Stanford
Center for International Development

Working Paper No. 212

The Emergence of Agricultural Commodity Markets in China

by

Jikun Huang

Scott Rozelle

April 2004

Stanford University
John A. and Cynthia Fry Gunn Building
366 Galvez Street | Stanford, CA | 94305-6015

The authors would like to acknowledge the comments of Belton Fleisher, Nick Hope, Hehui Jin, Phil Laney, Will Martin, Todd Meyer, Albert Park, T. Srinivasan and the insights of participants at workshops and seminars in the University of Illinois, the University of California, Berkeley, the International Food Policy Research Institute's Workshop on China and India, the 2002 International Rice Congress, the World Bank and other places. The research assistance of Min Chang, Hengyun Ma and Yuping Xie was invaluable. Rozelle is a member of the Giannini Foundation.

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China's reformers, more than anything, have followed a strategy based on providing incentives through property rights reforms, even though in China the shift to private ownership is today far from complete. The reforms started with the Household Responsibility System (HRS), a policy of radical decollectivization that allowed farmers to keep the residual output of their farms after paying their agricultural taxes and completing their mandatory delivery quotas. Farmers also began to exercise control over much of the production process (although in the initial years, the local state shared some control rights and in some places still do today). In this way the first reforms in the agricultural sector reshuffled property rights in an attempt to increase work incentives and exploit the specific knowledge of individuals about the production process (Perkins, 1994). In executing the property rights reforms, leaders also fundamentally restructured farms in China. Within a few years, for example, reformers completely broke up the larger collective farms into small household farms. In China today there are more than 200 million farms, the legacy of an HRS policy that gave the primary responsibilities for farming to the individual household. McMillan, Whalley and Zhu (1989), Fan (1991), Lin (1992) and Huang and Rozelle (1996) have all documented the strong, positive impact that property rights reforms had on output and productivity.

In addition to reforming property rights and transforming incentives, the other major task of reformers is to create more efficient institutions of exchange. Markets—whether classic competitive ones or some workable substitute—increase efficiency by facilitating transactions among agents to allow specialization and trade and by providing information through a pricing mechanism to producers and consumers about the relative scarcity of resources. But markets, in order to function efficiently, require supporting institutions to ensure competition, define and enforce property rights and contracts, ensure access to credit and finance and provide information (McMillan 1997, World Bank 2002). These institutions were either absent in the Communist countries or, if they existed, were inappropriate for a market system. Somewhat surprisingly, despite their importance in the reform process there is much less work on the success that China has had in building markets and the effect that the markets have had on the economy.

In part in response to the lacunae of research on markets and their impacts on the China's rural economy, in this paper our major goal is bring together the facts on the emergence of China's markets. To do so we will have four specifics objectives. First, we document the policy environment that has unfolded during the reform era. Second, we examine the data, and look at spatial patterns of market prices contours over time. Third, we examine the extent to which market prices are integrated – both between regions and between regional marketing centers and villages. Finally, we examine how the emergence of markets has affected the behavior of producers and their productivity.

In order to examine such a broad topic, we need to limit the scope of the analysis. We primarily restrict ourselves to China's main staple commodities—rice, maize and soybeans. These commodities—especially maize and soybeans—are ideal since the quality differences among regions are relatively narrow, a characteristics that facilitates integration analysis. Data on the major commodities also are more available over time and across space. As their share of the economy grows, more work is needed on the cash crops and livestock and aquaculture products.

Commodity Price and Marketing Policies

Price and market reforms are key components of China's transition strategy to shift from a socialist to a market-oriented economy. The price and market reforms initiated in the late 1970s were aimed at raising farm level procurement prices and gradually liberalizing the market. These reforms included gradual increases in the agricultural procurement prices toward market prices, reductions in procurement quota levels, the introduction of above quota bonuses for cotton, tobacco, and other cash crops, negotiated procurement of surplus production of rice, wheat, maize, soybean, edible oils, livestock, and most other commodities at price levels higher than those for quota procurement, and flexibility in marketing of surplus production of all categories of agricultural products by private traders. It is interesting that in the initial years there was little effort to move the economy to one in which most all resources and factors were allocated according market price signals.

As the right to private trading was extended to include surplus output of all categories of agricultural products after contractual obligations to the state were fulfilled, the foundations of the state marketing system began to be undermined (Rozelle et al., 2000). After a record growth in grain production in 1984 and 1985, a second stage of price and market reforms was announced in 1985 aimed at radically limiting the scope of government price and market interventions and further enlarging the role of market allocation. Other than for rice, wheat, maize and cotton, the intention was to gradually eliminate planned procurement of agricultural products; government commercial departments could only continue to buy and sell in the market. For grain, incentives were introduced through the reduction of the volume of the quota and the increase in procurement prices. Even for grain, after the share of compulsory quota procurement in grain production reached 29% in 1984, it fell to 18% in 1985 and 13% in 1990, while the share of negotiated procurement at market price increased from only 3% in 1985 to 6% in 1985 and 12% in 1990.

Because of the sharp drop in the growth rate of grain output and rise in food prices in the late 1980s, the pace of marketing reform stalled. Mandatory procurement of rice, wheat, maize, soybean, oil crops and cotton continued. To provide incentives for farmers to raise productivity and to encourage sales to the government, quota procurement prices were raised over time. The increase in the nominal agricultural procurement price, however, was lower than the inflation rate, which led to a decline in the real grain price (Huang et al., 2004).

As grain production and prices stabilized in the early 1990s, however, another attempt was made to abolish the grain ration system. Urban officials discontinued sales at ration prices to consumers in early 1993. For a year and a half, the liberalization move succeeded. Then, although it appeared that the state grain distribution and procurement systems had both been successfully liberalized, food prices rose sharply; other prices in the economy also rose. Some blamed rises in food prices for the nation's inflation. As a result, the state compulsory quota system was re-imposed in most parts of China in 1995, but at a lower procurement level. The share of grain compulsory quota procurement in total production remained at only 11% in 1995-97.

Since the middle 1990s, several new policies—some pro-market, others anti-market—were implemented. Immediately after the price rises in the middle 1990s, China started the provincial governor's "Rice Bag" responsibility system. The policy was designed to enhance food security and the performance of grain markets by making provincial governors and governments responsible for balancing the supply and demand of cereals in their provinces and for stabilizing local food markets and prices. Policies under the system included re-imposing grain rationing to poor consumers, investing in production bases inside the province, and attempting to keep grain from being shipped outside of the province. If comprehensively implemented, this policy might have reduced short-run agricultural price fluctuations, but not without costs. The widely held belief was that the policy could have adverse effects on the efficiency of resource allocation, the diversification of agricultural production, and farmer's incomes. However, numerous efforts to restrict the flow of grain were unsuccessful. Market flows continued and the share of government procurement (both quota and negotiated procurement) in domestic production fell from 26% in 1994 to 22% in 1996, reflecting the profits that traders could earn by shipping grain from low to high priced areas (Huang et al., 2004).

With three record levels of grain production in China in the late 1990s, and almost zero or negative inflation since 1997, rising grain stocks and declining food prices showed the economy had bounced back. However, in a sense, the government's policies were victims of their own success. With prices falling sharply, leaders worried about a repeat of the mid-1990s. Instead of proceeding with market reform, leaders actually opted for greater control over grain prices by price protection policy.

In fact, in the late 1990s leaders attempted to curb market forces more than in earlier retrenchments but by completely different measures. Market intervention policy shifted from taxing grain producers, through a lower government quota procurement price (lower than market price), to supporting grain prices by implementing a grain protection price (higher than market price). To reduce the financial burden of the protection price policy, in 1998 the central government initiated a controversial policy change prohibiting individuals and private companies from procuring grain from farmers.[1] In contrast to past policies, grain quota procurement prices for the first time were set above market prices, which meant a transfer in favour of those farmers able to sell at that price (Huang and Chen, 1999). Leaders expected that the commercial arms of grain bureaus could monopolize grain markets, and sell the procured grain at even higher prices in the market, thereby meeting the nation's goal of raising farmers' incomes. If the state could have exercised monopoly power in grain markets, it might have been able to implement price supports while enabling the state grain companies (i.e., the commercial arms of grain bureaus) to earn a profit and while reducing the government's financial burden in maintaining the state-run grain procurement and marketing system. The loser under this policy would have been the consumer who would have had to pay a higher price for grain.

These win-win (from the government's viewpoint) policies did not work, however, primarily because the government could not suppress market activities of

[1] Farmers were supposed to deal solely with the commercial arm of grain bureaus and the grain reserve system--although traders were allowed to operate in wholesale and retail markets.

traders and the commercialized grain system employees. Although above market prices were offered to farmers in some years, cash-strapped grain bureaus could not procure all of the grain that farmers wanted to sell. Grain production increased, but since grain bureaus were trying to sell grain to urban and commercial users at above market prices, they had few takers. The activities of millions of private grain traders could not be curtailed, and urban users continued to buy from their original channels at market determined prices. Not surprisingly, stocks started to accumulate, the real market price fell even further, and the commercialized grain bureaus, which had been forced to buy grain at high prices, now had huge grain stocks worth less than their purchase price and debts that were higher than ever.

In the early 2000s, marketing reforms were launched once more. Restrictions on marketing were removed, new efforts to commercialize the grain bureaus were begun, and the support prices extended to some farmers in some areas were eliminated. In short, another attempt tried to make the policy environment even more market-oriented. In fact, as seen from this recounting of nearly 25 years of reform, marketing reform has been an on again /off again policy effort. When grain prices are low and grain relatively abundant, markets are liberalized. But policymakers endeavour to curb markets in times of rising grain prices. What is unclear, however, is how effective policies have been in dampening market activity or facilitating the operation of well-functioning markets. We turn to this question in the next three sections.

