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## **Abstract**

We assess the comparative advantage and protection of China's major agricultural crops using a modified Policy Analysis Matrix (PAM) and 1996 to 1998 data. We consider the following commodities: early indica rice, late indica rice, japonica rice, south wheat, north wheat, south corn, north corn, sorghum, soybean, rapeseed, cotton, tobacco, sugarcane, and a subset of fruits and vegetables. Consistent with the intuition of the simple Heckscher-Ohlin model, the results strongly suggest that China has a comparative advantage in labor-intensive crops, and a disadvantage in land-intensive crops. Specifically, land-intensive grain and oilseed crops are less socially profitable than fruits and vegetables. Within the grain sector, high quality rice and high quality north wheat have a more comparative advantage than early indica rice and south wheat, respectively. The findings suggest that China's current grain self-sufficiency policy incurs efficiency losses. Our results shed light on likely changes in agricultural trade patterns in China, if accession to the World Trade Organization (WTO) takes place. We also stress the need for greater input productivity in grain production to improve its competitiveness if China keeps its food security policy.

**Key Words:** China, agriculture, comparative advantage, protection, DRC, EPC, agricultural trade.

## **FOOD SELF-SUFFICIENCY, COMPARATIVE ADVANTAGE, AND AGRICULTURAL TRADE: A POLICY ANALYSIS MATRIX FOR CHINESE AGRICULTURE**

Our paper is an empirical contribution to the debate on China's integration into the world economy. We assess the comparative advantage and protection of China's major agricultural crops using a modified Policy Analysis Matrix (PAM) and 1996 to 1998 data. We consider the following commodities: early indica rice, late indica rice, japonica rice, south wheat, north wheat, south corn, north corn, sorghum, soybeans, rapeseed, cotton, tobacco, sugarcane, and a subset of fruits and vegetables. Consistent with the intuition of the simple Heckscher-Ohlin model, the results strongly suggest that China has a comparative advantage in labor-intensive crops, and a disadvantage in land-intensive crops. Specifically, land-intensive oilseed crops (soybeans and rapeseed) and grains (wheat, corn, and sorghum) are less socially profitable than are labor-intensive fruits and vegetables, tobacco, cotton, and japonica rice. These findings suggest that China's grain self-sufficiency policy induces major efficiency losses and that significant gains in factor productivity will have to take place to improve the competitiveness of these crops, if food security objectives remain unchanged after accession to the World Trade Organization (WTO).

We find that agricultural protection in China is still reminiscent of the import-substitution era and reveals systematic patterns of input subsidization and output taxation through foreign exchange rate rationing (Krueger et al. 1991; Huang 2000). Effective protection patterns reveal the high effective protection enjoyed by corn, sorghum, and sugarcane, and the effective taxation burdening tobacco, cotton, and japonica rice. Patterns of comparative disadvantage and protection mirror each other. The least competitive crops tend to be the most protected ones.

China's accession to the WTO requires the eventual elimination or reduction of many policies distorting trade, production, and consumption of agricultural commodities,

which are inconsistent with WTO principles (Tuan and Cheng 1999). Reducing domestic and trade distortions would realign relative costs to relative world prices, reduce but not eliminate the production of importables (grains, oilseeds), and promote the production of exportables, such as vegetables, fruits, tobacco, and cotton. Hence, with accession to the WTO, China's agricultural trade patterns would be affected, increasing its dependence on world grain and oilseed markets to satisfy its domestic demand, and to absorb its exportable agricultural production (Garnaut et al. 1996; Carter et al. 1996; Carter and Li 2000; Wang 1997; Wailes et al. 1998; Lu 1997). In the long run, major factor productivity gains in agriculture would alter these predicted specialization patterns as shown by Huang and Chen (1999), and Huang et al. (1999). Realizing these productivity gains is a major challenge, in terms of policymaking and factor accumulation.

China's rapid economic growth and gradual transition towards a market economy have brought about significant changes in production and consumption patterns and somewhat in trade behavior in agriculture. However, the government, to a considerable extent, still distorts and controls input supply, output procurement, and trade flows—especially in the grain sector.

The switch from a large exporter to a large importer of grains, which occurred in 1994 and 1995, led some researchers to believe that China was beginning to rely more on relative scarcity signals to determine its trade patterns. However, alarmist warnings from outsiders about China's inability to feed itself led to a new agricultural policy bias promoting grain production and self-sufficiency (Brown 1995). Under a new grain policy, provincial governors were given responsibility to maintain the "grain bag." The policy bias toward grains shifted resource allocation away from other crops to grains. As a result, the harvested area for rice, wheat, and corn was increased from 80.3 million hectares (mha) to 86.1 mha between 1994 and 1999. The reverse pattern occurred for the production of several crops competing with grains in the land allocation: for example, the harvested area for cotton decreased from 5.53 mha to 3.75 mha during the same period.

