explicitly include them in the model's database. Based on trade data from UNCOMTRADE and production data from the FAO, we have disaggregated maize from cereal grains (gro) and soybeans from oilseeds (osd). To do this, we use a "splitting" program (SplitCom) developed by Horridge (2005). Second, we build new production activities for four biofuel industrial sectors. A new productive activity is included for sugar ethanol, corn ethanol, soybean diesel and rapeseed diesel. We introduced these into the GTAP database using a method similar to that developed by Taheripour (2007).[5]

Besides extending the database, we also modify the modeling framework to make it suitable for performing short-term, backcasting simulations. In the standard

[5] In this version of the model, we do not account for dry distillers grains (DDG).

GTAP modeling approach, it is assumed that capital and labor are perfectly mobile between the agricultural and non-agricultural sectors, so that marginal returns for these factors are equalized among industries. However, this assumption frequently is not supported by empirical evidence (De Janvry *et al.*, 1991). Moreover, in considering this assumption for short-time simulations, it is almost certain that adjustments of factors between capital and labor would be relatively limited. To model this, we segment capital and labor markets by specifying a CET structure which constrains labor-capital substitutability (Keeney and Hertel, 2005).

Scenarios

In this study, we develop three scenarios: one reference scenario and two alternative scenarios. Taken together, we are able to evaluate the impacts of two important events over the past several years—the rise of world oil prices and the emergence of a global biofuels industry. In this section, we are interested in the effect of these on the prices of China's agricultural commodities during the period preceding and during the on-going world food crisis, 2005-2008. (In the next section, we will address effects on international prices.) In the reference scenario, the world price of oil between 2005 and 2008 is fixed in the base year (2005) and is not allowed to rise. The reference scenario also is constructed under the assumption that biofuels production in the world did not expand beyond its production level of 2005 (see appendix A for a more complete description of the creation of the reference scenario). In other words, in the reference scenario there is no emergence of biofuels.

In the alternative scenarios, we first relax the first assumption of constant oil prices between 2005 and 2008 and then relax the other assumption about the static nature of biofuels production (also between 2005 and 2008). We relax these assumptions sequentially so we can look at the impact of higher oil prices and at the additional (incremental) effect of the emergence of biofuels. We choose to run these scenarios because the central question of our policy analysis is the assessment of the effects of the rise of the price of world oil prices and the emergence of the global biofuels industry on China's agricultural prices during the period between 2005 and 2008.

Towards this end, two specific scenarios are developed. In this scenario, we allow the oil price to rise to a level of about 120 dollars per barrel, a level that was reached in mid-2008. The actual annual growth rates of the oil price in 2006-2008 are presented in Table 1. The second scenario is designed to study the impacts of the emergence of the global biofuels industry. To understand the incremental effect of the the emergence of biofuels, we build on policy scenario 1 and allow for biofuel production to reach the level of production that was actually reached in 2008. In this scenario, we take into account the main biofuels producing countries in the world. The production changes during the period between 2006 and 2008 for the key biofuels producing countries in the world are summarized in Table 1.

Results from the world trade model

The results from our model provide a more in-depth understanding of the sources of the price rises in China over the past several years and the effects of China's policy responses. To show our results, Table 2 displays the findings in two ways. In the top row (row 1) of the first set of rows (rows 1 to 5), we list the actual, observed rise in China's domestic price between 2005 and 2008 (in percentage terms) for five key agricultural commodities. These price increases are created using the same data as Figures 2, 3 and 4. The figures in rows 2 and 3 come from the output of the modeling runs. Row 2 contains the simulated percentage changes in agricultural commodity prices that are due to the rise in the world price of oil. Row 3 contains the simulated percentage changes agricultural commodity prices that are due to the emergence of biofuels. Row 4 measures the interaction effect of the two shocks (and in the case of rice in column 1 is measured by subtracting the two individual shocks—16.6 and 16.7 percent—from the combined effect—36.07 percent—which is equal to 2.8 percent). Row 5 is the residual and is calculated by subtracting rows 2 plus 3 plus 4 from row 1. The combined impact of all of China's policy responses (and other factors with the exception of the rising prices of world oil and the emergence of biofuels) are captured by the residual.