Data

To assess the performance of China's markets in the past decade, we employ data from a number of different sources. First, we use a set of price data collected by China's State Market Administration Bureau (SMAB—*dataset 1*). Nearly 50 sample sites from 15 of China's provinces report prices of agricultural commodities every 10 days. This means there are 36 price observations available for each market site for each commodity each year. The prices are the average price of transactions that day in the local rural periodic market. The Ministry of Agriculture assembles the data in Beijing and makes them available to researchers and policy makers. Unfortunately, since 2000, the quality of the data has deteriorated.

Using the SMAB data, we can examine rice, maize and soybean prices from 1996 to 2000 (except for maize, as data are only available through 1998). The three crops are produced and consumed in nearly every province in China. Rice price data are available for 31 markets. Because of quality differences among rice varieties across China, we look at price integration among markets within four regions: South China (South), the Yangtze Valley (YV), the North China Plain (and Northwest China--NCP) and Northeast China (NE). For the provinces included in the sample, rice prices are available for over 90 percent of the time periods. Prices for maize and soybeans are available for 13 and 20 markets, respectively.[1] Product homogeneity in the case of maize and soybeans makes it possible to examine price integration among markets across a broader geographic range. We compare our results for the late 1990s (1996 to 2000) to results from 1988 to 1995 that were produced with the same data and published in Park et al. (2002).[2]

The second source of data on China's domestic market (*dataset 2*) comes from a price dataset collected by the Jilin Province Grain and Oil Information Center (GOIC).

For maize, between August 10, 1998 and February 24, 2003, weekly prices are reported for 15 of China's main maize production and consumption provinces, including Heilongjiang, Jilin, Liaoning, Hebei, Shandong, Jiangsu, Zhejiang, Shanghai, Hubei, Sichuan, Hunan, Fujian, Guangdong, and Guangxi (Meyer, 2002). From September 7, 1998, there is a price series from Liaoning for Dalian, the main port from which exports are shipped to foreign, and other domestic, markets.

To examine maize markets more carefully in the northeast region of the country and through the country in the post-accession period, we used a further dataset collected by the Jilin Province GOIC (*dataset 3*). The data in this dataset are first available after October 26, 2001, and they continue through February 25, 2003. This dataset is more detailed for two reasons. First, it includes prices from three markets in Heilongjiang, three markets from Jilin, three markets from Liaoning (including two in production regions and Dalian), and market sites in Guangdong, Fujian, Jiangsu and Hubei. Second, the dataset reports data more frequently, typically twice a week (every third day, then every fourth day).

The data from the Jilin Grain and Oilseed Price Information Center appear to be of higher quality than the price series in dataset 1.[3] Unlike the other price datasets available in China, there are few missing observations. There are also relatively few inconsistencies in the data. In other data sets, corrections frequently need to be made to account for missing observations and to adjust for prices recorded in price "per jin" when the data category is defined as price "per kilogram." Unlike our previous analyses of prices using other datasets from China, we made *no* correction to the data after they were provided to us by the US Grains Council.

In our discussions with the Monitoring and Marketing Divisions (MMD) of the NGIOC (the division of the GIOC in charge of collecting the data), we discovered that the data were mostly from members of the marketing arms of local grain storage bureaus (which make daily maize and soybean sales), traders in major ports (Dalian and Guangzhou), and end users (in the south). Most commonly, a member of MMD will make a call to a grain bureau official, trader and end user twice a week (Monday and Thursday). For example, in Dalian we were told that each Monday and Thursday MMD calls about 9 traders who are involved with shipping grain from Dalian to South China. These traders tell the MMD official the average FOB price at which corn is leaving Dalian. In the northeast (e.g., Jilin), we were told that MMD calls several grain bureaus in a region and asks them for unit value prices (value of shipments divided by volume) for the day. The MMD official averages the prices reported for the district.

The soybean data come from the same source, the Jilin Province GOIC, but are collected somewhat differently (*dataset 4*). Soybean data are only available on a monthly basis. The data series are complete and overall the quality of the data appears to be the equal to that of the maize dataset.

Price Trends and Spatial Patterns of Market Emergence

In this section, we use the data on prices to describe China's agricultural markets. We first plot the data over time and examine how prices move together in markets in the same geographic region and in markets separated by long distances. Next, we examine more rigorously transportation gradients in China's rice, maize and soybean markets. To put the results in perspective, we examine them over time and compare those of China with those of the US. Our hypothesis is that if prices in markets in different parts of China move together and if they create spatial patterns similar to those found in more market-oriented economies then our data are producing quantitative evidence that China's markets are emerging as functional and increasingly efficient.

Price Trends

Maize Using dataset 3, we can see how closely prices in Northeast China track each other (Figure 1, Panels A and B). In Panel A we plot the Dalian domestic price versus the prices in the three Heilongjiang market sites (chosen because they are the furthest Northeast markets from Dalian). While varying over time, the Dalian domestic price remains about US$127/metric ton (mt) between December 2001 and February 2003. During the same period, the prices in each of the three Heilongjiang markets move almost in perfect concert with one another. While also varying over time, the prices in Heilongjiang during the post-WTO-accession period are around US$110/mt to US$115/mt. Visual inspection also shows that although the market in Dalian and those in Heilongjiang are more than 1000 kilometres apart and prices vary by US$12/mt to US$17/mt, the prices in many periods are moving together. When the prices in Dalian move up (down), the prices in Heilongjiang tend to move up (down).

Similar patterns of price movements are found to exist between the two markets in western and central Liaoning and Dalian (Panel B). In fact, the prices in the two Liaoning producing areas track each other even more closely than the markets in Heilongjiang, a finding that perhaps is not surprising as Liaoning is a smaller province with better transportation and communication infrastructure. The co-movements of prices among the producing areas in Liaoning and the consumption center of the province, Dalian, are easily perceptible. The narrower price gaps among producer (lower trend lines) and user areas (higher trend line) when compared to the Heilongjiang-Dalian figure reflect the closer distances (and hence lower transportation costs) in Liaoning.

Using dataset 1, comparisons of prices between more distant points of China display similar patterns of closely aligned movements (Figure 2, Panels A and B). Although since the mid-1990s prices have moved together between Dalian and Guangdong and between Dalian and Fujian, the tracking of market prices appears to be even closer in recent years. Almost every turning point (a shift from low to high or high to low) in Guangdong and Fujian can be found also in the Dalian market. The synchronized movement of prices occurs even though the primary way in which grain moves between the two sets of markets is by ship. With the advent of private shipping and commercial trading, there are now many shipping lines and trading companies that move grain between the Northeast and South main consumption areas. The observations from Figure 2, Panels A and B, when linked with those from Figure 1, demonstrate that prices in Heilongjiang appear to depend on (shifts in) feed demand and corn availability in Guangzhou and Fujian.

Soybeans Using dataset 4, we find soybean prices similarly move together for pairs of markets both in the same region and across more distant locations. The bottom two price series in Panel A, Figure 3, trace the price trends for soybeans in Heilongjiang and Jilin. The two series are almost indistinguishable from one another, with Heilongjiang prices slightly lower from almost the entire period. The Guangdong price, the top line in Panel A, also shows that prices move in concert with one another inside China's domestic market even though the markets are thousands of kilometres apart. In only two short periods—early 2000 and late 2002—does the gap between the two markets deviate from a fixed margin that is almost equal to the transport price between the Northeast and the South.

Panel B in Figure 3 shows that prices appear to be even more integrated in the South. Throughout the entire period, market prices are so close that the individual price series are virtually indistinguishable. This degree of apparent integration is almost certainly a function of the nature of the market. During the period for which we have data (1999 to 2003) more than half of the soybeans marketed in South China are imported. According to traders in the US and China, the price for landing a ship-load of soybeans in Shanghai is virtually the same as doing so in Guangdong.

Cross commodity trends In addition to observing co-movements of maize prices between regions over time during the post-WTO-accession period, our data (dataset 3) also show that prices of different feed types move together (Figure 4). In South China, early rice is frequently used as a feed, albeit a slightly inferior one in the view of most livestock producers. But even though the price of maize is higher than feed rice across China, the price ratio of maize to feed rice is almost identical in markets in different provinces. Figure 4 illustrates how the price ratio of maize to feed rice varies over time in Guangdong and Fujian, with the trend of the ratios in each province tracking one another almost perfectly.

Figure 5 shows that the same co-movement of prices occurs inside the soybean market. The prices of soybeans and soybean meal also track one another almost perfectly for the entire sample period 1999-2003. Interestingly (although not shown), when the price of soybean oil is added, after 2000, oil prices (while higher) also move together with soybean and soybean meal. Before 2000, restrictions on imports of soybean oil kept its price *abnormally* higher than the prices of soybeans and soybean meal.

Price Determination

We also can use statistical analyses to analyze the behavior of prices of China's major commodities in another dimension. In this subsection we examine price behavior across space at a given time. If China's markets function well, there is a greater likelihood that when a price changes in one region (e.g., a price shock arises in Dalian due to an increased demand for exports or for shipments to elsewhere in China) prices will change throughout the rest of China. If price formation does not result from adequately functioning markets, price shifts at the border (e.g., Dalian) may not affect prices elsewhere in China. Indeed, if markets in China are fragmented, price changes in the coastal areas near the border could be more pronounced (for a given shift in demand), while in large regions of the country away from the border producers could be shielded from them. Hence, the hypothesis to be tested is: price relations across China's regions exhibit characteristics that apparently derive from China's domestic producers, consumers and traders facing price pressures generated by market forces. For purposes of comparison, we test our results from Northwest China against those obtained from the Mississippi Valley in the US.

A simple plotting of the relationship between the price of maize in Dalian and the prices in Liaoning, Jilin and Heilongjiang during the post-WTO-accession period

(December 2001 to February 2003) illustrates a price contour that is consistent with the existence of well-functioning markets (Figure 6). Since the main demand center in the Northeast and point of export for maize to foreign markets and to South China is Dalian, one would expect that, in an integrated marketing system, as a market became more remote the price should fall. Indeed, the price in a market a 1000 kilometers away from Dalian (e.g., the Jilin market) is, on average, about RMB 70/mt lower than the price in Dalian. In percentage terms, this means the price of Jilin corn is about 6 percent lower than the price of corn in Dalian.