In the following sections, we first review recent policy changes affecting Chinese agriculture. Next, we introduce the policy analysis matrix framework. We follow with a

presentation of the data used, and of our estimates of protection and comparative advantage. We conclude the paper with remarks on the implications of our findings.

### **Overview of China's Agricultural Policy**

China's leaders, as in many Asian countries, have been defining food security as grain security, bringing policymakers' active interference in grain markets and trade (Crook 1997, 1999). From the mid-1950s to the early 1980s, the people's communes controlled all aspects of the rural economy. Government-owned institutions managed the production and circulation of agricultural products from farm gate to consumers, and the century-old open marketing system was closed. The government strictly controlled the prices of farm products and cropping areas.

After rural economic reform was initiated in the early 1980s, the commune system was abandoned in favor of households as decision units under the "household responsibility system" (HRS). The old open marketing system was allowed to revive. Under the HRS, farm households were permitted to sign long-term land contracts to cultivate specific plots. Farmers were given somewhat greater production and marketing discretion. They were able to produce whatever they wanted and to sell their goods through local open markets as long as they delivered specified quotas to the government.

China's reform can be divided into several episodes (Carter et al. 1996; Huang 1998). In the period of 1978 to 1984, the household responsibility system was adopted and procurement prices and above-quota price premiums were increased. Centralized sown-area plans were relaxed to a certain extent, and procurement quotas were gradually reduced, and even abolished, for some commodities (Carter et al. 1996).

From 1985 to 1988, urban reforms were initiated. In agriculture, policy reform focused on liberalizing the mandatory procurement system, except for grain and cotton. In 1985, rural market reforms were introduced to abolish the unified purchasing and marketing system. State purchases of grain, cotton, and edible oilseeds were maintained, but quantities and prices of state purchases were negotiated between the government and farmers. The additional unit price for grain was significantly reduced. Meanwhile, a

number of other policies were implemented to encourage diversification of non-grain production (Huang 1998).

Starting in 1992, the Chinese government started market reforms to reduce the burden of the grain subsidies and to improve the economic efficiency of grain markets. Domestic prices for grain started to reflect movements in demand and supply in the domestic markets. As these market reforms accelerated in 1993, most provinces began to phase out the grain ration system that allowed urban consumers to purchase grain at low fixed prices. The government started implementing policies that placed grain production and procurement, at least partially, on a more market-oriented basis. These reforms led to resources being reallocated from grain production toward other crops. The market reforms led many observers to believe that China would steadily pursue an economic course based on free markets and comparative advantage.

During 1994 and 1995, many analysts in and outside of China questioned the country's capacity to produce enough grain to meet growing consumption requirements (e.g. Brown 1995; and Johnson 1994 for a dissenting view). Various research organizations including the U.S. Department of Agriculture (USDA), the International Food Policy Research Institute (IFPRI), and the Food and Agricultural Policy Research Institute (FAPRI) projected Chinese grain imports would reach 22 to 25 million metric tons (mmt) by 2005 and 40 to 45 mmt by 2020.

These reports might have had a sobering effect on the central leaders, pushing them to initiate the "governors' grain bag responsibility system," a policy designed to promote self-sufficiency in domestic grains at the provincial level. In this policy, various policy instruments were employed to boost grain output in 1995 and 1996. Under this policy, provincial governors assumed the sole responsibility of grain production and raised grain self-sufficiency rates. Each provincial government had the responsibility for

- (a) guaranteeing that a certain percentage of sown area is reserved for grains,
- (b) improving crop yields, insuring that local grain stocks are maintained, and
- (c) establishing and maintaining a local grain risk fund that can be drawn upon before central government resources in the event of a disaster.

In 1996, faced by high international grain prices, policymakers sharply increased quota prices for grains to stimulate grain production to assure adequate food supplies. As a result of good weather and higher prices, record grain production occurred in 1996. Large supplies began to depress prices in 1997 and a protected price was introduced, under which farmers would receive a minimally acceptable grain price floor covering their costs of production. Provinces added subsidies, including ones for chemical fertilizers, to their fixed-quota grain purchase price.

