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Is China's Corn Market at a Turning Point?

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Abstract

Many analysts see signs that China's corn market is reaching the turning point in a decade-long cycle. China curtailed corn exports in calendar year 2004 and may begin to import corn during marketing year 2004/05. Reduced Chinese exports are also driving U.S. prices higher. Higher prices and increased shipping rates have kept U.S. corn out of the China market, but growing demand and limited production capacity will eventually make China a net importer of corn. China's reduction in exports will expand opportunities for U.S. exports.

Keywords: China, corn, exports, imports, prices, export subsidy, interregional marketing.

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Introduction

In 2004, many analysts see signs that China's corn market is reaching the turning point in a decade-long cycle that could have major effects on the world market. China was a major corn importer in 1994 and 1995, but imports fell in subsequent years and China emerged as a major corn exporter. China's exports accelerated to 15.2 million metric tons (mmt) for marketing year 2002/03, up from 8.6 mmt in 2001/02, squeezing U.S. exports out of South Korea, Indonesia, Malaysia, and other important markets. Chinese exports are expected to fall sharply in 2004 as rising Chinese corn prices indicate a tightening of China's corn market. Reduced Chinese exports are opening new opportunities for U.S. exporters and strengthening world prices.

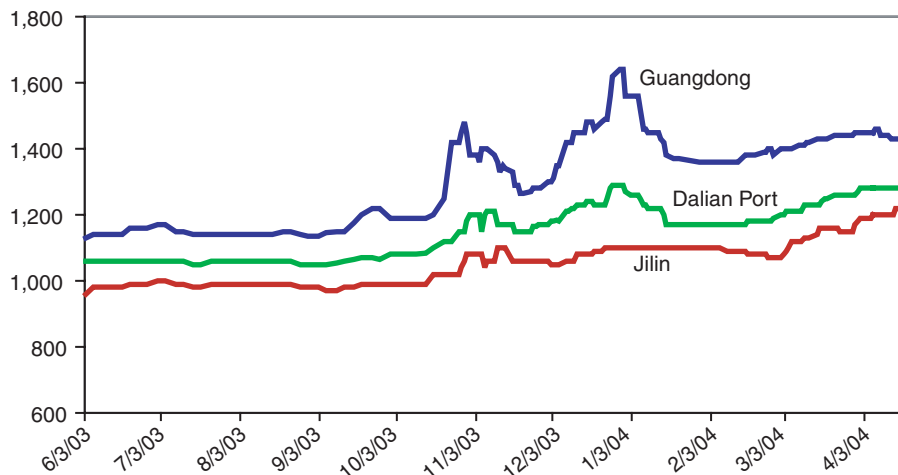
China's domestic corn markets tightened in late 2003. After several years of generally flat prices, corn prices increased sharply in October and December 2003 (fig. 1). Prices in Guangdong Province jumped to 1,450 yuan (\$175) per ton in October and as high as 1,600 yuan (\$193) in December after hovering around 1,150 yuan (\$139) per ton for nearly 2 years. Similar, but more modest, price spikes were seen at the Dalian Port. Prices also rose, but not as sharply, in production areas like Jilin and Shandong Provinces.

The late-2003 price spikes were short-lived and related to seasonal factors and rail transportation bottlenecks. A rush to export corn before the end of the calendar year—December exports were nearly three times the monthly average—temporarily limited the flow of corn to the domestic market, pushing prices unusually high in December 2003. Nevertheless, upward pressure on prices seems to indicate a tighter supply situation. The Guangdong price settled at about 1,370 yuan (\$165) in January 2004, about 20 percent above its September average. Prices in Dalian and Jilin settled about 12 percent above September prices despite the arrival of new-crop corn on the market. Prices continued to rise in February and March 2004.

Figure 1

China's wholesale corn prices, three locations, June 2003-April 2004

Yuan per ton



Source: China National Grain and Oils Information Center, unpublished data.

Subsidized Exports Alleviate Corn Surplus

With prices rising, the Chinese Government has rolled back its financial support for corn exports in order to divert more corn into the domestic market. China began subsidizing exports in 1999 to dispose of a staggering stockpile of corn accumulated in 1995-99, much of it in its four northeastern provinces (also known as Manchuria): Jilin, Heilongjiang, Inner Mongolia, and Liaoning. According to a report from China's National Grain Bureau, northeastern grain reserves (half of which was corn) in 2001 had jumped to 3.5 times their 1995 level.¹ Unpublished rural household survey figures from China's National Bureau of Statistics also indicate that onfarm beginning-of-year grain stocks in Jilin and Heilongjiang doubled between 1995 and 1997.

Corn is the mainstay of the agricultural economy in northeastern China, but there is not enough local demand to absorb the region's enormous production (see box, "Interregional Marketing and Exports," p. 12). Various measures (development of livestock feeding, alcohol production, starch, and other food processing) have been implemented to increase local demand, but the government has had to subsidize transportation of corn out of the region and foreign export sales in order to dispose of the excess stocks without driving down local prices.