The spatial graph is even more evident when using dataset 1 to look at the price of rice as markets move more distant from the coastal benchmark markets (Figure 7). For example, the prices in Southern China indica rice markets are plotted on the basis of their distance from Guangzhou. Prices for the Yangtze River Valley marketing sites are plotted in reference to Shanghai, those for North China against Tianjin, and those for the Northeast against Dalian. Plotted this way, price relations clearly show the fall in prices are markets move inland away from the coast. In Figure 7, a random period (July 1998) was chosen, although the identical figure can be drawn with the data from any marketing period. Although not shown here, similar spatial patterns are found for soybeans.

Multivariate Spatial Analysis Regression analysis of the relationship between prices (entering the equation either in linear or log form) in the local market and the distance from port and a series of time period dummies (one for each time period of analysis—that is, one for every half week in the sample and an interaction term) finds similar results for maize in the Northeast (Table 1). Holding all other factors constant, as maize marketing sites move farther away from Dalian, the price falls (row 1). While the coefficient on the distance from Dalian changes for each of the periods, its values still fall in a reasonable range (for each 1000 kilometers, the price of maize falls by RMB 54.4/mt (column 1). In log form, our results show that for each 1000 kilometers, the price falls by 5.6 percent (column 2). We also ran similar regressions with dataset 1 for 1998 to 2000 and generated similar results (not shown). In fact, the coefficient on the distance variable in the log price equation was even lower for all of China, most likely reflecting the higher transportation costs in the Northeast, where transportation has always been relatively constrained.

The spatial pattern of rice prices is similar to that of maize. A similar set of regressions was run for our rice price for 2000. For rice, however, we had to account for quality differences that essentially segment China's rice markets. In column 1 we use data for all regions but include location dummy variables, one for markets in South China, one for those in the Yangtze River Valley, one for those in North China (included as the base location) and one for those in Northwest China. The results of location-specific regressions are in columns 2 to 4 (though because there were not enough observations, results could not be reported separately for the Northeast region). In addition, a distance-squared variable was included in the rice regressions. Even with these modifications, the spatial patterns came through clearly. As markets move progressively further away from China's major port cities, the price falls. Since these ports (Guangzhou, Shanghai, Tianjin/Beijing and Dalian) are also major consumption centers, this price pattern is exactly what would be expected of a market economy.

When examining the magnitude of the transportation gradients estimated in Table 2 (and similar ones estimated from regressions for rice in 1998 and 1999 and for maize and soybeans for 1998 to 2000—not shown), we find three characteristics (Table 3). First, and more interesting because of the case made for robustness, the magnitudes of the transportation/transaction costs are similar to those reported in Park et al. (2002). That study employs a completely different methodology, and uses a maximum likelihood estimator to examine price differences when traders arbitrage away price difference between markets. Our estimates in Table 3, which were generated from regressions similar to those in Table 2, are almost the same. Second, the transportation gradients are falling over time. Although we cannot pinpoint the exact source of the fall in the transportation gradient, as in Park et al. (2002), the patterns are consistent with a marketing environment in which there is an improving infrastructure and more competitive markets. Finally, the results show that the transportation gradients in China are similar to those found in the US. When plotting similar data and running similar regressions on maize in the Mississippi valley, we find a pattern of spatial price spread similar to those found in China. In other words, assuming our findings are representative of average transportation gradients in China and the US, these results demonstrate that the time may be past when China's inland markets were isolated by poor transportation and other infrastructure weaknesses. In other words, the aggressive investment in roads and other infrastructure projects in the past decade seem to have dramatically improved the ability of traders to move agricultural commodities, or at least staple crops, around China at comparable costs to those in the US.

Market Integration in China

In this section we use more formal tests of market integration. In the first subsection we use traditional co-integration analysis to examine how prices move together over time. We do the analysis in several time periods. We first use the late 1990s for rice, maize and soybeans (using dataset 1). Because we use the same data as used in Park et al. (2002), we can compare the results with those from the early 1990s. Using datasets 3 and 4, we also examine co-integration for maize and soybean markets.

Co-integration Analysis

Co-integration means that although many developments can cause permanent changes in the individual elements of tested series, i.e. grain price, there is some long-run equilibrium relation between the individual components, represented by the linear combination, as in equation (1). In our paper, the Engle-Granger co-integration approach is applied to test China's market integration. The basic intuition is that one can write two price series in the following way:

$$\textbf{(1)} \qquad U_t = P_t^i - bP_t^j .$$

If each price series is stationary of order zero, I(0), then this condition implies the existence of a long-run equilibrium. In other words, in the long run, the two series will eventually return to a constant mean. Moreover, a linear combination of these two prices shows that it is efficient to predict one market's price based on information about another market's price. Equivalently, these two price series are co-integrated and the two markets are integrated.[4] If the price series are not stationary of order zero, we then need to test whether each element of the price series is stationary of order 1, I(1). This is done by applying a unit root test. Our analysis shows that all price series for the commodities in China's grain markets in the late 1990s are stationary of order one.

Using our stationary price series, the next step uses the OLS regression of one price series on another:

(2) $$P_t^i = \alpha + \lambda t + \beta P_t^j + e_t,$$

where t is the common trend of the two price series and where e_t is the error term. The main reason for running equation (2) is that it provides the residuals, e_t, to use in the augmented Dickey-Fuller test:

(3) $$\Delta e_t = \delta e_{t-1} + \sum_{j=2}^{N} \gamma \Delta e_{t-j} + \xi_t .$$

If the test statistic on the δ coefficient is less (i.e. more negative) than the relevant critical value from the Dickey-Fuller (D-F) table, the null hypothesis may be rejected and the two series are said to be co-integrated of order (1,1). This implies that the two markets from which the price series come are integrated. In our analysis, we assume markets are integrated when the absolute value of the test statistic is greater than 3 (which implies significance at the 10% level).

Results—Increasing Integration during the 1990s The results of the co-integration analysis illustrate that China's markets have continued to develop in the late 1990s, especially when the results are compared to the market integration research in the late 1980s and early 1990s (Table 4). In the middle part of the reform era (1988-1995), a time when markets were starting to emerge, between 20 to 25 percent of markets showed signs that prices were moving together during the study periods and sub-periods (Park et al., 2002). According to the Park et al. findings, although there were many market pairs in which prices did not move together (between the late 1980s and mid-1990s), there was evidence of rising integration.

With the results from the early 1990s as a baseline and using dataset 1, our current analysis shows that, during the late 1990s, China's markets continued along the path of maturation. In the late 1990s, examining the co-movement of prices among pairs of markets in our sample, we see a significant increase in the fraction of market pairings that are integrated. In fact, some markets in China are remarkably integrated. In the case of maize, for example, in 89 percent of cases, prices in one market move at the same time as in another (Table 4, column 2). This is up from only 28 percent of the time in the early 1990s. The share of market pairings (for soybeans, japonica rice and indica rice) that exhibit price integration also increases (rows 2 to 4). The integration of these markets is notable because, in many cases, the pairs of markets are separated by more than a thousand kilometers. For example, in many years, we find that soybean and maize prices move in concert between markets in Shaanxi and Guangdong provinces and between those in Sichuan province and southern Jiangsu.

Despite the significant progress in market integration, our results also show that there are pairs of markets during different years that are not integrated. For example, in a third of the cases, japonica rice prices moved in one market but not in another. The case of indica rice trade is even more notable. One explanation for this result is some kind of institutional breakdown or infrastructure barrier (e.g., some policy measure or a weak link in the transportation or communication infrastructure) that is fragmenting China's markets for certain commodities, as shown in Park et al. (2002). What might also be the case, however, since every province in China produces and consumes rice, during a certain year in certain regions, supply and demand might be sufficiently balanced that price differentials between those regions lie within the band between regional "export" and "import" prices. In that case, moderate price movements in one area might be insufficient to induce a flow into or out of another region that is effectively in equilibrium. Hence, even allowing for a non-trivial number of cases in the late 1990s in which market prices in pairs of markets do not move together, based on each of the analyses of market performance, one must conclude that the impacts of WTO on China's agriculture increasingly will be experienced across wide regions of the nation from coastal to inland areas.

Results—Maize and Soybeans 2000 to 2003 The results of the co-integration analysis for maize after 2000 (using dataset 3) also support both our descriptive findings and the conclusions of the determinants of commodity price analysis. Using the Dickey-Fuller tests, all pairs of markets in the Northeast are integrated in a statistically significant way (Table 5). Compared to the results in the late 1990s (reported in Table 4 and discussed in the previous subsection) our analysis shows that since 2000 maize markets in China have continued to become more integrated. Literally all pairs of markets in the Northeast sample are integrated.

In addition, the other pairs of key maize markets on the national level, for example, between Dalian and Guangzhou and Dalian and Fujian, also are integrated (Table 6). Again, the integration of these markets is notable because in many cases the pairs of market are separated by more than a thousand kilometers. After 2000, the co-movement of prices between pairs of markets in a national sample showed that maize markets were almost fully integrated (about 93 percent of the pairs). Interestingly, although the prices in Dalian and Hubei, and Dalian and Jiangsu markets do not move together in a statistical sense at the 5 percent level, we do find that the Dickey-Fuller statistic is close to the critical value. These results show that maize markets nationally have continued along their previous path of maturation. Compared with the late 1990s, the percentage of markets that are integrated rose from 89 percent to 93 percent.

Soybean markets after 2000 are also integrating rapidly. Correlation coefficients among all major soybean markets show the high degree of price co-movement (Table 7). In 28 out of 36 unique pairs of markets, the correlation coefficient exceeds 0.9. In most cases, the coefficients are above 0.95. In the other eight cases, the correlations are still high. In no case does the coefficient fall below 0.86. Clearly, even between markets as distant from each other as Heilongjiang and Guangdong, prices are correlated.