The 1998 grain reforms aimed at strengthening state control over the national grain system away from market forces. Grain trading by private companies was officially banned but not thoroughly enforced (Huang 2000b). Farmers were supposed to sell their grain-to-grain bureau stations, except for small amounts that could be sold in local markets. In reality, private traders bought large amounts of low quality wheat and early indica rice.

In 1999, the government started another new reform of China's grain marketing system, in the name of reducing government costs. On paper, the new grain reform allows more differentiation of procurement prices based on grain quality, encouraging greater production of other crops besides cereal grains, and granting grain companies more discretion over procurement. In practice, transactions between private traders and farmers went on a free-market basis for most grains (Huang 2000b). Whereas grain bureaus have limited capacity to administer quality differentials, the market transactions do reflect some premia for quality.

Price support measures in Chinese agriculture involve various border controls on trade, and state controls over domestic producer prices through procurement policies. The central government controls international trade in almost all major agricultural products. These controls break the link between world prices and the prices paid by consumers and received by producers for most agricultural commodities. China conducts a large share of its international trade through state trading enterprises (STEs). The Cereal, Oil, and Foodstuffs Importing and Exporting Corporation (COFCO) is a giant corporation playing a key role in China's food trade (Carter et al. 1998). While the trade system for many

other tradable products in China has undergone a big change, its foreign grain trade system is still centralized.

Since 1986, China has reapplied to join the General Agreement on Tariffs and Trade (GATT) and its successor, the WTO. Negotiations for China's membership are ongoing. The U.S.–China agreement, signed in Beijing on November 15, 1999, signaled China's desire and commitment to participate in the global trade community. Based on the agreement, China has committed to cut agriculture tariffs by more than one-half on many products beginning in the year 2000 and continuing through 2004. China committed to end its system of discriminatory licensing and import bans for bulk commodities, and it will establish significant and growing tariff rate quotas (TRQs) for state-traded commodities such as wheat, corn, cotton, rice, and soybean oil. The within-quota tariffs will be low, between 1 and 3 percent.

Upon accession, China has committed to not use export subsidies for agricultural products and will cap and then reduce trade-distorting domestic subsidies. China will eliminate scientifically unjustified restrictions on agricultural products. For example, China agreed to the removal of scientifically unjustified restrictions on imports of U.S. wheat and made a commitment to lift its ban on imports of citrus fruit from California, Arizona, Texas, and Florida.

In summary, despite substantial rural and economic reforms, which have occurred since 1978, there is still a significant degree of state intervention in Chinese agriculture. Cropping patterns are still partly determined by nonmarket influences such as the state purchase contracts and control of trade flows, the associated input distribution systems, and the state-controlled production centers for priority commodities.

### **The Policy Analysis Matrix and Measures of Comparative Advantage and Protection**

We use the PAM framework developed by Monke and Pearson (1998), augmented by a recent development in price distortion analysis brought by Masters and Winter-Nelson (1995), which accounts for the valuation of nontraded inputs. The PAM has been

applied to several countries (see, for example, Barichello et al. 1998; Nelson and Panggabean 1991; Yao 1997; Yao and Tinrappa 1995).

The PAM framework involves the derivation of several important indicators of protection and comparative advantage. As shown in Table 1, the PAM is a product of two accounting identities. The first one defines profit as the difference between revenues and costs, measured in either private or social terms. The second identity measures the effects of distortions (distorting policies and/or market failures) as the difference between observed values and social values as indicated by the divergences row in the PAM. These divergences are approximations because social values are evaluated at the initial distorted levels of outputs and inputs. Hence, the PAM provides guidance for incremental changes rather than wholesale ones.

**Table 1. Policy analysis matrix**

	Revenues	Costs		Profits
		Tradable Inputs	Domestic Factors	
Valued at private prices	A	B	C	D <sup>1</sup>
Valued at social prices	E	F	G	H <sup>2</sup>
Divergences	I <sup>3</sup>	J <sup>4</sup>	K <sup>5</sup>	L <sup>6</sup>

Source: Based on Monke and Pearson (1998).

<sup>1</sup>Private profits, D, equal A minus B minus C.

<sup>2</sup>Social profits, H, equal E minus F minus G.

<sup>3</sup>Output transfers, I, equal A minus E.

<sup>4</sup>Input transfers, J, equal B minus F.

<sup>5</sup>Factor transfers, K, equal C minus G.

<sup>6</sup>Net policy transfers, L, equal D minus H.

