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WORKING PAPER 43

Effects of Trade Liberalization on Agriculture in China: Commodity Aspects

Jikun Huang and Chunlai Chen

The CGPRT Centre
Working Paper Series, August 1999

The CGPRT Centre

The Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) was established in 1981 as a subsidiary body of UN/ESCAP.

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In co-operation with ESCAP member countries, the Centre will initiate and promote research, training and dissemination of information on socio-economic and related aspects of CGPRT crops in Asia and the Pacific. In its activities, the Centre aims to serve the needs of institutions concerned with planning, research, extension and development in relation to CGPRT crop production, marketing and use.

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Effects of Trade Liberalization on Agriculture in China: Commodity Aspects

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Abbreviations

APEC	Asian and Pacific Economic Cooperation
CAAS	Chinese Academy of Agricultural Sciences
CAPSiM	China's Agricultural Policy Simulation Model
CCAP	Center for Chinese Agricultural Policy
CG	Coarse Grain
COFCO	China National Grain, Oil and Food Import and Export Corporation
ERPR	Effective Real Protection Rate
ERS	Economic Research Service of the United States Department of Agriculture
FTCs	Foreign Trade Corporations
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
mt	Metric Tons
MOA	Ministry of Agriculture
NPRs	Nominal Protection Rates
NRP	Nominal Rate of Protection
RMB	Chinese Currency
SOE	State Owned Enterprises
SSB	State Statistical Bureau
TVE	Township and Village Enterprise
WTO	World Trade Organization

Foreword

Responding to the growing concern for the effects of trade liberalization on regional agriculture, the CGPRT Centre has implemented a three-year research project "Effects of Trade Liberalization on Agriculture in Selected Asian Countries with Special Focus on CGPRT Crops (TradeLib)" since March 1997, in collaboration with partners from ten countries: China, India, Indonesia, Japan, Malaysia, Pakistan, the Philippines, the Republic of Korea, Thailand and Viet Nam. In all these countries, important issues regarding trade liberalization were investigated with an identical research framework by national experts.

The investigation covers major crops which might receive either favorable or unfavorable effects of trade liberalization both in export and import. I believe that the project will provide broad and practical knowledge on various aspects of the effects of trade liberalization; moreover, the information will be useful for researchers and policy planners not only in participating countries but also in other countries in the region. However, I would like to note that, since this project was conceived and started before the current currency and economic crisis began in the middle of 1997, the analysis handles basically the period before the crisis with available current information.

I am pleased to publish **Effects of Trade Liberalization on Agriculture in China: Commodity Aspects** as the report of the second phase of the country study of China. A report of the first phase of the country study, which includes institutional and structural aspects on the same subject, was published recently. I certainly hope these reports will be fully utilized for the improvement of agricultural trade and the encouragement of regional agriculture.

I thank Dr Jikun Huang and Dr. Chunlai Chen of China for their intensive research and the Center for Chinese Agricultural Policy for allowing them to work with us and for providing continuous support. I am very much obliged to Dr Boonjit Titapiwatanakun for his devoted contribution to the project as the regional advisor. I would also like to express appreciation to the Government of Japan for funding the project.

Haruo Inagaki
Director
CGPRT Centre

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This is a report of a country study for China under the overall project entitled "Effects of Trade Liberalization on Agriculture in Selected Asian Countries with Special Focus on CGPRT Crops (TradeLib)". It is the second part of the Chinese study focusing on commodity and local agriculture related to trade liberalization.

The report benefited from fruitful discussions with many Chinese government officials, the staff of the CGPRT Centre, and the national experts from the 10 Asian countries participating in this project.

The completion of this report would not have been possible without the assistance from many officials, who helped in providing data required for this study, from the Ministry of Foreign Trade and Economic Cooperation, Ministry of Finance, Ministry of Agriculture, and General Customs Administration.

We wish to express our sincere thanks to Dr. Haruo Inagaki, Director of the CGPRT Centre, for providing us the opportunity to participate and taking a keen interest in this study. We also sincerely acknowledge the valuable comments and guidelines of Dr. Boonjit Titapiwatanakun, Regional Advisor for this project, Dr. Michio Kanai, Project Leader of the TradeLib project, CGPRT Centre, and Professor Scott Rozelle, of the University of California at Davis.

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Executive Summary

Reform and trade liberalization in China's external sector, because of its strategic role in the economy, has proceeded gradually. Gradual trade liberalization in step with reforms in the other sectors of China's economy has its logic. In the initial stage, reformers only implemented measures that provided incentives to sets of corporations and institutions and did not alter or only partially altered the institutional structure that was set up to achieve the objectives of foreign trade in national industrialization, economic growth, and national security (i.e., food self-sufficiency in the agricultural sector). As experience gained from the reforms grew and the objectives of trade could be achieved through alternative settings of institutions and policies, trade liberalization processed smoothly since the late 1980s.

In the past 20 years, the study (reported in the first part of the project) shows that China's foreign trade regime has gradually changed from a highly centralized, planned and import substitution regime to a more decentralized, market-oriented and export promotion regime.

The reforms of the economy in general and international trade in particular have significantly impacted on the economic structure and patterns of international trade in China. Economic reforms resulted in considerable growth of the national economy and dramatically changed the structure of China's economy in general and agriculture in particular. The changing pattern of comparative advantage within agriculture is consistent with China's resource endowments. China was a net exporter of labor intensive and labor/capital intensive agricultural products, such as horticultural products, animal products and processed agricultural products, and was a net importer of land intensive agricultural products, such as grains, cotton, and edible vegetable oils in the past. The study also shows that since 1985, when the external trade reform was initiated, the patterns of China's agricultural trade, particularly the patterns of agricultural exports, have gradually moved more closely towards reflecting China's resource endowments.

However, this study also reveals that room for further liberalization exists in terms of limiting non-tariff measures to control agricultural imports, further commercialization of state trading, and improving the efficiency of foreign trade management. Indeed, China has decided to take further trade liberalization steps in the coming years. China applied to join GATT and then the World Trade Organization (WTO) in 1986. Although China has not been accepted as a member of the WTO, China has committed to comprehensively implementing the Uruguay Round agreements upon its accession into the WTO.

With 13 years negotiation on China's WTO accession, particularly the recent progress made during Premier Zhu Rongji's visit to the United States in April of 1999, it is likely that a decision concerning China's joining the WTO will come soon. The sheer size of China's economy and its rapid growth will make China a crucial player in the future development of world markets for inputs and outputs of food and agricultural products, agribusiness, and industry.

While the negotiation is still ongoing, there has been also growing concern on the impacts of China's accession to WTO on China's domestic agricultural production, prices and markets, employment and farmer's income, particularly in the short term. How to sustain agricultural growth, achieve food security, and increase farmers' income with the process of agricultural trade liberalization are priority concerns of not only policy makers but also farmers. What are the impacts of trade liberalization on China's agricultural production? What are the implications of trade liberalization to China's food security? How will trade liberalization impact on China's domestic agricultural commodity prices, agricultural employment, farmer's

income, and agricultural trade in the short run and in the long run? What are the policy implications of the changes in the economy resulting from trade liberalization in the future?

The answers to these questions are by no means clear. Some researchers claim that the impacts of China's accession to the WTO on China's agricultural production and trade are marginal. Others believe that while both China and the rest of the world will benefit from China's WTO accession for the economy as a whole, the impacts of trade liberalization on China's agricultural sector should not be understated.

China's ability to feed itself in the 21st century has been widely discussed in the literature. The most striking feature of the projections of food surpluses and deficits is their wide range. Such a wide range of food economy predictions is perplexing. China's emergence as either a major importer or a major exporter could have enormous consequences for world grain markets and prices. Moreover, most previous studies assume that China's current trade policies will be continued in the future. Evidence from most recent work indicates that China will face great challenge in achieving its food security in a more liberalized economy.

Based on a projection model developed at the Center for Chinese Agricultural Policy (CCAP), CCAP's Agricultural Policy Simulation and Projection Model, several policy scenarios are formulated and the impacts of trade liberalization on China's agricultural demand, supply, trade, prices, welfare, employment as well as farmers' income in local crop production are projected and estimated.

The scenarios formulated for simulation analysis include baseline, free trade, and free trade with increasing productivity enhancement investment scenarios. A baseline scenario assumes that China will continue its current domestic and external policies and not join WTO in the future. In contrast to the baseline scenario, a free trade scenario assumes that China will continue liberalizing its agricultural sector and reach a free trade environment for most agricultural commodities by the year 2005. This represents a maximum impact of trade liberalization on China's agriculture. The actual impact of trade liberalization and China's joining WTO on domestic agriculture will be in between the simulation results of the baseline and the free trade scenarios. In order to provide long term prospects on China's food security under a free trade regime, we project China's food supply, demand and trade toward 2020 under a free trade scenario without and with the progressive improvement in agricultural productivity enhancement investment. The latter scenario assumes that the annual growth rate of agricultural research expenditure will rise from 4% (baseline assumption) to 6%.

Our simulation results on trade liberalization conclude that the producers of most crops (except for rice and horticulture) will have reduced income from their farming activities not only because of a decline in the price received by the farmers, but also a reduction in production. However, most animal product producers, particularly farmers raising hogs and poultry, will benefit from trade liberalization as the increase in the export demand raises livestock prices and the surging maize import lowers the feed price.

The impacts of trade liberalization on China's agriculture are remarkable not only on agricultural prices, but also on domestic production and consumption, and external trade. Under the free trade scenario, the fall in domestic prices of grain raises grain consumption and slows down the production. Our projection shows that China's domestic grain production will fall far behind domestic grain consumption under the free trade scenario. Compared to the baseline scenario, the grain deficit between domestic supply and demand will be further increased. China's net grain imports would rise to about 60 million mt in 2005 if the grain market were liberalized. Among these, 40 million mt or two-thirds of imported grains are maize.

Our study also concludes that maize, the third major crop just behind rice and wheat, will soon pass over rice and wheat, and become a top crop in terms of the magnitude of its domestic consumption (demand), and it will soon become the number one imported crop product in China. China will likely be one of the world's largest importers of maize in the coming years if the market is fully liberalized in the future. In contrast to what many scholars'

believe, while trade liberalization will raise the wheat import in the short run, the wheat import will soon decline after the initial shock of trade liberalization. China will become nearly self-sufficient in wheat in the long term (by 2020).

On the other hand, China is likely to be one of the major exporters of livestock products in the world. Pork and poultry exports will expand profoundly with trade liberalization. Trade liberalization will tend to raise domestic animal product prices to levels present in the world market. The interesting point is that feed grain consumers are the animal product producers. Thus, the producers of animal products will have double gains (lower production cost as the feed price declines and higher meat prices) with a more liberalized economy. Consequently, there will be an expansion in the production of animal products, particularly the production of pork and poultry in China after trade liberalization.

In relation to food security and grain self-sufficient issues, our study shows that a completely liberalized economy in the short term will challenge the current food security goal defined by the government. China's grain self-sufficiency rate will decline rapidly from 98% in the mid-1990s to less than 90% in 2005 if the free trade regime is assumed by the year of 2005. However, it is worth noting that this is an extreme case, representing a maximum impact of trade liberalization on China's grain economy. The actual impact of China's joining the WTO will be lower than the results from this free trade scenario.

In the long term, our study shows that the most effective policy that could improve China's food security and raise the grain self-sufficiency level is to increase agricultural productivity enhancement investment such as agricultural R&D, rural and agricultural infrastructure and irrigation. If these policies are formulated properly, China could achieve its grain self-sufficiency target in the second decade of the next century, even if the grain market is completely liberalized in 2000-2005.

The welfare analysis of this study reveals that trade liberalization will generally be unfavorable to grain producers but favorable to livestock and fish producers in China. In terms of consumers, trade liberalization will raise their welfare in grain, but reduce their welfare in the meat sector. For overall social welfare, our study shows that social welfare gained from the liberalization within China's agricultural sector is minimal. However, the welfare changes differ significant among agricultural products, between producer and consumer, and over time.

The impacts of trade liberalization on agricultural employment in this study are surprisingly lower than those found in other studies for China, but they are consistent with the actual employment changes observed in Mexico and other developing countries during the period when their economies were liberalizing. However, a significant impact of trade liberalization is found for maize and wheat. Maize production would lose employment by more than 2.3 million man-years and wheat by 1.14 million man-years in 2000-2005. The employment expansion in the rice and livestock sectors will not be able to fully offset the decline in employment in the crop sector. For agriculture as a whole, a rough estimate of the reduction in employment due to trade liberalization might range from 2 to 2.5 million man-years in the period of 2000-2005.

Examination of the impacts of trade liberalization at the local farm level is based on a partial budget analysis for rice, wheat and maize, the three most important crops in China. The results show that rice farmers in China will be one of the few winners within the agricultural sector in the process of trade liberalization. The gains come essentially from the rise in the domestic rice price and the reduction in production costs as most agricultural input prices will fall with trade liberalization. These gains from liberalization are found for all rice producers in China, but the gains vary among provinces and by variety.

The partial budget analyses also demonstrate that wheat and maize production would be much less profitable after trade liberalization. Farmer's income from wheat and maize production will decline significant with trade liberalization, as the large decline in output prices

could not be compensated for by the cost reduction from cheaper imported agricultural inputs. Most maize and wheat farmers in southern China might record a negative profit if the opportunity costs of family labor are accounted for in crop production.

Based on the findings of this study, a number of policy recommendations are made in the last section of this report. The study calls for a greater role for the market to determine trade patterns in order to reap comparative advantage gains in the course of trade liberalization. Policy steps to achieve comparative advantage gains include removing implicit taxes on farmers and reforming domestic grain pricing and marketing systems.

Further commercialization of the state trading system will improve the efficiency of foreign trade under a more liberalized economy, which is essential for China to maximize its potential gains in some sectors and/or to minimize its likely losses in other sectors of the economy due to trade liberalization. Improved grain handling, internal transport, and external port capacities will be the other important areas for policy intervention.

This study also calls for a revision of the grain self-sufficiency policy. If a food grain self-sufficiency concept could be adopted by policy makers instead of the total grain self-sufficiency concept, China would benefit greatly from realizing the full gain in trade liberalization by shifting more land from the productions of feed grain to exportable products (i.e., horticultural products).

To maintain a high level of food security and to ensure that the comparative advantage of China's agriculture does not decline as far as we have projected under the free trade scenario, China has to substantially raise its investment in agricultural research and extension, irrigation, and other productivity-enhancing activities. This is one of the most effective measures to reduce China's grain imports and expand labor intensive agricultural product export.

Policies recommended for China to minimize its short term shocks from trade liberalization include measures that could be adopted under the WTO framework such as setting an adequate minimal market accession level, a reasonable level of the above quota tariffs, an acceptable length of the transition period, and a moderate depreciation of the domestic currency.

New policies on assisting farmers in adjusting their production and employment structures, and on setting up a better tax and income re-redistribution system are also suggested. This is particular important for the poor whose income mainly depends on crop production. Access to credit and market information is another important factor that will help farmers obtain re-employment in other sectors. A further effort is needed to assess the consequence of trade liberalization on China's agriculture and farmer's income in a more detailed manner and to increase the awareness of policy makers and farmers regarding China's agriculture and the trade liberalization.

1. Introduction

1.1 Background

With the rapid economic growth in Asia and the Pacific region, in particular in Asian developing economies, trade of agricultural products has been expanding rapidly. According to the FAO database, agricultural trade in the Asian and Pacific region recorded US$61.542 billion in imports and US$50.695 billion in exports in 1993 and their increases in the last ten years were 54% and 82%, respectively. With the success of the Uruguay Round negotiation on General Agreement on Tariffs and Trade (GATT) in December 1993, the movement toward trade liberalization has been active in the world as well as in Asia and the Pacific region. However, concern about the effects of trade liberalization on regional agricultural production has been growing. Sustainable agricultural development and increasing farm incomes are priorities of all countries in the region. In order to proceed smoothly with the adjustment process towards more liberalized economic environments, the effects of trade liberalization need to be analyzed and identified. Therefore, the United Nations ESCAP CGPRT Centre, organized the project of "Effects of Trade Liberalization on Agriculture in Selected Asian Countries with Special Focus on CGPRT Crops (TradeLib)". China is one of the countries participating in the project.

Since the economic reforms initiated in late 1978, China's economic performance has been outstanding. Growth of the economy has been remarkable. China's foreign trade has been expanding even more rapidly than its overall economic growth. From 1980 to 1997, the total value of China's foreign trade increased from US$38.14 billion to US$325.06 billion, with an annual growth rate of 13.4%. During the same period, the total value of China's agricultural trade increased from US$9.29 billion to US$25.15 billion, with an annual growth rate of 6.0%. China applied to join GATT and then the World Trade Organization (WTO) in 1986. Although China has not been accepted as a member of the WTO, China has committed to comprehensively implementing the Uruguay Round agreements upon its accession into the WTO.

With 13 years negotiation on China's WTO accession, particularly the recent progress made during Premier Zhu Rongji's visit to the United States in April of 1999, it is likely that China will join the WTO before the end of 1999. The sheer size of China's economy and its rapid growth will make China a crucial player in the future development of world markets for inputs and outputs of food and agricultural products, agribusiness, and industry. While the negotiation is still ongoing, there has also been growing concern about the impacts of China's accession to WTO on China's domestic agricultural production, prices and markets, employment and farm incomes, particularly in the short term. How to sustain agricultural growth, achieve food security, and increase farmers' incomes with the process of agricultural trade liberalization have been the priority concerns of not only policy-makers but also farmers. What are the impacts of trade liberalization on China's agricultural production? What are the implications of trade liberalization on China's food security? How will trade liberalization impact on China's domestic agricultural commodity prices, agricultural employment, farm income, and agricultural trade in the short run and in the long run? What are the policy implications of the changes in the economy resulting from trade liberalization in the future?

The answers to these questions are by no means clear. Some researchers claim that the impacts of China's accession to the WTO on China's agricultural production and trade are marginal (Anderson 1997). Others believe that while both China and the rest of the world will benefit from the China's WTO accession for the economy as a whole, the impacts of trade

liberalization on China's agricultural sector should not be understated (Wang 1997; Development Research Center 1998; China Agricultural University 1999; Huang 1998; Huang and Chen 1999).

1.2 Objectives of the study

The project "Effects of Trade Liberalization on Agriculture in Selected Asian Countries with Special Focus on CGPRT Crops (TradeLib)" organized by the United Nations ESCAP CGPRT Center aims at:

- Identifying the international trade of agricultural products in the region under liberalized market conditions;
- Characterizing the situation and prospects of agriculture in selected Asian countries with special attention to the effects of trade liberalization;
- Specifying policy options for improving farmers' income in the process of trade liberalization; and
- Providing concerned policy-makers and researchers with discussions and suggestions on the above findings.

The project consists of three studies: an institutional study on international agricultural trade liberalization (institutional study), a study of trade liberalization on commodities (commodity study), and a study of effects of trade liberalization on local agriculture (local agriculture study).

The present report is the second (commodity study) and third (local agriculture study) parts of the whole project for China. The commodity study was conducted at the national aggregate level and focuses on seven major agricultural commodities, including rice, wheat, maize, soybean, pork, beef and poultry. The study applies CCAP's China's Agricultural Policy Simulation and Projection Model (CAPSiM) to simulate the impacts of trade liberalization on the production, consumption, trade, and prices of the selected seven agricultural commodities at the national level.

The local agriculture study mainly focuses on the impacts of trade liberalization on the income of grain production at the local or farm level. The major grains included in this study are rice, wheat and maize. A partial farm budget analysis was used to examine the impact of trade liberalization on the profitability of grain production at the farm level of the selected three major grains.

1.3 Structure of the report

The report is organized as follows. Chapter 1 provides an introduction of the report, a summary of the institutional study in the first part of the project, and the current issues on institutions and trade policies. Chapter 2 analyzes the effects of trade liberalization on production, consumption and trade of the selected agricultural commodities at the national level. Chapter 3 analyzes the effects of trade liberalization on production of selected agricultural commodities at the local level. Finally, the prospects and strategies for agricultural trade liberalization are summarized in the last chapter.

1.4 Summary of the study on institutions and structure of foreign trade

1.4.1 Reform in foreign trade

A detailed study of institutional and policy aspects of trade liberalization (the first part of the China country project) is reported in Huang and Chen (1999). In this sub-section, a summary of the trade institutions and policies is provided. China's foreign trade regime can be

broadly divided into two periods: the highly centralized foreign trade regime under a planned economy before 1978 and the increasingly liberalized foreign trade regime since the economic reforms started in 1979. Through nearly 20 years of reform and implementation of an open door policy, China's foreign trade regime has gradually changed from a highly centralized and planned regime to a more open and liberalized regime. These changes include decentralization of the foreign trade regime, reduction in government intervention in foreign trade, commercialization of foreign trade corporations, and reduction of trade barriers.

After the founding of the People's Republic of China in 1949, China soon established the socialist planned economy. With the desire of accelerating growth of the national economy and achieving rapid development of national industrialization, like many other developing countries, China adopted an "import substitution" industrialization strategy. To meet the demands of the socialist planned economic system and to implement the "import substitution" industrialization strategy, China established a highly centralized and planned foreign trade regime. Export was aimed to serve import and foreign trade was aimed to serve national industrialization. Foreign trade was conducted strictly under rules and regulations of trade organization, operation, management, control, planning, and financing (Huang and Chen 1999).