The details of the current corn export policy are complex and not clear to outsiders. A number of actors are involved, including central government policymakers, provincial and local governments, the State Administration of Grain, local grain marketing and storage entities, China's Agricultural Development Bank, railway and port officials, as well as the exporting companies. Government policymakers decide on annual targets for exports with quotas for each province. Export sales are carried out by the two approved exporters, Jilin Grain Group and China Cereals, Oils and Foodstuffs Import and Export Corporation (COFCO). After entering the World Trade Organization (WTO) in December 2001, China had to abandon direct export subsidies to comply with its WTO commitments. In 2002 and 2003, China rebated value added tax payments on grain exports and waived railroad construction taxes on grain shipped by rail (see Gale for details). However, the savings from these measures do not appear to account for the entire difference between domestic and export prices (Rozelle). A complex web of storage payments and loans accounts for much of the financial support for exports.

China has exported corn at prices well below Chinese domestic prices, suggesting that exporters received substantial subsidies. For example, during the 2000/01 marketing year, the domestic price in Dalian (the primary port in northeastern China) averaged \$139 per ton, but export sales were made at \$103 per ton, free on board (f.o.b.). This implies that exporters must have received a subsidy equivalent to \$36 per ton (table 1). This also means that domestic feed mills and other users in China paid significantly more for Chinese corn than did customers in South Korea and Southeast Asia.

¹ Grain stock figures were excised from the Grain Bureau's report. These grain reserves do not include stocks held by farmers.

Table 1—Estimated China corn export policy costs, 1998-03

Marketing year ¹	Dalian price (domestic market)	China export f.o.b. price	Implied subsidy per ton ²	Exported quantity	Implied financial cost ³
	——Dollars per ton——			Mil. tons	Mil. dollars
1998/99	138	105	33	3.3	110
1999/00	109	100	9	9.9	90
2000/01	139	103	36	7.3	260
2001/02	125	103	22	8.6	190
2002/03	127	104	23	15.2	350
Oct.-Dec. 2003	146	111	35	5.7	200

¹Marketing year is October to September.

²Estimated subsidy per ton is the difference between the domestic Dalian price and the export free on board (f.o.b.) price.

³Total implied financial cost is per-ton subsidy multiplied by tons exported during year.

Sources: China National Grain and Oils Information Center; China Customs Statistics; and USDA, ERS calculations.

The export policy has been expensive. When multiplied by the quantity of exports, the implied cost of the corn export policy was the equivalent of \$260 million for the marketing year. China agreed to eliminate export subsidies after joining the WTO in December 2001, but the price comparisons suggest that export prices were still \$22 to 23 per ton below domestic prices after WTO entry in 2002 and 2003. The implied cost of the corn export policy fell to \$190 million in 2001/02, but shot up to \$350 million in 2002/03 due to a higher volume of exports (table 1). During October-December 2003, a higher Dalian price boosted the implied subsidy to \$35 per ton, and the cost jumped to \$200 million for the first 3 months of 2003/04 marketing year.

Reduced Government Support for Exports

China does not release information on grain stocks, but there are indications that they have diminished to levels comparable to 1994/95, before the stock build-up began. In fact, many of the same conditions that spurred the government's ramp-up in grain production 10 years earlier—spikes in grain prices, fears of food price inflation, and concerns about falling grain production—started to reappear in 2003 and early 2004.

With a tightening domestic market, China's Government reduced its support for corn exports in 2004. Many press reports identified expected cuts in export and grain storage support as a factor behind the accelerated pace of exports in 2003, as traders sought to make sales before the policy was changed.

The export policy pits the central government against local beneficiaries of the policy in northeastern China. Central government officials would like to reduce the financial burden of the export program and ensure that sufficient corn is available for the domestic market. Policymakers in China are also beginning to recognize that support for exports primarily benefits the inefficient state-owned marketing system with little benefit for farmers. Policymakers are now replacing export and storage subsidies with direct payments to farmers. However, local grain bureaus, provincial and local governments, and export companies reap substantial benefits from the corn export policy

and oppose its curtailment. Corn exports are a major source of foreign exchange earnings for the northeastern economy. With the high stakes involved in this policy, a compromise is likely, wherein the export policy is maintained, but at a less generous level. Thus, exports are likely to continue but at a slower pace.

An export quota of just 1.4 mmt was set for the first 6 months of 2004. The quota was mostly filled by March, but there were indications that exporters were still eager to sell abroad. While rising Chinese prices were a factor in cutting the pace of exports, U.S. prices also rose—partly due to China’s curtailment of exports—as did shipping rates from the U.S. Gulf of Mexico to Asia. With higher U.S. prices and shipping rates, Chinese corn prices were competitive with U.S. corn in Asian markets—even without subsidies. If these conditions persist, China could resume exporting corn but at a slower pace than in 2003.

Rising Domestic Prices Suggest Export Slow-Down

While government policy and the domestic supply and demand balance seem to be the key factors determining China’s exports, historical trends suggest that domestic and international prices also influence the timing of Chinese corn sales. China’s export price has remained remarkably stable and tends to remain slightly above the U.S. Gulf of Mexico price, suggesting that the export price is set by Chinese policymakers using the U.S. price as a reference (fig. 2). The Dalian price fluctuates much more from month to month than does the export price.

Chinese exports tend to be high during periods when the U.S. price rises above the Chinese price, and they tend to drop off when the U.S. price is lower (fig. 3). Rozelle showed that China’s export price moves in tandem with domestic prices when he made adjustments for the time lag between the signing of contracts and the actual export of corn. He concluded that exports were influenced by the Dalian price.