The figures in the second set of rows (rows 6 to 10) are calculated from the information in rows 1 to 5. Row 6 is 100 percent in all cases and represents the total change (or 100 percent of the change) in China's domestic price between 2005 and 2008. Row 7 contains the simulated *shares* of the total change in agricultural commodity prices that are due to the rise in the world price of oil. Row 8 contains the simulated shares of the total change in agricultural commodity prices that are due to the emergence of biofuels. Row 9 is the share of the price change explained by the interaction effect. Row 10 is the residual share (100 minus the sum of rows 7 + 8 + 9), a figure that captures the contribution (in terms of the share of the rise of total price) of the combined impact of all of China's policy responses (and other factors with the exception of the rise in the world price of oil and the emergence of biofuels).

Our analysis clarifies how rising world oil prices and the emergence of biofuels have affected agricultural prices in China. As shown in Table 2, row 2, had there been no other effects, the higher price of oil would have pushed up the price of food and feed grains from 16.6 to 27.9 percent, through higher input prices As seen from row 7, this by itself is enough to account for 85 percent of the actual rise in the price of rice. The prices of wheat and maize inside China, had there not been any other factors, would have risen by more (190 percent for wheat and 105 percent for maize) than what prices actually rose by (11.2 percent for wheat and 26.5 percent for maize—columns 2 and 3). The price of oil also would have forced up the prices of soybeans and pork. Because the actual prices of soybeans and pork increased by more that the prices of the major grains, the share of the total rise accounted for by the rise of the world price of oil is smaller, about 39 percent of the total rise for soybeans and 17 percent of the total rise for pork (row 7).

We also find that the emergence of biofuels production added about an equal amount of upward pressure on China's grain prices (Table 2, row 3). Had there not been any other effects, the emergence of biofuels through the competition for land for the production of feedstock would have pushed up the price of food and feed grains from 16.1 (for wheat) to 20.6 percent (for maize). As seen from row 8, this by itself is enough to account for between 78 (for maize) and 144 percent (for wheat) of the actual rises in the prices of rice, wheat and maize. In other words, almost all (or even more) of the actual rise in the price of China's grain can be accounted for by the rise of biofuels. The emergence of biofuels production would also have forced up the prices of soybeans and pork (columns 4 and 5, rows 3 and 8). The interaction effects are relatively small (rows 4 and 9).

Taken together—and without considering any other factors (e.g., the response of China's government), the combined effect of the rise of the world price of oil and the the emergence of biofuels would have had a significant impact on China's agricultural commodity prices. While the combined effect is not quite equal to the rise in prices internationally (from Figure 1), it is close. Maize would have increased by more than 50 percent (27.9+20.6 + 5.7) and soybeans by more than 60 percent (30.4+24.5 + 7.4).

This would have accounted for almost half of the world's rise in prices. Interestingly, although our model does not allow us to definitively identify the source(s) of the rest of the rise of the world prices, the fact that there still is a considerable gap between the actual price rise and the price rise accounted for by world oil prices and biofuels, there may be stock in the notion the speculation played a role in the recent sharp increase in food prices. Other factors (e.g., production declines due to unaccounted for shocks to production) could account for part of the gap. Be that as it may, our results are consistent with an interpretation that at least a large part of the rise of prices in recent years are associated with the rise of world oil prices and the emergence of biofuels.

The relatively large negative numbers in rows 5 and 10 in Table 2 are consistent with an interpretation that China's food price stabilization measures—i.e., releasing grain stocks and levying export assessments—played a role in moderating the rise of grain prices in its domestic market between 2005 and 2008. Although other factors may have played a role, it seems like that the actions taken by officials did dampen the price of rice by 16.6 percent. Since the actual rise in the price of rice between 2005 and 2008 was 19.5 percent, this means that had it not been for these other factors, the price of rise would have increased by 16.6 percent more (or by a total of 35.1 percent=18.5+16.6). Likewise, wheat would have increased by 29.6 percent more and maize by 27.7 percent more. Instead of having moderate price rise, the prices of wheat and maize would have been significantly higher.