Foreign trade rights were granted by the Ministry of Foreign Trade to only a few the state-owned enterprises (SOE) or corporations under the planned trade regime. For a nation as a whole, only 12 national specialized general foreign trade corporations and their port sub-corporations had trading rights. For example, foreign trade of agricultural products was monopolized by the China National Grain, Oil and Food Import and Export Corporation (COFCO), the China National Native and Animal Products Import and Export Corporation, and the China National Textiles Import and Export Corporation.

Foreign trade planning was the core of China's foreign trade regime before 1979. The state foreign trade plan was mandatory and covered aspects of foreign trade, including foreign trade procurement, transfer and allocation, export, import, foreign exchange earnings and payments and so on. The Ministry of Finance, instead of the foreign trade corporations, was responsible for making profits and losses from trade.

Since the economic reforms initiated in 1979, China has been liberalizing its trade sector gradually. In the early stage of the trade reforms (1979-1987), the highly centralized and monopolized foreign trade system was progressively reformed and decentralized by establishing more new trade ports and granting more corporations and production firms direct foreign trading rights. From 1979 to 1987, more than 2,200 foreign trade corporations were established, increasing 11 times over the number of foreign trade corporations in 1979.

In order to improve the efficiency and effectiveness of the trade sector, the mandatory planning of foreign trade was replaced by a new system that allowed trade to response to changes in both domestic and international markets. Government direct administrative intervention was gradually reduced.

Similar to the household responsibility system of rural economic reform, China introduced the trade contract responsibility system in 1987. The system allows trade corporations to retain the foreign exchange over the planned exports. To facilitate the implementation of the foreign trade contract responsibility system, the Chinese government introduced a number of complementary measures. These include relaxing foreign exchange control, establishing foreign exchange swap centers (1988), introducing full export tax rebates (1988), and partially decentralizing decision-making powers.

The foreign trade reforms, followed by implementation of the trade contract responsibility system, has been trying to introduce a more market-oriented trade regime in the economy since 1991. Government export subsidies were phased out in the early 1990s. The import tariff rates were reduced substantially. An "agent system" was introduced to foreign trade in 1991 to stimulate commercialization of the trade sector. The official exchange rate and the swap market exchange rate were unified and a single managed floating exchange rate was

adopted in 1994. Meanwhile, the foreign exchange retention system was abolished and replaced by a foreign exchange bank settlement system in 1994. The foreign trade contract responsibility system implemented by the state-owned foreign trade enterprises was abolished and replaced by a tax system in 1994. At the same time, a shareholding system was tried in the state-owned foreign trade enterprises. The government has accelerated the process of granting foreign trading rights to production enterprises, commercial material enterprises and scientific and research institutions since 1994. The RMB became convertible on current accounts at the end of 1996.

Import tariffs have been reduced substantially since the early1990s. China's average tariffs (47.2% in 1991) were among the highest in the world (World Bank 1997), but China has gradually reduced its import tariff rates in recent years. By 1998, China's simple average tariff rate was down to 17% for all importable commodities, and about 20% for agricultural commodities, levels considered very low for a non-WTO member developing country.

In summary during the past nearly 20 years, China's foreign trade regime has gradually changed from a highly centralized and planned regime to a more open and liberalized regime. The impacts of these reforms on foreign trade performance are shown by the growth of the trade sector and the pattern of imports and exports over time.

1.4.2 The structure of foreign trade

Rapid economic growth during the past 18 years has dramatically changed the structure of China's economy. The share of the agricultural sector in China's economy has been declining continuously. The share of agricultural GDP in China's total GDP declined from 30% in 1980 to 19% in 1997, while the share of agricultural employment in China's total employment declined from 69% to 50% during the same period. Moreover, with the declining trend of the agricultural sector in China's economy, the structure of the agricultural economy has also changed. Although the farming sector has remained the most important sector in the agricultural economy, its share has declined over time from 75.6% in 1980 to 56.4% in 1997. In contrast, the animal husbandry and fishery sectors have been growing very rapidly. The share of the animal husbandry sector increased from 18.4% in 1980 to 31.0% in 1997, and the share of the fishery sector increased from 1.7% to 9.3% during the same period.

From 1980 to 1997, the value of China's agricultural trade grew 6.04% annually. During the same period, the annual growth rates of agricultural exports and imports were 7.96% and 3.91%, respectively. Because China's overall trade growth has been much faster than that of agricultural trade, the importance of agricultural trade in China's total trade has been declining since 1980 and particularly since the early 1990s. From 1980 to 1997, the share of agricultural trade in China's total trade declined from 24.35% to 7.74%, and at the same time the shares of agricultural export and import in China's total export and import declined from 23.03% and 25.54% to 8.40% and 6.89%, respectively.

In terms of the patterns of China's agricultural trade, the study reveals two main points. First, the patterns of China's agricultural trade were consistent with China's domestic resource endowments during the reform period. China was a net exporter of labor intensive and labor/capital intensive agricultural products, such as horticultural products, animal products and processed agricultural products, and was a net importer of land intensive agricultural products, such as grains, cotton, and edible vegetable oils (Huang and Chen 1999). Second, the study shows that since 1985 the patterns of China's agricultural trade, particularly the patterns of agricultural exports, have been gradually moving more closely towards reflecting China's resource endowments.

In terms of the overall effects of trade liberalization on China's agriculture, the study reveals that, in general, China's agriculture would face great challenges and shocks from trade liberalization. There would be some structural changes in the agricultural economy, as more resources move away from land intensive agriculture, where China has a comparative

disadvantage in production, to land saving and labor intensive agriculture, where China has a comparative advantage in production. As a result, China's land intensive agricultural sector, especially the grain sector, might shrink and the labor-intensive agricultural sector, especially horticultural, animal husbandry and agricultural processing sectors, would expand more rapidly. Consequently, China would increase exports of labor intensive agricultural products such as horticultural products, animal products and processed agricultural products, and at the same time China would dramatically increase imports of land intensive agricultural products such as grains, vegetable oils, sugar, cotton and wool.

1.5 Current issues on institutions and policies

Although significant progress in liberalizing the trade sector has been made since the economic reforms, a number of issues and concerns remain. China's government still largely monopolizes international trade in agricultural products. State trading and non-tariff barriers are the major issues raised in China's accession to the WTO. On the other hand, unlike many neighboring countries where governments have protected agricultural prices and subsidized farmers, China consistently taxed farmers until the mid-1990s through the state agricultural procurement system by maintaining procurement prices below border price equivalents. Implicit taxes are still imposed on many commodities if the real effective exchange rate is applied - a situation exacerbated by the Asian financial crisis and the decision to not devaluate the domestic currency. However, if estimated at market prices, the nominal protection rates of most of China's agricultural commodities have ranged between 10% to 50% in recent years, indicating the potentially significant impact of trade liberalization on China's agriculture in the future.

2. Effects of Trade Liberalization on Production, Marketing and Demand of Selected Commodities

2.1 Trade patterns of selected agricultural commodities

The commodities selected for this study include four grains and three major livestock products, namely rice, wheat, maize, and soybean, which account for nearly 90% of the total grain production in China. Livestock products include pork, beef and poultry, which account for more than 90% of livestock output value in China.

Table 2.1 presents the exports, imports and trade balance of the selected agricultural commodities from 1981 to 1998. China has been a net exporter of rice in most years of the past four decades. Although China also imports some rice of certain varieties, the quantity has been very small, averaging less than 0.2 million metric tons (mt) annually in the 1980s and the early 1990s. The increase in rice imports in the mid-1990s was due to the hiking of the domestic rice price and fear of grain shortage that led to a grain export blockade in 1995 and 1996. Rice exports presented a general increasing trend over time, except for the late 1980s and early 1990s, and reached a historical high (1.52 million mt) in 1994.

China is one of the world's largest wheat importers. Annual imported wheat ranges from 5 to15 million mt, but exhibits a cyclical pattern of an increase for three or four years followed by a decrease for three or four years, a pattern closely linked not only with the domestic wheat production trend, but also with trade intervention policies.

China has been a net exporter of maize in most periods since the mid-1980s despite its domestic market prices being higher than the border prices (but government procurement prices of maize were lower than border prices in most years during the past two decades). China shifted from a maize net importer to net exporter in 1984 (Table 2.1). Since then, China gradually increased maize exports. The annual maize export reached a historical high of about 10 million mt in 1992-1994. The import surge in 1995 was mainly due to the fear of a grain deficit as the domestic grain price inflated significantly in 1995 and the implementation of the grain export blockade policy in 1995.

While China has been a net importer of soybean in most years of the past two decades with annual net exports of 0.5 to 1.3 million mt, soybean became one of the major imported grains in China after the mid-1990s. By 1998, China imported more than 3 million mt of soybean to meet the increasing domestic production and demand deficit.

Pork is one of the major exportable agricultural products in China. Its annual exports were relatively stable around 0.3 million mt annually in the past two decades. Poultry exports presented an increasing trend and has became a top livestock product since the mid-1990s. The annual export of poultry reached 0.3-0.4 million mt recently. Among the three selected livestock products, beef is the least traded product, a trade pattern consistent with China's livestock structure where beef accounts for less than 5% of the livestock economy.

Table 2.1 Exports and imports of selected agricultural commodities ('000 tons).

	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Rice																		
Export	446	470	580	1,160	1,010	950	1,020	700	320	330	690	950	1,430	1,520	50	270	940	3,750
Import	63	61	131	201	200	300	500	300	57	67	93	100	96	512	1,642	760	326	240
Balance	383	409	449	959	810	650	520	400	263	263	597	850	1,334	1,008	-1,592	-490	614	3,510
Wheat																		
Export	0	0	0	0	0	0	0	0	0	0	0	92	1	17	261	707	0.7	6
Import	13,004	13,797	11,110	100,000	5,410	6,110	13,200	14,550	14,880	12,530	12,370	10,580	6,457	7,211	11,638	8,312	1,861	1,490
Balance	-13,004	-13,797	-11,110	-100,000	-5,410	-6,110	-13,200	-14,550	-14,880	-12,530	-12,370	-10,488	-6,456	-7,194	-11,376	-7,604	-1,860	-1,484
Maize																		
Export	75	50	0	890	6,340	5,640	3,920	3,920	3,500	3,410	7,800	10,300	11,786	9,928	111	158	6,617	4,690
Import	676	1,569	2,110	55	91	588	1,542	109	68	369	1	0	0	1	5,182	441	0.4	250
Balance	-601	-1,519	-2,110	835	6,249	5,052	2,378	3,811	3,432	3,041	7,799	10,300	11,786	9,927	-5,071	-283	6,617	4,440
Soybean																		
Export	140	150	350	840	1,140	1,370	1,710	1,480	1,250	940	1,110	660	345	927	375	192	186	170
Import	568	362	0	0	1	291	273	152	1	1	1	121	99	52	294	1,108	2,876	3,193
Balance	-428	-212	350	840	1,139	1,079	1,437	1,328	1,249	939	1,109	539	247	876	81	-916	-2,690	-3,023
Pork																		
Export	166	306	302	301	316	321	312	285	306	345	329	267	265	306	342	314	103	100
Import	0	0	0	0	0	0	0	0	0	0	0	0	0.05	0.14	3	2	3	16
Balance	166	306	302	301	316	321	312	285	306	345	329	267	265	305	339	312	100	84
Beef																		
Export	8	12	16	15	32	26	34	54	57	97	132	20	20	23	25	25	31	40
Import	0	0	0	0	0	0	0	0	0	0	0	1	2	3	2	4	3	4
Balance	8	12	16	15	32	26	34	54	57	97	132	19	18	20	23	21	28	36
Poultry																		
Export	-	-	-	-	-	28	58	92	94	110	123	158	176	252	390	450	324	274
Import	-	-	-	-	-	0	0	24	49	68	130	174	240	344	625	750	210	194
Balance	-	-	-	-	-	28	58	68	45	42	-7	-16	-64	-92	-235	-300	114	80

Source: Various issues of China Customs Statistics.

2.2 Demand, supply, and trade simulation model

In order to evaluate the impacts of trade liberalization on China's agricultural sector, particularly on the selected agricultural commodities, a quantitative method was employed using an existing CCAP's Agricultural Policy Simulation and Projection Model (CAPSiM). CAPSiM was developed out of the need to have a framework for analyzing policies affecting agriculture in general, polices related to the macro-economy and trade, and policies directed to agricultural commodities in particular. CAPSiM is a partial equilibrium model. It is the first and most comprehensive model for China's food demand, supply and trade analysis. Most of the elasticities and parameters used in the CAPSiM are estimated econometrically with imposition of theoretical constraints. In the projection or policy simulation, prices can be determined endogenously or exogenously. CAPSiM explicitly accounts for urbanization and market development (demand side), technology, agricultural investment, environmental trends and competition for labor and land use (supply side), as well as the price responses of both demand and supply.

The main purpose of the CAPSiM is to project key agricultural variables in the short-term as well as in the long run in response to changes of exogenous shocks to the economy. It is also designed for analyzing the likely impacts of specific policies on key variables such as crop sown area, yield, production, prices, consumption, commodity demand and its components (food, feed and other use), stock, and export and import for each agricultural commodity.

Details of the model description can be found in Huang et al. (1997 and 1998), and Huang and Li (1999). A brief description of the model is provided below and some of the key parameters are attached as Appendix Tables to this report. Both demand and supply elasticities vary over time. The parameters and elasticities reported in Appendix Tables 1-6 are mainly those for the year 1996.

2.2.1 Model specification

CAPSiM includes production, demand, import and export, storage change, and market cleaning sub-models. The specifications of each sub-model are defined below.

2.2.1.1 Domestic production

Crop production

Area:

$$\log AA_{it} = a^{A}_{i0} + \Sigma_j b^{A}_{ij}(\log p^{S}_{jt})$$

$$Area_{it} = AA_{it} + Z^{A1}_{it} + Z^{A2}_{it} + Z^{A3}_{it}$$

Yield:

$$\log YY_{it} = a^{Y}_{i0} + \Sigma_j b^{Y}_{ij}(\log p^{S}_{jt}) + c_i \log R_t + k_i \log I_t + g_i \log Z^{Erosion}_{t} + h_i \log {}^{Salinity}_{t}$$

$$Yield_{it} = YY_{it} + Z^{Y1}_{it} + Z^{Y2}_{it}$$

Production:

$$Q_{it} = Area_{it} * Yield_{it}$$

Where:

AA = crop sown area supply responding to price changes;
Area = crop harvested area considering climate and other non-price shocks;
Q = total production;

Z^{A1} = area change due to exogenous shock of climate;
Z^{A2} = area change due to exogenous shock of non-price policy;
Z^{A3} = area change due to other exogenous shock;
P^S = prices of outputs and inputs for producer;
YY = crop yield without considering the impacts of climate shocks;
Yield = crop yield considering the impacts of climate shocks;
R = technology stock of agriculture;
I = irrigation stock;
$Z^{Erosion}$ = ratio of erosion area to total land area;
$Z^{Salinity}$ = ratio of salinity area to cultivate area;
Z^{Y1} = yield change due to exogenous shock of climate;
Z^{Y2} = yield change due to other exogenous shocks;
i = index crop, including: rice, wheat, maize, sweet potato, potato, other coarse grains, soybean, cotton, oil crop, sugar crop, vegetable, and other crops.
j = index crop output and input, including: rice, wheat, maize, sweet potato, potato, other coarse grains, soybean, cotton, oil crop, sugar crop, vegetable, and other crops, fertilizer, labor, and land.

a^A, b^A, a^Y, b^Y, c, k, g, and h are the area or yield supply response parameters used in the CAPSiM. An example of these parameters (elasticities) for the year of 1996 is summarized in Appendix Tables 1-2. Appendix Table 3 reports the supply response elasticities (c's) of agricultural research stock before 2005.

Animal Product Supply Responses

Production

$$\log qq_{it} = a^q_{i0} + \sum_j b^q_{ij}(\log p^S_{jt})$$

$$q_{it} = qq_{it} + Z^{q1}_{it} + Z^{q2}_{it}$$

Where:
qq = livestock domestic supply with response to price changes;
q = total livestock production;
Z^{q1} = livestock production change due to exogenous shock of disease;
Z^{Y2} = livestock production change due to other exogenous shocks;
i = index animal products: pork, beef, mutton, poultry, egg, milk, and fish;
j = index animal products and inputs: pork, beef, mutton, poultry, egg, milk, fish, maize and labor.

a^q and b^q are the animal product supply response parameters used in the CAPSiM. An example of these parameters (elasticities) for the year of 1996 is summarized in Appendix Table 4.

Production by mode

$$q_{ikt} = \theta_{ikt}\ q_{it}$$

$$\theta_{ikt} = \theta_{ik}(t-1) + \gamma_{ik}$$

$$\Sigma_k \theta_{ikt} = 1$$

Where:
θ = share of each production mode;
γ_{ik} = annual change in θ;

k = index production mode, including: backyard, specialized household, and commercial intensive production.

2.2.1.2 Domestic demand

Food demand

$$\log d^R_{it} = a^{RD}_{i0} + \Sigma_j b^R_{ij}(\log p^D_{jt}) + e^R_i \log Y^R_t + m_i \log Z^{MKT}_t$$

$$\log d^U_{it} = a^{UD}_{i0} + \Sigma_j b^U_{ij}(\log p^D_{jt}) + e^U_i \log Y^U_t$$

$$d_{it} = \theta^R_{td}{}^R_{it} + \theta^U_{td}{}^U_{it}$$

$$D^{Food}_{it} = d_{it} * Pop_t$$

Where:

d^R, d^U = per capita food demand in rural and urban areas, respectively;
d = per capita food demand in national level;
D^{Food} = national total food demand;
p^D = consumer price;
Y^R, Y^U = per capita income in rural and urban areas, respectively.
Z^{MKT} = food market development index;
b^R, b^U = price elasticity matrix of food demand in rural and urban areas, respectively.
e^R, e^U = income elasticities of food demand in rural and urban areas, respectively.
m = market development elasticity of food demand in rural area;
θ^R, θ^U = rural and urban shares in the total population;
Pop = total population;
i and j = index food, including: rice, wheat, maize, sweet potato, potato, other coarse grain, soybean, sugar, oil, fruit, vegetable, pork, beef, mutton, poultry, egg, milk, fish and other food.

Food demand elasticities in the rural and urban areas used in CAPSiM are provided in Appendix Tables 5-6.

Total feed demand

$$D^{Feed}_{jt} = \Sigma_k(1 + \delta_{jkt})\beta_{jk}\theta_{jkt}q_{jt}$$

$$\theta_{jkt} = \theta_{jk(t-1)} + \gamma_{jk}$$

$$D^{Feed}_t = \Sigma_j D^{Feed}_{jt}$$

$$D^{Feed}_{it} = \Sigma_i f_{it} D^{Feed}_t$$

$$f_{it} = (1 + r_f)^t f_{i(t-1)}$$

Where:

q = livestock production;
D^{feed} = total feed demand;
β = feed/meat ratio;
δ = efficiency of gain in feeding livestock;

f = grain i's share of total feed grain;
r_f = annual growth rate of f;
i = index individual grain and other feed, including: rice, wheat, maize, sweet potato, other coarse grain, and soybean;
j = index meat products, including: pork, beef, mutton, poultry, egg, milk, and fish;
k = index production mode, including: backyard, specialized household, and commercial intensive (company) production.

Other demand

$$D^{Seed}_{it} = (1 + \beta^{S}_{t})^{t}\, d^{Seed}_{i(t-1)} AA_{it}$$

$$D^{Ind}_{it} = (1 + \beta^{I}_{i})^{t}\, D^{ind}_{i(t-1)}$$

$$D^{Waste}_{it} = (1 + \beta^{W}_{i})^{t}\, d^{Waste}_{i(t-1)} Q_{it}$$

Where:
D^{seed} = total seed use;
D^{ind} = industrial use;
D^{waste} = post-harvest loss;
d^{Seed} = seed use (kg) per hectare;
d^{Waste} = waste (loss) as share of production;
β^{S} = annual growth rate of seed use per hectare;
β^{I} = annual growth rate of industrial use;
β^{W} = annual growth rate of post-harvest loss;
i = index individual commodities, including: rice, wheat, maize, sweet potato, potato, other coarse grain, soybean, cotton, oil crop, sugar crop, vegetable, and other crops.

Total crop product demand

$$D_{it} = D^{Food}_{it} + D^{Feed}_{it} + D^{Seed}_{it} + D^{Ind}_{it} + D^{Waste}_{it}$$

Where:
D = total demand;
i = index individual grains, including: rice, wheat, maize, sweet potato, potato, other coarse grain, soybean, cotton, rapeseed, sugar crop. and other crops.

2.2.1.3 Stock

$$B_{it} / D_{it} = B_{i(t-1)} / D_{i(t-1)} + l p^{D}_{it}$$

Where:
B = stock;
l = marginal change in grain stock due to grain price change.