A simple regression analysis shows the relationship between corn exports and prices. Using monthly data on corn exports, the China Dalian price, and the U.S. price (the U.S. Gulf of Mexico price plus freight to north Asia) for 1998-03, ordinary least squares analysis yields the following equation:

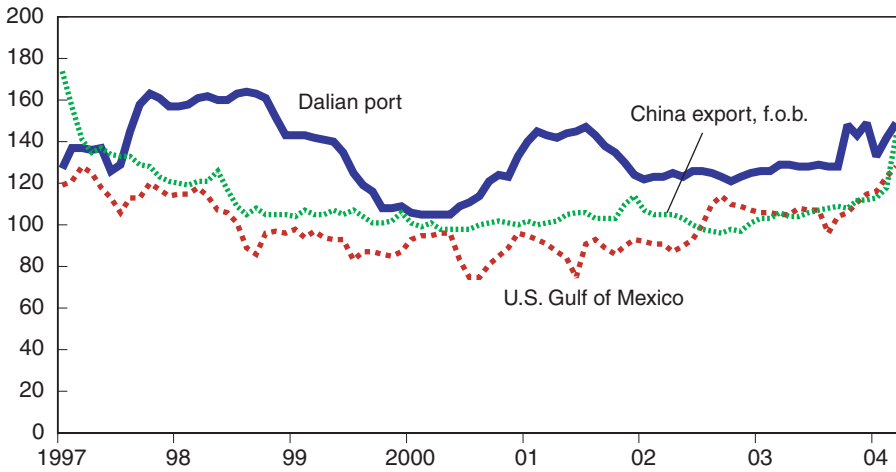
$$\ln(\text{Exports}_t) = 21.62 - 3.30 \ln(\text{China Dalian price}_{t-4}) + 2.94 \ln(\text{U.S. Gulf price}_{t-1}) + \text{month effects.}$$

The equation explains 73 percent of the month-to-month variation in corn exports (see appendix “China Corn Export Regression Model” for description and full results). The price coefficients are statistically significant and are consistent with economic logic. Domestic price increases tend to reduce China’s exports, and increases in U.S. prices tend to increase Chinese exports. The time lag of the two price effects differs. Domestic Chinese prices affect exports with a lag of 4 months, while international prices have a more immediate effect on exports just 1 month after a price change. The longer lag for the China Dalian price is consistent with Rozelle’s finding that prices are set according to domestic market conditions at the time of an

Figure 2

Corn prices: China Dalian and export f.o.b. compared with U.S. Gulf of Mexico f.o.b., monthly, 1997-04

Yuan per ton



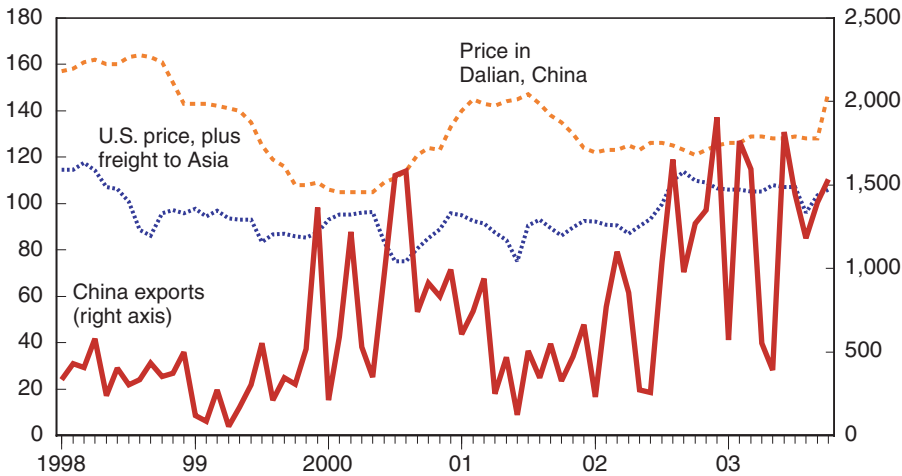
Sources: China National Grain and Oils Information Center, unpublished data, and China Customs Statistics.

Figure 3

China corn exports and prices, monthly, 1998-03

Dollars per ton

1,000 ton



Sources: China National Grain and Oils Information Center, unpublished data; USDA, ERS; and China Customs Statistics.

export sale, which may be up to 6 months before the corn is physically exported. A shorter lag was appropriate for the U.S. Gulf of Mexico price, probably because foreign customers with optional-origin contracts switch from China to other origins when the U.S. Gulf of Mexico price falls below the Chinese price.

According to the model, a 1-percent increase in the Dalian price reduces Chinese exports by 3.3 percent 4 months later. Thus, the model predicts that the 15-percent Dalian price increase in October 2003 would result in a 50-

percent decrease in exports in February 2004. Actual exports in February 2004 were 445,000 tons, down from 1.77 million tons in February 2003. China's cutback on exports had a feedback effect on world prices not captured in this simple model. U.S. prices also increased in subsequent months, partly in response to China's expected cut in exports and its effect on world supplies. Increasing freight rates also pushed the delivered price of U.S. corn higher in Asia. Economic conditions in the first 4 months of 2004 were favorable to Chinese exports—even without subsidies—but Chinese export sales ceased after Chinese policymakers set a maximum quota for exports that was filled by February.