The data in the first row provide a measure of private profitability (D), defined as the differences between observed revenues (A) and costs (B+C) valued at actual market prices. Measures A, B, C, and D reflect transfers and taxes. They show the competitiveness of the agricultural system, given current technologies, output values, input costs, and policy transfers. The second row of the matrix in Table 1 calculates social profitability measured at “social” prices that reflect social opportunity costs. Efficient outcomes are achieved when an economy aligns its private price signals to social prices. Social profits measure efficiency and provide a measure of comparative

advantage. At the margin, a positive social profit indicates that the system uses scarce resources efficiently and the commodity has a static comparative advantage. When social profits are negative, a sector cannot sustain its current output without assistance from the government, with a resulting waste. The cost of domestic production exceeds the cost of importing at the margin.

Three coefficients are used to compare the extent of policy transfers or policy incentives between agricultural commodities. The nominal protection coefficient (NPC) is a ratio that contrasts an observed (private) price with a comparable world (social) price. This ratio indicates the impact of policy on divergence between the two prices for output (NPCO) and tradable inputs (NPCI). Subsidies to output are indicated by NPCO larger than one, and inputs subsidies lead to NPCI smaller than one. The EPC is a ratio of value added in private prices (A-B) to value added in world prices (E-F). This coefficient indicates the degree of policy transfer from output and tradable input distortions. A value greater than one indicates a net subsidy to value added.

Three indicators are used to compare the relative efficiency or comparative advantage between agricultural commodities. The first indicator is the domestic resource cost (DRC). The DRC is defined as  $G/(E-F)$  and indicates whether the use of domestic factor is socially profitable ( $DRC < 1$ ) or not ( $DRC > 1$ ). It has been widely used in developing countries to measure efficiency or comparative advantage and guide policy reforms (World Bank 1991; Appleyard 1987; Morris 1990; Gonzales et al. 1993; Alpine and Pickett 1993). However, the DRC may be biased against activities that rely heavily on domestic nontraded factors, i.e., land and some subsets of labor. A good alternative for the DRC is the social cost-benefit ratio (SCB), which accounts for all cost and avoids classification errors in the calculation of DRC (Masters and Winter-Nelson 1995). SCB is defined as  $(F+G)/E$ . Land is a more restricted factor than other domestic factors in China's crop production (7 percent world land and 25 percent world population). Therefore another indicator, the SCB without land-cost (LSB) is used to measure the return to this fixed factor for this study. LSB is defined as  $(E+G \text{ without land cost})/E$ . Higher values of SCB and LSB indicate stronger competitiveness.

## **Data Sources, Modeling Assumptions, and Results**

The basic information needed for compiling a PAM are yields, input requirements, and the market and social prices of inputs and outputs. The major sources of data used for the private account in the PAM are 1996, 1997, and 1998 farm household survey data on China's cost-of-production. The survey was conducted by China's Price Bureau in cooperation with the Ministry of Agriculture, the Ministry of Forestry, the Ministry of Domestic Trade, the China Silk Import and Export General Company, the China Federation of Supply and Marketing Cooperatives, China's Tobacco Administration Bureau, China's Chinese Medicine Administration Bureau, and China's Light Industry General Committee. The survey has been carried out for decades. Many of the same households are included in the survey each year. The number of households in the survey varies across agricultural activities, according to the relative importance of each activity in each household. Part of the data is available in China's Rural Statistical Yearbook (China's State Statistical Bureau, various issues).

The choice of social prices has a significant impact on the calculation of the PAM. We use the world price as a reference price for most commodities in the study. The U.S. FOB Gulf prices are used as reference prices for wheat, corn, sorghum, and soybeans. The cash Vancouver price, the Cotlook A Index, and FOB Caribbean price are represented as the reference prices for rapeseed, cotton, and sugar, respectively. These world prices are obtained from FAPRI. Rice quality varies among the different varieties grown in China, as well as in other countries. Using a reference world price for rice raises quality differential problems. To avoid quality differentials, we use China's unit value of exports as the reference price for the different types of rice. For the same reason, we use the unit value exported from China as the reference price for tobacco leaves because a representative world price for leaf tobacco is hard to identify. The unit values are calculated as the value of the exported commodity divided by the total quantity exported from China. The unit value data come from China's Customs Statistics Yearbook (Customs General Administration of PRC 1997). Vegetable and fruits markets are free markets in China with no explicit price distortions during the study period. The domestic prices for fresh apples, fresh oranges, Chinese cabbage, and green beans are used as an

approximation of social prices for these vegetables and fruits. Hence, we abstract from second-round effects of distortions in other markets on these fruit and vegetable prices.