Since the price rise of soybeans rose more than the combined contribution of the increase in the world price of oil and the emergence of biofuels, the residual in row 5, column 4 of Table 2 is positive. Likewise it is positive for the case of pork (row 5, column 5). Although our analysis does not allow us to identify the exact cause of these additional rises, in the case of soybeans it may be a speculative component of the international price that was transmitted through the border from foreign markets. In the case of pork, it is almost certain that the negative production shock of last year kept the price up above the price that it would have been had there only been the rise in the price of oil and the emergence of biofuels.

V. Assessing the Impact of Biofuels on World Prices

We also can use our modeling framework to decompose the change in the world price of wheat, maize and soybeans—in this case the price shift in the US (Table 3). According to our findings, of the 118.7 percent increase in the price of US wheat that was experienced in the US, 18.2 percentage points was due to the rise in the price of oil, 26.1 percentage points was due to the emergence of the biofuels sector and 4.8 percentage points was due to their interaction effect (column 1). In total, 41 percent of the total rise in price ([18.2+26.1+4.8]/118.7) is due to the higher price of oil and biofuels.

The share explained by rising oil prices and the emergence of biofuels is higher for the US price of maize, the nation's main feedstock commodity (Table 3, column 2). In this case of the 114.5 percent rise in price, 30.6 percentage points are due to the rise in the price of oil, 44 percent is due to the emergence of biofuels and 13.5 percent in an interaction effect. Therefore, according to our analysis, 77 percent of the rise of the US price of maize ([30.6+44.0+13.5]/114.5) is due to these energy-related factors.

The share explained for soybeans by higher oil prices and the emergence of biofuels is in the middle of the cases of wheat, a non-feedstock and maize, a feedstock (Table 3, column 3). About 66 percent of the rise in the price of US soybeans is due to energy related factors ([25.5+30.0+7.6]/96.1). Although soybeans are also not used as feedstock, it is most likely relatively more affected by higher oil prices and the emergence of biofuels because soybeans are such close substitutes for maize in agricultural production systems.

VI. Discussion and Implications for Policy

While China's food price stabilization measures may have helped its leaders meet their food security goals by keeping domestic grain prices from rising as they have on international markets, this does not mean that such a set of policies is optimal for the world. It also does not mean that grain prices can be suppressed indefinitely. In this final section, we examine these two issues.

The first question—has China's growth caused the rising food prices on international markets because of its rapid growth and rising demand for imports—in fact, is relatively easy to answer. If China's rapid growth increased its demand for food so much that importers bid up the price of food internationally, China in a fairly direct way might be responsible for rising world food prices. Table 4 shows the trend in imports, exports and net exports for most of China's major agricultural commodities between 2004 and 2007, a time that overlaps the beginning of the take off of world food prices. As is clear from this table, in the case of almost all major commodities—rice, wheat and corn, not only did imports into China did not rise, exports did. In other words, net imports fell. This means that at exactly the time that world food prices were taking off, China was actually increasing shipments into key international markets. The same is true for commodities such as fruits, vegetables and pork. Only in two markets, that for soybeans and that for vegetable oil, did imports rise. Surely, a 15 percent rise between 2005 and 2007 could not cause the world food crisis.

Therefore, China's demand for food, despite its rising demand for certain commodities, certainly cannot be blamed for the initial increases in world food prices that have appeared since 2007. However, it is likely that China's counter measures to keep their own domestic price of food down helped exacerbate the world food crisis once it began. By levying export assessments on major grain and oilseed crops and fertilizer, China is keeping agricultural commodities and inputs off world markets. With a reduction in supply—due to a falling amount of exports—world prices almost certainly rose to levels that they would not have had China continued exporting. Of course, China did not act alone. According to the World Bank, there were 28 countries in addition to China that levied export assessments or prohibited exports in response to rising prices (World Bank, 2008). Should these countries have sacrificed their own food security and inflation goals in order to keep world markets open?