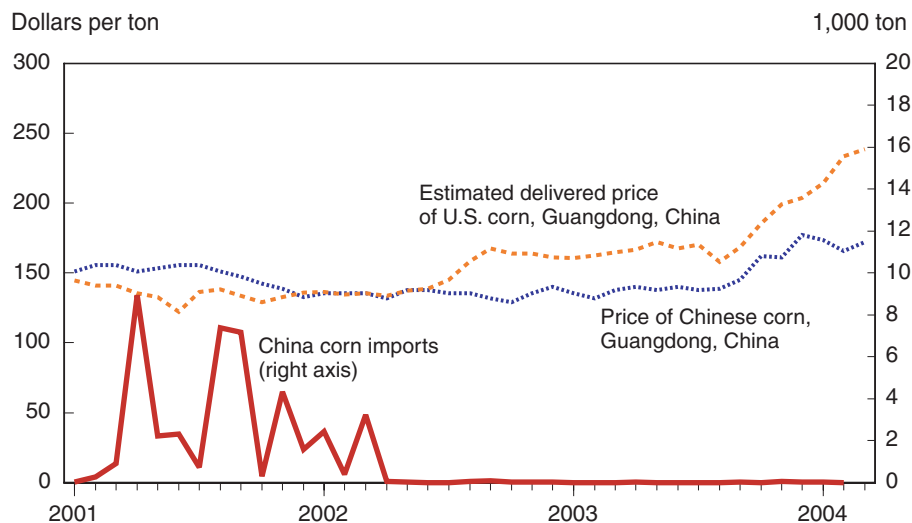
In addition to prices, month effects in the model show a seasonal pattern in Chinese exports. China's exports tend to be the highest in December (following the corn harvest and the last month of the calendar year) and July. Exports tend to be the lowest in January, April, and May.

Modest Rise in Imports Possible

Many analysts anticipate that changing market conditions could bring Chinese buyers back into the import market in 2004. China's imports of corn have been negligible since early 2002 when the U.S. Gulf of Mexico CNF price to Guangdong, China, rose well above the domestic price (fig. 4). Price spikes in corn-consuming areas of southern China and a widening south-north price differential in the Chinese market suggest tightening supplies in major corn-consuming areas that could be alleviated by imports. There is also speculation that officials may import grain to replenish dwindling state grain reserves.

Market conditions were still unfavorable for imports in early 2004. Following sharp price spikes in December 2003, prices in Guangdong stabi-

Figure 4
Guangdong, China, corn prices and corn imports, monthly, 2001-03



Note: Estimated delivered price is the U.S. Gulf of Mexico price plus 1 percent duty, 13 percent value added tax, fees for shipping insurance, unloading, and port fees detailed by Meyer in 2002.

Sources: China Customs Statistics; China National Grain and Oils Information Center; U.S. Wheat Associates; and USDA, ERS calculations.

lized at levels below the estimated delivered cost of U.S. corn. At the same time, U.S. corn prices rose on the basis of tightening world supplies, with Chicago futures prices surpassing \$3 per bushel. Spiraling international shipping costs also reduced the competitiveness of U.S. corn in China and elsewhere in Asia. Rising Chinese corn prices late in 2003 would normally have made U.S. corn competitive in the Chinese market. However, shipping costs to Asia more than doubled to as much as \$55 per ton, largely due to China's enormous demand for shipments of soybeans, oil, steel, and other raw materials that tied up a large share of the world's ocean freight capacity. High shipping costs are likely to persist into 2004, dampening the growth in U.S. exports.

The curtailment of exports keeps more corn in China's domestic market, which prevents prices from spiraling out of control. Keeping domestic prices in check will in turn reduce demand for imports. This process worked in reverse in December 2003 when a huge volume of corn exports diverted corn away from the domestic market, pushing Guangdong prices as high as 1,600 yuan per ton. This experience suggests that increased shipments from northeastern China to Guangdong could alleviate upward pressure on the Guangdong price, keeping imported corn uncompetitive. The strategy seemed to work in January-March 2004. Corn prices continued to trend upward but at a moderate pace. The differential between the Guangdong and Dalian market prices narrowed from over 20 percent in December 2003 to about 15 percent in March 2004.

China's WTO accession agreement set a 7.4-mmt tariff-rate quota for corn imports in 2004.² The duty for in-quota imports is just 1 percent, but China also adds a 13-percent value added tax on imported grain that raises the effective duty to over 14 percent (Gale). Some agricultural industry representatives complained that the Chinese Government interfered with corn imports during 2002 by allocating import quotas in small uneconomic quantities and allocating quotas to applicants in western and northern provinces where there is little demand for imported corn. There are differing opinions on whether the allocation process restricts imports, and it was hard to test since there was little demand for imports during 2002 and 2003. It is not clear whether the allocation of quotas will constrain imports when they are profitable again.

Compliance with China's regulations on labeling genetically modified (GM) foods may also be a complicating factor for Chinese imports of corn. As many as eight different GM corn varieties grown in the United States need to be tested and approved by Chinese authorities before they can be imported. China had approved four varieties by April 2004, and two additional varieties were scheduled for later review.

Exchange Rate Revaluation Could Benefit U.S. Exports

In 2003, China resisted strong pressure from trading partners to revalue its exchange rate. The value of its currency is fixed at approximately 8.28 yuan per U.S. dollar, a rate that some economists estimated was as much as 40 percent below the rate that would prevail if the yuan were freely traded. The

² Prior to WTO accession in 2002, corn imports were subject to a 1-percent duty on imports within an annual unannounced quota and were monopolized by COFCO, the government's designated company for importing grain. The situation is similar now except that the quota for each year is set by China's WTO commitments and made public, and a specified percentage of each year's quota is made available to other trading entities besides COFCO.

declining value of the dollar in 2003 further reduced the value of China's yuan against third-country currencies.