2.2.1.4 Trade

$$\log X^{import}_{it} = \alpha^{import}_{i} + \alpha_{1i}(p^{rural}_{it} / p^{import}_{it})$$

$$\log X^{import}_{it} = \alpha^{export}_{i} + \alpha_{1i}(p^{rural}_{it} / p^{export}_{it})$$

$$X^{netimport}_{it} = X^{import}_{it} - X^{export}_{it}$$

$$p^{import}_{it} = p^{ib}_{it}(1 + PSE^{import}_{it})$$

$$p^{export}_{it} = p^{xb}_{it}(1 + PSE^{export}_{it})$$

$$p^{ib}_{it} = XR_t p^{cif}_{it}$$

$$p^{xb}_{it} = XR_t p^{fob}_{it}$$

$$PSE^{import}_{it} = (p^{rural}_{it} - p^{ib}_{it}) / p^{ib}_{it}$$

$$PSE^{export}_{it} = (p^{rural}_{it} - p^{xb}_{it}) / p^{xb}_{it}$$

Where:
X^{import} = import;
X^{export} = export;
$X^{netimport}$ = net import;
XR = exchange rate;
p^{rural} = rural consumer price;
PSE = producer subsidy equivalence;
p^{ib} and p^{xb} = import and export prices converted by the official exchange rate;
p^{cif} and p^{fob} = the border prices for importable and exportable products;
i = index individual commodities, including: rice, wheat, maize, sweet potato, potato, other coarse grain, soybean, cotton, oil crop, sugar crop, vegetable, fruit, pork, beef, mutton, poultry, egg, and fish.

2.2.1.5 Market clearing

$$X^{netimport}_{it} + S_{it} = D_{it} + B_{it} - B_{i(t-1)}$$

Where:
S = total domestic production, $S = Q^S$ for crop, S = q for animal products;
D = total domestic demand;
Bt – Bt-1 = stock changes;
i = index individual commodities, including: rice, wheat, maize, sweet potato, potato, other coarse grain, soybean, cotton, oil crop, sugar crop, vegetable, fruit, pork, beef, mutton, poultry, egg, and fish.

2.2.1.6 Model simulation

Prices can be either endogenously or exogenously determined in the CAPSiM. Supply equations, which include area and yield for various crops and total production for seven animal products, allow producers' response to own and cross price changes, shifts in agricultural

technology, changes in irrigation stock, environmental stress (e.g., erosion and salinity areas), and other exogenous shocks such as climate, disease and non price policies, etc.

Demand equations, which are projected separately by urban and rural regions, allow consumers' responses to own and cross price changes, shifts in income and market development as well as other demand shocks.

The total change in supply for each different commodity between periods is projected by the first order derivative of equation (1a) for crops and equation (1b) for animal products. It can be stated in terms of its components as follows:

$$(1)\ \frac{\Delta S_{it}}{S_{it\text{-}1}} = \eta_{si}\frac{\Delta P_{it}}{P_{it\text{-}1}} + \sum_{j\neq i}\eta_{sj}\frac{\Delta P_{jt}}{P_{jt-1}} + \delta c_i\frac{\Delta R_t}{R_{t-1}} + \delta k_i\frac{\Delta I_t}{I_{t-1}} + \delta g_i\frac{\Delta Z_t^{Erosion}}{Z_{t-1}^{Erosion}} + \delta h_i\frac{\Delta Z_t^{Salinity}}{Z_{t-1}^{Salinity}}$$

Where:

S = total domestic production, S = QS for crop, S = q for animal products;

ηsi = own price elasticity of domestic of ith commodity (derived from area and yield elasticities for crops);

ηsj = cross price elasticity of domestic of ith commodity (derived from area and yield elasticities for crops);

δ = 1 for crops and 0 for animal products;

In a similar way, total change in demand for different commodities between periods is derived by the first order derivative of equation (2a):

$$(2)\ \frac{\Delta D_{it}}{D_{it\text{-}1}} = \xi_{di}\frac{\Delta P_{it}}{P_{it\text{-}1}} + \sum_{j\neq i}\xi_{dj}\frac{\Delta P_{jt}}{P_{jt\text{-}1}} + e_i\frac{\Delta Y_t}{Y_{t\text{-}1}} + \delta m_i\frac{\Delta z_t^{mkt}}{z_{t-1}^{mkt}}$$

Where:

D_{it} = domestic demand curve for i^{th} commodity;

ξ_{di} = own price elasticity of demand for i^{th} commodity (weighted rural and urban elasticities);

ξ_{dj} = cross price elasticity of demand for i^{th} commodity (weighted rural and urban elasticities);

δ = 1 for rural, 0 for urban.

Figure 2.1 Price determination in a subsequent period.

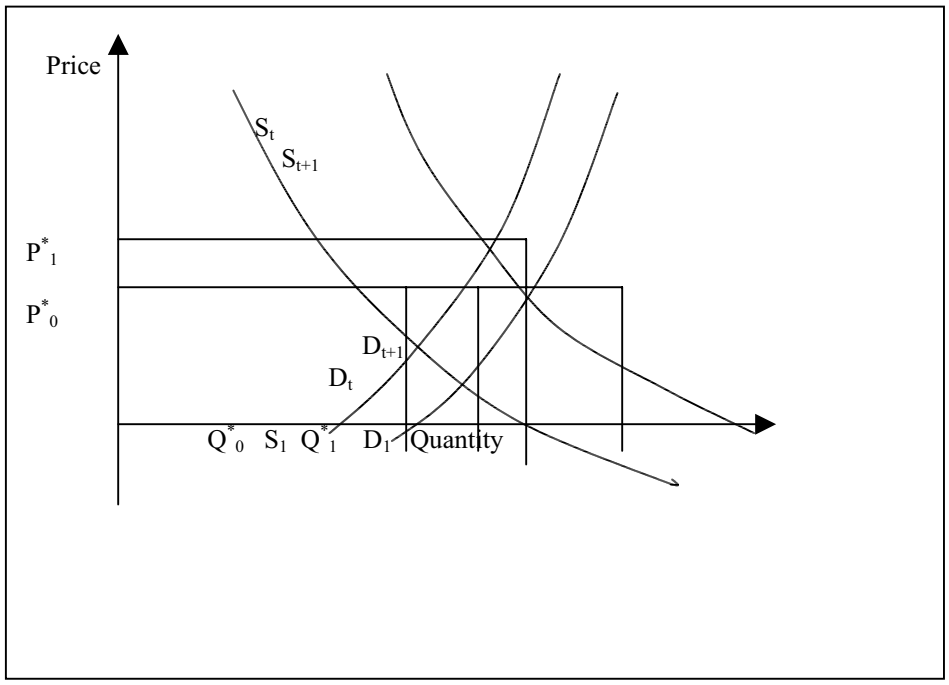

Figure 1 graphically illustrates price determination in the period *t+1*. Finding the equilibrium values, P_1* and Q_1*, requires knowing S_1 and D_1. Recall from (1a, 1b, 2a) above that for the ith commodity, when $\Delta P_{it} = 0$, the following is evident:

$$(3)\ \frac{\Delta S_t |_{\Delta P_{it}=0}}{Q^*_{t-1}} = \sum_{j \neq i} \eta_{sj} \frac{\Delta P_{jt}}{P^*_{jt1}} + \delta c_i \frac{\Delta R_t}{R_{t-1}} + \delta k_i \frac{\Delta I_t}{I_{t-1}} + \delta g_i \frac{\Delta Z_t^{Erosion}}{Z_{t-1}^{Erosion}} + \delta h_i \frac{\Delta Z_t^{Salinity}}{Z_{t-1}^{Salinity}}$$

$$(4)\ \frac{\Delta D_t |_{\Delta P_{it}=0}}{Q^*_{t-1}} = \sum_{j \neq i} \xi_{dj} \frac{\Delta P_{jt}}{p^*_{jt-1}} + e_i \frac{\Delta Y_t}{Y_{t-1}} + \delta m_i \frac{\Delta Z_t^{mkt}}{Z_{t-1}^{mkt}}$$

With (3) and (4), Figure 1 shows that S_1 and D_1 can be estimated as follows:

$$(5) S_1 = Q^*_0 [1 + \sum_{j \neq i} \eta_{sj} \frac{\Delta P_{j1}}{P^*_{j0}} + \delta c_i \frac{\Delta R_1}{R_0} + \delta k_i \frac{\Delta I_1}{I_0} + \delta g_i \frac{\Delta Z_1^{Erosion}}{Z_0^{Erosion}} + \delta h_i \frac{\Delta Z_1^{Salinity}}{Z_0^{Salinity}}]$$

$$(6) D_1 = \sum_{j \neq i} \xi_{dj} \frac{\Delta P_{j1}}{P^*_{j0}} + e_i \frac{\Delta Y_1}{Y_0} + \delta m_i \frac{\Delta z_1^{mkt}}{z_0^{mkt}}$$

Note that (5) and (6) simply add Q_o^* and the changes in demand or supply attributed to shifters, i.e. variables other than own price which is held constant at P_o^*. Once S_1 and D_1 are known, the equilibrium values are solved in an exactly identical process as before using the analogous equations:

$$(7) \quad \Delta P_1 = \frac{P_o^*(D_1 - S_1)}{(S_1 \eta_s - D_1 \xi_d)} \quad such\ that \quad P_1^* = P_o^* + \Delta P_1$$

$$(8) \quad Q_1^* = D_1[1 + \xi_d \frac{\Delta P_1}{P_o^*}] = S_1[1 + \eta_s \frac{\Delta P_1}{P_o^*}]$$

From here on, the cycle of calculations repeats in a recursive, dynamic fashion for the entire simulation period.

2.3 Welfare analysis

2.3.1 Producer welfare

Assume the market equilibrium prices of ith commodity in time t and t+1 are p^s_{it} to $p^s_{i(t+1)}$, respectively. The changes from p^s_{it} to $p^s_{i(t+1)}$ could result from any shift of the demand and/or supply curves or other exogenous shocks. Let W^p_t and $Wp_{(t-1)}$ be the producer welfare in the time periods t and t+1, respectively. Based on the models described in the section 2.2, the producer welfare in time t could be estimated as:

$$W^P_t = \int_0^{p^S_{it}} Q_{it} dp_i^S = \int_0^{p^S_{it}} A_{it} * Y_{it} dp_i^S$$

$$= \int_0^{p^S_{it}} (AA_{it} + Z_{it}^{A1} + Z_{it}^{A2} + A_{it}^{A3})(YY_{it} + Z_{it}^{Y1} + Z_{it}^{Y2}) dp_i^S$$

$$= \int_0^{p^S_{it}} (e^{a_{i0}^A} \prod_j p_{jt}^{S\, b_{ij}^A} + Z_{it}^{A1} + Z_{it}^{A2} + Z_{it}^{A3})$$

$$* (e^{a_{i0}^Y} \prod_j p_{jt}^{S\, b_{ij}^Y} * R_t^{c_i} * I_t^{k_i} * Z_t^{Erosion\, g_i} * Z_t^{Salinity\, h_i} + Z_{it}^{Y1} + Z_{it}^{Y2}) dp_i^S$$

$$= \int_0^{p^S_{it}} e^{(a_{i0}^A + a_{i0}^Y)} \prod_j p_{jt}^{S\, (b_{ij}^A + b_{ij}^Y)} * R_t^{c_i} * I_t^{k_i} * Z_t^{Erosion\, g_i} * Z_t^{Salinity\, h_i} dp_i^S$$

$$+\int_0^{p_{it}^S} e^{a_{i0}^A}\prod_j p_{jt}^{S\,b_{ij}^A} * (Z_{it}^{Y1}+Z_{it}^{Y2})dp_i^S$$

$$+\int_0^{p_{it}^S}(Z_{it}^{A1}+Z_{it}^{A2}+Z_{it}^{A3}) * e^{a_{i0}^Y}\prod_j p_{jt}^{S\,b_{ij}^Y} * R_t^{c_i} * I_t^{k_i} * Z_t^{Erosion\,g_i} * Z_t^{Salinity\,h_i} dp_i^S$$

$$+\int_0^{p_{it}^S}(Z_{it}^{A1}+Z_{it}^{A2}+Z_{it}^{A3})(Z_{it}^{Y1}+Z_{it}^{Y2})dp_i^S$$

$$=\frac{1}{b_{ii}^A+b_{ii}^Y+1} * AA_{it} * YY_{it} * p_{it}^S + \frac{1}{b_{ii}^A+1} * AA_{it} * (Z_{it}^{Y1}+Z_{it}^{Y2}) * p_{it}^S$$

$$+\frac{1}{b_{ii}^Y+1} * (Z_{it}^{A1}+Z_{it}^{A2}+Z_{it}^{A3}) * YY_{it} * p_{it}^S + (Z_{it}^{A1}+Z_{it}^{A2}+Z_{it}^{A3})(Z_{it}^{Y1}+Z_{it}^{Y2})p_{it}^S$$

And the producer welfare in the following period, time t+1, is:

$$W^P{}_{t+1} = \int_0^{p_{i(t+1)}^S} Q_{i(t+1)}dp_i^S = \int_0^{p_{i(t+1)}^S} A_{i(t+1)} * Y_{i(t+1)}dp_i^S$$

$$=\int_0^{p_{i(t+1)}^S}(AA_{i(t+1)}+Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+A_{i(t+1)}^{A3})(YY_{i(t+1)}+Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2})dp_i^S$$

$$=\int_0^{p_{i(t+1)}^S}(e^{a_{i0}^A}\prod_j p_{j(t+1)}^{S\;\;b_{ij}^A}+Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+Z_{i(t+1)}^{A3})$$

$$*(e^{a_{i0}^Y}\prod_j p_{j(t+1)}^{S\;\;b_{ij}^Y} * R_{t+1}^{c_i} * I_{t+1}^{k_i} * Z_{t+1}^{Erosion\,g_i} * Z_{t+1}^{Salinity\,h_i}+Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2})dp_i^S$$

$$=\int_0^{p_{i(t+1)}^S} e^{(a_{i0}^A+a_{i0}^Y)}\prod_j p_{j(t+1)}^{S\;\;(b_{ij}^A+b_{ij}^Y)} * R_{t+1}^{c_i} * I_{t+1}^{k_i} * Z_{t+1}^{Erosion\,g_i} * Z_{t+1}^{Salinity\,h_i} dp_i^S$$

$$+\int_0^{p_{i(t+1)}^S} e^{a_{i0}^A}\prod_j p_{j(t+1)}^{S\;\;b_{ij}^A} * (Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2})dp_i^S$$

$$+\int_0^{p_{i(t+1)}^S}(Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+Z_{i(t+1)}^{A3}) * e^{a_{i0}^Y}\prod_j p_{j(t+1)}^{S\;\;b_{ij}^Y} * R_{t+1}^{c_i} * I_{t+1}^{k_i} * Z_{t+1}^{Erosion\,g_i} * Z_{t+1}^{Salinity\,h_i} dp_i^S$$

$$+\int_0^{p_{i(t+1)}^S}(Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+Z_{i(t+1)}^{A3})(Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2})dp_i^S$$

$$=\frac{1}{b_{ii}^A+b_{ii}^Y+1} * AA_{i(t+1)} * YY_{i(t+1)} * p_{i(t+1)}^S$$

$$+\frac{1}{b_{ii}^A+1} * AA_{i(t+1)} * (Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2}) * p_{i(t+1)}^S$$

$$+\frac{1}{b_{ii}^{Y}+1}*(Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+Z_{i(t+1)}^{A3})*YY_{i(t+)}*p_{i(t+1)}^{S}$$
$$+(Z_{i(t+1)}^{A1}+Z_{i(t+1)}^{A2}+Z_{i(t+1)}^{A3})(Z_{i(t+1)}^{Y1}+Z_{i(t+1)}^{Y2})p_{i(t+1)}^{S}$$

Therefore, the change in producer welfare between the time periods t an t+1 is the difference between W^P_t and $W^P_{(t-1)}$.

2.3.2 Consumer welfare

Taking account of the fact that there is no intersection between the demand curve and the price axis but these two lines get closer as the price goes up, we can approximately estimate the consumer welfare in time t as the area under the demand curve and between the prices of p^D_{it} and np^D_{it}, given a sufficiently large value of n. Then the consumer welfare in time t, W^C_t can be estimated as:

$$W^C_t = \int_{p_{it}^D}^{np_{it}^D} D_{it}\,dp_i^D$$
$$= pop_t\theta_t^R d_{it}^R \frac{(np_{it}^D)^{b_{ii}^R+1}-p_{it}^{D\,b_{ii}^R+1}}{p_{it}^{D\,b_{ii}^R}(b_{ii}^R+1)}$$
$$+pop_t\theta_t^U d_{it}^U \frac{(np_{it}^D)^{b_{ii}^U+1}-p_{it}^{D\,b_{ii}^U+1}}{p_{it}^{D\,b_{ii}^U}(b_{ii}^U+1)}$$
$$+Otherdemand_{it}\frac{(np_{it}^D)^{b_{ii}^O+1}-p_{it}^{D\,b_{ii}^O+1}}{p_{it}^{D\,b_{ii}^O}(b_{ii}^O+1)}$$

Similarly, the consumer welfare in time t+1 is:

$$W^C_{t+1} = \int_{p_{i(t+1)}^D}^{np_{it}^D} D_{i(t+1)}\,dp_i^D$$
$$= pop_{t+1}\theta_{t+1}^R d_{i(t+1)}^R \frac{(np_{it}^D)^{b_{ii}^R+1}-p_{i(t+1)}^{D\;b_{ii}^R+1}}{p_{i(t+1)}^{D\;b_{ii}^R}(b_{ii}^R+1)}$$
$$+pop_{t+1}\theta_{t+1}^U d_{i(t+1)}^U \frac{(np_{it}^D)^{b_{ii}^U+1}-p_{i(t+1)}^{D\;b_{ii}^U+1}}{p_{i(t+1)}^{D\;b_{ii}^U}(b_{ii}^U+1)}$$
$$+Otherdemand_{it}\frac{(np_{it)}^D)^{b_{ii}^O+1}-p_{i(t+1)}^{D\;b_{ii}^O+1}}{p_{i(t+1)}^{D\;b_{ii}^O}(b_{ii}^O+1)}$$

Therefore, the change in consumer welfare in the time periods t and t+1 is the difference between W^P_t and $W^P_{(t-1)}$.

2.4 Agricultural production, marketing and trade-related policies

2.4.1 Production growth

The trends of agricultural production growth

Agricultural production growth is one of the main accomplishments of China's development and national food security policies. Production growth rates have outpaced population growth since the early 1950s, with the exception of the famine years of the late 1950s and early 1960s. Even between 1970 and 1978, when much of the economy was reeling from the effects of the Cultural Revolution, grain production grew at 2.8% annually (Table 2.2), oil crop production grew 2.1% annually and fruit and meat output increased by 3-7%.

Table 2.2 Growth rate (%) of agricultural economy by sector and selected agricultural commodity, 1970-97.

Commodity	Pre-reform	Reform Period		
	1970-78	1979-84	1985-95	1996-97
Agricultural output value	2.3	7.5	5.6	7.4
Crops	2.0	7.1	3.8	6.2
Forestry	6.2	8.8	3.9	4.5
Livestock	3.3	9.0	9.1	7.9
Fishery	5.0	7.9	13.7	12.7
Grain production	2.8	4.7	1.7	2.9
Rice	2.5	4.5	0.6	4.1
Wheat	7.0	7.9	1.9	9.8
Maize	7.0	3.7	4.7	-3.5
Soybean	-1.9	5.1	2.9	2.4
Cash crops				
Oil crops	2.1	14.9	4.4	-2.1
Cotton	-0.4	7.2	-0.3	-1.7
Fruits	6.6	7.2	12.7	9.9
Red meats	4.4	9.1	8.8	11.2
Pork	4.2	9.2	7.9	10.2
Beef	0.0	10.8	9.2	11.8
Poultry	n.a.	7.9	18.1	10.2

Source: SSB, Statistical Yearbook of China, various issues; A Statistical Survey of China, 1996. MOA, Agricultural Yearbook of China, various issues.

Note: Growth rates are computed using regression methods. Growth rates of individual and groups of commodities are based on production data; sectoral growth rates refer to value added in real terms.

Decollectivization, price increases, and relaxation of trade restrictions on most agricultural products fueled China's food economy takeoff (1978-84). Grain production increased 4.7% annually, in which rice production increased 4.5%, wheat production increased 7.9%, maize production increased 3.7% and soybean production increased 5.1%. Oil crops, livestock, and aquatic production grew spectacularly, expanding annually in real value terms by 14.9%, 9.0%, and 8.8%, respectively (Table 2.2).

As the one-time efficiency gains of the shift to the household responsibility system were exhausted by the mid-1980s, agricultural production decelerated (Table 2.2). The decline was most pronounced for grains and oil crops, sectors in which prices and markets were still highly regulated. Growth rates of other crops, livestock and poultry, and fishery products have remained steady or increased during the reform period in response to rising demand and market and price liberalization (Table 2.2).

Past studies demonstrate that a number of factors contributed simultaneously to agricultural growth during the reform period. The earliest empirical efforts focused on the contributions of the household responsibility system (McMillan et al. 1989; Fan 1991; Lin 1992). These studies conclude that most increased productivity was a result of institutional innovations, particularly the rural household responsibility system that restored the primacy of

the individual household in place of the collective production team system as the basic unit of production and management in rural China.

Recent studies show that technological change has become the primary engine of agricultural growth, since the completion of the household responsibility system reforms in 1984 (Huang and Rozelle 1996; and Huang et al. 1997). Results also indicate that reforms beyond decollectivization have high potential to affect agricultural growth. Price policy has had a sharp influence on the growth of both grain and cash crops during the post-reform period. Favorable output to input price ratios contributed to rapid growth in the early 1980s. However, the new market force is a two-edged sword. Price ratio deterioration, caused by gradually increasing output prices and rapidly rising input prices, was one cause of the agricultural production slowdown of the late 1980s and early 1990s. Rising wages and land use opportunity costs constrained the growth of grain output throughout that period and the growth of cash crops since 1985.

Growing environmental degradation, including erosion, salinization, and the loss of cultivated land may reduce the agricultural land base. Both erosion and salinization have increased since the 1970s, to the detriment of grain, rice, and other agricultural production output (Huang and Rozelle 1995; Huang et al. 1998).