Formal co-integration analysis confirms the results of the correlations. According to our results using dataset 4, all of China's major soybean markets are now integrated with soybean markets in Heilongjiang and Guangdong (Table 8). We use the Heilongjiang market as a benchmark since Heilongjiang is by far the nation's top producer of soybeans. By contrast, Guangdong is China's largest consumer of soybeans, for both oil and feed. The other markets in our sample comprise all other soybean-using markets for which data are available. In the top part of the table we show that each series has a unit root and is shown to follow an I(1) pattern, or is stationary in first differences.

Examined in this way, we find that all markets are co-integrated with both Heilongjiang and Guangdong. The Dickey-Fuller tests statistics of co-integration are all significant for all pairs of markets. This means that since 2000 if the price moved in either Guangdong (from a consumption shock) or in Heilongjiang (from a production shock), prices moved in all of China's other markets. Clearly, when compared to Table 4 (in which 68 percent of China's soybean markets were shown to be integrated in the late 1990s), soybean markets have become more integrated.

Assessing Village-to-Regional Market Integration

The inter-regional integration of markets, however, is only half of the story. While the analysis in the previous section demonstrates a remarkable degree of integration between markets on the coast and those inland, such an analysis is still not sufficient to be confident that households in China's villages are integrated into the nation's marketing network. To complete our integration analysis, we also need to examine the extent to which villages are integrated into regional markets.

Our investigation of village-regional market integration tests whether farmers in China's villages are price takers, or if they reside in villages that are isolated, meaning that local prices are determined by local supply and demand. The equation to test for village-regional market integration is:

$$P_i = a0 + a1*A_i + b1*T_i + d1*D + e_i. \qquad (3)$$

Put briefly, if variables that affect local grain availability, A_i, in village *i* significantly affect the village price, P_i, we will assume villages are isolated and regional markets do not extend into China's villages. By contrast, if the variables that affect local availability do *not* affect the local price, we conclude that villagers are price takers and markets are essentially integrated.[5] Availability in each village during the survey year is measured as the sum of production, P_i, and storage, S_i. We would expect that a rise (fall) in availability would negatively (positively) affect the village price if markets are isolated. Alternatively, we would expect changes in local availability to have no effect on the village price if markets are integrated. Since it is total availability that matters (note that $A_i=P_i+S_i$), it is total availability (or production plus storage at the beginning of the period) that should enter equation (3). In our analysis, we run equation (3) separately for rice, wheat, maize and soybeans.

When examining the impact of local grain availability on the household's grain price in equation (3), we need to control for other factors, D_i, in our cross sectional analysis. In equation (3), we assume that D_i includes two components, one spatial—measured as the distance of the village from the county seat (the typical site of the regional market; the further the village is from the county seat, the lower the local price), and the other temporal—the timing of the grain sale (if the sales of grain by the households in the village occur during the first three months after the harvest, we would expect a lower price). Because village price levels in different provinces also are expected to vary due to each province's location (with respect to the port) and infrastructure (e.g., the quality of its road and rail networks), we also include a provincial dummy. In the case of rice, since quality varies so much from region to region, we also include regional quality dummies (one for each of South China, the Yangtze River Valley, and North/Northeast China).

The data for this study were collected in a randomly selected, nearly nationally representative sample of 60 villages in six provinces of rural China (henceforth, the China National Rural Survey—CNRS). To accurately reflect varying income distributions within each province, one county was randomly selected from within each income quintile for the province, as measured by the gross value of industrial output. Two villages were randomly selected within each county. The survey teams used village rosters and our own counts to choose randomly twenty households, including some with their residency permits (*hukou*) in the village and some without. A total of 1199 households were surveyed.

The data from the survey allow us to construct a number of variables that potentially could affect the price that the farmer received in the village. The CNRS project team gathered detailed information on both the production and marketing behavior of all of the farmers in the sample and the characteristics of each village and its relationship to the nearest regional market. From each individual respondent in the survey in each village, we know the price and timing of the sale for each commodity. We average the price associated with all of household sales in the village, weighting each sale by its volume in kilograms. With the information on timing, we can construct a set of variables that measures the proportion of village sales that occurs within (each of) the first three months after the harvest. From a community questionnaire, we know how far the village's center is from the nearest paved road and the distance to the county market both in kilometers. Finally, for each crop that the farmer cultivates, we know if the farmer's crop suffered an output shock, and recorded both the incidence and the percentage by which the yield fell. These are aggregated to the village level.

We exclude any variable that controls for the presence of a community buffer stock system, primarily because such an institution is almost never observed in modern China. However, farmers, at least in the past, have been known to hold large stores of grain. It is possible that in an isolated village if a production shock occurred and the local price began to rise, farmers could draw on their own stocks and the local price could fall and exhibit no net change (causing villages to appear to be integrated into the regional market, when in fact they were not). We use beginning year stocks of farm households, aggregated to the village level, to measure the potential that households stocks could play in increasing availability. We can ignore sales among farmers within a village, since such transactions are rare (according to our data, less than four percent of sales are among farmers in the same village).

To test our hypothesis, we regress grain price, P_i, on total grain availability, A_i, for each of the i main staple crops (where i = 1), holding the other variables, T_i and D, constant. In our analysis, we measure total grain availability in three ways: as the production shock, P_i, alone, as the production shock, P_i, and grain storage, S_i, and as the interaction between the grain storage variable and the production shock variable (or a direct proxy of $A_i=P_i+S_i$). Since the third definition (the interaction effect) is the most intuitive (because it captures total grain availability of the village in one variable), we report in Table 9 the results from regressions that use this version of the variable (the results of the regressions using the alternative variables are reported in Huang et al., 2004). If villages are isolated from the regional markets, when there is a positive production shock and high levels of grain storage—that is, when the interaction term is large—the coefficient on the interaction term should be negative and significant. If markets are integrated into China's larger marketing networks, the coefficient should be insignificant.

Our analysis clearly shows markets in China are integrated down to the village level (Table 9). The signs of the coefficients (and levels of significance in some cases) on the variable measuring the distance of a village from the regional marketing center demonstrate that the further a village is from a market the lower is the price the farmer receives. More importantly for our purposes, the t-ratios of the coefficients of the village supply shock variables are all small, signifying that the local village's crop levels do not affect the local prices. The main implication of this finding is that factors outside the village primarily affect the prices that farmers receive, making the farmers price takers. Moreover, when we interact our main variables of interest with a dummy variable set to one when a village is poor (i.e., a village that is in the bottom two income deciles), the coefficient remains insignificant. In other words, farmers in China's villages, even remote, poor ones, are linked to China's regional markets.

Effects of Market Emergence

Few authors have attempted to quantify the gains from market liberalization. Part of the explanation might reside in the short periods covered by the analyses, the inability of standard methodologies and measures/indicators of market liberalization to separate efficiency gains from market reform from overall gains in the reforming economy, and the breadth of the studies. For China, Wen (1993) found total factor productivity (TFP) growth had stopped after 1985, a trend he blames on the failure of the market liberalization stage of reform. Wen's conclusions have two shortcomings. First, his analysis ends in 1990, a period that might be too short to have allowed the liberalization reforms to take effect. Second, he only examines the net change in TFP and neglects other factors that could be affecting productivity.

Holding the effect of technology constant and using data through 1995, Jin et al. (2002) find that TFP growth restarts in the 1990s, a finding that they claim could be linked to further liberalization of the economy. Like Wen, however, they do not explicitly examine the improvements in efficiency that are associated with market development. Shenggen Fan (1999) uses stochastic frontier production decomposition analysis to isolate the efficiency gains of Jiangsu provincial rice producers in the late reform era, a time when most of the property rights reforms had already been implemented and a time with market liberalization was just getting started. Fan finds that there have been only limited gains in allocative efficiency after 1984, a result that he suggests is due to the partial nature of China's market liberalization. Unfortunately, Fan does not explicitly model the interactions between property rights reform and market liberalization. Also, his study examines only one crop in one province, a fact that limits the general applicability of his study, since it is possible that much of the gain from market liberalization may come from shifting among crops (and between cropping and non-cropping activities).

The only truly systematic attempt at trying to measure the returns to market liberalization in China is in our papers with deBrauw (deBrauw et al. 2000, and forthcoming). These papers develop measures of increased responsiveness and flexibility within a dynamic adjustment cost framework (as developed by Larry Epstein, 1981) to estimate the return to market liberalization reforms, holding the incentive reforms and other factors constant. We find that the behavior of producers in China has been affected by market liberalization, but that the gains have been relatively small. Small gains in responsiveness (that are measured by price elasticities of factor demand for variable inputs—in this case, fertilizer) between the early and late reform periods are attributed to the gradual market liberalizing changes of the late 1980s. Farmers also have increased their speed of adjustment of quasi-fixed factors (which in the case of China's agriculture includes labor and sown area) to price changes (and other shifts in exogenous factors) between the early and late reform period.

The work in deBrauw et al. (forthcoming) also measures the effects on overall welfare of the increased flexibility and responsiveness. In this work, we found that the gains in efficiency from increased responsiveness and flexibility in the late reform period is positive and significant. However, the size of the gains is substantially less in percentage terms (less than one percent *per year*) than that from the incentive reforms in the early reform period (up to seven percent per year or about 40 percent over the whole period). The conclusion is that although the gains are small, they are still positive and China's gradual market reform policy appears to have avoided the collapse that was experienced throughout CEE and CIS nations. It is also quite feasible that additional gains have occurred as integration has continued in the late 1990s and beyond 2000.

Unfortunately, the results of the deBrauw paper cannot illuminate the interactions among property rights reform and market liberalization, since the analysis assumes that the time period of the reform identifies the effect of individual policies (that is, all of the property rights reforms were complete before 1984 and market liberalization did not begin until after 1985). As well, the results only examine the effect of market liberalization. Lin (1991) and Huang and Rozelle (1996) show, however, that the effects of property rights are enhanced when coupled with market liberalization. If so, then the gains that were measured in deBrauw's paper and attributed to property rights, at least in part, should be attributed to improved performance of markets.