The Chinese Government has given no indication that it will adjust the exchange rate, but a minor revaluation could take place to slow the rapid growth in foreign exchange reserves and prevent the economy from overheating. In the long term, China has committed to moving to a more flexible exchange rate as part of the broader reform of its foreign trade and financial system.

An appreciation of China's currency against the U.S. dollar would improve the competitive position of U.S. corn by making Chinese exports more expensive and imports more attractive in the Chinese market. For example, a minor appreciation of the Chinese currency from 8.28 to 8.00 yuan per dollar would increase the Dalian corn price by \$5 per ton, and Chinese traders would need to raise f.o.b. export prices or accept fewer yuan per ton from export sales.³ An 8.28-to-8.00 appreciation would also reduce the delivered price of U.S. corn in southern China by 50 yuan per ton, making imports more attractive.

Long-Term Outlook: Net Importer

Continued growth in corn consumption and limited capacity for production growth will eventually make China a net importer of corn. According to USDA estimates, China consumed more corn than it produced beginning with the 2000/01 marketing year. China remained a net exporter of corn by drawing down stocks by over 50 percent. In the long run, as stocks are depleted, China's exports will fall and imports will rise. USDA Agricultural Baseline projections indicate that Chinese imports will rise to 5 million tons by 2013/14 (USDA, Office of the Chief Economist). Exports are projected to fall from 8.5 mmt in 2003/04 to 1.3 mmt in 2013/14. China's imports are projected to overtake its exports by 2009/10.

Corn consumption, driven by a growing livestock industry, is expected to grow beyond China's production capacity. Animal feed accounts for about three-fourths of domestic corn use. Statistics on livestock and feed use are scarce and unreliable, so estimates of corn demand are uncertain, but demand for corn as feed is probably growing at a rate at least equal to China's 8-to-9-percent gross domestic product (GDP) growth rate. Food consumption studies indicate that demand for meat, dairy, and fish products tends to grow at about the same rate as income. Demand for livestock products is boosted further by rural-to-urban migration since urban meat, dairy, and poultry consumption is much higher than rural averages. Farmers are also using more corn in feed rations. Traditional livestock feeding methods include crop residues and table scraps, but more farms are now using commercial feeds that include corn as the main ingredient. Chinese farmers have also fed animals large amounts of low-quality rice and wheat, but recent policy changes have discouraged production of low-quality grains.

Direct human consumption of corn as food accounts for about 5 percent of domestic corn use in China, and this component of demand is stable or declining. As Chinese consumers have grown wealthier, they have consumed less corn and other coarse grains, which are considered "inferior

³ The Chinese Government conceivably could provide subsidies to compensate exporters for a currency appreciation. In the 1990s Asian financial crisis, when most other Asian currencies were sharply devalued, the Chinese Government resisted devaluation and rebated value added tax payments for exports to keep exporters competitive.

goods.” Urban household surveys indicate a slight increase in coarse grain consumption in recent years, but movement of people from rural to urban areas has an offsetting downward effect since urban people eat much less corn than rural people.

Industrial use of corn is growing rapidly due to a combination of market demand and government-directed investment. Industry and food-processing users account for about 10 percent of China’s corn use. Growing demand for food products is increasing the demand for corn used for making starch and other food products. Fuel alcohol production facilities are being built in several important corn-producing areas as a means of increasing the demand for corn and reducing dependence on petroleum imports.

It seems unlikely that China’s corn production capacity can keep up with consumption growth. Corn area and yields grew rapidly in 1985-95, but cropland is now being lost to urbanization and corn must compete with soybeans, cotton, horticultural crops, and other land uses. Some environmentally fragile wetlands, forests, and hillsides cultivated to boost grain and soybean production in earlier years are being taken out of production by land retirement programs. In 2004, strong growth in soybean and cotton prices is likely to shift some acreage from corn to soybeans or cotton.⁴ A Ministry of Agriculture planting intentions survey predicted that corn planted area would decrease 2.4 percent in 2004.

Rising yields contributed to production growth in earlier decades, but yield growth has stagnated in recent years. Chinese corn yields are still well below those of its chief competitors—the United States, Canada, Argentina, and Europe. However, they are about 50 percent higher than yields in other developing countries and recent history indicates that progress in yield growth has stagnated. Corn yields grew steadily through the 1980s and early 1990s as a result of improved efficiency, varietal improvement, fertilizer use, and good weather (fig. 5). Since peaking at over 5 tons per hectare in 1996, the upward trend in yield growth has disappeared. Since 1995, the trend in yields has been dominated by year-to-year fluctuations, mostly due to varying weather in northeastern China where summer drought, early freezes, or heavy rains at harvest can reduce yields. Given that planted area is not likely to expand significantly, any increase in production capacity will have to come from yield growth.