Structure of agricultural and rural economy

With the growth patterns presented above, the structure of the agricultural economy changed substantially in the early reform period (Table 2.3). Cropping was the dominant sub-sector within agriculture, contributing 80% of the gross value of agricultural output in 1978, but falling to 56% in 1997. The share of livestock increased from 15% in 1978 to more than 30% in 1997. The share contributed by aquatic output in 1997 was four-fold greater than that in 1978.

Table 2.4 shows that diversification has occurred within the crop sector. While grain still dominates the crop sector, its share in total crop sown area has declined from 80% in 1978 to 73% in 1997. The area shares of those products with higher income elasticity increased considerably over time. For example, the area share of oil crops, vegetables and fruits in the total area increased from only 7% in 1978 to 21% in 1997.

Table 2.3 Changing structure of the agricultural economy in China, 1978-96.

	1978	1980	1985	1990	1995	1996	1997
Share in agricultural value	100	100	100	100	100	100	100
Crops	80	76	69	65	58	58	56
Forestry	3	4	5	4	4	3	3
Livestock	15	18	22	26	30	30	31
Fishery	2	2	4	5	8	9	9

Source: SSB, Statistical Yearbooks of China, various issues; Rural Statistical Yearbook of China, various issues.

Table 2.4 Agricultural land use patterns in China, 1978-97.

Year	Cultivated Land (million ha)	Multi-crop Index (%)	Crop Sown Area Share (%)				
			Grain	Oil Crops	Vegetable	Fruit	Others
1978	993.9	151	80	4	2	1	12
1980	993.1	147	80	5	2	1	11
1985	968.5	148	76	8	3	2	11
1990	956.7	155	77	7	4	3	8
1995	949.7	158	73	9	6	5	6
1997	954.7	161	73	8	7	6	6

Source: SSB.
Note: Shares may not add up to 100% due to rounding.

2.4.2 Agricultural development strategy and policies

Food self-sufficiency has been and will continue to be the central goal of China's agricultural policy. The Ninth Five-year Plan for 1996-2000 and the National Long Term Economic Plan to 2010 both call for continued agricultural production growth, annual farmer income growth of 4%, near maintenance of food self-sufficiency, and the elimination of absolute poverty. Strategies to achieve the above targets and goals include deepening rural economic and institutional reforms, improving incentives for farmers and local governments to invest in agriculture (particularly land), increasing the rate of regeneration of renewable resources, regulating the exploitation of non-renewable resources, providing input and output price incentives to increase the multiple cropping index, extending applications of scientific methods to the agricultural sector, adjusting rural economic structures, optimizing agricultural production linkages, strengthening anti-poverty programs, further opening the agricultural sector to foreign investment, and improving the efficiency of agriculture's foreign capital use.

Public investment policies

The overriding concern of the industrially-biased development strategy was the accumulation of capital for industrialization. China looked to agriculture, the source of nearly 60% of national income and more than 80% of employment in the early 1950s, to provide the needed capital.

Table 2.5 indicates that while government expenditure and investment had shown a general increasing trend in the pre-reform period, their shares to the total economy have shown a declining trend even since the early 1960s. Because the share of agricultural production (such as value added) in the economy has also been declining over time, we constructed an index of government investment bias to evaluate public investment policy. This was done by roughly dividing the ratio of government investment (expenditure) in agriculture to total government investment (expenditure) by the ratio of agricultural GDP to total GDP. As Table 2.5 shows, the bias index of government expenditure in agriculture is much below the 100% level, indicating strong government expenditure biases against agriculture. While reform has accelerated the growth of agriculture since the late 1970s, Table 2.5 also indicates that the new institutional arrangement has not provided incentives for investment in agriculture.

Declining public agricultural expenditures attracted attention to agricultural production sustainability and future domestic food supply problems. Investment policy reviews led to increased investment in the early 1990s (Table 2.5). Both the Ninth Five-Year Plan (1996-2000) and China's Long Term Plan to 2010 advocate increasing public agricultural investment, including investments in rural infrastructure and loans and credits for agricultural production. Irrigation and water control are the top priorities of future government investment.

Fiscal and financial policies

To have a better understanding of government policy bias among sectors, we need to look at both fiscal and financial policies as well as at the state agricultural product procurement policy (implicit tax). Table 2.6 shows that government fiscal expenditure on agriculture has been consistently higher than fiscal revenue from agricultural tax and other fees collected from agriculture. However, this fiscal revenue from agriculture based on explicit tax and fees is only a small portion of the total agricultural capital contribution to the industrial and urban sectors. It is also interesting to note that rural development in the TVE sector has contributed significant fiscal income for the government and has led to a net capital outflow from the rural to the urban sector since 1985.

Table 2.5 Government investment (billion yuan in 1985 prices) in agriculture, 1965-96.

Year	Fiscal Expenditure			Index of Government Expenditure Bias	Water Control Investment
	Total	Agriculture	Agricultural Share (%)		
1965	60.3	7.1	12	26	1.3
1970	85.9	6.5	8	19	2.3
1975	108.3	13.1	12	32	3.4
1978	143.7	19.3	13	48	4.5
1980	145.6	17.8	12	41	3.2
1985	200.4	15.4	8	27	2.0
1990	190.2	19.0	10	37	3.0
1992	212.9	21.4	10	46	5.5
1994	239.2	22.0	9	46	6.9
1995	245.5	20.4	8	41	6.5
1996	269.2	22.3	8	41	6.9

Source: SSB, Statistical Yearbooks of China, various issues.

Note: Values are in real 1985 prices. Government investment (expenditure) bias is estimated using an approximation by roughly dividing the ratio of government expenditure in agriculture to total government expenditure by the ratio of net income of agriculture to total national income. Index values of less than 100% represent an investment policy that has an anti-agriculture bias.

Table 2.6 Capital flow (billion yuan in 1985 prices) from agriculture/rural sectors to industry/urban sectors through fiscal, financial and grain procurement systems.

Year	Fiscal System		Financial System		Grain Marketing (implicit tax)	Cash Flow from	
	Agri to Industry	Rural to Urban	Agri to Industry	Rural to Urban		Agri to Industry	Rural to Urban
1978	-15.2	-12.4			17.9	2.6	5.4
1980	-13.8	-10.8	5.0	1.6	16.6	7.7	7.3
1985	-6.6	4.2	8.3	2.5	5.6	7.3	12.4
1990	-11.2	5.8	19.5	11.9	15.5	23.8	33.2
1995	-7.4	44.4	18.3	10.0	18.1	29.0	72.4
1996	-6.5	42.2	15.7	9.8	11.8	21.0	63.8

Source: Huang et al. 1998.

A significant capital outflow from agriculture to industry occurred in the last two decades through the financial system, particularly through Rural Credit Cooperatives (Huang and Ma 1998). A much higher value of capital outflow from rural to urban sectors than from agriculture to industry clearly shows that capital accumulated from agriculture not only supports industrialization in the urban sector but also provides notable financial resource for the successful development of rural industry.

After accounting for agricultural explicit tax through the government procurement system, China accumulated a total amount of about 313 billion yuan (at 1985 prices) from the agricultural sector for national industrialization in 1978-96, and about 563 billion yuan from the rural sector for the urban economy in the same period (Table 2.6). Moreover, the shifting capital from agriculture to industry and from the rural to the urban sector has shown an increasing trend since the reforms initiated in the late 1970s. While the structural change in the economy induced by the relative comparative advantage of the sectors accounted for a large portion of this capital reallocation, government pro-industrial policy stimulated the course of capital movement between agricultural and non-agricultural sectors and between rural and urban areas.

Food price and marketing policies

Price and market reforms are key components of China's development policy 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 prices and gradually liberalizing the market. These reforms included increases in quota and above quota prices, reduction in quota levels,

introduction of above quota bonuses for cotton, tobacco, and other cash crops, negotiated procurement of surplus production of grains, oils, and most other commodities, and flexibility in marketing of surplus production of all categories of agricultural products privately. Nonetheless, the limited and differential rate of liberalization of agricultural markets has had substantial impact on productivity and commodity composition at the household and national levels (Huang et al. 1997). The shift from the collective and household responsibility system also raised the price responsiveness of farm households. 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.

After a record growth in agricultural 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. Farmers and state commercial departments were to "negotiate" purchase contracts before the planting season at the weighed average quota and above quota prices. Other than for grains and cotton, the intention was to gradually eliminate planned procurement of agricultural products; government commercial departments may only continue to buy and sell at the market. The contract system, however, also resulted in a negative impact on agricultural production as the marginal price of the producer declined.

Because of the sharp drop in agricultural production and severe food price inflation after 1985, however, implementation of the new policy stalled. Mandatory procurement of grains, oil crops, and cotton continued at the "contract price" which basically was a weighted average of the former quota and above quota prices. To provide greater incentive for farmers to raise productivity and sell to the government, contract prices were raised over time. However, the increase in the nominal agricultural procurement price was lower than the inflation rate, which led to a decline in the real agricultural product price.

As agricultural production and prices stabilized in 1990-1992, another attempt was made to basically abolish the compulsory quota system and the sale at ration prices to consumers in early 1993. While both the state distribution and procurement systems were successfully liberalized, the state compulsory quota system was again re-imposed in most parts of China in 1994 and all over China since 1995. This reversed policy was a result of higher food price inflation and fear of the shortage of food supply. Several new policies were implemented since late 1994. Government grain procurement once again became compulsory. A provincial governor's "Rice Bag" responsibility system was introduced. The system is designed to strengthen food security and grain markets by making provincial governors and governments responsible for balancing grain supply and demand and stabilizing local food markets and prices. This policy has already contributed to increased output, more stable grain production and a significant reduction in short-run agricultural price fluctuations. However, such a policy is not without costs. Although its impact on national grain market integration is minimal and far lower than expected (Rozelle et al. 1996; Yu and Huang 1998), the policy's impact on the efficiency of resource allocation, diversification of agricultural production, and farmer's incomes should not be ignored.

With three record levels of grain production in China in 1995-1997, almost zero or negative inflation since 1997, increasing grain stocks, and decline in food prices recently, China initiated a new grain marketing and reserve policy in April 1998, a policy that has been highly debated by economists both inside and outside China. Individuals and private companies are prohibited from procuring grain from farmers. Commercial arms of grain bureaus and the grain reserve system are the only ones who will procure grain from farmers. Grain sale prices by grain bureaus should be set at a level higher than procurement prices in order to avoid loss in marketing by grain bureaus.

To measure the impact of government policy on agricultural prices, the domestic price is compared with the price in the absence of government intervention or under free trade. The impact of commodity-specific price interventions such as the domestic procurement and distribution system, tariffs, export taxes, and quantitative trade restriction on domestic prices was estimated by the nominal protection rate (NPR), the percentage difference between domestic and border prices converted at the official exchange rate. To measure the total effect of government interventions, including the effect of exchange rate distortions, the net NPR or effective real protection rate (ERPR) was estimated, i.e., the percentage difference between domestic and border prices converted at the equilibrium exchange rate.

In order to investigate different price and marketing policies on agricultural incentives, nominal price protection rates were estimated at various policy (price) levels. In Table 2.7, we show the estimates of nominal protection rates based on various producers' prices from 1985 to 1998 for selected agricultural commodities, namely rice, wheat, maize, and soybean. In Table 2.8, we show the estimated ERPRs for the same commodities based on the real effective exchange rate. The two different estimates of protection rates represent upper and lower bounds of the degree of protection or "disprotection" (taxed) due to commodity-specific and exchange rate policies.

Several observations may be made from Tables 2.7 and 2.8. The quota prices consistently represented a disprotection to farmers. The estimated rate of disprotection, as expected, is more severe when the real effective exchange rate is used.

The introduction of negotiated procurement significantly reduced the disprotection from government procurement operations (see NPRs on negotiated procurement prices). Note, however, that the protection rates based on the real effective exchange rate remain negative for all grains.

Not surprisingly, the most heavily taxed commodities are the exportable products (i.e., rice). Wheat, an importable commodity, is more favored. Among grains, the most heavily taxed is rice which has the lowest NPR based on both the procurement and market prices. Aside from the lower quota price NPR for rice, the proportion of grain procurement at the higher negotiated price is typically higher for maize and soybeans.

It is interesting to note that the proportional difference between market and procurement prices is much greater for maize and soybeans compared to rice. Evidently, export controls are more restrictive on rice, the main food staple (Tables 2.7 and 2.8).

In summary, despite substantial efforts to liberalize the price and market structure of the agricultural sector, most grains continue to be heavily penalized by commodity specific policies. When the impact of overvaluation of the domestic currency due to the trade protection system is considered, the agricultural incentives are be even more undervalued. These distortions in price incentives depress agricultural production and redistribute income from farmers to urban consumers and the agro-processing sector.

Input price and marketing policies

China has liberalized most agricultural input prices and markets except for the seeds of hybrid rice and maize. China depends heavily on the international market for fertilizer, importing about one-fourth of the amount it requires. Domestic potassium production is extremely limited; about 90-98 percent of the potassium used in China is imported. Trade policy has a substantial impact on the domestic fertilizer price and market.

Estimates of the nominal protection rate (NPR) show that the government's pre-1985 policy promoting domestic production of agricultural inputs forced farmers to buy domestically produced inputs at prices higher than the world market level, as much as double (100%) in the early 1970s (Huang and David 1995). The difference has generally declined over time because depreciation of the yuan raised import prices to levels approaching domestically produced input prices. Farmers did not receive a significant price subsidy, close to 30%, until the early 1990s.

When the government lifted retail level price controls in 1993, the fertilizer NPR climbed over 20%. The input price policy does not compensate for artificially low procurement prices that apply to many food commodities. The World Bank estimates that average nominal protection for agricultural crops was –40% in 1993-94. When implicit tariffs on agricultural inputs are considered, the effective rate of protection falls even lower to –43%. The evidence suggests that input price policies exacerbated the policy bias against agriculture.

Technology development policies

After the 1960s, China's research institutions grew rapidly from almost none in the 1950s, producing a steady flow of new varieties and other technologies. Chinese farmers used semi-dwarf varieties several years before the release of Green Revolution technology elsewhere. China was the first country to develop and extend the use of hybrid rice. Chinese-bred maize, wheat, and sweet potatoes were comparable to the best in the world in the pre-reform era (Stone 1988).

However, fiscal constraints have limited China's ability to invest more on agricultural research and extension since the 1980s (Tables 2.9 and 2.10). China's agricultural research and extension intensity is one of the lowest in the world (Huang and Hu 1998).

A nationwide reform in research was launched in the mid-1980s. The reform attempted to increase research productivity by shifting funding from institutional support to competitive grants, supporting research useful for economic development, and encouraging applied research institutes to support themselves by selling the technology they produce (Rozelle et al. 1996).

Although competitive grant programs may have increased the efficacy of China's agricultural research system, reliance on commercial revenue to subsidize research and compensate for public funding shortfalls has weakened it. Empirical evidence demonstrates the declining efficacy of China's agricultural research capabilities in the early 1990s (Rozelle et al. 1996).

The Chinese government, taking into account the role science and technology have played in raising agricultural productivity and the recent weakening of the research system, established several programs to stimulate agricultural technology development and facilitate farmers' adoption of new technologies. Both the Ninth Five-Year Plan and the Long Term Plan to 2010 conclude that China will rely heavily on new technology, particularly new crop and livestock varieties, to raise future agricultural production.

Land tenure policy

China initiated rural economic land reform in 1978. Production teams distributed agricultural land among households depending on family size or a combination of family size and labor, although ownership remained collective. A number of publications highlight the importance of this reform to the growth of agricultural production in the long term. The effects of equitable distribution of land to farmers on food security and poverty are obvious.

Table 2.7 Nominal protection rates (NPR) of grain at official exchange rates, 1985-98.

	Quota Procurement Price				Negotiated Procurement Price				Market Price			
Year	Rice	Wheat	Maize	Soybean	Rice	Wheat	Maize	Soybean	Rice	Wheat	Maize	Soybean
1985-89	-30	4	-13	-13	-5	34	17	15	14	52	37	39
1990-94	-37	-14	-35	-32	-16	14	-7	7	-2	26	12	26
1995-98	-18	-9	-2	-26	-7	0	8	2	4	20	25	13

Source: Author's estimates.

Table 2.8 Effective real protection rates (ERPR) of grain at real effective exchange rates, 1985-98.

	Quota Procurement Price				Negotiated Procurement Price				Market Price			
Year	Rice	Wheat	Maize	Soybean	Rice	Wheat	Maize	Soybean	Rice	Wheat	Maize	Soybean
1985-89	-69	-54	-61	-61	-58	-42	-48	-49	-50	-34	-40	-38
1990-94	-70	-59	-69	-67	-60	-46	-75	-49	-53	-39	-46	-40
1995-98	-41	-35	-29	-48	-34	-29	-23	-28	-26	-14	-10	-20

Source: Author's estimates

Table 2.9 Agricultural research expenditure in China, 1985-96.

Year	Agri Research Expenditure at 1990 Prices			Share of State Finance (%)	Agri Research Intensity (%)	Per Scientist Expenditure (yuan)
	Total (million)	State Finance (million)	Development Income (million)			
1985	2,196.7	1,645.3	551.4	75	0.52	54,559
1986	2,058.5	1,464.7	593.8	71	0.48	46,917
1987	2,000.3	1,351.2	649.1	68	0.44	41,352
1988	2,142.9	1,430.1	712.8	67	0.46	39,613
1989	2,139.5	1,429.4	710.1	67	0.47	28,303
1990	2,049.8	1,242.9	806.9	61	0.39	35,213
1991	2,313.8	1,246.9	1,066.9	54	0.43	39,981
1992	2,546.3	1,330.0	1,216.3	52	0.44	43,735
1993	2,667.1	1,269.4	1,397.7	48	0.46	44,646
1994	2,952.3	1,387.6	1,564.7	47	0.44	48,688
1995	2,832.3	1,423.7	1,408.6	50	0.39	47,396
1996	2,879.7	1,514.4	1,365.3	53	0.36	36,657

Source: The State Sciences and Technology Commission.

Table 2.10 Agricultural technology extension expenditure in China, 1986-95.

Year	Real Agricultural Extension Expenditure (million at 1990 price)	Real Agriculture Expenditure per Staff (yuan at 1990 price)	Agri Extension Intensity (%)
1986	1,737	4,508	0.24
1987	1,810	4,472	0.32
1988	1,691	4,113	0.24
1989	1,545	3,599	0.23
1990	1,740	3,828	0.23
1991	1,993	4,021	0.25
1992	2,099	3,408	0.25
1993	2,081	3,444	0.23
1994	2,089	2,850	0.24
1995	2,170	3,215	0.23

Source: Desk survey conducted by author in the Ministry of Agriculture, and the Ministry of Finance.

Renewal of the land contract system is a significant shift of agricultural land institutional arrangements. The new land contract introduced in 1994/1995 offered thirty or fifty-year term extensions from the expiration of the original contract. Farmers may also transfer land use rights in return for payment, although land remains collectively owned. Policy makers designed use right transfers to encourage farmers to invest in agricultural, especially grain, production by counteracting the effects of unclear land titles and small scale holdings. The policy may also encourage land consolidation and agricultural commercialization. A recent land tenure survey conducted by the author in eight Chinese provinces indicates that efficient land and input use and increased farmer investments resulting from a well defined land use right and tenure system might increase agricultural production. Further investigation is necessary to determine the extent of possible increases.

Foreign exchange and agricultural trade policies

China has become a much more open economy with foreign trade growing at an even more impressive rate than GDP. The value of trade (export and import) relative to GDP rose from 12% in 1980, to 23% in 1985, and up to 36% by 1997, a three-fold increase during the reform period. The total value of agricultural trade of China increased from 11.6 billion US$ in 1980 to 31.2 billion US$ in 1997, increasing by 2.7 times. However, the share of agricultural

trade in the total trade value decreased from 30.4% in 1980 to 10% in 1997 due to higher growth in trade of manufactured goods.

China's open door policy contributed to this rapid growth of the external economy and greater reliance on both domestic and international trade to meet consumer demand. Historically, overvaluation of the domestic currency for trade protection purposes has reduced agricultural incentives. Real exchange rates remained constant and even appreciated during the 30 years prior to reforms, but depreciated rapidly after reforms, with the exception of several years following the high domestic price inflation of 1985. From 1978 to 1992, the real exchange rate depreciated more than 400%. Economic productivity growth and technological innovation in agriculture, foreign trade, and industry contributed to low inflation and the success of exchange rate adjustments. Within Asia, China is second only to Indonesia in aggressively adjusting exchange rates over the last two decades except for the most recent five years (real exchange rate has appreciated by about 30% from 1992 to 1997). Falling exchange rates increased export competitiveness and so have contributed to China's phenomenal export growth record (i.e. non-grain food products) and the spectacular national economic performance of the 1980s.

Although China is not a member of the World Trade Organization (WTO), it participated in the UR negotiation on agricultural trade and made commitments to change agricultural trade policy in accordance with multilateral trade rules and to reduce the tariff levels according to UR Agricultural Agreement. In fact, China has been making great efforts to establish a trade system that conforms with the general international trade rules in seeking WTO accession. This process will certainly promote the reform of China's agricultural trade policy in the future. In addition, China also made commitments at the Asia-Pacific Economic Cooperation (APEC) forum to support its long-term goal of investment and trade liberalization in a manner consistent with WTO objectives. China also signed the Bogor Declaration of APEC in November 1994 in which APEC set a target of eliminating trade barriers by 2010 for developed member country economies and 2020 for developing member economies. So for, the topic of early liberalization of sectors including aquatic products, grain, edible oil has been discussed at APEC. All of these suggest changes in China's agricultural trade policy over the next couple of decades.