Conclusions

In this paper, we have shown in a number of ways the steady improvement in agricultural commodity markets that have occurred in China during the past decade. Regardless of whether we employ descriptive statistics or more formal techniques, our results are consistent with the emergence of integrated markets for rice, maize and soybeans. Moreover, conclusions about markets are robust, even when looking across long distances and at different time periods. Transaction costs also appear to have continued to fall.

Although these conclusions will not surprise frequent visitors to rural China, such a picture of markets may be surprising to some when juxtaposed against the policy background. During the period over which we have measured a steady improvement in the performance of markets, there has been a repeated cycle of reform followed by back-tracking. Nevertheless, despite recurring attempts to slow down or halt the operation of markets during this time, commodity markets have steadily gained strength in rural China.

The power of markets to continue a process of integration despite adverse policy interventions perhaps more than anything shows the genius of China's gradual method of transition. As argued by McMillan (1997), market reform in China has really been one of entry-driven competition. In China's case, entry has come from both the commercialization of the state and the emergence of a private trading sector. In doing this, China enfranchised millions of individuals in the trading of commodities. While this has produced the rise in integration and fall in transaction costs documented in the paper, it also has eroded the power of the state to control agricultural markets by traditional command and control methods. Our results suggest that if the nation's leaders want to control markets in the future they will have to devise new ways to intervene – probably by using indirect methods instead of trying to suppress traders. There are now just too many traders to deal with directly, as shown by the continuation of integration trends even as the Government tried to suppress trading.

Indeed, one of the real lessons of our work is that Chinese leaders, domestic and foreign traders, and other observers all should recognize that rural China now has one of the world's least distorted and most integrated agricultural markets. Of course, for poverty alleviation and other purposes this can be a two-edged sword. Nevertheless, if policy makers make productive investments and promulgate sound policies, well-functioning markets enable those involved in agricultural production and consumption activities to benefit and facilitate the implementation of policies with minimal distortion.

Table 1. Price and Log Price Determination Regression for All Periods (10/2001-3/2003)

Explanatory Variables	(1) Dependent Variable: Price at level (RMB)	(2) Dependent Variable: Log Price
Distance from Dalian (1000 km)	-54.4* (30.2)	-0.056* (30.35)
Distance*Group Dummy	-0.0235* (9.66)	-0.00003* (10.54)
Group Dummy	-89.55* (9.90)	-0.093 (10.02)
Constant	1058.84* (165.24)	6.97* (1064.88)
Time Period Dummies	Included	Included
Adjusted R-square	0.82	0.83
No of Observations	1152	1152

Note: The parentheses provide t-statistics. Coefficients marked with * are statistically significant from zero at 1 % level.

The group dummy (gd) picks up a one time-period effect. Setting gd = 0 indicates the early WTO accession period; gd = 1 indicates the recent period.

The F-test statistic in (1) is F[2, 1022] = 120.87, in (2) is F[2, 1022] = 133.66. Both models reject the null hypothesis that there is no structural change.

Data source: Dataset 3.

Table 2. OLS Regression Explaining Rice Prices in China's Main Marketing Regions, 2000 (data source: dataset 1)

Explanatory Variable	Full Sample	South China	Yantze River	Yellow River
Dist-Port	-0.00004**	-0.0004**	0.0001	-0.00007**
	(-1.89)	(-4.38)	(1.30)	(-2.13)
Dist-Port^2	+1.9*e-8**	+2.7*e-7**	-1.5e-7**	2.8*e-8**
	(2.99)	(5.59)	(5.02)	(3.31)
Dist-Road	-0.005**	-0.004**	-0.008**	0.0003
	(11.6)	(7.10)	(5.36)	(0.31)
Dist-Rail	-0.001**	-0.001**	-0.0001	-0.002**
	(5.60)	(7.18)	(0.06)	(3.22)
Region Dummies				
South	0.20**			
Yangtze	-0.04**			
Northeast	-0.06**			
Period Dummies	Included	included	included	Included
No. of Obs.	1132	304	327	501

Table 3. Percentage change in price for every 1000 kilometers of distance from port

	Maize	**Soybean**	**Rice**
China 1998	-4%	-10%	-10%
1999	-4%	-11%	-9%
2000	-3%	-8%	-7%
US – 1998	**-5%**	**-3.5%**	**na**

Notes: Figures for column 3 (rice, China) from Table 2 (and similar regressions for 1998 and 1999); figures for columns 1 and 2 (maize and soybeans, China) from regressions for maize soybeans for China that are similar to those for rice. Figures for US from spot market prices reported by the Chicago board of trade for 15 markets in 1998.

Table 4. Percentage of Market Pairs that Test Positive for Integration based on Dickey-Fuller Test in Rural China, 1988 to 2000

Commodity	1989-1995	1996-2000
	(Percent of Market Pairs)	
Maize	28	89
Soybeans	28	68
Rice, Yellow River Valley (mostly japonica rice)	25	60
Rice, Yangtze Valley and South China (mostly indica rice)	25	47

Note: Results for the two periods both use data from the State Market Administrative Bureau (SMAB). For results from 1989 to 1995 for maize and rice, see Park et al. (2002). Rice results are for the whole country in 1989-1995. Results for soybeans for 1989 to 1995 are from Wang (1998). Results from 1996 to 2000 are by authors using Dataset 1.

Table 5. Co-integration Tests on Northeast Maize Markets and Dalian Market

Region	Test Statistics	Lags	5% Critical Value	Conclusion
Augmented Dickey-Fuller Tests			-2.89	
1. Center HLJ	-1.98	9		Each one is unit root and Proved to be I(1), stationary at 1st difference
2. East HLJ	-1.99	9		
3. West HLJ	-1.78	9		
4. Center JLN	-1.99	9		
5. East JLN	-1.72	9		
6. West JLN	-1.62	9		
7. Center LNG	-2.24	10		
8. West LNG	-2.07	10		
9. Dalian port	-2.80	16		
Augmented Dickey-Fuller Tests for Pair Markets				
1. Center HLJ/Dalian	-3.34	9		All pair markets are co-integrated Dalian market is integrated with all other regional markets.
2. East HLJ/Dalian	-3.49	9		
3. West HLJ/Dalian	-3.16	9		
4. Center JLN/Dalian	-3.49	9		
5. East JLN/Dalian	-3.24	9		
6. West JLN/Dalian	-3.33	9		
7. Center LNG/Dalian	-3.98	9		
8. West LNG/Dalian	-3.84	9		

Notes: 1. Augmented Dickey-Fuller test was implemented over the pair markets.
2. Gauss program file "adf-test.prg" is used.
3. Data set used: dataset 2. Price series is bi-weekly and data are analyzed at the market level (that is, there are more than one observation per province)

Table 6. Co-integration Tests on Major Maize Consumption Markets and the Dalian Market, 1999 to 2003.

Region	Test Statistics	Lags	5% Critical Value	Conclusion
Augmented Dickey-Fuller Tests			-2.89	
1. Dalian port	0	7		Each one is unit root and proved to be I(1), stationary at 1st difference
2. Hubei	-0.8	4		
3. Jiangsu	-1.89	10		
4. Fujiang	-1.8	7		
5. Guangdon	-1.71	7		
Augmented Dickey-Fuller Tests for Pair Markets				
1. Hubei/Dalian	-2.46	6		Hubei and Dalian are not co-integrated
2. Jiangsu/Dalian	-2.71	6		Pair markets are co-integrated with Dalian, 5%.
3. Fujianf/Dalian	-5.09	6		
4. Guangdon/Dalian	-6.15	6		

Notes: 1. Augmented Dickey-Fuller test was implemented over the pair markets.
2. Gauss program file “adf-test.prg” is used.
3. Data set used: dataset 2 and 3. Price series are monthly and at the provincial level.
4. Johansen Test on all markets confirmed the results that there are 3 co-integrating equations.
.

Table 7. Correlation Coefficients between Each Price Series for All Soybean Markets in Data.

	Guang-dong	Shang-hai	Jiang-su	Jiangxi	Hebei	Henan	Shan-dong	Tianjin	Heilong-jiang
Guang-dong	1	0.998	0.997	0.996	0.874	0.914	0.916	0.865	0.926
Shanghai	0.998	1	0.999	0.998	0.874	0.918	0.920	0.863	0.926
Jiangsu	0.997	0.999	1	0.998	0.877	0.923	0.924	0.867	0.927
Jiangxi	0.996	0.998	0.998	1	0.891	0.933	0.935	0.881	0.940
Hebei	0.874	0.874	0.877	0.891	1	0.956	0.965	0.992	0.956
Henan	0.914	0.918	0.923	0.933	0.956	1	0.990	0.948	0.966
Shandong	0.916	0.920	0.924	0.935	0.965	0.990	1	0.955	0.971
Tianjing	0.865	0.863	0.867	0.881	0.992	0.948	0.955	1	0.946
Heilong-jiang	0.926	0.926	0.927	0.940	0.956	0.966	0.971	0.946	1

Data source: Dataset 4.

Table 8. Co-integration Tests on China's Soybean Markets with Heilongjiang and Guangdong Markets as Center Markets.