U.S. Corn Takes a Bigger Share

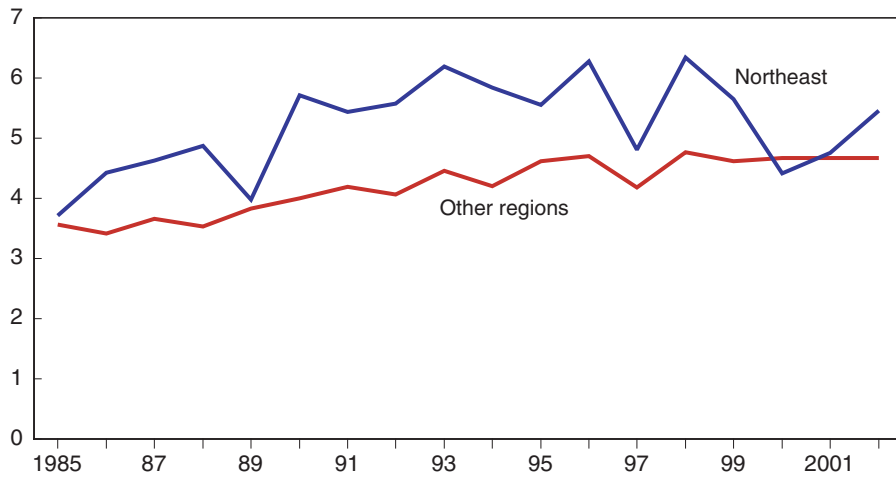
A turnaround in the Chinese corn market will be favorable for U.S. corn growers. A scaling back of Chinese exports will allow U.S. exports to grow and put upward pressure on world prices. U.S. corn was squeezed out of South Korea and Southeast Asia by Chinese exports from 2000-03 (fig. 6). A decline in Chinese exports is likely to allow U.S. corn to regain market share in Asia, although progress has been restrained by continued high freight rates from the U.S. Gulf of Mexico to Asia in early 2004. World prices are rising as a result of reduced competition from China, further benefiting U.S. producers.

⁴ The government maintains its dominant role in corn procurement and marketing in the northeastern provinces, but the government has largely withdrawn from the corn market in other parts of China. Thus, most farmers plant according to which crops will yield the highest returns.

Figure 5

China corn yield, by region, 1985-02

Kg. per hectare



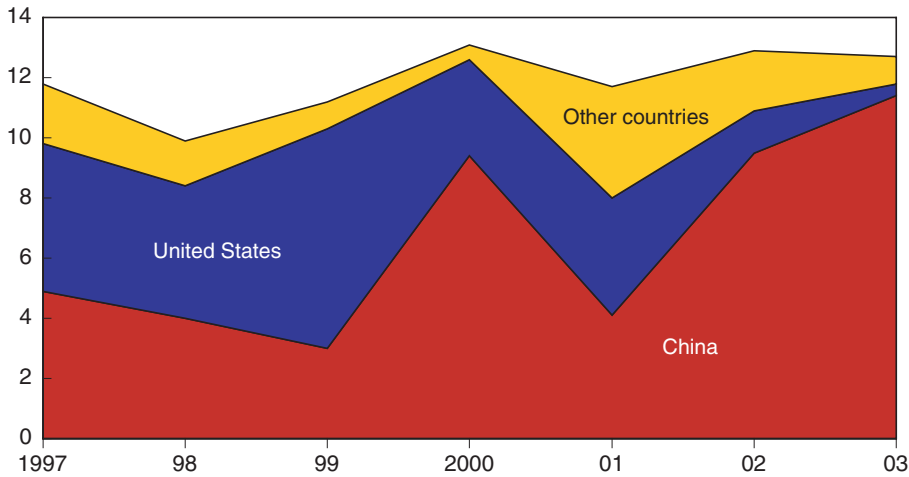
Note: Northeast consists of Liaoning, Jilin, Heilongjiang, and Inner Mongolia.

Source: China National Bureau of Statistics.

Figure 6

China imports, selected Asian countries, by country of origin, 1997-03

Mil. tons



Note: Chart shows imports by South Korea, Malaysia, Indonesia, Thailand, and the Philippines. The 2003 data for Indonesia and the Philippines are for January-October.

Source: Customs data from various countries obtained from the World Trade Atlas database.

Interregional Marketing and Exports

Given the geographic separation of corn production and consumption, interregional shipments of corn are important (Meyer, 2002). Most of China's corn is produced in northern China, while most consumption takes place in the relatively wealthy southern coastal provinces, including Guangdong, Shanghai, Zhejiang, and Fujian Provinces. Northeastern provinces (Jilin, Heilongjiang, and Liaoning Provinces, and Inner Mongolia autonomous region) account for about 35 percent of national production but just 9 percent of feed use. Corn produced in the northeast is shipped by rail or truck from production areas to Dalian, a major port in Liaoning Province. It is then shipped by water to domestic markets in Guangdong or other southern cities. Nearly all exports to South Korea or other countries also are shipped from Dalian.

A National Grain Bureau report estimated that, on average, 10.8 mmt of grain procured in the Northeast was sold locally, 8.5 mmt was sold outside the region, and 6.3 mmt was exported each year during 1997-01. Based on the Grain Bureau's figures, only about one-fourth of grain procured in the Northeast was sold within the region, and more grain went into reserves (13.8 mmt) than was sold locally (10.8 mmt) during that period. These figures are not broken out by type of grain, but they probably reflect trade patterns in corn since it is the predominant grain in the Northeast.

The North China Plain (Hebei, Shandong, and Henan Provinces) produces roughly the same amount of corn as the northeast, but this region's economy is more diversified and local demand is greater than in the northeast. North China also has significant surpluses that move by rail and truck to supply markets in Shanghai and inland south-central China.