While China's actions of releasing stocks and constraining exports may have kept prices inside China lower than the world market over the past year, in the longer run it will become almost impossible to sustain current price relations. Eventually stocks will run out, and if demand grows faster than supply China may have its own food crisis in the future. Because of this, we believe that it is important for China's government to balance the potential crisis of today with that of tomorrow. If instead prices are allowed to rise now, the higher prices in 2008 will stimulate domestic production of key commodities. In the longer run, this rising supply will help moderate future price increases.

In addition to dwindling grain stocks, another source of pressure is the rising price of soybeans relative to grain, which we expect will lead farmers in China to shift resources from grain into soybeans. During a field trip this past spring, we found many maize farmers in the Northeast of China were shifting back into soybeans, after not having planted them for many years.

Policy implications

As we have seen, policy changes have been able to limit food price increases inside China to a remarkable degree, but it is inevitable that China will confront greater pressures to raise food prices in near future. The analysis presented here has clear implications for how China should respond.

First, the government needs to prepare itself and its citizens to accept food price rises. Releases of grain stocks and export levies/quantitative restrictions have kept prices down in the short run but domestic food prices will increase, unless enormous resources are put into subsidizing imports.

Second, government can help producers increase production. Policies have lowered prices and reduced production incentives, but when prices rise the ability of farmers to respond depends in part on public investments in the agricultural sector. These include investments to promote agricultural productivity and expand infrastructure (e.g., technology and irrigation and roads) which will lead to improvements in yields and efficiency. With these complementary investments, high and rising food prices can be seen as an opportunity to stimulate the rural economy and foster a strong agricultural sector, helping the poorest in China who have land and can now earn higher incomes.

Finally, it should be recognized that some consumers get hurt from higher prices. Fortunately in China most all of the poor have land and there are few truly destitute urban residents, although there are some poor net consumers. Because of this, it is essential to construct (enhance) a social security system in urban and rural areas to provide the necessary support for vulnerable citizens.

Appendix A. Construction of the Reference Scenario

The construction of reference scenario is separated into two steps. The first step is to calibrate technological change during 2005-2008, using a recursive process involving two databases, one for each time period. In our case these time periods are 2001 to 2005 and 2005 to 2008. The changes in marco economic data (e.g., population and GDP across all countries) are taken from National Bureau of Statistics of China (NBSC). The changes of labor and capital are taken from the studies of Huang and Yang (2006), Tongeren and Huang (2004) and Walmsley et al. (2000). During the updating procedure, GDP growth is set exogenously and technological change is endogenously determined within the model. In order to better reflect the technological change in the agricultural sector, we use the information on technological change from the International Food Policy Research Institute (IFPRI) IMPACT model. Besides, the updating procedure also includes certain important policy events during this period. The important policy changes are: China's WTO accession between 2002 and 2005; the global phase out of the Multifibre Agreement under the WTO Agreement on Textiles and Clothing (ATC) by January 2005; and the EU enlargement with the accession of a number of Central and Eastern European countries (CEECs).

The second step in our procedure generates the reference scenario, with GDP computed endogenously given the exogenous technological change that was calibrated in the previous step. The difference from our first step is that the biofuels production during 2006-2008 is assumed not to have expanded beyond its production level of 2005, and world oil price was fixed as that in 2005. This counterfactual limit on biofuels production and crude oil prices is implemented through the domestic production tax on biofuel industries and the technology of natural resource use in crude oil extraction.