Market	Test Statistics		Conclusion
Augmented Dickey-Fuller Tests		5% critical value with constant	
Heilongjiang	-1.05		Each one is unit root, and thus, I(1).
Tianjin	-0.48		
Hebei	-0.26		
Shanghai	-1.15		
Jiangsu	-1.08		
Jiangxi	-1.09		
Shangdong	-0.33		
Henan	-0.17		
Guangdong	-1.22		
Augmented Dickey-Fuller Tests for Pair Markets		Critical value with constant and trend: (5%) -3.46 (1%) -4.06	
Center Markets: Heilongjiang			
Tianjin	-3.87*		All markets are integrated with Heilongjiang market
Hebei	-3.73*		
Shanghai	-4.11**		
Jiangsu	-4.07**		
Jiangxi	-4.23**		
Shandong	-4.77**		
Henan	-4.8**		
Guangdong	-4.01*		
Center Markets: Guangdong			
Heilongjiang	-4.1**		All markets are integrated with Guangdong market.
Tianjing	-3.6*		
Hebei	-3.54*		
Shanghai	-3.61*		
Jiangsu	-3.63*		
Jiangxi	-3.67*		
Shandong	-4.27**		
Henan	-4.52**		
Note: 1. Augmented Dickey-Fuller test was implemented over the pair markets. 2. Program in Eviews. 3. Data source: Dataset 4			

Table 9. Ordinary Least Squares Regression Explaining Effect of Local Grain Availability on the Price Level of Major Crops in China's Villages in 2000 (Dependent Variable: Village-Level Price)

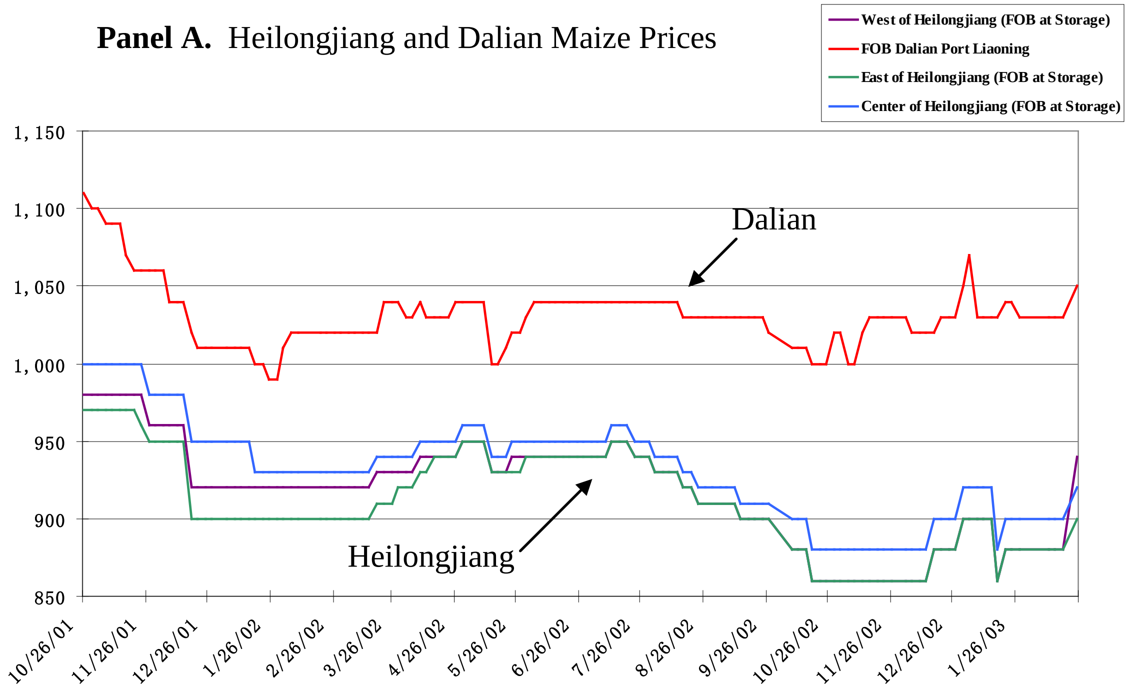
Explanatory Variable	Rice	Wheat	Maize	Soybean
Local Grain Availability				
Village Level Climate Shocks (Production Shock) [a]	-	-	-	-
Village Level Grain Storage at the Beginning of Year (Grain Storage) [a]	-	-	-	-
Interaction: Production Shock * Grain Storage [a]	-3.15e-06 (1.31)	7.50e-07 (0.37)	-3.91e-07 (0.33)	.000045 (0.15)
Control Variables				
Distance to the nearest county (km)	-.00074 (0.74)	-.0079 (2.1)*	-.0005 (0.55)	-.032 (2.76)*
Variables Representing Proportion of Grain Marketed during Each of First Three Months after Harvest	-	Included	Included	Included
Quality Dummies	Included	-	-	-
Provincial Dummies	Included	Included	Included	Included
Adjusted R-square	0.16	0.38	0.50	0.15
No. of observations	31	30	28	17

Note: T-ratios in parentheses. Coefficients marked with *** , ** and * are statistically significant from zero at the 20 and 10 and 5 percent level.

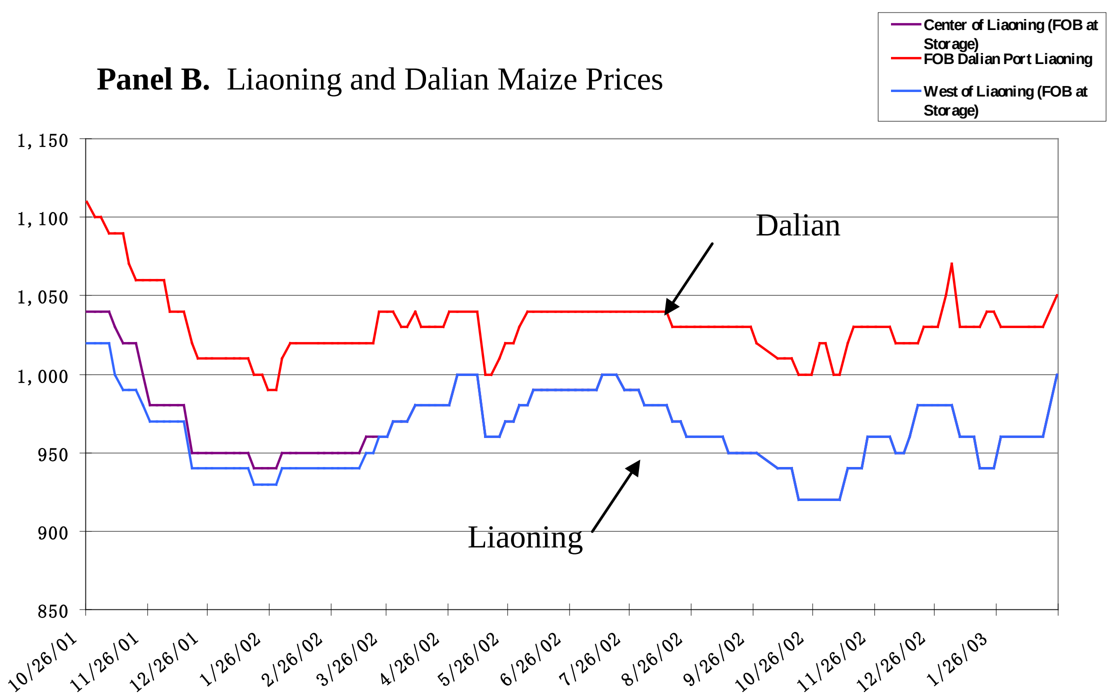
[a] Independent measures of Production shocks and Grain storage are not included in this version

Figure 1. Maize Prices in Heilongjiang, Liaoning and Dalian (RMB/mt), October 2001 to February 2003

Panel A. Heilongjiang and Dalian Maize Prices



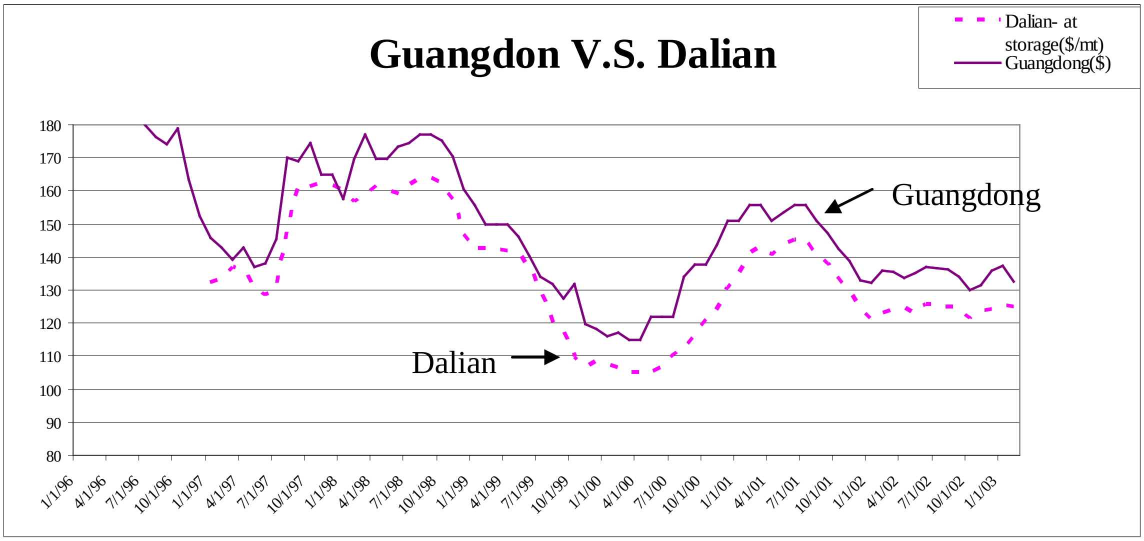
Panel B. Liaoning and Dalian Maize Prices