According to Meyer (2002), Guangdong is the largest market for inter-provincial corn trade, with shipments to Guangdong from other Chinese provinces estimated at 6 to 8 mmt annually. Guangdong has one of the country's most prosperous economies, the largest feed milling industry, and produces very little corn. Since it has the highest corn price, Guangdong is also the primary potential market for foreign imports of corn. However, imported grain must compete with corn shipped from northeastern China.

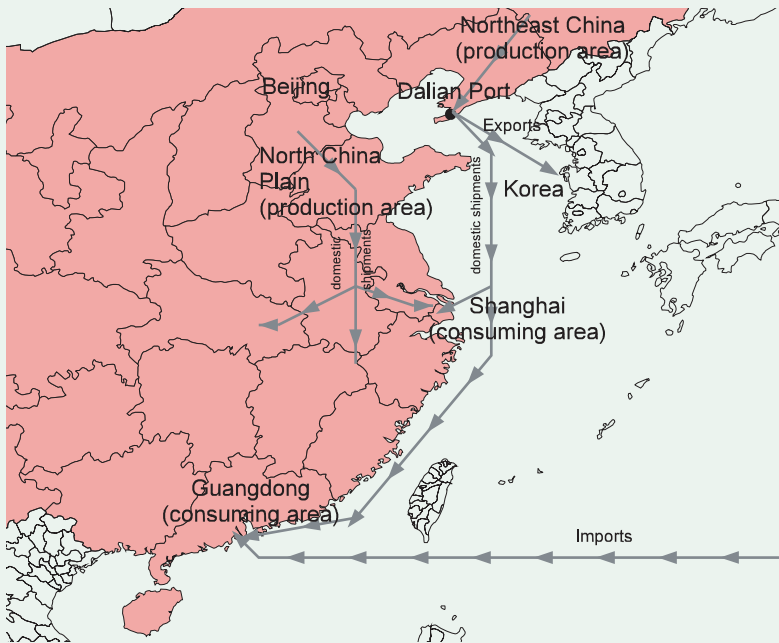
Chinese corn prices follow a gradient that reflects transportation costs from the northeast. Prices are lowest in the northeast and highest in Guangdong. In September 2003—a period of relatively stable corn markets—the price in Guangdong was 1,135 yuan (\$137) per ton, 12 percent higher than the price of 980 yuan (\$118) in Jilin. A steepening of this price gradient reflects regional imbalance in corn supply, conditions that could lead to corn imports. In October and December, a generally tighter supply situation was exacerbated by a surge of exports (spurred by an anticipated change in export policy with the end of the calendar year). Prices shot up across the country, but the increase was greatest in

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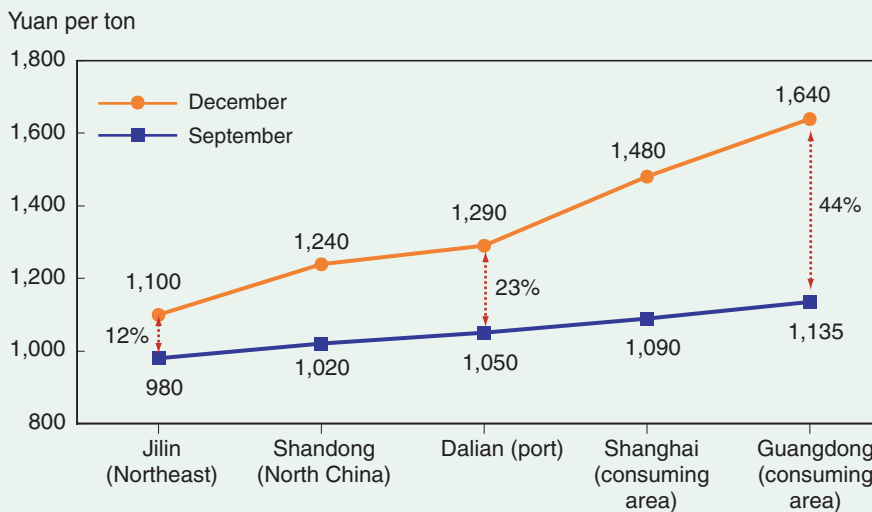
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Guangdong. At their peak in December 2003, Guangdong prices rose 44 percent from their September level, reaching 1,640 yuan (\$198). In the Jilin producing area, the increase in price was more modest—just 12 percent. The price gradient steepened and the differential between Jilin and Guangdong was nearly 50 percent in December. The price gradient flattened when prices fell in January 2004.

Interregional shipments of China's corn



China wholesale corn prices, selected locations, and dates, 2003



Source: China National Grain and Oils Information Center, unpublished data.

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Appendix 1—China Corn Export Regression Model

An export supply function was estimated to investigate the responsiveness of Chinese corn exports to domestic and international corn prices (app. table 1). Similar Chinese export supply models were estimated by Chern and Yu, using data from earlier time periods. Explanatory variables include the price of corn in China, the price of U.S. corn, and dummy variables corresponding to each month to capture seasonal effects.