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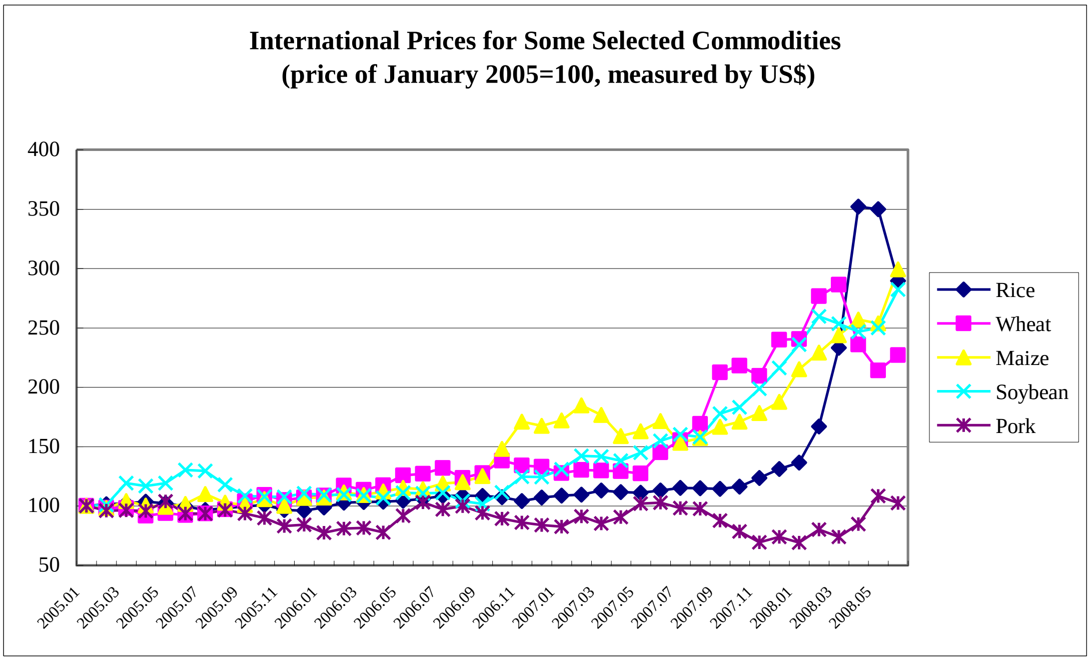
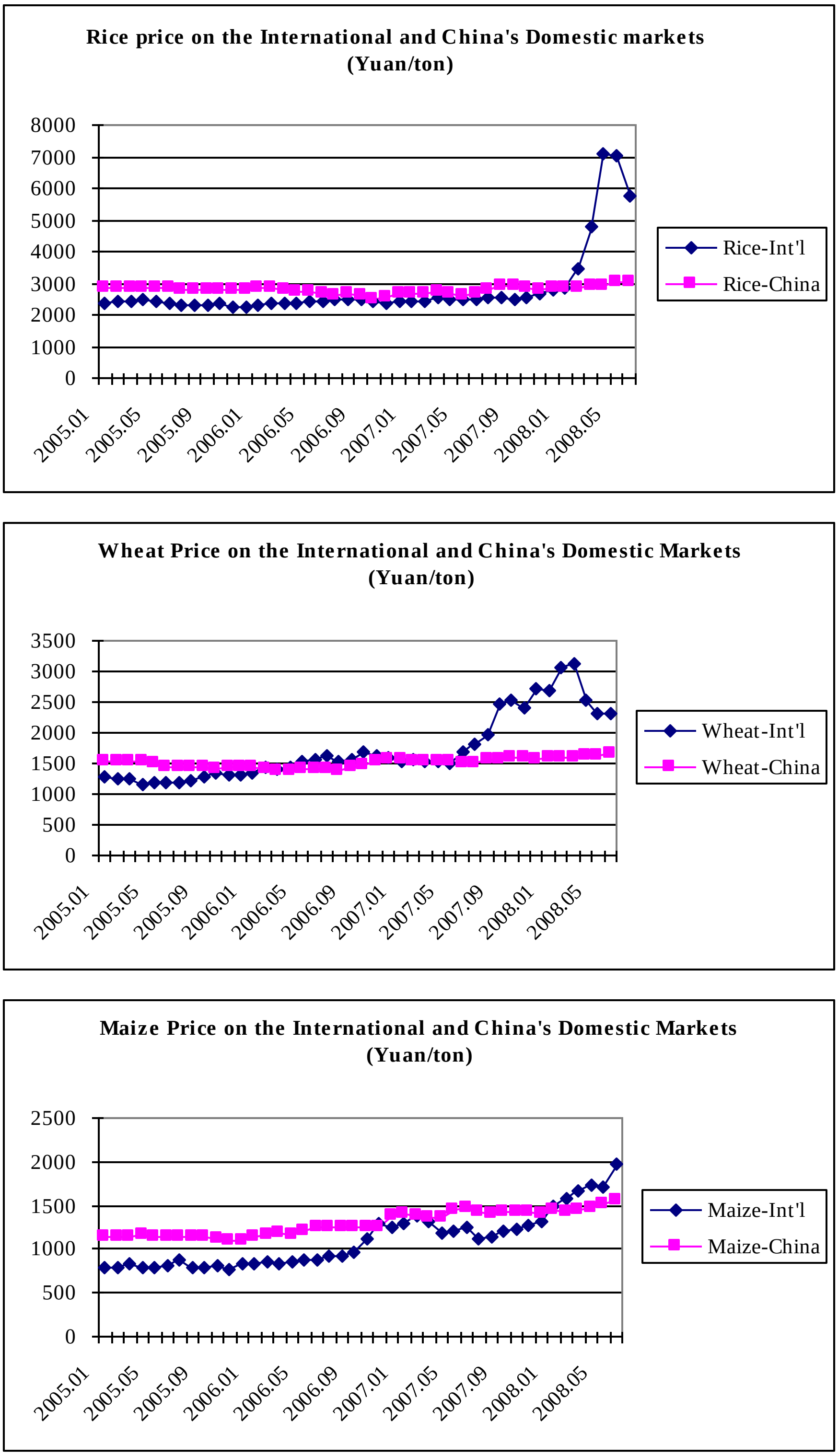