China began seeking to resume its membership of GATT in 1986. Past studies have already demonstrated that the accession of China to the WTO would accentuate many of the beneficial effects of the Uruguay Round. Specifically, it would boost not only China's trade but also that of many other countries, adding substantially to world welfare (Anderson 1997; Anderson and Peng 1998; Wang 1997). But despite 18 accession meetings during the Uruguay Round and several meetings since WTO was founded, it is still waiting. The major stumbling blocks causing the delay in accession include whether China would be granted developing country status in the WTO, whether China would be a "fair" competitor given the dominance of still existing state-owned manufacturing and trading enterprises, what the extent and conditions of market access into China would be, and whether China can deliver on its promise of stricter enforcement of intellectual property rights (Anderson 1997).

2.5 Effects of trade liberalization at the national level

2.5.1 Debate on China's food economy

China's ability to feed itself in the 21st century has been widely discussed and is a subject of much concern and study among researchers of China's agricultural economy. The preponderance of serious evidence indicates that China will be able to feed itself, although grain imports will probably rise over the next several decades.

Various attempts at projecting future trends in China's grain imports and exports have been published or are currently being used and periodically updated. The most striking feature

of the projections of grain surpluses and deficits is their wide range. At one extreme, China is predicted to become a net exporter of grain. The Chinese Academy of Agricultural Sciences (CAAS 1985) forecasts that China will have the capacity to export 47 million mt in the year 2000. Chen and Buckwell (1991) construct a scenario where they argue that China can move from being an importer of about 10 million mt in the mid-1980s to a net exporter of 17 million mt in 2000.

Other analysts believe China will eventually become a net importer of grain, some believing imports will rise gradually, others more sharply. The medium-term forecasts of the Economic Research Service of the United States Department of Agriculture (ERS 1995) predict that China will be a moderate importer through 2005. Anderson and Peng (1998) predict that China's grain imports will rise to 33 million mt early in the 21st century.

Yang and Tyers (1989) forecasted that China would import roughly 50 million mt annually in the late 1990s. Rozelle et al. (1996) and Huang et al (1997) predict that China will need to import 30-40 million mt annually to meet domestic demand for the first two decades of the twenty-first century. Most international food trade and production specialists believe that current suppliers can meet China's rising import demands without long-term price increases or threats to world food security.

In contrast, another set of researchers predicts China's grain imports will increase significantly. Brown (1995) argues that China's production will fall between 216 and 378 million mt short of demand, forcing the nation to use foreign exchange earnings from the booming export sector to import enough grain to fill the gap. He predicts that China's imports will drain world grain supplies, force prices up, and deny poorer nations the grain necessary to feed their populations. Garnaut and Ma (1992) project that at per capita income growth rates of 6 to 7.2% (rates under those experienced between 1992 and 1994), China will require imports of 50 to 90 million mt by 2000. Carter and Zhong (1991) predict that consumption will outpace production, leaving a food balance deficit of more than 100 million mt by 2000. Chen and Buckwell (1991) arrive at a high-growth scenario where China imports 59 million mt by 2000.

Since all analysts are essentially forecasting from the same general base period, the predicted changes in the relative rates of growth of grain supply and demand lead to the differences in expected grain balances. Brown projects actual declines in grain production of 0.6% per year (or a 20% decline by 2030), most of which comes from a nearly 50% fall in sown area. Carter and Zhong project zero growth in production, while all other estimates of grain production growth are positive, ranging from 1.1% to 1.8% for baseline or slow growth scenarios, and to 2.9% for rapid growth scenarios.

Variation in demand projections is similar. Several projections of demand growth are in the range of 1.0 to 1.7% per year, but demand growth rates in excess of 2% are projected by Garnaut and Ma and Chen and Buckwell. The long term predictions from ERS estimate much higher cereal imports, with a number of the alternative scenarios forecasting food balance shortfalls of 100 million mt. Given the significant variation in both supply and demand projections, it is not surprising that projected net imports are widely differing. The largest import projections result from highly pessimistic supply projections (Brown; Carter and Zhong) and high-side demand projections (Garnaut and Ma; ERS).

Projections by commodity are much less common. Fan et al. (1994) predict that rice exports will continue, mainly due to their assumption that demand elasticities will continue to be positive and rice production growth will continue at current levels. Unpublished projections by Fan and Agcaoili and recent long range projections by the ERS forecast rising imports for wheat. Their estimates, however, do not take into consideration many of the structural changes facing China's food economy.

The most difficult part of evaluating current projections is that the sources of the parameters of the forecasting models, and forces behind the changes in important state variables (e.g., population and income growth), are not transparent. The parameters on which all of these

grain projections are based (except Carter and Zhong and Fan et al.) are either partly or wholly synthetic. There is also little scope for assessing the impact of policy variables. With the exception of the ERS and Fan and Agcaoili models, no other model can be used to systematically assess the effect of policy tools that are under the control of government. Fundamental forces in the economy, such as urbanization and market development, are ignored. Given the rapid structural change in China's economy-in-transition and the importance of policy in China, the omission of such important variables reduces the robustness of predictions from currently available models.

Such a wide range of net import predictions is perplexing. China's emergence as either a major importer or a major exporter could have enormous consequences for world grain markets and prices. China is experiencing rapid development and transformation. Continual reforms and the dynamic nature of China's economy require that researchers update predictions frequently.

Moreover, most previous studies and all studies mentioned above assumed that China's current trade policies will continue in the future. The impacts of trade liberalization on China's food and agriculture have not been examined explicitly in the existing literature. The evidence from recent unpublished work indicates that China will face a great challenge in achieving its food security in a more liberalized economy (Wang 1997; Development Research Center 1998; China Agricultural University 1999; Huang 1998; Huang 1999). The imports of most land intensive products such as grain, cotton, oil crops and sugar crop products would increase substantially with trade liberalization or with China's accession to the WTO.

The purpose of this section is to report projection results which incorporate recent government policies and the likely impacts of trade liberalization on China's agriculture based on a projection model developed at the Center for Chinese Agricultural Policy (CCAP), CCAP's Agricultural Policy Simulation and Projection Model (CAPSiM, see the sections 2.2 and 2.3).

2.5.2 Defining projection scenarios

All simulations begin with the years 1994-1996, the base period. Base period data on production and utilization are three-year averages centered on 1995.

Baseline scenario

Income growth and population growth will remain important determinants of food balance in the future. Population growth peaked in China in the late 1960s and early 1970s. Since then, fertility rates and the natural rate of population growth have begun to fall. Relying on the United Nation's demographic predictions, the growth rate during 1996-2000 is assumed to be 1.11% per annum. This annual rate falls during the next 5 years to 0.88%, a level that is considerably under the world's projected growth rate (1.70-1.80%), but above recent projections by China's demographers. The share of urban population will rise from 28% in the base year to 31% by 2000, to 35% in 2005, and 46% in 2020.

Baseline per capita income growth rate is forecast to average about 4% in the rural sector and 4.5% in the urban sector. Growth rates in the late 1980s and early 1990s were substantially above this level in the urban economy (around 6-7%), and significantly below this in rural areas (less than 1% per year between 1985 and 1992). However, in recent years the overheated urban growth has slowed, and since 1991, the rural economy has begun to pull out of its recession, growing at 4% per year.

Agricultural commodity prices under the baseline scenario are endogenously determined and are generated from the simulations using the CAPSiM model, assuming the current trade policy (tariff levels and non-tariff restrictions) remains.

Supply will respond most to prices, new technology and irrigation investment. The fertilizer price is assumed to be constant in the projection period, but the opportunity costs of

land for crop production and labor for the whole agricultural sector are assumed to grow 1% and 2%, respectively, in 1996-2005.

Technological change has significantly contributed to China's agricultural growth in the past (Huang and Rozelle 1996; Fan and Pardey 1997). However, annual expenditures on research declined from 1985 to 1990, and irrigation expenditures dropped from 1975 to 1985. Because of lags, these early investment dips will keep baseline projections of investment growth below historic rates in the early projection period. The recent recovery in research and irrigation investments, together with the experience of other Asian countries and China's commitment to a strong domestic grain economy, lead to the expectation that China will sustain its recent upturn in investment funding over the long run. The annual growth rates of research and irrigation expenditure are assumed to be 4.0% and 3.5%, respectively, in 1996-2005. Erosion and salinization are expected to continue to increase at a steady but slow pace.

Alternative scenarios: free trade and productivity enhancement growth scenarios

While China is not a WTO member, it is likely that China will join WTO soon given the progress that has made in recent various WTO negotiations. On the other hand, a precise formulation for a scenario that China will fit in after joining WTO is difficult as the final agreement has not been reached despite 13 years of negotiations. In order to have a better understanding of the impact of China's accession to the WTO on China's domestic agricultural market and trade, we assume that China will continue liberalizing its agricultural sector and reach a free trade environment for most agricultural commodities by the year of 2005. Specifically, the free trade scenario in this study assumes 14 major agricultural products (seven grain products including rice, wheat, maize, soybean, sweet potato, potato and other grains, and seven animal products including pork, beef, mutton, poultry, egg, milk and fish) will gradually reduce tariff levels, export subsidies, and trade barriers after 2000, and will reach a zero tariff, and completely phase out non-tariff trade barriers by the year 2005. This represents a maximum impact of trade liberalization on China's agriculture. The actual impact of trade liberalization and China's joining WTO will lay between the simulation results of the baseline scenario and the free trade scenario.

Under the free trade scenario, both import tariff and trade barriers for agricultural inputs such as fertilizer and pesticides will also be reduced and eventually be phased out in 2005. Therefore, the fertilizer and pesticide prices are assumed to decline by 20% from 2000 to 2005. All other assumptions are the same as those defined in the baseline scenario.

It is worth noting that the CAPSiM is a country partial equilibrium model. The impacts of China's trade liberalization on the world market prices are not examined given the nature of the model. It is expected that the increase in the import of feed grain under the free trade scenario will raise international market prices of feed, particular the maize price. Similarly, as we will see from the simulation results presented in the next section, trade liberalization will increase China's pork and poultry exports. Therefore, we expect that world pork and poultry prices will decline with the extent of China's trade liberalization.

In order to estimate the impacts of the world agricultural price changes (due to China's trade liberalization) on China's agricultural trade, we simulated the free trade scenario in two stages. In the first stage, the world prices of all agricultural products are assumed to be constant in real terms in 2000-2005. The results from the first stage on China's imports and exports of various agricultural commodities then are used to adjust for possible changes in the world market. In the second stage, the model will simulate changes in world prices. This procedure could be repeated until the marginal changes from additional rounds of simulation in imports or exports of agricultural commodities are minimal.

In order to provide in formation on long-term prospects of China's food security under a free trade regime, we projected China's food supply, demand and trade toward 2020 under a free trade scenario with and without progressive improvement in agricultural productivity

enhancement investment. The later assumes that the annual growth rate of agricultural research expenditure will rise from 4% (baseline assumption) to 6%.

2.5.3 Impacts of trade liberalization on China's agricultural prices

Table 2.11 presents the price differences of the selected agricultural products in China's domestic markets under the two scenarios with and without trade liberalization from 2000 to 2005 projected by CAPSiM.

General impacts

In the base year (1994-1996), China's domestic prices of most grain products exceeded the grain prices in the world market, while the domestic prices of most animal products were lower than the prices in world markets. Under the baseline scenario, the increases in domestic production of rice, wheat, other grains, and most animal products will nearly meet the increase in domestic demand for these commodities, and the changes in their trade over the period of 2000-2005 will be marginal (see next sub-section). Therefore, the changes in domestic prices (real term in 1995 prices) of most of these commodities will range only from -1% to 2% in 2000-2005 (Table 2.11). This implies that China's domestic grain prices, except the price of rice, will continue to be higher than grain prices in the world market from 2000 to 2005. On the other hand, animal products, mainly the livestock sector, will continue to be heavily taxed. Furthermore, the differences between grain prices in China's domestic market and in the world market will increase from 2000 to 2005. In particular, the price of maize, wheat and soybean in China's domestic market will far exceed prices in the world market.

In contrast, under the free trade scenario, China's domestic grain market prices (except for rice) will decline gradually from 2000 to 2005. The prices of wheat, maize and soybean in China's domestic market will decline significantly, ranging from -10% to -20%, in 2000-2005.

Table 2.11 also shows the price differences between the baseline and free trade scenarios. The results indicate that producers of crops (except for rice) will lose their income from farming activities under the free trade scenario (compared to the baseline scenario) as the crop product prices decline with trade liberalization. However, most animal product (except for beef, mutton, and milk) producers, particularly the farmers raising hogs and poultry, will benefit from trade liberalization. The prices of the pork, poultry, egg, and fish will be about 5% to 15% higher than those under the baseline scenario in 2005.

Impacts on individual agricultural commodities

Among the various grains, rice is the only commodity whose price will rise with trade liberalization. The increased price of rice is the result of an increase in the rice export and a reduction of rice demand due to cross-price substitution of other food grains (mainly wheat), but the price difference between the baseline and free trade scenarios will be only about 3.5% even by 2005 (Table 2.11).

Under the baseline scenario, China's domestic wheat market price will continue to be higher than that in the world market, but the wheat price protection rate will gradually decline over time. Trade liberalization will lower the domestic wheat price significantly. The domestic market price of wheat will decline to 1,406 yuan/ton in 2005, representing a declining rate of 20.2% over the period of 2000-2005 (Table 2.11).

Table 2.11 Impact of trade liberalization on agricultural commodity prices in China (free trade vs baseline scenarios), 1985-96.

	Price in 2005 (yuan/ton in 1995 prices)		Price Change in 2000-2005 (%)		Price Difference in 2005 (%)
	Baseline	Free trade	Baseline	Free trade	Free trade vs baseline
Rice	2,333	2,415	-0.4	4.1	3.5
Wheat	1,756	1,406	-1.1	-20.2	-19.9
Maize	1,459	1,080	7.5	-20.1	-26.0
Soybean	2,918	2,322	0.4	-20.2	-20.4
Sweet potato	1,208	1,066	0.7	-9.6	-11.8
Potato	1,211	1,085	-0.4	-9.5	-10.4
Other grains	2,290	2,097	-1.8	-9.7	-8.4
Pork	12,795	14,633	0.8	14.8	14.4
Beef	14,666	14,518	1.8	0.0	-0.1
Mutton	18,841	18,345	3.4	0.0	-2.6
Poultry	11,643	12,798	0.9	10.4	9.9
Egg	6,557	6,831	-3.5	0.0	4.2
Milk	3,379	2,672	1.5	-20.2	-20.9
Fish	9,032	9,529	-4.8	0.0	5.5

The grain price that is most significantly affected by the trade liberalization is maize. Under the baseline scenario, the maize price in China's domestic market will continue to increase from 2000 to 2005. As a result, the maize price in China's domestic market will rise to 1,459 yuan/ton in 2005, an increase of 7.5% over that in 2000. With free trade regime implemented in 2000-2005, the maize price in China's domestic market will fall by about 20% in 2005 over that in 2000, or about 26% lower than the price projected under the baseline scenario (Table 2.11).

The impact of trade liberalization on the soybean price is next only to that of maize and similar to wheat (Table 2.11). In 2005, China's domestic market soybean price will be 20% higher than the soybean price in the world market. After trade liberalization, the soybean price in China's domestic market will decline from 2,908 yuan/ton in 2000 to 2,322 yuan/ton in 2005, a decline of 20% from 2000 to 2005.

The impact of trade liberalization on the prices of sweet potato, potato and other grains in China's domestic market is similar. Under the free trade scenario, the prices of these coarse grains will be about 10% lower than prices under the baseline scenario in 2005 (Table 2.11).

Trade liberalization will tend to increase the prices of animal products in China's domestic market. Under the baseline scenario, although the domestic pork price will gradually increase during the period from 2000 to 2005, it will be lower than the pork price in the world market by 14.4% in 2005 (Table 2.11). On the contrary, after trade liberalization starts in 2000 (free trade scenario), domestic pork price will rise from 12,746 yuan/ton in 2000 to 14,633 yuan/ton in 2005, increasing about 15% from 2000 to 2005. The domestic price of pork will be about 14% higher than that in the baseline scenario in 2005.

Similar positive effects of trade liberalization on domestic prices are found for poultry, eggs and aquatic products. The domestic prices of poultry, eggs and aquatic products under the free trade scenario are projected to be about 10%, 4% and 6%, respectively, higher than those estimated from the baseline scenario. On the other hand, trade liberalization will significantly decrease the domestic price of milk. The milk price under the free trade regime will decline by more than 20% over the period of 2000-2005. Beef and mutton are agricultural products on which trade liberalization has the least impact (Table 2.11).

In summary, under the free trade scenario, the prices of grains except rice in China's domestic market will decline by about 20% for wheat, maize and soybean, and 10-11% for the other coarse grains from 2000 to 2005. At the same time, the prices of animal products except milk will increase. In particular the prices of pork and poultry will increase by 15% and 11%, respectively, from 2000 to 2005. Such large changes in the prices of agricultural products in China's domestic market will undoubtedly generate considerable impacts on China's domestic production, consumption and international trade of related agricultural products.

The decline in the prices of grain with trade liberalization, particularly maize, wheat and soybean will dampen the profitability of grain production, and reduce the earnings of farmers whose incomes are mainly from grain production. While demand for maize, wheat and soybean is expected to rise with the decline in their prices, grain production growth is expected to slow down with the increasing liberalization of agricultural trade. In contrast, increases in the prices of pork and poultry will directly increase the returns of these animal products and, therefore, increase the income of pork and poultry producers. Such a "windfall" income increase to these animal product producers will stimulate their production of pork and poultry. Consequently, there will be an expansion in the production of animal products, particularly the production of pork and poultry, in China after trade liberalization.

The interesting point is that the feed grain consumers are the animal product producers. Thus the producers of animal products will have double gains with a more liberalized economy. On one hand, animal product producers will gain from the increase of animal product prices. On the other hand, animal product producers who are also the feed grain consumers will gain from the decline in the feed grain prices, which will reduce the production costs. Consequently, we expect that there will be not only a large increase in feed grain demand, but also a large expansion in animal product production after trade liberalization.

2.5.4 Impact of trade liberalization on production, demand and trade of agricultural commodities

2.5.4.1 Baseline scenario

Tables 2.12 and 2.13 present the projections of production, consumption and trade of grains and animal products under the baseline scenario in 2000-2005.

An overview

According to the analysis, per capita food grain consumption in China hit its zenith in the late 1990s and will fall over the remaining forecast period. The average rural resident will slightly increase food grain consumption through 2005, and urban resident food grain consumption will level off in the projection period. The ebb of per capita food grain demand at the national level will occur at a time when both rural and urban food grain demands do not decline because of the impact of urbanization.

Because of the higher quality of fine grains, total rice and wheat consumption per capita will rise slightly through the year 2000, reflecting their still positive, albeit small, income elasticities. Both rural and urban consumers will demand higher quantities of rice and wheat. Per capita demand for other food grains, however, will fall over the projection period.

In contrast, per capita demand for red meat is forecast to rise sharply throughout the projection period. Rural demand will grow more slowly than overall demand, but urbanization trends will shift more people into the higher-consuming urban areas (in middle 1990s an urban resident consumed about 60% more red meat than his/her rural counterpart). While starting from a lower level, per capita demand for poultry will rise proportionally more. The projected rise in meat and poultry product demand will stimulate aggregate feed grain demand.

Baseline projections of the supply of grain show that China's producing sector will gradually fall behind the increase in demand. The gap between the forecast annual growth rate of production and demand implies a rising deficit. Although China's domestic total grain production will increase from 431.68 million mt in 2000 to 463.78 million mt in 2005 with an annual growth rate of 1.44%, China's domestic total grain consumption will increase from 446.00 million mt to 481.34 million mt with an annual growth rate of 1.60%. The higher level and faster growth rate of domestic grain consumption compared to domestic grain production indicate a widening gap between domestic supply and demand for grains. The net imports of grain will rise from 14.8 million mt in 2000 to nearly 20 million mt in 2005 (Table 2.12). Despite the increase in grain imports in the period of 2000-2005, the grain self-sufficiency level will remain as high as 95-96% in the early 21st century.

In the livestock and aquatic sector, increases in domestic production nearly match the increases in demand. The annual production growth rates of various animal products will range from 3% to 7% in the period of 2000-2005, and those growth rates are equivalent to the growth rates of the demand for these products in the same period. The sector will continue to be an exportable one, but the amount of exported livestock products and fish will be very small compared to the size of the total domestic production or consumption.

Results for individual grains

Except for sweet potato and soybean, China will import all kinds of grains in the period of 2000-2005 under the baseline scenario. Wheat will continue to be the largest imported grain, followed by maize and rice. However, the trends of grain imports vary among commodities. The imports of rice and wheat will present a declining trend over the projection period as the growth rate of demand for those food grains declines, while the maize import will increase significantly over time to meet the increasing domestic demand for feed as the livestock sector expands. Imports or exports of other grains (all together) are marginal, accounting for less than 3% of the total consumption.