The Chinese price is represented in the model by the average price for domestic sales at Dalian (the primary port for shipments of corn overseas and to southern China). Price analysis by Rozelle indicates that corn prices in various Chinese domestic markets move together, so the Dalian price is a good indicator of market conditions in China. As can be seen in figure 2 of this report, domestic prices do not move together with the f.o.b. export price (even though domestic and export shipments are made from Dalian). The U.S. price is the average price at the U.S. Gulf of Mexico price plus shipping costs to Japan. This represents the delivered cost of U.S. corn in north-east Asia, the primary market for Chinese corn. Movements in the U.S. price capture changes in U.S. market conditions and shipping costs. The U.S. and domestic prices were entered separately in the model instead of as a ratio since the lag lengths differ, and it was not clear *a priori* whether exports would respond to each of the two prices.

Statistical models of export supply usually include indicators for domestic supply and demand (Chern and Yu), but preliminary analysis showed that these variables did not have significant explanatory power. Recent Chinese exports have not corresponded to year-to-year changes in domestic supply. For example, the acceleration of Chinese exports in 2003 coincided with a relatively poor harvest and a sharp decline in domestic stocks, the opposite of what would be expected. Exports have also accelerated as corn inventories have declined, again contrary to expectations. Exports have not corresponded to indicators of demand growth such as GDP or per capita income growth. The Dalian price reflects market participants' assessment of supply and demand conditions in the Chinese market and is arguably the best indicator of domestic market conditions.

The estimation used data for 68 months (May 1998 through December 2004). The equation includes a 4-month lag for the China Dalian price, based on Rozelle's results and experimentation with different lag lengths. The analysis found that shorter lags were appropriate for the U.S. Gulf of Mexico price. Dalian and U.S. prices have a low correlation of -0.14, so collinearity between the two prices is not a severe econometric problem. T-values were -7.1 for the Dalian price and 5.5 for the U.S. price. Longer lags of the U.S. Gulf of Mexico price did not have statistically significant explanatory power, but shorter lags of 1 to 3 months had consistently strong effects on exports. It was also found that the Dalian price had significant effects with lags of 3 to 6 months, but effects were much weaker when the Dalian price was lagged only 1 or 2 months.

Appendix table 1—Monthly China corn export regression model

Variable	Parameter estimate	Standard error	T -value
Intercept	21.62*	3.64	5.94
Ln [Dalian price(t-4)]	-3.30*	0.47	-7.09
Ln [U.S. Gulf Price + freight(t-1)]	2.94*	0.54	5.49
Month dummies (January excluded)			
February	0.523	0.300	1.75
March	0.970*	0.300	3.23
April	-0.086	0.300	-0.29
May	-0.048	0.287	-0.17
June	0.350	0.287	1.22
July	1.060*	0.287	3.69
August	0.917*	0.287	3.19
September	0.927*	0.287	3.23
October	0.821*	0.287	2.86
November	0.773*	0.287	2.69
December	1.243*	0.289	4.31

R-square = 0.73.

F = 11.3.

Durbin-Watson statistic = 1.76.

N = 68, monthly data 1998-03.

*Coefficient significantly different from 0 with 95 percent confidence.

Estimated with ordinary least squares. Dependent variable is log of monthly Chinese corn exports (in kilograms).

Sources: China Customs Statistics; China National Grain and Oils Information Center; USDA, Agricultural Marketing Service; and U.S. Wheat Associates.

Appendix table 2—China corn planted area and production by province, 2000-02

Province	Planted area			Production		
	2000	2001	2002	2000	2001	2002
	————1,000 hectares————			————1,000 tons————		
Total	23,056	24,282	24,634	106,001	114,094	121,310
Northeast						
Jilin	2,197	2,610	2,580	9,932	13,285	15,400
Heilongjiang	1,801	2,133	2,286	7,908	8,196	10,705
Liaoning	1,423	1,567	1,432	5,511	8,187	8,580
Inner Mongolia	1,298	1,519	1,562	6,292	7,570	8,215
North						
Shandong	2,414	2,505	2,530	14,675	15,324	13,160
Henan	2,201	2,200	2,320	10,750	11,515	11,898
Hebei	2,479	2,543	2,577	9,945	10,596	10,350
Shanxi	794	838	891	3,548	3,099	4,353
Beijing	136	100	87	587	539	461
Tianjin	131	141	147	410	752	711
South						
Anhui	486	589	651	2,190	2,799	3,568
Jiangsu	423	430	437	2,368	2,599	2,617
Hubei	424	401	391	2,167	1,949	1,874
Guangxi	611	557	520	1,842	1,685	1,610
Hunan	279	270	273	1,251	1,151	1,192
Guangdong	189	165	142	761	652	535
Zhejiang	52	52	52	203	211	223
Fujian	37	35	36	111	108	112
Jiangxi	25	20	17	85	62	55
Hainan	18	17	16	52	49	51
Shanghai	5	5	5	37	37	30
West						
Sichuan	1,236	1,201	1,208	5,474	4,523	5,251
Yunnan	1,130	1,138	1,129	4,733	4,773	4,615
Shaanxi	1,057	1,005	1,000	4,137	3,528	3,745
Guizhou	727	722	704	3,422	3,194	3,432
Xinjiang	382	410	502	2,685	2,938	3,329
Gansu	464	467	504	2,105	1,990	2,192
Chongqing	501	490	477	1,975	1,806	1,974
Ningxia	131	148	155	820	948	1,043
Tibet	3	3	4	14	17	17
Qinghai	2	2	2	12	12	12

Source: China National Bureau of Statistics.