The world prices are adjusted to be compared at the farm gate by first adding to them (subtracting) the international transportation cost of the commodity from (to) the originating market to (from) the domestic market. The transportation cost is assumed to be the ocean freight rates from the United States to China for imported commodities. The transportation cost for exported commodities is assumed to be one-half of these freight rates since most of China's agricultural products in this study go to neighboring countries. The data on the ocean freight rates were obtained from the USDA. Social prices at the farm gate are then calculated by subtracting the domestic marketing cost to the board prices. The domestic marketing costs are assumed to be equal to 10 percent of the border price, which is approximately equal to the difference between domestic wholesale price and producer price.

Reference prices in U.S. dollar terms are converted to China's currency, the RMB. China maintains fixed foreign exchange rate policy and limited currency convertibility. Starting in the late 1980s, China had dual exchange rates: official and secondary. Market-determined exchange rates existed alongside the overvalued fixed-official rates in the so-called two-tiered exchange rate system. While the overvalued official exchange rates distorted trade conducted by state trading companies, the share of transactions made at market-determined rates gradually increased (World Bank 1994; USDA 1998). With roughly 80 percent of all trade transactions taking place at the market exchange rate, China's government decided in 1994 to unify the two exchange rates. The official currency was devalued to the then market rate of 8.7 RMB per U.S. dollar. China did not give up its fixed exchange rate policy after 1994: the new rate is still pegged to the U.S. dollar. There is a consensus view that China's currency is overvalued (Yin and Stoeberl 1994; Shuguang et al. 1999).

Adjusting the exchange rate for the impacts of output price distortions and macroeconomic policy effects is a complex task. In this study, we assume that the 1994 unified exchange rate was a shadow exchange rate, with relative purchase power parity holding between China and the United States. We calculate the shadow nominal

exchange rates based on the real effective exchange rates from 1994 to 1997 from the World Bank (World Bank 1996, 1997, 1998). The estimated shadow nominal exchange rates are 9.41 RMB/U.S.\$, 10.13 RMB/U.S.\$, 10.58 RMB/U.S.\$, and 10.31 RMB/U.S.\$ for 1995, 1996, 1997, and 1998, respectively. The domestic prices and calculated social prices are reported in Table 2.

**Table 2. 1996 to 1998 private and social prices for commodities in China (Yuan/mt)**

Commodity	1996		1997		1998	
	Private	Social	Private	Social	Private	Social
Rice	1626	2597	1394	2408	1350	2040
Early Indica	1572	1679	1302	1316	1189	1311
Late Indica	1540	2462	1369	2281	1342	1995
Japonica	1800	3564	1508	3509	1498	2714
Wheat	1620	1723	1402	1603	1332	1357
Corn	1145	1060	1113	923	1076	774
Sorghum	900	968	888	871	886	719
Soybeans	2965	3113	3006	2925	2262	2540
Rapeseed	2527	3176	2528	3120	2648	2707
Cotton	14392	14790	14104	15194	11876	15066
Tobacco	9834	8266	7529	12066	5679	9173
Sugarcane	315	225	253	219	219	167
Apples	1371	1371	1081	1081	1004	1004
Oranges	1647	1647	1069	1069	1537	1537
Cabbage	359	359	477	477	392	392
Green Beans	1178	1178	1334	1334	1133	1133

Source: Calculated by authors.

Input shadow prices are also required for the PAM. China imported chemical fertilizer, plastic materials, and pesticides from international markets. The shadow prices for chemical fertilizer, plastic materials, and pesticides are the respective import parity prices at the farm gate.

There are differences in private labor costs among crops. The private labor wage is influenced by noncropping and off-farm opportunities. The maximum wage rate in the crop sectors is used as the social cost of labor for the study.

Following Monke and Pearson (1989), the social valuation of land in China is calculated based on the social profits before land cost, a measure of land rents. Valuation of land is a difficult exercise. For example, the social value of land devoted to green bean production is much higher than for other crops. However, vegetable crops require conditions of financial and production management that are very different from the conditions for other field crops. In the short run, farmers cannot readily convert to green beans. Hence the highest land valuation cannot be used as a short-run indicator of opportunity cost of land within a region. Using the same criteria of social profit before land cost yields a negative social value for land for some crops. We follow a conservative and resistant approach by using a weighted average of measures from rice, wheat, corn, sorghum, soybeans, cotton, tobacco, sugarcane, and cabbage for all commodities.