Under the baseline scenario, the growth rate of rice production in 2000-2005 will be much lower than the growth rates obtained in the 1980s and 1990s, which is evidence of the impacts of declining the public investment in agricultural R&D since the mid-1980s (Huang et al. 1998; Huang and Li 1999). Rice production will rise from 132.86 million mt tons in 2000 to 138.91 million mt in 2005 with an annual growth rate of only 0.89% (Table 2.12). On the demand side, slowdown in the population growth, urbanization, food market development (leading to a more diversified consumption pattern), and stagnation of per capita rice consumption, will all dampen the growth rate of rice demand. The projected annual growth rate of total rice consumption will be only 0.88% in 2000-2005, similar to the rate of growth in rice production. On the balance, China will import only about 0.8-1.0 million mt annually in the early 21st century.

Wheat has been a major import product in the past two decades in China. Under the baseline scenario, our projection shows that wheat production will continue to fall behind consumption in 2000-2005, but the supply and demand deficit will start to decline after 2001. Production will rise from 108.36 million mt in 2000 to 115.52 million mt in 2005, with an annual growth rate of 1.29% (Table 2.12). At the same time, wheat consumption will increase from 119.76 million mt to 125.44 million mt with an annual growth rate of 0.93%. Since the growth rate of wheat production is slightly higher than that of wheat consumption during this period, the quantity of net wheat imports will fall from the peak level of 11.54 million tons in 2001 to 9.92 million tons in 2005, although China will still be a net wheat importer. Our long-term projection shows that the growth rate of wheat demand in China will present a slightly declining trend in the entire period of 2000-2020. China will become self-sufficient in wheat by 2020.

Table 2.12 Projection of grain production, consumption and trade under the baseline scenario ('000 tons), 2000-2005.

Commodity	2000	2001	2002	2003	2004	2005	Annual Growth Rate (%)
Rice							
Production	132,858	133,836	134,809	136,025	137,424	138,908	0.89
Consumption	133,719	134,837	135,852	137,040	138,345	139,690	0.88
Net Import	861	1,001	1,043	1,015	921	782	
Wheat							
Production	108,362	109,444	110,558	111,992	113,682	115,519	1.29
Consumption	119,775	120,980	122,007	123,134	124,287	125,440	0.93
Net Import	11,413	11,536	11,449	11,142	10,605	9,921	
Maize							
Production	118,717	121,069	123,610	126,519	129,752	133,209	2.33
Consumption	120,367	124,157	128,163	132,544	137,147	141,898	3.35
Net Import	1,650	3,088	4,553	6,025	7,395	8,689	
Soybean							
Production	14,445	14,572	14,733	14,941	15,188	15,459	1.37
Consumption	14,211	14,409	14,610	14,826	15,051	15,278	1.46
Net Import	-234	-163	-123	-125	-137	-181	
Sweet potato							
Production	24,069	24,335	24,628	24,968	25,337	25,712	1.33
Consumption	23,945	24,229	24,531	24,873	25,236	25,599	1.34
Net Import	-124	-106	-97	-95	-101	-113	
Potato							
Production	9,938	10,066	10,200	10,350	10,512	10,678	1.45
Consumption	9,996	10,131	10,269	10,418	10,575	10,732	1.43
Net Import	58	65	69	68	63	54	
Other grains							
Production	23,293	23,424	23,572	23,774	24,020	24,292	0.84
Consumption	24,463	24,558	24,639	24,735	24,837	24,943	0.39
Net Import	1,170	1,134	1,067	961	817	647	
Total grains							
Production	431,682	436,746	442,110	448,569	455,915	463,777	1.44
Consumption	446,474	453,299	460,072	467,572	475,478	483,577	1.60
Net Import	14,792	16,554	17,961	19,002	19,563	19,799	

Note: Consumption (or demand) includes stock changes.

In contrast to rice and wheat, the demand for maize will present an increasing growth trend in the future in China. Although maize will be highly protected in the future under the baseline scenario (see price changes in the last sub-section), maize production will fall behind maize consumption, and China will turn from a maize exporter to a major maize importer in the world grain market. This implies a widening gap between maize production and consumption in China's domestic market and a rising trend in net maize imports by China. From 2000 to 2005, maize production will increase from 118.72 million mt to 133.21 million mt with an annual growth rate of 2.33%, while maize consumption will increase from 120.37 million mt to 141.90 million mt with an annual growth rate of 3.35% (Table 2.12). Because of the higher demand and faster growth rate in maize consumption than in maize production, China has to increase maize imports considerably throughout the projection period in order to support expansion of the livestock sector. Under the baseline scenario, maize imports will increase from 1.65 million mt in 2000 to 8.69 million mt in 2005. As a result of the increasing maize import, the maize

self-sufficient level will decline from about 100% in the mid-1990s to 94% in 2005 and further down to less than 90% by 2020.

A high level of soybean production will keep China's soybean production growth slightly higher than the growth in demand. China's domestic production of the other coarse grains will be lower than domestic consumption in the projection period. However, the growth rates of production of these grain crops are generally higher than the growth rates of their consumption, and the net imports of these coarse grains will gradually decline.

Results for individual animal products

Increase in income and population and expansion in the urban sector and food markets will lead to significant growth in the demand for livestock and fish products in China in the next century. The annual growth rate of red meat consumption is projected to be about 3.4% to 4.5% in the early 21st century, a rate much higher than that for grain demand.

Pork accounts for about 70% of meat or nearly 90% of red meat consumption. Its demand will rise from 23.20 million mt in 2000 to 27.46 million mt in 2005 with an annual growth rate of 3.43% in 2000-2005 (Table 2.13). Under the baseline scenario, pork production is also projected to grow at 3.39% annually, a growth rate close to the demand growth. It should be noted that the livestock data used in this paper are significantly different from the data published by the State Statistical Bureau. The CAPSiM uses a completely new set of data that corrects for over-reporting of livestock production and under-reporting of its consumption. Since the level of pork production is higher than that of pork consumption in the base-year, China will continue to be a net pork exporter for the entire projection period. However, the total export of pork will only account for less than 1% of the total domestic production.

The trends of production, consumption and trade of beef and mutton are roughly the same as those for pork. However, the annual growth rates of beef and mutton production will be higher than that of pork, as the prices of beef and mutton are projected to rise more than the pork price in the early 21st century. The higher growth rates of demand for beef and mutton are also projected because the income elasticities of beef and mutton are higher than that for pork. On the supply and demand balance, China will continue to be a small net exporter of these two products in 2000-2005.

Poultry and milk are the only two animal products that require import (4-5% of domestic consumption) to meet the increasing demand. Poultry consumption will rise from 6.29 million mt in 2000 to 7.89 million mt in 2005 with an annual growth rate of 4.61%. Because domestic poultry consumption is higher than domestic poultry production in the base year, although the growth rate of poultry production is slightly higher than that of poultry consumption, China will still be a net poultry importer in 2000-2005. The annual import of poultry will be around 0.25 - 0.29 million mt in 2000-2005. Milk imports will present a slightly increasing tread, rising from 0.30 million mt in 2000 to 0.33 million mt tons in 2005, accounting for 3.4% of the total consumption (Table 2.13).

The projected growth rates of egg and fish production are almost equal to those of their consumption in 2000-2005 (Table 2.13). China's domestic egg production will increase from 12.08 million mt in 2000 to 14.85 million mt in 2005, and fish production will increase from 11.33 million mt to 15.08 million mt in the same period, which keeps China fully self-sufficient in both eggs and fish.

Table 2.13 Projection of animal product production, consumption and trade under the baseline scenario ('000 tons), 2000-2005.

Commodity	2000	2001	2002	2003	2004	2005	Annual Growth Rate (%)
Pork							
Production	23,455	24,240	25,036	25,879	26,770	27,703	3.39
Consumption	23,197	23,995	24,795	25,640	26,530	27,462	3.43
Net Import	-258	-245	-241	-239	-240	-241	
Beef							
Production	2,421	2,531	2,643	2,761	2,885	3,015	4.49
Consumption	2,401	2,511	2,624	2,743	2,867	2,998	4.54
Net Import	-20	-20	-19	-18	-18	-17	
Mutton							
Production	1,411	1,473	1,536	1,603	1,673	1,746	4.35
Consumption	1,410	1,472	1,535	1,602	1,672	1,745	4.36
Net Import	-0.7	-0.6	-0.6	-0.6	-0.6	-0.5	
Poultry							
Production	6,047	6,321	6,610	6,918	7,247	7,595	4.66
Consumption	6,293	6,587	6,885	7,200	7,534	7,885	4.61
Net Import	246	266	275	282	287	290	
Egg							
Production	12,083	12,582	13,101	13,651	14,234	14,848	4.21
Consumption	12,054	12,553	13,072	13,622	14,204	14,817	4.21
Net Import	-29	-29	-29	-29	-30	-31	
Milk							
Production	6,721	7,191	7,675	8,198	8,760	9,364	6.68
Consumption	7,020	7,509	10,269	8,525	9,091	9,697	6.67
Net Import	299	318	324	327	331	333	
Fish							
Production	11,326	12,009	12,710	13,455	14,245	15,081	5.89
Consumption	11,286	11,951	12,626	13,342	14,102	14,909	5.73
Net Import	-40	-58	-84	-133	-143	-172	

2.5.4.2 Free trade scenario

An overview

The impacts of trade liberalization on China's agriculture are remarkable not only on agricultural prices and trade, but also on domestic production and consumption. Under the free trade scenario, domestic grain prices (except for rice) will fall. The fall in the domestic price of grain raises grain consumption and slows down the growth of grain production. China's domestic grain production will fall far behind domestic grain consumption. From 2000 to 2005, domestic grain production will increase from 430.81 million mt to 453.15 million mt with an annual growth rate of 1.02% (Table 2.14). However, during the same period, China's domestic grain consumption will grow at 2.69% annually, a growth rate more than twice that of production growth, and reach 512.75 million mt in 2005. Compared to the baseline scenario, the grain deficit between domestic supply and demand will be further enlarged after trade liberalization, leading to a surging grain import in the early years of the next decade.

Table 2.14 shows that China's net grain imports will increase to 59.61 million mt in 2005, a level representing about 12% of the total grain consumption in China. Compared with the baseline scenario, China's domestic grain production will decline by 10.63 million mt (or

2.3%), while China's domestic grain consumption will increase by 29.28 million mt (or 6.0%) in 2005.

The impacts of trade liberalization on China's animal sector are also significant. However, in contrast to the grain sector, trade liberalization has positive impacts on domestic prices, export and production of major animal products. Trade liberalization will increase domestic prices of pork and poultry substantially, and induce a moderate rise in the prices of eggs and fish. The increase in the prices of these major animal products and the decrease in the feed price resulting from trade liberalization will stimulate domestic production of these products on the one hand, and dampen their consumption on the other hand. Livestock and fish product exports will expand considerable, particular pork, poultry and fish (Table 2.15).

Table 2.14 Impacts of trade liberalization (free trade) on grain production, consumption and trade, 2000-2005.

	Free Trade Scenario		Free Trade vs Baseline Sceanrio	
Commodity	In the year 2005 ('000 tons)	Annual growth rate in 2000-2005 (%)	Difference in 2005 ('000 tons)	Annual average difference in 2000-2005 ('000 tons)
Rice				
Production	144,652	1.77	5,744	2,419
Consumption	138,313	0.55	-1,377	-248
Net Import	-6,339		-7,121	-248
Wheat				
Production	110,458	0.43	-5,061	-2,672
Consumption	132,721	2.06	7,281	4,059
Net Import	22,263		12,342	6,731
Maize				
Production	122,793	0.69	-10,416	-5,375
Consumption	162,105	5.91	20,207	11,389
Net Import	39,312		30,623	16,764
Soybean				
Production	14,792	0.47	-667	-331
Consumption	16,102	2.41	824	533
Net Import	1,310		1,491	865
Sweet potato				
Production	25,502	1.26	-210	-233
Consumption	26,872	2.17	1,273	792
Net Import	1,370		1,483	1,024
Potato				
Production	10,588	1.35	-90	-95
Consumption	10,831	1.48	99	107
Net Import	243		189	202
Other grains				
Production	24,360	0.93	68	14
Consumption	25,810	1.01	867	498
Net Import	1,450		803	485
Total grains				
Production	453,145	1.02	-10,632	-6,272
Consumption	512,753	2.69	29,176	17,130
Net Import	59,608		39,809	23,402

Results for individual grains

While trade liberalization has a general adverse impact on the grain sector, its impacts vary largely among various grains. The most serious impact of trade liberalization on grains is on maize, followed by wheat and soybean.

Under the free trade scenario, China's domestic maize production will fall far behind maize consumption for the entire projection period. From 2000 to 2005, both maize production and consumption will increase continuously. However, the growth of maize consumption is

much higher than that of maize production. By 2005, maize consumption will reach 162.11 million mt, with an annual growth rate of 5.91% in 2000-2005 (Table 2.14), while maize production will rise from 118.62 million mt in 2000 to 122.79 million mt in 2005, with an annual growth rate of only 0.69%. The massive increase in maize consumption due to the decline in maize price and surging feed demand for livestock production expansion after trade liberalization will lead to a large deficit in China's domestic maize supply. Consequently, imports of maize will increase dramatically from less than 2 million mt in 2000 to 39.31 million mt (nearly one-quarter of China's maize consumption) in 2005. China would likely be the world largest importer of maize in the coming years if the sector were completely liberalized.

Table 2.15 Impacts of trade liberalization (free trade) on animal product production, consumption and trade, 2000-2005.

	Free Trade Scenario		Free Trade vs Baseline Scenario	
Commodity	In the year 2005 ('000 tons)	Annual growth rate in 2000-2005 (%)	Difference in 2005 ('000 tons)	Annual average difference in 2000-2005 ('000 tons)
Pork				
Production	31,984	6.33	4,281	2,071
Consumption	25,727	2.16	-1,735	-839
Net Import	-6,257		-6,016	-2,910
Beef				
Production	3,090	4.94	75	39
Consumption	3,119	5.49	121	53
Net Import	29		46	14
Mutton				
Production	1,779	4.68	33	18
Consumption	1,841	5.58	96	42
Net Import	62		63	24
Poultry				
Production	8,683	7.42	1,088	525
Consumption	7,502	3.66	-383	-187
Net Import	-1,181		1,471	-712
Eggs				
Production	15,478	6.32	1,630	799
Consumption	14,547	3.89	-270	-129
Net Import	-1,931		-1,900	-927
Milk				
Production	8,888	5.68	-476	-209
Consumption	11,716	10.90	2,019	910
Net Import	2,828		2,495	1,118
Fish				
Production	15,721	6.72	640	307
Consumption	14,581	5.37	-328	-169
Net Import	-1,140		-968	-476

Note: The production and consumption data used in CAPSiM are significantly different from the data published by the State Statistical Bureau. The database in CAPSiM on livestock and aquatic production and consumption corrects for the problem of over-reporting production and under-estimating consumption of these products.

Compared with the baseline projections, the net impacts of trade liberalization on the annual maize production, consumption, and trade will be -5.38 million mt, 11.39 million mt, and 16.76 million mt, respectively, for the average of 2000-2005 (Table 2.14). In 2005 the year of complete liberalization under the free trade scenario, the net impact of trade liberalization on maize production, consumption, and trade will reach the highest levels as -10.42 million mt (or a reduction of 7.8%), 20.21 million mt (or an increase of 14.2%), and 30.62 million mt (or an increase of 3.52 times), respectively.

Although wheat is a food grain and the food grain consumption response to the price change is weaker than that of feed grains, the impact of trade liberalization on wheat is also

substantial. From 2000 to 2005, the annual growth rate of wheat production will fall from 1.29% in the baseline to 0.43% in the free trade scenario (Table 2.14), while the wheat consumption growth rate will rise from 0.93% in the baseline to 2.06% in the free trade scenario in the same period.

Wheat production is projected to be only 110.46 million mt in 2005, 5.06 million mt (or 4.4%) lower than that in the baseline projection (Table 2.14). The large increase in wheat consumption after trade liberalization will widen the gap between wheat supply and demand. As a result, wheat imports will rise sharply from 11.73 million mt in 2000 to 22.26 million mt in 2005. Compared with the baseline projections, under the free trade assumption, annual wheat production will decline by 2.67 million mt, while wheat consumption will increase by 4.06 million mt for the average of 2000-2005. Wheat consumption under the free trade scenario will tend to increase by 7.28 million mt (or 5.8%) compared to the baseline scenario in 2005. The net impact of the free trade versus baseline scenarios on wheat import will be as high as 12.34 million mt (rise from 9.92 million mt to 22.26 million mt) in 2005.

Soybean is the other grain crop that will be affected significantly by trade liberalization. Under the baseline scenario, China is a net exporter of soybean though the amount of soybean exported is minimal. However, with the significant decline in the soybean price under the free trade scenario, soybean production will fall behind soybean consumption and China will become a net soybean importer starting from 2001. From 2000 to 2005, both soybean production and soybean consumption will continue to increase; however, the growth rate of soybean consumption (2.41%) will be higher than that of soybean production (0.47%). By 2005, soybean consumption will reach 16.10 million mt (5.4% higher than the baseline scenario), about 9% higher than its production (14.79 million mt, or 4.3% lower than the baseline). Soybean net import will reach more than 1.3 million mt or about 8% of the domestic soybean consumption in 2005.

A similar but much weaker impact of trade liberalization on root crops was found in our simulation analyses. The increase in production of sweet potato and potato will not be able to meet the increase in domestic demand. Imports of these products will rise with trade liberalization (Table 2.14).

Rice and other coarse grains (mainly millet, sorghum and barley) are the only crops within grains that will benefit from trade liberalization. Under the free trade scenario, China's domestic rice production will gradually exceed rice consumption in the projection period. Rice production will rise from 132.86 million mt in 2000 to 138.91 million mt in 2005 with an annual growth rate of 1.77%. The higher growth rate of rice production compared to that in the baseline (0.89% in Table 2.12) is mainly due to two factors, namely the rise in rice price and the decline in the prices of inputs such as fertilizer and pesticides under the free trade scenario.

The increase in the rice price under the free trade scenario reduces the annual rice consumption growth rate from 0.8% in the baseline to only 0.55% in the period of 2000-2005. The larger increase in rice production than in rice consumption leads to a rice surplus and shifts China from being a net rice importer in 2000 and 2001 to becoming a net rice exporter after 2001. Compared with the baseline scenario (Table 2.12), the free trade regime will raise annual rice production by 2.42 million mt in 2000-2005, and by 5.74 million mt (or an increase of 4.1% over the baseline) in 2005 (Table 2.14). Rice consumption will reach only 138.31 million mt in 2005, 1.38 million mt (1%) lower than the baseline figure in 2005. The impact of trade liberalization on rice exports is substantial. The average annual rice export will increase by 2.67 million mt for the period of 2000-2005, and compared to the baseline scenario, the impact of the free trade regime on rice exports will reach as high as 7.12 million mt in 2005 (Table 2.14).

Results for individual animal products

Under the free trade scenario, China's domestic pork production will increase from 23.46 million mt in 2000 to 31.88 million mt in 2005 (Tables 2.13 and 2.15), with an annual growth

rate of 6.33% (3.39% under the baseline scenario). At the same time pork consumption will rise from 23.12 million tons to 25.73 million tons, rising 2.16% annually (compared to 3.43% in the baseline). Because the increase in pork production is far higher than the increase in pork consumption after trade liberalization, China will increase pork exports dramatically from 0.41 million mt in 2000 to 6.26 million mt in 2005 with an annual growth rate of 72.14%. Compared with the baseline projections (Table 2.13), free trade will raise pork production by 4.28 million mt (from 27.70 million mt to 31.98 million mt, or 15.5% increase). In contrast pork consumption will decline 1.74 million mt in 2005 (Table 2.15).

With trade liberalization China's domestic poultry production will far exceed poultry consumption and turn China's poultry trade from deficit to surplus. Under the free trade assumption, poultry production will increase from 6.07 million mt in 2000 to 8.68 million mt in 2005, with annual growth of 7.42%, a growth rate much higher than the consumption growth rate (3.66%). Export will rise to more than 1 million mt by 2005.

A significant impact of trade liberalization was also found for fish, eggs and milk, but the impacts are different for the different commodities. For example, trade liberalization will lead to expansion of fish production (4.2% in 2005) and export (about 1 million mt in 2005) as well as the expansion of egg production and export, while it will curb the milk sector. About one-quarter of the milk consumption will have to be imported from the world market after 2005, compared to about 3% of imported milk in the baseline scenario. Given the relatively small role of beef and mutton in the livestock economy, while the relative impacts of trade liberalization on their production, consumption and trade are large, the absolute impact levels are much lower than those found for the other animal products discussed above.

2.5.5 Impacts of trade liberalization on China's grain self-sufficiency

Food security has been and will continue to be one of the central goals of China's policy. While food security has many dimensions, one of the targets that was set by the Chinese government recently is to achieve a grain self-sufficiency level at or above 95% in the future. Although this level of grain self-sufficiency has been debated since it was set, any changes including trade liberalization that could result in a grain self-sufficiency level far below 95% in the long term would not be adopted by the current government, if alternative solutions were available.

Table 2.16 presents China's grain self-sufficiency rates under three scenarios in 1995-2020. The third scenario assumes that the growth rate of agricultural research expenditure in real terms rises from 4% (the assumption used in the other scenarios) to 6% during the entire period of the projection.

Several interesting points could be derived from the results presented in Table 2.16. First, under the baseline scenario, while the grain self-sufficiency rate will decline over time (from 98.1% in the 1994-96 to about 96% in most years of the next two decades), China will be able to achieve one of the major components of its food security (grain self-sufficiency) target in the future (Table 2.16). The only grain with a self-sufficiency level below 95% in the long term is maize. The maize self-sufficiency rate will decline significantly from 101.4% in 1994-96 to 93.9% in 2005 and further down less than 90% in 2020.