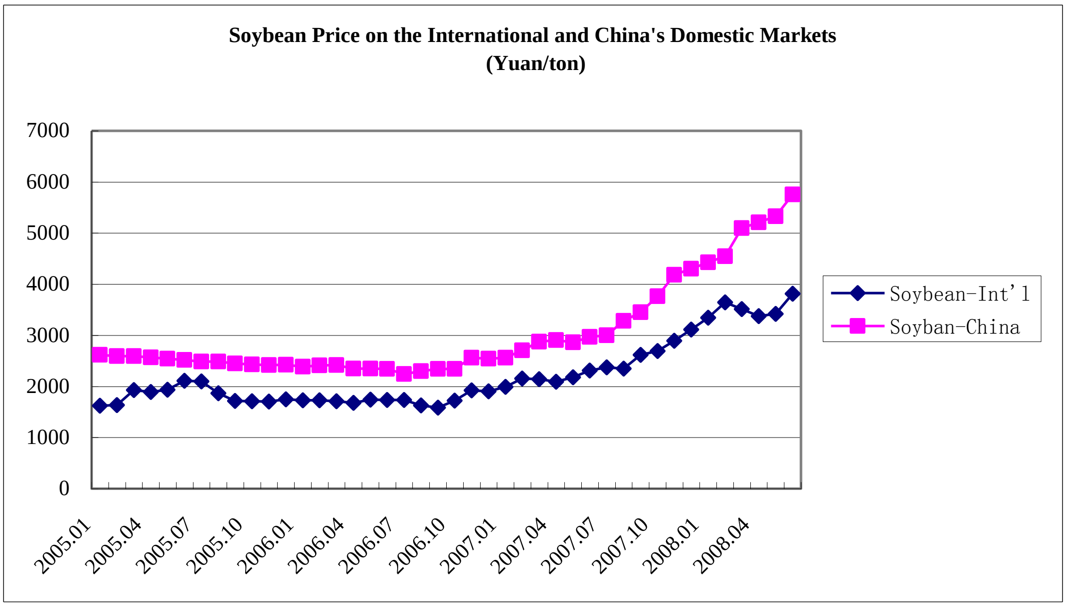
Data sources: International Monetary Fund (2008). The rice price refers to the 5 percent broken, milled white rice price of Thailand (nominal price quote); the wheat price refers to the No.1 Hard Red Winter, ordinary protein price, FOB Gulf of Mexico; the maize price refers to the U.S. No.2 Yellow Maize price, FOB, Gulf of Mexico; The soybean price refers to the Chicago Soybean futures contract (first contract forward), No. 2 yellow and par; The pork price refers to the 51 to 52% lean hogs price in the U.S.