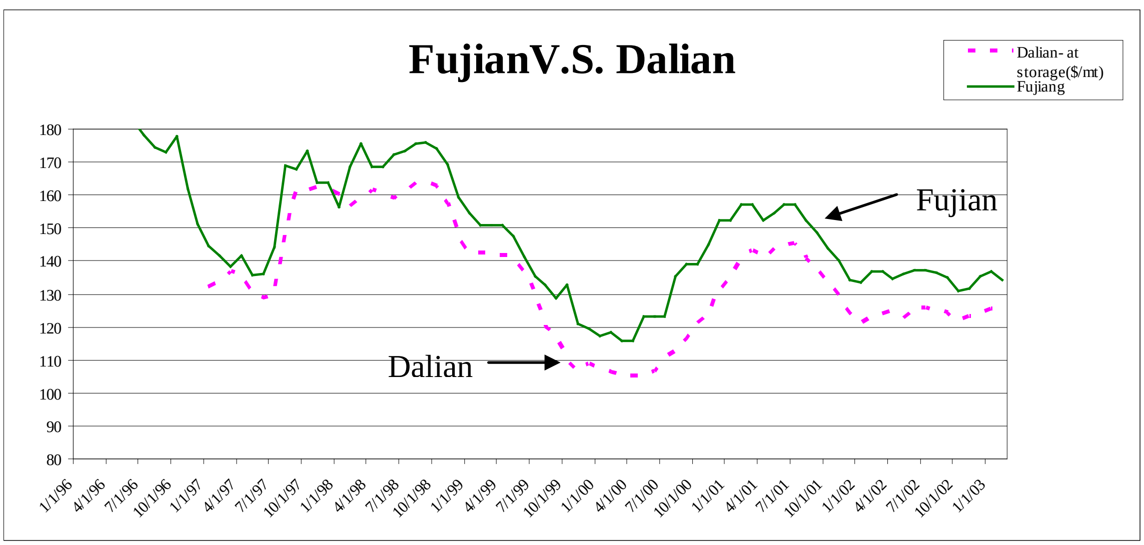
Data source: Dataset 3

Figure 2. Maize Prices in Guangdong, Fujian and Dalian (RMB/mt), 1996 to February 2003

Panel A. Guangdong and Dalian Maize Prices

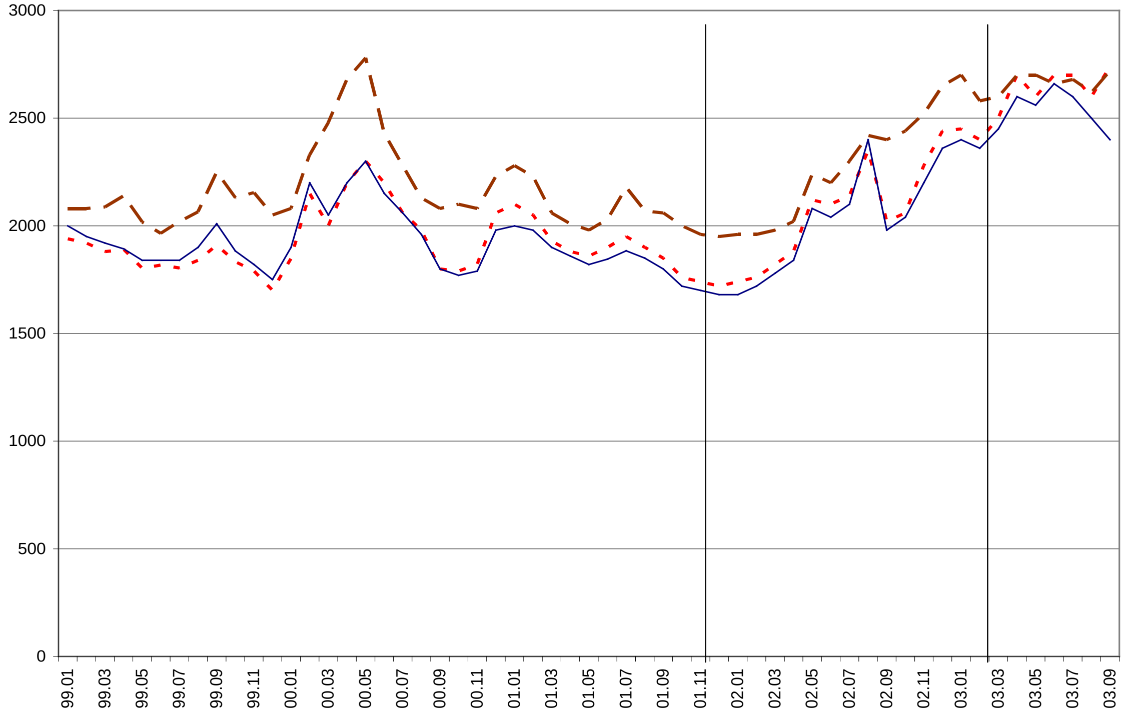


Panel B. Fujian and Dalian Maize Prices

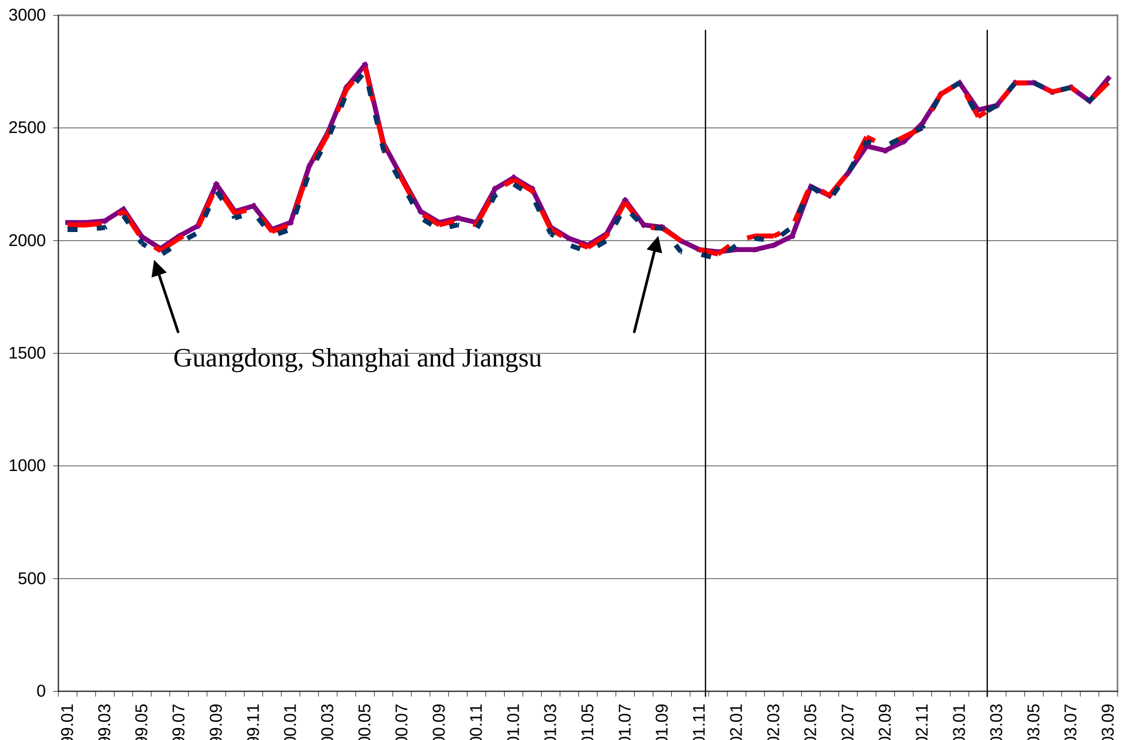


Data source: Dataset 2

Figure 3. Soybeans Prices in Heilongjiang, Jilin, Guangdong, Shanghai and Jiangsu (RMB/mt), January 1999 to September 2003
Panel A.