The next step in the analysis involves the disaggregation of nontraded and traded inputs. This step is necessary to permit identification of tradable-input and domestic-factor divergences. We decompose both total private and total social costs into their domestic factor and tradable-input components. Many classes of domestic factors could be recognized. Decomposing all input costs into their exact domestic factor and tradable-input components is a tedious task, which often only has a trivial effect on results (Monke and Pearson 1989). We assume that labor, land, farm capital depreciation, animal power, and manure are totally nontradable.

After prices and tradable and nontradable proportions of the inputs are estimated, the input and output data are used to construct the farm budgets and 57 PAMs, one per commodity and per year. Due to space limitation, these calculated tables are not reported here. However, they are available from the authors upon request. The summary results on protection, comparative advantage, and ranks in comparative advantage are reported in Tables 3 to 5, respectively.

The NPCO in Table 3 shows that policies provided nominal protection for corn, sugarcane, and to a lesser extent, sorghum. In 1998, as world prices continued to drop, the Chinese Government actively procured and stored corn to support domestic prices. Provincial grain bureaus built temporary storage facilities that doubled or tripled existing capacity. China exported over 6 mmt of corn in calendar year 1998 with subsidies to

reduce stocks. The government spent US \$30/mt to subsidize exports of corn in 1998 (USDA 1998). Sugarcane and sugar beet prices have been determined mainly by market forces. However, the government provides a “guidance price” for sugar refineries to procure sugarcane and sugar beets from farmers. The “guidance prices” are allowed to vary within 10 percent, up or down, from the price issued by the government. Smuggling in sugar has been effectively cracked down since 1996. In 1999, the average sugarcane procurement price declined by more than 20 percent over 1998 to reflect the market conditions.

**Table 3. Summary results of the coefficients for Chinese agricultural protection (1996 to 1998)**

	NPCO				NPCI				EPC			
	1996	1997	1998	Avg.	1996	1997	1998	Avg.	1996	1997	1998	Avg.
Rice	0.75	0.72	0.77	0.75	0.75	0.71	0.78	0.75	0.76	0.75	0.77	0.76
Early Indica	0.93	0.98	0.90	0.94	0.80	0.74	0.80	0.78	0.97	1.07	0.94	0.99
Late Indica	0.79	0.75	0.81	0.78	0.75	0.72	0.79	0.75	0.80	0.76	0.81	0.79
Japonica	0.55	0.47	0.59	0.54	0.72	0.66	0.76	0.71	0.52	0.44	0.57	0.51
Wheat	0.93	0.87	0.97	0.92	0.84	0.77	0.86	0.82	0.97	0.91	1.03	0.97
Corn	1.05	1.16	1.33	1.18	0.88	0.80	0.90	0.86	1.11	1.33	1.52	1.32
Sorghum	0.92	1.00	1.19	1.04	0.86	0.79	0.89	0.85	0.94	1.09	1.28	1.10
Soybean	0.94	1.01	0.89	0.95	0.85	0.83	0.83	0.84	0.96	1.06	0.90	0.97
Rapeseed	0.80	0.81	0.97	0.86	0.80	0.74	0.81	0.78	0.80	0.83	1.02	0.88
Cotton	0.95	0.92	0.79	0.89	0.70	0.70	0.73	0.71	1.03	0.98	0.81	0.94
Tobacco	1.19	0.63	0.62	0.81	0.77	0.71	0.77	0.75	1.28	0.61	0.59	0.83
Sugarcane	1.13	1.14	1.28	1.18	0.89	0.82	0.90	0.87	1.25	1.31	1.53	1.36

Source: Calculated from authors’ model.

The policies implemented during 1996 to 1998 decreased the producer prices of high-quality japonica and late indica rice. This situation changed in 1999 with new prices reflecting the domestic market valuation of different types of rice. Leaf tobacco was highly taxed in China in 1997 and 1998. The private prices of wheat, soybean, rapeseed, and cotton are also lower than their social prices, mostly due to currency overvaluation.

NPCI values indicate that the policies are reducing input costs for all commodities in the study, and the three-year average prices for tradable inputs are in the range of 70 to 87 percent of social prices. These distortions in inputs and output markets are difficult to reconcile with the targeting of some obvious noneconomic objectives, such as declared self-sufficiency (Vousden 1990). For example, input hiring decisions are highly and

heterogeneously distorted. These distortions induce some unnecessary deadweight loss to achieve self-sufficiency. With the presumption of constant return-to-scale production, efficiency in production implies no input distortions.