Second, although the baseline scenario or the policies embodied in the baseline assumptions would ensure a high level of grain self-sufficiency, the costs related to this scenario should not be underestimated. All grain prices except rice in domestic markets will significantly exceed prices in the international market. For example, maize, wheat and soybean domestic prices will exceed international prices by about 26%, 20% and 21% in 2005, respectively, and the gap between domestic and international prices will increase after 2005, particular the maize price. The maize price will reach as high as the wheat price by 2020. Whether the government budget and consumers can sustain such a high level of grain price protection policy is an issue that needs to be considered.

Third, the complete trade liberalization (the free trade scenario) will obviously challenge the current food security goal defined by the government. China's grain self-sufficiency rate will decline rapidly from 98% in the mid-1990s to 88.4% in 2005 (Table 2.16), a level that is hardly accepted by the current government. Although the grain self-sufficiency rate will rise gradually after 2005, there will still be about 8% of domestic grain demand that needs to be met by import sources in 2020. However, it is worth noting that this is an extreme case (the free trade regime), representing the maximum impact of trade liberalization on China's grain economy. The actual impact of China's joining the WTO will be lower than the results from this free trade scenario.

Table 2.16 Grain self-sufficiency rates (%) under various scenarios, 1995-2020.

Scenario	1994-96	2005	2010	2020
Baseline				
Total grain	98.1	95.9	96.1	96.9
Rice	99.7	99.4	99.9	101.3
Wheat	92.2	92.1	95.1	99.7
Maize	101.4	93.9	91.3	89.8
Soybean	100.1	101.2	101.9	102.9
Free trade				
Total grain	98.1	88.4	89.9	92.1
Rice	99.7	104.6	107.1	114.7
Wheat	92.2	83.2	88.3	96.9
Maize	101.4	75.7	74.4	72.2
Soybean	100.1	91.9	94.4	95.5
Free trade with rise in agri research expenditure*				
Total grain	98.1	88.4	90.4	97.2
Rice	99.7	104.6	107.6	119.5
Wheat	92.2	83.2	88.8	102.1
Maize	101.4	75.7	75.0	77.7
Soybean	100.1	91.9	95.0	100.7

* The third scenario assumes that the growth rate of agricultural research expenditure in real terms rises from 4% (the assumption used in the other scenarios) to 6% during the entire period of the projection.

Fourth, the most effective policy that could improve China's food security and raise the grain self-sufficiency level in the long term is to increase agricultural productivity enhancement investment such as agricultural R&D, rural infrastructure and water control (i.e., irrigation). For example, Table 2.16 shows that China could achieve its grain self-sufficiency target in the long term (after 2015) under the free trade regime, if the annual growth rate in agricultural research investment is increased from 4% to 6%.

Finally, the shocks of trade liberalization on China's grains differ largely between food and feed grains. Maize will be the major imported grain and will be used in producing exportable livestock products. Therefore, it is not maize, but rice and wheat production and self-sufficiency that have direct and most important impacts on food and, particularly grain, security (food grain self-sufficiency) in China. If the food grain self-sufficiency concept were to replace the total grain self-sufficiency concept and be adopted in China, China would achieve the 95% food grain self-sufficiency level even under a completely liberalized market in the future (Table 2.16).

2.5.6 Impacts of trade liberalization on agricultural employment and the welfare of producers and consumers

2.5.6.1 Employment

Trade liberalization will lead to structural changes in agricultural production. Some agricultural sectors are expected to shrink over time, such as grain production, as we have discussed above, and the production of cotton, oil crops and sugar crops (Wang 1997; Development Research Center 1998). Other sectors such as livestock and horticulture are expected to expand with trade liberalization. To get a better understanding of the impacts of trade liberalization on agricultural employment, this study will focus on the grain and livestock sectors.

Table 2.17 presents our rough estimates of the changes in employment in grain production in 2000-2005. The changes in employment are calculated by comparing the production changes in the free trade scenario over the baseline scenario given the parameters for input (labor) and grain output. Full rural employment for a laborer is defined as 255 working days (= 1 man-year). As the table shows, the grain production sector would lose 2.62 million man-years during 2000-2005 under the free trade scenario compared to the baseline scenario. However, the employment changes vary among various grains. Rice production would increase employment by 1.17 million man-years. The most significant employment loss is found in wheat and maize production. Wheat production would lose 1.14 million man-years and maize production would lose 2.31 million.

In contrast, the animal production sectors would create relatively large rural employment opportunities after trade liberalization. As the table shows, animal production sectors would generate a total of 1.21 million rural man-years of employment. Among them, the employment increase in pork production accounts for 73%. For grain and livestock sectors as a whole, a net reduction of employment due to the free trade (vs the baseline scenario) would be about 1.41 million man-years. While we are not able to estimate the impacts of trade liberalization on other crop production due to lack of data, the reduction in employment in the production of cotton, oil crops and sugar crops is expected to be larger than the expansion in employment in the horticultural sector for the reasons of relative size of these commodities and possible impacts of trade liberalization on their production. For agriculture as a whole, then a rough estimate of the reduction in employment due to trade liberalization might range from 2 to 2.5 million man-years in the period of 2000-2005.

Table 2.17 Impacts of the free trade regime on agricultural employment in 2000-2005.

	Change in Production (million tons)	Change in Labor Working Days (million working days)	Change in Employment (million man-years)
Grain		-665	-2.62
Rice	5.74	298	1.17
Wheat	-5.06	-290	-1.14
Maize	-10.42	-588	-2.31
Soybean	-0.67	-76	-0.30
Sweet potato	-0.21	-9	-0.04
Potato	-0.09	-5	-0.02
Other grains	0.07	5	0.02
Animal products		310	1.21
Pork	4.28	225	0.88
Beef	0.07	4	0.02
Mutton	0.03	5	0.02
Poultry	1.09	29	0.11
Eggs	1.63	29	0.11
Milk	-0.48	-9	-0.04
Fish	0.64	27	0.11
Total		-355	-1.41

2.5.6.2 Welfare of producers and consumers

The annual welfare changes of producers and consumers for 14 agricultural commodities (seven for grains and seven for animal products) under the baseline and free trade scenarios were estimated based on CAPSiM as described in the sections 2.2 and 2.3. The results of these estimates for the period of 2000-2005 are reported in Appendix Tables 7 and 8. Because all assumptions are the same except for trade policies in the baseline and free trade scenarios, the differences between the estimates in Appendix Tables 7 and 8 measure the impacts of trade liberalization (or free trade in this study) on the welfare of producers and consumers of the selected agricultural products. The differences or the welfare gains/losses of the free trade vs baseline scenarios for both producers and consumers are summarized in Table 2.18.

The results show that all grain producers except rice producers will lose welfare because of trade liberalization. The welfare of wheat producers will decrease by 30.5 billion yuan, maize producers by 50.6 billion yuan, and soybean producers by 8.7 billion yuan from 2000 to 2005. Meanwhile, rice producers will gain from the free trade regime by 14.8 billion yuan in the same period, a value less than one-third of the loss by maize producers. For the grain sector as a whole, the reduction of producer's welfare due to trade liberalization could reach as much as 80.9 billion yuan for the period of 2000-2005 (Table 2.18).

For producers in the livestock and aquatic sectors, the biggest winner is the farmer in hog raising, followed by the farmers producing poultry, eggs and fish (Table 2.18). The farmers in pork production will increase their welfare by 76.4 billion yuan from 2000 to 2005 because of trade liberalization. Dairy farmers and mutton raisers record a net loss in their welfare. However, for the sector as a whole, producers will increase their total welfare by about 99 billion yuan from 2000 to 2005 from trade liberalization (compared to the baseline scenario). Although the gain by livestock and fish producers is larger than the loss by grain producers, if we account for the producer welfare loss of cotton, edible oil, sugar crops and other crops, and possible gains in horticulture, it is likely that the total impact of trade liberalization on the producers' welfare will be negative.

On the consumer size, because of the importance of rice in food consumption and the increase in rice price with trade liberalization, rice consumers' welfare will decline considerably. From 2000 to 2005, rice consumers will lose their welfare by more than 41.4 billion yuan, while the welfare of wheat, maize and soybean consumers generally increases with trade liberalization. In particular, wheat consumers will gain additional welfare by 24.7 billion yuan from 2000 to 2005, a level close to the decline in the rice consumers' welfare. For the grain sector as a whole, grain consumers will increase welfare by only 3.1 billion yuan from 2000 to 20005, or only 500 million yuan annually (Table 2.18).

In the animal product sector, pork consumers will lose their welfare by 30.2 billion yuan in the period of 2000 to 2005, mainly because of the significant difference between the prices of pork under the baseline and the free trade scenarios. Since consumer gains from trade liberalization in beef, mutton and other products (except poultry) are much smaller than the losses in pork, consumer welfare from the consumption of all the animal products will have a net lose of 14.8 billion yuan in the period 2000 to 2005. For all commodities we studied (grains and animal products), compared with the baseline scenario, the free trade policy will reduce consumer welfare by about 11.8 billion yuan in 2000 to 2005 (Table 2.18).

The last panel of Table 2.18 shows the total social welfare changes (or welfare net gains from trade liberalization) between the baseline and the free trade scenarios. The results show that the grain sector will lose total social welfare by 77.9 billion yuan. On the other hand, the animal sector will gain total social welfare (84.1 billion yuan) greater than the losses in the grain sector, leading to a slight increase in total social welfare of 6.3 billion yuan in the entire period of 2000 to 2005 with the free trade scenario (vs the baseline scenario). But it is interesting to note that the relative gains from trade liberalization will increase over time during

the liberalization period. Indeed, the impacts on total social welfare will be negative in the initial years, and then turn positive after 2003.

Table 2.18 Changes in annual welfare gains (billion yuan in 1995 prices) between the free trade and baseline scenarios, 2000-2005.

Component	2000	2001	2002	2003	2004	2005	Total 2000-2005
Producer Welfare Gains	-9.7	-5.7	1.1	6.0	10.9	15.4	18.1
Grain	-8.8	-19.7	-16.7	-14.1	-11.7	-9.9	-80.9
Rice	-3.3	-1.1	2.7	3.7	4.9	5.7	14.8
Wheat	-0.7	-6.7	-6.3	-5.9	-5.6	-5.3	-30.5
Maize	-3.5	-10.6	-9.9	-9.3	-8.7	-8.5	-50.6
Soybean	-0.5	-1.9	-1.7	-1.6	-1.5	-1.4	-8.7
Sweet potato	-0.5	-0.8	-0.7	-0.5	-0.3	-0.1	-3.0
Potato	-0.2	-0.3	-0.3	-0.2	-0.1	0.0	-1.1
Other grains	-0.1	-0.4	-0.4	-0.4	-0.3	-0.3	-2.0
Animal products	-0.9	14.0	17.8	20.1	22.6	25.3	99.0
Pork	-0.5	11.1	13.7	15.4	17.3	19.4	76.4
Beef	-0.1	-0.1	0.1	0.1	0.1	0.1	0.1
Mutton	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	-0.4
Poultry	0.0	2.1	2.5	2.9	3.2	3.6	14.3
Egg	-0.2	1.3	1.6	1.7	1.9	2.1	8.4
Milk	0.0	-1.0	-0.9	-1.0	-1.1	-1.2	-5.1
Fish	0.0	0.6	1.0	1.1	1.2	1.3	5.2
Consumer Welfare Gains	7.0	2.0	-2.1	-4.3	-6.4	-7.9	-11.8
Grain	3.6	3.3	1.4	-0.2	-1.8	-3.1	3.1
Rice	3.5	-6.1	-7.9	-9.2	-10.4	-11.3	-41.4
Wheat	-0.6	7.0	7.1	7.1	7.1	7.0	34.7
Maize	0.3	0.8	0.8	0.7	0.7	0.7	4.0
Soybean	0.5	1.8	1.6	1.4	1.1	1.0	7.3
Sweet potato	0.2	0.1	0.0	-0.1	-0.2	-0.3	-0.3
Potato	0.0	-0.1	-0.1	-0.1	-0.2	-0.2	-0.6
Other grains	-0.2	-0.3	-0.1	-0.1	0.0	0.0	-0.7
Animal products	3.4	-1.3	-3.5	-4.1	-4.6	-4.8	-14.8
Pork	2.2	-4.6	-6.2	-6.8	-7.3	-7.6	-30.2
Beef	0.0	0.9	0.9	1.0	1.0	1.1	5.0
Mutton	0.0	0.7	0.7	0.8	0.8	0.9	3.9
Poultry	0.2	-0.2	-0.2	-0.3	-0.3	-0.3	-1.1
Egg	0.5	0.1	0.0	-0.1	-0.2	-0.2	0.1
Milk	0.1	1.1	1.0	1.0	1.0	1.0	5.3
Fish	0.3	0.7	0.3	0.3	0.3	0.3	2.1
Sum of P. & C. Welfare Gains							
Grain crops	-5.2	-16.5	-15.3	-14.4	-13.5	-13.0	-77.9
Rice	0.2	-5.0	-5.3	-5.4	-5.5	-5.6	-26.6
Wheat	-1.3	0.3	0.8	1.2	1.5	1.7	4.3
Maize	-3.2	-9.9	-9.2	-8.6	-8.0	-7.7	-46.6
Soybean	-0.1	-0.1	-0.1	-0.2	-0.4	-0.5	-1.4
Sweet potato	-0.3	-0.7	-0.7	-0.6	-0.5	-0.4	-3.2
Potato	-0.1	-0.4	-0.4	-0.3	-0.3	-0.2	-1.7
Other grains	-0.3	-0.7	-0.5	-0.4	-0.3	-0.3	-2.6
Animal products	2.5	12.7	14.4	16.0	18.0	20.5	84.1
Pork	1.7	6.5	7.5	8.7	10.1	11.8	46.2
Beef	0.0	0.9	1.0	1.0	1.1	1.2	5.2
Mutton	0.0	0.6	0.7	0.7	0.8	0.8	3.5
Poultry	0.2	1.9	2.3	2.6	2.9	3.3	13.2
Egg	0.3	1.4	1.5	1.6	1.7	1.9	8.5
Milk	0.1	0.2	0.1	0.0	0.0	-0.1	0.2
Fish	0.3	1.3	1.3	1.4	1.5	1.6	7.3
Total Welfare Gains	-2.7	-3.7	-1.0	1.6	4.5	7.5	6.3

Note: Consumer welfare gains for feed grains are not included in grain consumption, but in the animal sector.

3. Effects of Trade Liberalization at the Farm Level

3.1 Selection of location specific agricultural commodities

Trade liberalization has important implications not only for the national aggregate demand, supply, trade and market price, but also for the adjustment of local agricultural production structure and farmers' income. In order to better understand trade liberalization at the local or farm level, we selected three major grain crops (rice, wheat and maize), crops that will be significantly affected by trade liberalization as shown in the previous chapter of this study.

Rice, wheat and maize are also the major crops and play a very important role in China's domestic agricultural economy and international trade. They account for more than 80% of the total grain production and more than three-quarters of the total grain sown area in China. The study of the effects of trade liberalization on the production of these three commodities has special significance both for the local agricultural economy and for farmers' income. In this study, the effects of trade liberalization on the local producers of each grain will be examined at different locations.

3.2 Methodology

Partial budget analysis is generally used to evaluate the effect on farm profits of a proposed change in the way a farm is operated, for example, different methods of weed control, and purchase of equipment for farm operation and doing contract work for other farmers. Basically, the partial budget analysis deals with comparison of both advantages and disadvantage between scenarios with and without the changes. Therefore, those items that remain constant with and without changes such as fixed costs are not considered in the analysis. In this study we use partial budget analysis to evaluate the effects of trade liberalization on farmer's income from production of rice, wheat and maize in various locations across the country.

Crop production output, inputs and price data in the base year (1996-97) are from China's national "Cost of Agricultural Production Survey". This is a unique data set that covers most agricultural commodities in the major agricultural production provinces. This information is generated as part of a data collection program run by the State Price Bureau since the mid-1970s (SPB). In the 1996-97 enumeration, over 15,000 households living in more than 2000 counties were questioned about their costs of production for about 50 agricultural commodities. Price Bureau officials claim that they have maintained a random selection process. Data are self-recorded by the households. During the last several years, these data have been published jointly by the State Development and Planning Commission, the State Economic and Trade Commission, the National General Supply and Sales Cooperatives, the Ministry of Agriculture, and the Ministry of Foreign Trade and Economic Cooperation ("The Compiled Materials of Costs and Profits of Agricultural Products of China", SPB, 1988-1998). Based on annual household surveys conducted by county Price Bureau personnel, detailed information is available by crop for over 50 variables, including both revenue and expenditure (in value terms) and quantity data.

In conducting the partial budget analyses for the three selected major grains, the following principles and assumptions are make:

- The base year data are the average of 1996 and 1997 calculated from "The Compiled Materials of Costs and Profits of Agricultural Products of China".
- Rice is measured in paddy form (both quantity and price of rice are in paddy in this chapter, but they are measured as milled rice in other chapters). The conversion rates of paddy to milled rice vary among locations (provinces) and among varieties (i.e., indica and japonica, conventional and hybrid rice), ranging from 0.67 to 0.73. An average value of 0.7 is often used in converting paddy to milled rice at the national level. In our budget analysis, no effort is make to estimate the milled rice conversion rate from paddy for each variety and by location (province). So all rice quantities and prices are measured in paddy as reported by the farmers in the cost and production survey.
- The impacts of trade liberalization on rice, wheat and maize farmers' income are evaluated in 2005, the year when we assume full trade liberalization is implemented. The growth rates of crop yields from the base year to 2005 under the baseline and free trade scenarios are simulated from CCAP's CAPSiM model. According to the CAPSiM yields will increase by 6.41% for rice, 10.24% for wheat and 14.21% for maize in the baseline scenario over the period of 1996/97 to 2005, while grain yields will rise by 8.20% for rice, 9.11% for wheat, and 11.56% for maize in the free trade scenario from the base year (1996-97) to 2005.
- Grain prices in the base year (1996-97) are the actual free market prices in rural local markets, and the grain price changes in the period (1996-97)-2005 for both baseline and free trade scenarios are endogenously determined by the CAPSiM.
- The growth in the variable inputs, except labor input, is assumed to be proportional to their contributions to the yield growth. According to the CAPSiM, the shares of total factor inputs in the yield growth (contribution) are 50% for rice, 51% for wheat and 48% for maize. We further assume that the proportion of each factor input in its contribution to yield change is equal to its share in the total variable costs.
- The prices of chemical fertilizers, plastic film and pesticides are assumed to decline by 10% from 1996-97 to 2005 under the baseline scenario and by 20% in the same period under the free trade scenario.
- The labor input is assumed to decline by 2% annually and the wage rate of labor is assumed to increase by 1% annually from the base year to 2005 for both the baseline and free trade scenarios.

The partial budget analysis is conducted for three cases: the actual level in the base-year (1996-97), the baseline scenario in 2005, and the free trade scenario in 2005. Based on these analyses, a comparison is made to examine the differences between the baseline and free trade scenarios in 2005.

3.3 Specification of variable costs and returns

In general, partial budget analysis involves estimating the costs and returns that are due to the changes. These cost and return variables are discussed and specified in the following paragraphs.

The costs of production are divided into variable costs and fixed costs. In the partial budget analysis, we consider only the variable costs, particularly for the tradable inputs. Variable costs in grain production include the costs of seeds and seedlings, fertilizers, farm plastic film, pesticides, animal labor, machinery and equipment, irrigation and fuel, labor, and other material inputs. In the analysis, both production and input costs are normalized to a per hectare basis. Thus, all values are in yuan per hectare (8.3 yuan = 1 US$ in 1996-97).

Seeds and seedlings include purchased seeds and seedlings and farmer grown seeds and seedlings used in the production of crops. The costs of seeds and seedlings are calculated by

using the market retail prices of the seeds and seedlings multiplied by the quantity of seeds and seedlings used in the crop production.

Fertilizer includes both organic and chemical fertilizers. The cost of organic fertilizers (farmyard manure, compost manure, animal droppings, green manure and other) is estimated by the farmers based on the effort in collecting the organic fertilizer and the actual costs related to applying organic fertilizers before moving to the crop field. Chemical fertilizer is one of the major components of grain production inputs. They include nitrogenous fertilizer, phosphate fertilizer, potassium fertilizer, and other inorganic and trace element fertilizers. The market retail prices of these chemical fertilizers are used to estimate the fertilizer cost.

Pesticides and farm plastic film are also frequently purchased inputs in grain production. Farm plastic film is used in the early production stage of crop seedlings to increase soil temperature and prevent cold strike. Pesticides include insecticides, fungicides, herbicides, and other agricultural pharmaceutical.

Animal labor includes hired animal labor and farmer owned animal labor used in crop production. The costs of animal labor are calculated by using the average rental rate of animal labor prevailing in the local market multiplied by the quantity of working days of the animal labor used per hectare of crop production. The costs of machinery and equipment are based on the rental rate of the machinery and equipment prevailing in the local market. Irrigation and fuel costs include the fees paid by the farmer for crop irrigation and the consumption of fuel and electricity power.

Labor includes both hired and family labor. The opportunity cost of family labor is used to compute the family labor cost. Other variable costs are the costs of other variable inputs not specified above but incurred in the production of the crop.