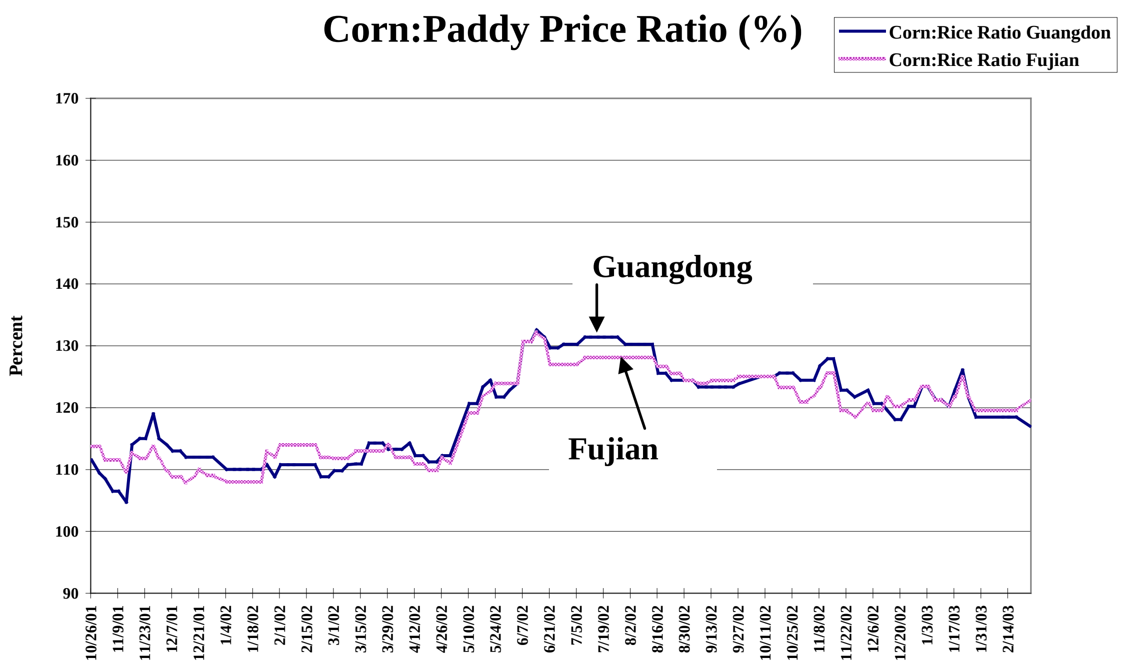


Panel B. Guangdong, Shanghai and Jiangsu Soybean Prices



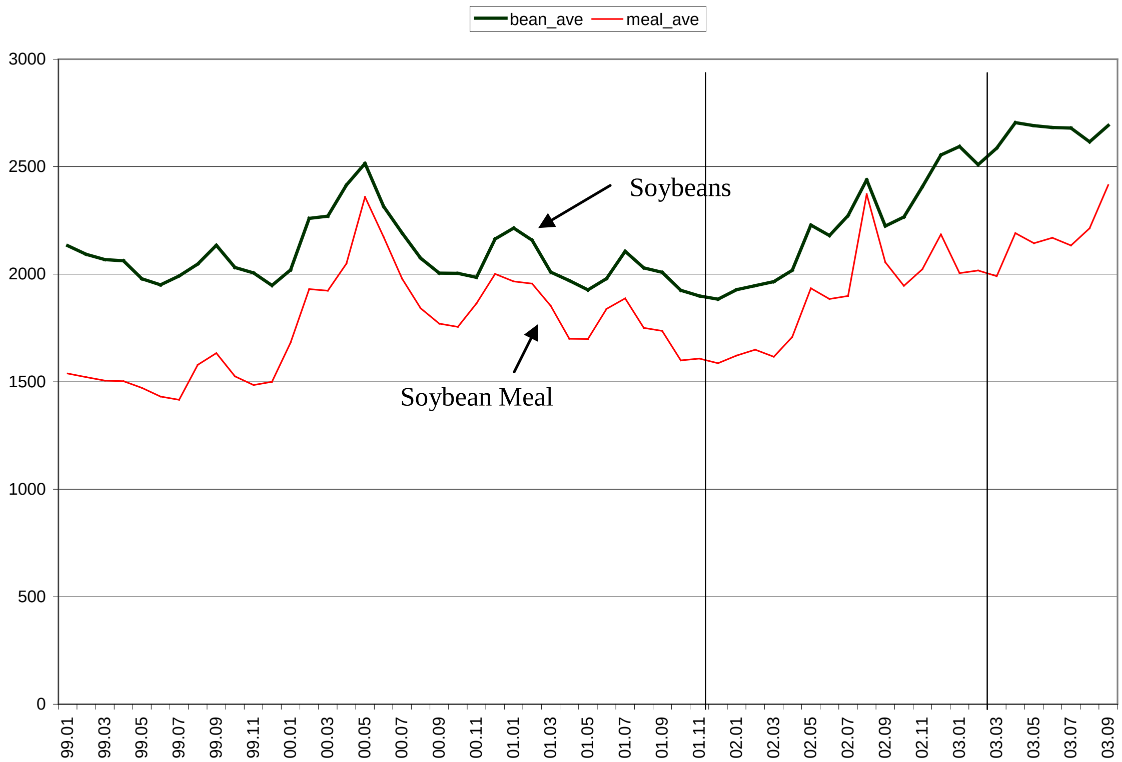
Data source: Dataset 4

Figure 4. The Ratio of Corn to Feed Rice (Paddy) Prices in Guangdong and Fujian Provinces between October 2001 and February 2003



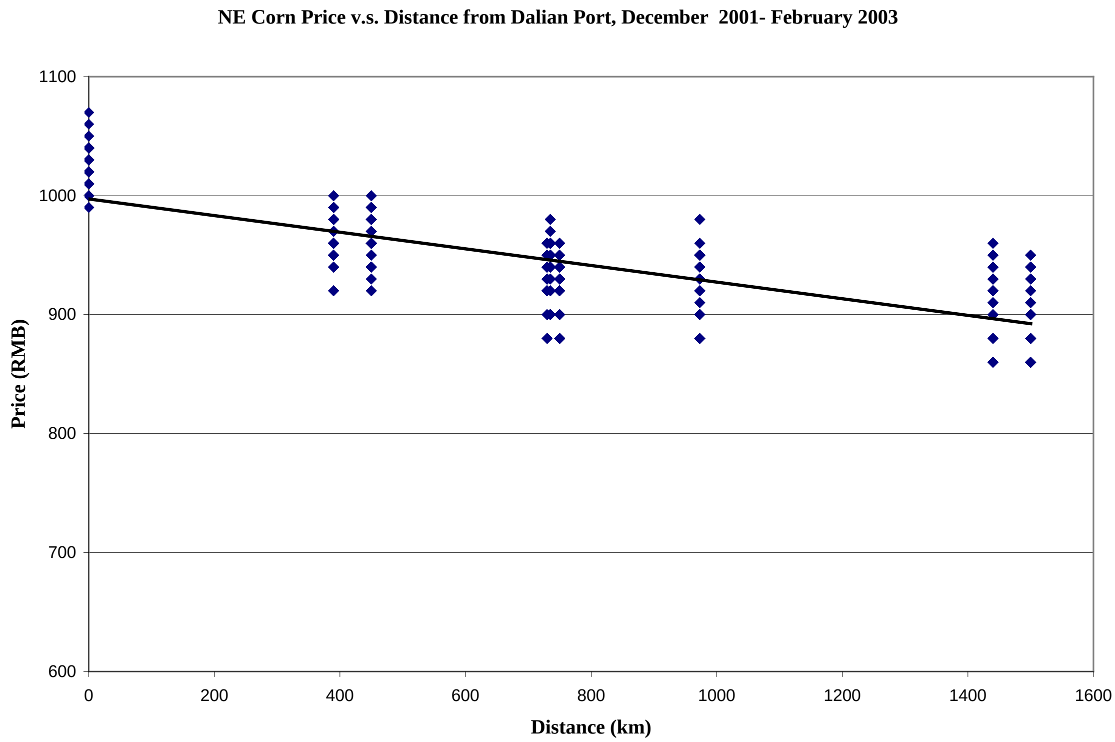
Data source: Dataset 3

Figure 5. Comparisons of China's Average Soybean and Soybean Meal Prices (RMB/mt), January 1999 to September 2003

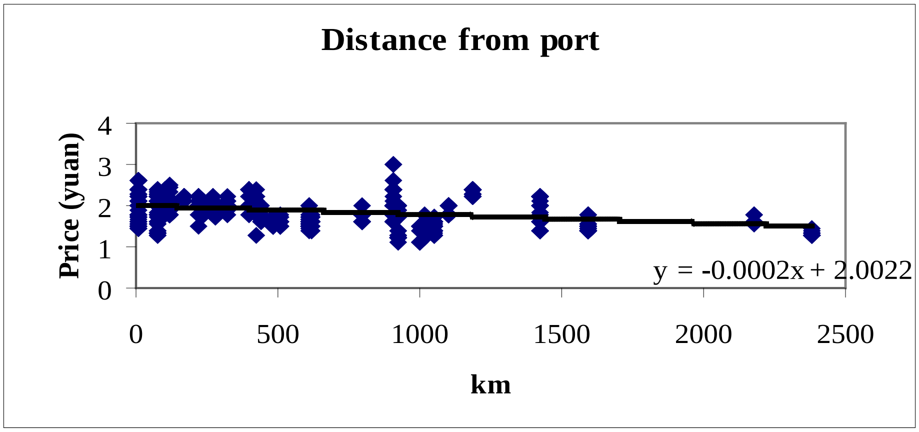


Data source: Dataset 4

Figure 6. Changes in Maize Prices across Northeast China as Markets Increase Distances from the Port of Dalian, 2000-2003



Data source: Dataset 3



Data source: Dataset 1

Figure 7. Changes in rice price across China as markets increase distance from port (in four marketing areas—southern China, Yangtze River Valley, northern China and Northeast China), July 1998

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Endnotes

[1] Since we use data over time, we need to convert prices to a real basis. Nominal prices from our data set are deflated using monthly consumer price indices calculated and reported by the China National Statistical Bureau. Deflation facilitates transaction cost comparisons across time and allows us to disregard transaction cost increases within periods associated with inflation.

[2] To produce the results, we run co-integration tests on the each pair of markets using the data for each year. So, in other words, we use 36 observations (since the price data are available every ten days) and count the number of pairs of markets that are cointegrated in a statistically significant way (see next endnote and text for explanation of testing). For example, for the case of soybeans, for the late 1990s (1996 to 2000), this means that we are examining the extent of integration between 190 (20*19/2) pairs of markets in each of 5 years, which equals a total of 950 pairs of markets. Hence, since we found that prices in 646 markets were integrated (according to the testing procedure), we report that 68 percent of markets are integrated in the late 1990s. Since we only use 36 observations per test, and since co-integration tests typically perform better with longer time series, by splitting our data into annual increments, we are biasing the results against accepting integration. We do this in order to make our analysis comparable to Park et al. (2002) which follows a similar procedure.

[3] For illustrative purposes (e.g., for our CV analysis and the for the determinants of price analysis), we compare some of our results to results from 1988 to 1995 that were reported in Park et al. (2002) and to results from 1996 to 2000 for Huang, Rozelle and Chang (2003). Note, however, the data sources while attempting to measure the same prices, may be different, and hence not entirely comparable, due to differences in data collection methods. In other words, while illustrative of changes over time, the comparisons should only be used generally to help put the situation in the post-accession period into the context of China's corn and other markets during the 1990s.

[4] Note that we do not need to have the *b* coefficient be unity to conclude co-integration and integrated markets (which is only needed if one wants to apply the much more restrictive criteria of the Law of One Price.

[5] The data for this study were collected in a randomly selected, nearly nationally representative sample of 60 villages in 6 provinces of rural China (henceforth, the China National Rural Survey—CNRS). To accurately reflect varying income distributions within each province, one county was randomly selected from within each income quintile for the province, as measured by the gross value of industrial output. Two villages were randomly selected within each county. The survey teams used village rosters and our own counts to randomly choose twenty households, both those with their residency permits (*hukou*) in the village and those without. A total of 1199 households were surveyed. The CNRS project team gathered detailed information on both the production and marketing behavior of all of the farmers in the sample and the characteristics of each village and its relationship to the nearest regional market. From each individual respondent in the survey in each village, we know the price and timing of the sale for each commodity. From these data, we construct an average village price for each month in yuan per kilogram. In a community questionnaire, we know how far the village's center is from the nearest paved road and the distance to the county market both in kilometers. Finally, for each crop that the farmer cultivated, we know if the farmer's crop suffered a shock, recording both the incidence and the percentage by which the yield fell. We do not include any variable that controls for the presence of a community buffer stock system, primarily because such an institution is almost never observed in modern China. In addition, sales among farmers within a village are rare (according to our data, less than 5 percent of sales).