The values of the EPC show that there is a big difference in the degree of policy transfer across commodities. Corn, sugarcane, and sorghum enjoy a heavy support of 32 percent, 10 percent, and 36 percent on three-year average, respectively for their value-added, while japonica rice, late indica rice, and leaf tobacco face a net tax of 49 percent, 21 percent, and 17 percent, respectively, on average on their value-added.

The three competitive indicators—DRC, SCB, and LSB—are reported in Table 4 and then ranked by decreasing order in Table 5. They mirror the conclusions reached with the protection indicators. There is a positive correlation between protection and lack of comparative advantage. The DRC values for japonica rice, cabbage, green beans, tobacco, cotton, apples, oranges, and late indica rice are smaller than or close to one and clearly smaller than those for most grains and oilseeds. Most oilseeds and grain crops are produced inefficiently in China, with the DRC value greater than one. The results show government policies on grain self-sufficiency lead to significant allocative inefficiency and that there are significant differences in DRC values between the different types of rice, wheat, and corn. Japonica rice production exhibits more efficiency than early indica rice production. The recent relaxation of state controls on rice markets, which provide less incentive to produce lower quality rice, represents some improvement, however. North wheat and north corn are produced more efficiently than south wheat and corn. Hence internal patterns of regional specialization in grain production exhibit some inefficiency. Historically, rice production has been exhibiting a higher labor/land ratio than wheat and corn, which partly explains why rice is more competitive than corn and wheat. The respective ratios were 16.44 days/mu for rice, 10.75 days/mu for wheat, and 14.17 days/mu for corn in 1998.

The value of SCB ratios led to only a slight change in commodity ranking compared to the estimated DRCs. Japonica rice, cabbage, green beans, tobacco, cotton, apples, and oranges are worth expanding. Corn, wheat, rapeseed, sorghum, and soybean production should be reduced. The land profitability indicator slightly changes the commodity

ranking, but essentially brings the same message. Social profits of land devoted to fruits and vegetables, tobacco, cotton, and the higher quality rice are much higher than those for oilseeds, wheat, corn sorghum, and sugarcane. The social profits of land for south corn and south wheat are negative, indicating that corn and wheat production in South China would drastically decrease without assistance from the government. Low yields are the major cause of lack of competitiveness for these two products.

**Table 4. Results of the indicators for Chinese agricultural comparative advantage**

	DRC			SCB			LSB		
	1996	1997	1998	1996	1997	1998	1996	1997	1998
Rice	0.83	1.02	0.94	0.85	0.99	0.94	7650	6135	5096
Early Indica	1.09	1.54	1.32	1.07	1.39	1.24	3377	456	1336
Late Indica	0.95	1.14	1.06	0.96	1.11	1.04	4507	2485	2652
Japonica	0.43	0.40	0.46	0.51	0.47	0.54	15925	16343	11896
Wheat	1.42	1.39	1.76	1.29	1.27	1.49	1938	1634	430
South Wheat	1.84	1.82	2.65	1.60	1.58	1.99	437	111	-1153
North Wheat	1.24	1.17	1.43	1.17	1.12	1.28	2733	2638	1293
Corn	1.54	2.03	1.91	1.40	1.69	1.63	1366	-244	-62
South Corn	2.14	2.34	2.51	1.84	1.92	2.04	-699	-1162	-1298
North Corn	1.27	1.77	1.53	1.20	1.52	1.37	2579	591	978
Sorghum	1.48	2.45	1.62	1.37	1.98	1.48	1812	-285	785
Soybeans	1.32	1.58	1.25	1.27	1.47	1.21	2466	1222	2015
Rapeseed	1.74	1.65	2.19	1.59	1.51	1.90	905	732	-544
Cotton	1.06	0.94	0.79	1.04	0.95	0.83	3411	4449	5981
Tobacco	1.07	0.72	0.88	1.06	0.76	0.90	3073	9733	5039
Sugarcane	1.04	1.11	1.36	1.02	1.07	1.21	3645	2308	322
Apples	0.93	1.10	0.78	0.95	1.07	0.83	5525	1692	7240
Oranges	0.84	1.19	0.85	0.89	1.12	0.90	7031	601	6070
Cabbage	0.77	0.65	0.59	0.81	0.70	0.65	8307	12087	11252
Green Beans	0.68	0.70	0.67	0.73	0.75	0.72	10842	10531	10115