Figure 1. Price Indices (January 2005 = 100) of Rice, Wheat, Maize, Soybeans and Pork in International Markets, 2005 to 2008.



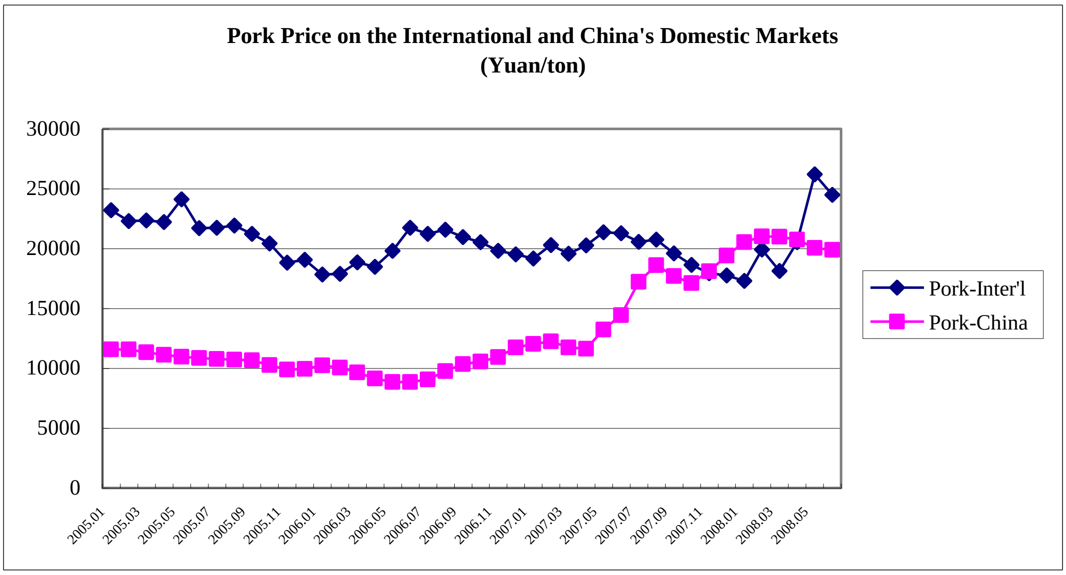
Data sources: For international prices, see Figure 1. China's domestic prices are from China's Monthly Economic Indicators; and China's Ministry of Agriculture's wholesale market price report.

Figure 2. Graphical analysis comparing the international and China domestic prices of rice, wheat and maize, January 2005 to June 2008.



Data sources: For international prices, see figure 1. For China's domestic prices see figure 2.

Figure 3. Graphical analysis comparing the international and China domestic prices of soybeans, January 2005 to June 2008.



Data sources: For international prices, see figure 1. For China's domestic prices see figure 2.

Figure 4. Graphical analysis comparing the international and China domestic prices of pork, January 2005 to June 2008.

Table 1. The actual percentage changes of key variables that define the two alternative scenarios in our simulation of the rise in the world price of crude oil and the emergence of biofuels during the period 2006 to 2008.