**Table 5. Comparative advantage ranking (1996 to 1998 average)**

	DRC		SCB		LCB	
	Average (1996-98)	Rank	Average (1996-98)	Rank	Average (Yuan/ha) (1996-98)	Rank
Japonica Rice	0.43	1	0.51	1	14721	1
Cabbage	0.67	2	0.72	2	10549	2
Green Beans	0.68	3	0.74	3	10496	3
Tobacco	0.89	4	0.90	4	5948	4
Cotton	0.93	5	0.94	5	4614	6
Apples	0.94	6	0.95	6	4819	5
Oranges	0.96	7	0.97	7	4567	7
Late Indica	1.05	8	1.04	8	3215	8
Sugarcane	1.17	9	1.10	9	2092	10
North Wheat	1.28	10	1.19	10	2221	9
Early Indica	1.32	11	1.23	11	1723	12
Soybeans	1.38	12	1.31	12	1901	11
North Corn	1.52	13	1.37	13	1383	13
Sorghum	1.85	14	1.61	14	771	14
Rapeseed	1.86	15	1.66	15	364	15
South Wheat	2.10	16	1.72	16	-202	16
South Corn	2.33	17	1.93	17	-1053	17

## Conclusions

Our results strongly suggest that, with the exception of the higher quality rice, the production of grains and oilseeds suffers from a comparative disadvantage over other crops in China. Our results are consistent with the intuition of the simple Heckscher-Ohlin model (Leamer 1984; Bowen et al. 1987; Hayes et al. 1995). China has limited arable land and an abundant labor force, relative to the world (Garnaut et al. 1996). These endowments give China a certain comparative advantage in labor-intensive goods for the world market (Huang 2000a; Huang and Chen 1999). Labor-intensive crops, such as vegetables, tobacco, cotton, and fruits are currently better suited for Chinese agriculture. Among grain and oilseed crops, japonica rice is the only crop that exhibits a comparative advantage. Among grains, rice tends to be more competitive than other crops, partly because it has a higher labor/land ration than wheat and corn. Hence, China's self-

sufficiency policy goes against its current comparative advantage, except for high quality rice production.

The cotton case deserves a qualifier. Since 1996, China has expanded its production of cotton and has accumulated large stocks of cotton, which are reflected via expectations in low world prices. We can reasonably guess that the DRC for cotton evaluated at 1999 prices would be higher than one and that China would be ill advised to further expand cotton production. Assessing this conjecture, however, requires data not yet available.

Further, we can conclude that grain self-sufficiency policies reduce allocative efficiency twice. First, self-sufficiency could be achieved with smaller deadweight losses by reducing input market distortions. The latter distortions are inconsistent with predictions of the targeting principle for self-sufficiency. In addition, any noneconomic objective is inherently costly even with proper policy instrument targeting. The recurrent large levels of inventory holdings suggest that the targeting was not optimum, but rather an economic aberration guided by old policy reflexes. Chinese grain production was and is sufficient to meet domestic food demand (Johnson 1994, 1999). Our results are also in agreement with recent findings obtained by Estrin (1990) using a stochastic production frontier approach to grain output. The promotion of grain production and the pursuit of self-sufficiency in China are inefficient.

While static efficiency gains in grain production could be achieved in the short run with a reform of distortions, long run gains are possible through greater factor productivity. This dynamic perspective on comparative advantage of grain production is particularly relevant in the context of China's accession to the WTO. If China persists with its food security objective, higher productivity gains will have to occur in grain production, or else large grain imports will take place as implied by WTO accession. The substantial productivity gains of land and labor that have occurred the last 20 years have relied strongly on increased use of fertilizer and chemicals (Fan and Pardey 1997; Huang and Rozelle 1996). Eventually, these two sources of productivity gains will become exhausted. Significant investments in agricultural research and infrastructure, especially

irrigation,<sup>1</sup> have to take place (Huang and Chen 1999; Huang et al. 1999). Further, the capital intensity of agriculture will have to increase to foster substitution possibilities between machinery capital and relatively unskilled labor (Johnson 2000). More human capital will be required as well for this substitution to take place. The current state of credit and land markets in China makes this capitalization of agriculture difficult and hence, a major challenge to Chinese policymakers.

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<sup>1</sup> The improvements in irrigation infrastructure are especially acute in the context of grain production in Northeast and North China. Over the long term, the potential to increase higher quality grain production faces increased water constraints because both agricultural and nonagricultural uses have put high pressure on available water resources over the past 20 years. The latter have sharply cut river flows and drawn down aquifer levels (Crook and Diao 2000).

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