	2006 over 2005	2007 over 2006	2008 over 2007[a]
Alternative scenario 1:			
World price of crude oil	16	10	72
Alternative scenario 2:			
World cruel oil price	16	10	72
Bio-Ethanol production			
USA	25	33	33
Brazil	11	27	27
EU	75	8	8
Bio-diesel production			
USA	233	80	80
EU	54	17	17

Data sources: The production growth rates of bioethanol are calculated based on data from BP statistical review (http://www.bp.com). The growth rates of biodiesel in USA and EU are based on the data from US National Biodiesel Board (NBB) (http://www.biodiesel.org/), and European Biodiesel Board (http://www.ebb-eu.org). The growth rates of world cruel oil price are based on data from BP statistical Review of World Energy Data (http://www.bp.com).

[a] As data on biofuels production in 2008 are not available, we assume that that production in 2008 enjoyed the same growth rate of biofuel production in 2007. The growth of the price of oil in the world is calculated based on the average crude oil in the first six months of 2008 and average prices in 2007.

Table 2. Decomposition analysis of the actual change in the prices of key agricultural commodities in China into the international price of oil, the emergence of biofuels, the interaction of oil price and the emergence of biofuel and other factors, 2005 to 2008.

	Rice	Wheat	Maize	Soybean	Pork
	Percentage change between 2005 and 2008				
Price change	**19.5**	**11.2**	**26.5**	**77.7**	**89.9**
Impacts of:					
Oil	16.6	21.3	27.9	30.4	15.3
Biofuel	16.7	16.1	20.6	24.5	17.9
Interaction of oil & biofuel	2.8	3.4	5.7	7.4	2.7
The rest	-16.6	-29.6	-27.7	15.4	54.0
	Share of total change in price between 2005 and 2008				
Price change	**100**	**100**	**100**	**100**	**100**
Impacts of:					
Oil	85	190	105	39	17
Biofuel	86	144	78	31	20
Interaction of oil & biofuel	14	31	22	10	3
The rest	-85	-265	-105	20	60

Notes: The numbers in rows 2 to 4 of each column add to the number in row 1. Row 4 is calculated as a residual. The numbers in rows 6 to 8 of each column add to 100 percent. The percentages in row 6 (7 or 8) are calculated as row 2 (3 or 4) divided by row 1.

Table 3. Decomposition analysis of the actual change in the prices (FOB) of wheat, maize and soybean in USA into the international price of oil, the emergence of biofuels, interaction of oil price and the emergence biofuels, and other factors, 2005 to 2008.

	Wheat	Maize	Soybean
	Percentage change between 2005 and 2008		
Price change	118.7	114.5	96.1
Impacts of:			
Oil	18.2	30.6	25.5
Biofuel	26.1	44.0	30.0
Interaction of oil and biofuel	4.8	13.5	7.6
The rest	69.6	26.4	33.0

Table 4. China's agricultural imports and exports of major commodities, 2004 to 2007 (1000 tons).

	2004	2005	2006	2007
Imports				
Rice	757	522	730	471
Wheat	7259	3544	584	101
Maize	2	4	65	35
Soybean	20230	26591	28237	30821
Vegetable	166	98	197	99
Vegetable oil	6758	6203	6695	8397
Sugar	1214	1391	1349	1193
Fruit	1122	1160	1297	1347
Pork	71	53	24	69
Poultry	5	5	17	35
Exports				
Rice	896	686	1253	1305
Wheat	1088	605	1114	2337
Maize	2318	686	3099	4914
Soybean	335	414	379	455
Vegetable	4537	5200	5679	8173
Vegetable oil	65	228	399	168
Sugar	85	358	154	111
Fruit	1749	2000	1983	2558
Pork	291	250	269	248
Poultry	19	27	9	10
Net imports				
Rice	-140	-164	-523	-834
Wheat	6171	2940	-530	-2236
Maize	-2316	-682	-3034	-4879
Soybean	19895	26177	27858	30366
Vegetable	-4371	-5103	-5482	-8074
Vegetable oil	6693	5975	6295	8229
Sugar	1129	1033	1194	1082
Fruit	-627	-840	-686	-1211
Pork	-221	-197	-245	-179
Poultry	-14	-22	8	24

Data sources: China Agricultural Yearbook, various years; trade data of 2007 was from National Statistical Bureau of China.