The variable costs are the sum of all input costs listed above. Agricultural tax, land rent and all fixed costs related to crop production are not included in the analysis. Therefore, the actual costs involved in the crop production are higher than the variable costs identified above and defined in this partial budget analysis.

The gross output value includes the main product output value and by-product output value. Market prices are used in estimating both main product and by-product values. It should also be noted that the actual crop output value is normally much smaller than the output value we estimated in this study because not all farm crop products are sold at market prices. Policy intervention in the grain market (through state grain procurement system) has heavily taxed agriculture in most periods of the last four decades in China (see section 2.4.2).

We define the difference between the gross output value and the variable costs as "quasi-revenue". This quasi-revenue has no specific meaning except for estimating income changes due to trade liberalization (relative to the baseline scenario). We use this special term, quasi-revenue instead of net income, for three reasons: i) the gross output value is not the actual value received by farmers for the reasons explained above; ii) the variable costs only cover a part of the total production costs; and iii) the difference between the gross output value and the variable costs is not the net income or profit received by farmer.

3.4 Partial budget analysis

3.4.1 Rice

Rice is the largest grain crop both in terms of sown area and production in China. In the period of 1995 to 1997, the annual sown area of rice was 31 million hectares with an annual rice production of 170 million mt measured in paddy (119 in milled rice), which accounted for 28% of China's total grain sown area and 31% of China's total grain production, respectively. Both indica and japonica rice are grown in China. Indica rice is mainly grown in the southern part of China, accounting for nearly 90% of the total rice in the 1970s and less than 80% in the 1990s. Japonica rice is mainly grown in the northern part of China. While the share of japonica

rice in national rice production is small, it has been increasing over time from about 10% in the 1970s to more than 20% in the mid-1990s.

Indica rice can be planted in different seasons during the cropping year in the southern part of China. Based on the rice cropping pattern and planting season, indica rice is further divided into the early season indica rice (normally followed by late season indica rice), the middle season indica rice (planting one season of rice followed by another non-rice crop during a cropping year), and late season indica rice (the major cropping pattern is rice-rice). Japonica rice is mainly planted in northern China with one crop season per year, or followed by non-grain and short growing period crops such as vegetables within one cropping year. Traditionally, China has been a major rice exporter in the world. However, with increases in the population and income, domestic rice consumption has been growing faster than production since the 1980s. Rice export has presented a declining trend since the middle 1980s.

Because the costs and prices of rice production vary by rice variety, we examined the effects of trade liberalization on rice farming in China both at the aggregate level (for all rice weighted by the sown area) and by province and by the four major categories of rice, namely early season indica, middle season indica, late season indica, and japonica rice.

Table 3.1 reports the partial budget analysis of rice production (for all varieties of rice) in the base year (1996-97) and in 2005 under the baseline and free trade scenarios in China as a whole. As the table shows, the quasi-revenue (gross value net of variable cost) of rice production increases over time under both scenarios. It rises from 4,333 yuan/ha in the base year to 5,860 yuan/ha in 2005 for the baseline scenario, and from 4,333 yuan/ha to 6,578 yuan/ha in the same period for the free trade scenario. The difference between the net return over variable costs under the above two scenarios represents a maximum impact of trade liberalization on rice producer's income measured on a per hectare basis in 2005. The results show that rice farmers will be better off with trade liberalization. Rice producer income per hectare will rise by 718 yuan, or a 12.24% increase over the baseline quasi-revenue in 2005.

Several factors contribute to the rise in rice producer income with trade liberalization. Trade liberalization will raise the domestic rice price and lower the prices of most agricultural inputs, particular chemical fertilizer and pesticides. The changes in this price structure of inputs and outputs will induce not only changes in rice yield, but also in the cost of rice production. Rice yield per hectare under the free trade scenario will be 0.112 ton (or 1.66%) higher than that in the baseline scenario in 2005 (Table 3.1). The combined impacts of rising price and yield of rice due to trade liberalization will lead to a total output value gain of 592 yuan/ha, or an increase of 5.26% in the output value over the baseline scenario. Moreover, trade liberalization will reduce rice production cost by 126 yuan/ha because of the lower input prices paid by farmers.

Table 3.2 presents a summary of the partial budget analysis results for the four different rice varieties. Japonica rice has the highest income per hectare regardless of the base year or in 2005 under the both scenarios, followed by middle reason indica rice. The early and late reason indica rice are the least profitable rice types. However, despite the larger differences in the rice yields, unit production costs and profitability among various rice varieties, the impacts of trade liberalization on rice farming are very similar across the varieties. The japonica rice farmer gains the most (869 yuan/ha), or 216 yuan/ha or 251 yuan/ha more than the farmer who plants late reason rice and the early season rice, respectively, in 2005. Gains in rice farming income come from both the increase in output value as a result of increase in rice price and yield, and the decline in most rice input prices therefore reducing the cost of rice production. In general, the reduction of production cost accounts for nearly 20% of the total gains from trade liberalization, while increasing the output and rice price account for about 80% in 2005.

In relative terms, the results in the Table 3.2 are consistent with those presented in Table 3.1. Trade liberalization will reduce rice production cost by 2-3% and increase the rice output

value by more than 5% by 2005. The total gains from liberalization will reach a level equal to about 10-15% of the quasi-revenue from per hectare rice production in 2005.

Table 3.1 Partial budget analysis of rice production in China: baseline versus free trade scenarios.

Item	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value (yuan/ha)	10,072	11,255	11,847	592	5.26
Yield (ton/ha)	6.342	6.750	6.862	0.112	1.66
Price (yuan/ton)	1,504	1,579	1,635	56	3.55
Output value (yuan/ha)	9,539	10,659	11,220	561	5.26
By-product (yuan/ha)	533	596	627	31	5.20
b) Variable costs (yuan/ha)	5,736	5,395	5,269	-126	-2.34
Seeds and seedlings	312	328	340	12	3.57
Organic fertilizer	152	152	152	0	0.02
Chemical fertilizer	1,117	1,011	900	-111	-10.96
Plastic film	46	42	37	-5	-11.10
Pesticides	227	205	182	-23	-11.08
Animal labor	329	330	330	0	0.05
Machinery	231	231	231	0	0.04
Irrigation and fuel	258	258	259	0	0.04
Labor	2,932	2,706	2,706	0	0.00
Other variable costs	131	131	131	0	0.02
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)	4,333	5,860	6,578	718	12.24

Note: Some figures may not add up due to rounding errors.
Source: Authors' estimates.

The partial budget analysis of rice production at the national level reveals that rice production will be more profitable after trade liberalization. However, China is a large country with not only a wide range of natural endowments but also different levels of economic development among provinces. The impacts of trade liberalization on rice producer income by both variety and province are conducted and presented in Appendix Tables 9-12.

As Appendix Tables 9-12 show, the gains from liberalization vary among provinces. For the early season indica rice, Fujian, Guangxi, and Guangdong (South China) will have relatively large gains of 759 yuan/ha, 739 yuan/ha, and 689 yuan, respectively, in 2005 (Appendix Table 9), while the gains in rice income for rice farmers in Hunan, Zhejiang, Hubei and Jiangxi (Central and East China) will be below 600 yuan per hectare in 2005. It is interesting to note that the relatively low income gain from trade liberalization (it is still substantial) for the rice farmer who plants early season rice in Central and East China is compensated by their relatively greater income gains from the production of the middle and late season rice (Appendix Tables 10-11).

Table 3.2 Partial budget analysis of the rice production by variety in China: baseline versus free trade scenarios.

Item	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Early season indica rice					
a) Gross value (yuan/ha)	8,893	9,926	10,448	522	5.26
b) Variable cost (yuan/ha)	5,818	5,460	5,329	-131	-2.40
c) (a)-(b) (yuan/ha)	3,075	4,466	5,119	653	14.62
Middle season indica rice					
a) Gross value (yuan/ha)	10,762	12,031	12,663	632	5.25
b) Variable cost (yuan/ha)	5,320	5,005	4,903	-102	-2.04
c) (a)-(b) (yuan/ha)	5,442	7,026	7,760	734	10.45
Late season indica rice					
a) Gross value (yuan/ha)	8,382	9,372	9,865	493	5.26
b) Variable cost (yuan/ha)	5,301	4,973	4,848	-125	-2.51
c) (a)-(b) (yuan/ha)	3,081	4,399	5,017	618	14.05
Japonica rice					
a) Gross value (yuan/ha)	12,237	13,694	14,413	719	5.25
b) Variable cost (yuan/ha)	6,405	6,061	5,911	-150	-2.47
c) (a)-(b) (yuan/ha)	5,832	7,633	8,502	869	11.38

Source: Authors' estimates.

In general, japonica rice production in China is more profitable than indica rice production. However, japonica rice is limited only to the northern part of China and production expansion is highly dependent on the availability of water in northeast and north China. Caution should be taken in interpreting the results from Appendix Table 12 as in our simulation analysis, we do not account for water constraints in expanding rice production in northeast and north China. Given this limitation (or assumption), compared to the indica varieties, the results presented in Appendix Table 12 indicate that the rice farmer in northern China (northeast and north China, where japonica rice dominates) will gain much more than the rice farmer in southern China (where indica dominates rice production).

3.4.2 Wheat

Wheat is the second largest crop in terms of sown area and the third largest crop in terms of production in China. In the period of 1995 to 1997, the annual sown area of wheat was 29 million hectares with an annual wheat production of 106 million mt, which accounted for 27% of China's total grain sown area and 25% of China's total grain production. The northern provinces are the main wheat production regions in China. However, wheat is also grown in some southern provinces. China's domestic wheat production is short of its domestic consumption. Consequently, China has to import a large quantity of wheat from the international market to meet its domestic consumption each year. The annual import of wheat averaged more than 10 million mt in 1980-97.

Table 3.3 reports the partial budget analysis of wheat production in China. As the table shows, in the base year of 1996-97, the gross value of wheat production was 6,575 yuan per hectare, the variable costs of wheat production were 4,359 yuan per hectare, and the quasi-revenue was 2,217 yuan per hectare, which is less profitable than rice production in China.

In contrast to rice production, trade liberalization will have a significant negative impact on the wheat producer's income. For example, under the free trade scenario, the per hectare gross value of wheat production will only be 5,808 yuan in 2005, 1,521 yuan less than the baseline scenario in the same year (Table 3.3). Although the variable costs of wheat production per hectare will decline by 211 yuan, the income loss due to the trade liberalization is projected to be as high as 1,310 yuan per hectare in 2005, or a decrease of 40.89% in the quasi-revenue. The large decline in wheat farmer's income is mainly caused by the sharp fall of the wheat price

after trade liberalization. As Table 3.3 shows, after trade liberalization the wheat price will fall by 19.93% compared to the wheat price under the baseline scenario in 2005.

Table 3.3 Partial budget analysis of wheat production in China: baseline versus free trade scenarios.

Item		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value	(yuan/ha)	6,575	7,329	5,808	-1,521	-20.75
Yield	(ton/ha)	4.028	4.450	4.405	-0.045	-1.01
Price	(yuan/ton)	1,511	1,525	1,221	-304	-19.93
Output value	(yuan/ha)	6,087	6,787	5,379	-1,408	-20.75
By-product	(yuan/ha)	488	542	429	-112	-20.75
b) Variable costs	(yuan/ha)	4,359	4,126	3,915	-211	-5.11
Seeds and seedlings		471	478	383	-96	-19.98
Organic fertilizer		180	181	181	0	0.00
Chemical fertilizers		1,024	933	828	-105	-11.23
Plastic film		10	9	8	-1	-11.11
Pesticides		91	82	73	-9	-11.12
Animal labor		138	139	139	0	-0.02
Machinery		370	372	371	0	-0.05
Irrigation and fuel		211	211	211	0	-0.03
Labor		1,809	1,667	1,667	0	0.00
Other variable costs		53	53	53	0	0.00
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)		2,217	3,203	1,893	-1,310	-40.89

Source: Authors' estimates.

The extent of the trade liberalization impact on wheat farmer's income varies among regions. Wheat is mostly planted and is more profitable in northern China (Appendix Tables 13 and 14). In the base year (1996-97), the quasi-revenue of wheat production was 2,959 yuan per hectare in northern China, a value much higher than that in southern China (only 955 yuan per hectare). Trade liberalization will reduce the wheat farmer's quasi-revenue from 2,959 yuan per hectare in 1996-97 to 2,548 yuan per hectare in 2005 in northern China. Compared to the baseline scenario, there is a net income reduction of 1,472 yuan per hectare due to trade liberalization in 2005 (Appendix Table 13). The quasi-revenue in southern China under the free trade scenario will only be about 813 yuan per hectare in 2005, an income level that will hardly make the wheat producer survive (remember the quasi-revenue we computed in this study does not net all fixed costs, land rent cost, tax and others, and does not consider the divergence of state procurement prices from the market price). Wheat producers will hardly make a profit in most of the northern provinces (Appendix Table 15) and will lose money (negative profit) in all southern provinces if the wheat market is liberalized (Appendix Table 16).

3.4.3 Maize

Maize is the third largest crop in its sown area (behind rice and wheat) and the second largest crop in output (behind rice only) in China in recent years. In the period of 1995 to 1997, the annual sown area of maize was 23 million hectares with an annual maize production of 114 million mt, which accounted for 21% of China's total grain sown area and 27% of China's total grain production. Maize has been produced in many parts of China, but is concentrated more in the northern and the south-west provinces. China has been a net maize exporter since the mid-1980s. However, with the fast increase in feed grain demand resulting from the rapid growth of demand for meat, China's domestic maize production will not match domestic consumption in the near future.

Table 3.4 reports the impact of trade liberalization on maize farmers' income based on a partial budget analysis. As the table shows, in the base year of 1996-97, the quasi-revenue of

maize production was 2,483 yuan per hectare, which is much less than the income in rice production but slightly higher than that in wheat production in China.

Table 3.4 Partial budget analysis of maize production in China: baseline versus free trade scenarios.

Item	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value (yuan/ha)	6,786	8,927	6,455	-2,472	-27.69
Yield (ton/ha)	5.488	6.262	6.116	-0.146	-2.327
Price (yuan/ton)	1,129	1,302	964	-338	-25.98
Output value (yuan/ha)	6,196	8,153	5,896	-2,258	-27.69
By-product (yuan/ha)	587	774	560	-214	-27.69
b) Variable costs (yuan/ha)	4,301	4,085	3,880	-204	-5.00
Seeds and seedlings	289	334	247	-87	-26.04
Organic fertilizer	185	185	185	0	-0.05
Chemical fertilizers	1,015	928	823	-106	-11.37
Plastic film	56	50	45	-6	-11.13
Pesticides	58	52	46	-6	-11.13
Animal labor	212	213	213	0	-0.06
Machinery	172	172	172	0	-0.05
Irrigation and fuel	159	159	159	0	-0.05
Labor	2,106	1,941	1,941	0	0.00
Other variable costs	51	51	51	0	-0.01
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)	2,483	4,843	2,575	-2,268	-46.83

Source: Authors' estimates.

The results presented in Table 3.4 indicate that the impact of trade liberalization on the maize farmer's income is substantial. Under the free trade scenario, the gross value of maize production will be 6,455 yuan per hectare in 2005, a decline of 2,472 yuan per hectare over the baseline scenario. The quasi-revenue of maize production will decline by 2,268 yuan per hectare, a decline of 46.83% in the quasi-revenue in 2005. This large decline in the maize farmer's income is mainly caused by the sharp fall of maize price after trade liberalization. With trade liberalization maize prices will fall by 25.98% over the baseline in 2005.

A further detailed analysis of trade liberalization by region and by province indicates that the largest losers in maize production will be in Shaanxi, Jilin, Gansu and Liaoning in northern China, and Hubei, Guangxi, Sichuan and Guizhou in southern China.

4. Prospects and Strategies

The conclusions and policy implications of this section are drawn from the overall study of the trade liberalization project in China that includes two stages. The first stage focuses on an institutional study of international agricultural trade liberalization, which was reported as Working Paper 42 of the CGPRT Centre. The second stage presented in this report focuses on commodities and local agricultural studies related to trade liberalization.

4.1 Institutions, policy and trade patterns

4.1.1 Reforming China's external sector

Reform and trade liberalization in China's external sector, because of its strategic role in the economy, has proceeded gradually. Gradual trade liberalization in step with reforms in other sectors of China's economy has its logic. In the initial stage, reformers only implemented measures that provided incentives to sets of corporations and institutions and did not alter or only partially altered the institutional structure that was set up to achieve the objectives of foreign trade (i.e., food self-sufficiency in the agricultural sector). As experience was gained from the growing reforms and the objectives of trade could be achieved through alternative settings of institutions and policies, trade liberalization has processed smoothly since the late 1980s.

This study shows that the highly centralized and monopolized foreign trade operation system has been gradually reformed and decentralized through granting trade rights to more trade corporations and production firms in the past two decades. The trade planning system has gradually moved from a strictly mandatory plan to a combination of mandatory and guidance plan with flexible adjustments based on the market situation. The planning system was first replaced by quota and licensing systems, and then moved to a tariff-quota system.

While state trading and decision making processes are still concerns of many negotiators in China's access to WTO, foreign trade corporations and companies have been gradually reformed and largely commercialized by reducing government direct administrative intervention and by introducing trade instruments to manage foreign trade. The commercialization of state trade corporations was initially promoted by introducing the trade contract responsibility system, and then by transforming trade companies into handling agents and letting trade companies deal in their commodities based increasingly on market forces, and implementing various other trade related policies on monetary, foreign exchange, financial and trade controls. The trade regime has also been gradually moving from an import substitution system to a more export-oriented system. The major policies introduced to improve the efficiency and responsiveness of state trading and to promote exports include introducing the export tax rebate policy, implementing the trade contract responsibility system, reducing the number of commodities requiring import and export licenses, reducing tariffs, and shifting the management of foreign exchange, etc.

The move toward a more market-oriented trade system is indicated by various aspects of China's trade policies and trade patterns. The centralized trade management and operation system was first replaced by the foreign trade contract responsibility system, which was then replaced by a tax system; the foreign exchange retention system was abolished and replaced by a foreign exchange bank settlement system; a single managed floating foreign exchange system was introduced in 1994; government export subsidies were phased out; and the financial system related to foreign trade was adjusted to meet the reformed trade system.

Foreign exchange controls, though still highly interventional, have been relaxed significantly since the late 1980s by introducing the foreign exchange retention system and establishing foreign exchange swap centers in the early reform period, and the two-tier exchange rate was consolidated in December 1993. The RMB became convertible on current accounts at the end of 1996. While tariffs now are still high compared to the existing WTO member countries and some non-tariff measures are commonly applied to "strategic products" such as agricultural and food products, foreign trade control in China has also been significantly liberalized since the early 1990s. China's average tariffs were reduced from 47.2% in 1991 to 17% in 1998, a level considered to be very low for a developing country. Apart from these, China has actively participated in consultations on tariff-related actions for early voluntary sectoral liberalization. China's simple average agricultural import tariff was reduced from 42.2% in 1992 to 23.6% in 1998.

During the 1980s China extensively used quotas and licensing to control its foreign trade. However, since the early 1990s China has progressively and drastically reduced the number of items subject to export and import quotas and licensing administration. The products subject to quota, licensing and other import control measures accounted for only 5% of the total import tariff lines in 1998.

In summary, through nearly 20 years of reform, China's foreign trade regime has gradually changed from a highly centralized, planned and import substitution regime to a more decentralized, market-oriented and export promotion regime. While significant progress has been made since the economic reforms in liberalizing the trade regime, China's foreign trade regime still has major inefficiencies. The issues related to state trading in some agricultural products are major concerns of China's trade partners.

4.1.2 Changing agricultural trade patterns

Reforms of the economy in general and international trade in particular have significantly impacted on the economic structure and patterns of international trade in China. Economic reform resulted in considerable growth of the national economy and dramatically changed the structure of China's economy in general and agriculture in particular. The results of this study also show that more rapid growth and trade pattern changes are recorded for China's external sector. Because China's overall trade growth has been much faster than that of agricultural trade, the importance of agricultural trade in China's total trade has declined considerably since 1980 and particularly since the early 1990s.

Within various agricultural commodity trades, this study reveals two main points. First, the patterns of China's agricultural trade were consistent with China's domestic resource endowments during the reform period. China was a net exporter of labor intensive and labor/capital intensive agricultural products, such as horticultural products, animal products and processed agricultural products, and was a net importer of land intensive agricultural products, such as grains, cotton, and edible vegetable oils in the past. Second, the study shows that since 1985, when the external trade reforms were initiated, the patterns of China's agricultural trade, particularly the patterns of agricultural exports, have been gradually moving more closely towards reflecting China's resource endowments.

However, this study also reveals that room for the further liberalization exists in terms of limiting non-tariff measures to control agricultural imports, further commercializing state trading, and improving the efficiency of the foreign trade management. Indeed, China has decided to take further trade liberalization steps in the coming years. This is indicated by in the recent Joint China-US Statement signed by China Premier Zhu Rongji and US President William Jefferson Clinton on the Status of Negotiation on China's accession to the World Trade Organization in April 1999.

4.2 The impact of trade liberalization

4.2.1 Demand, supply and trade balance

Our simulation results show that the impacts of trade liberalization on China's agriculture are significant not only on agricultural prices and trade, but also on domestic production and consumption. Under the free trade scenario, a fall in the domestic price of grain raises grain consumption and slows down the production. Our projection shows that China's domestic grain production will fall far behind domestic grain consumption under the free trade scenario. Compared to the baseline scenario, the grain deficit between domestic supply and demand will be further increased. China's net grain imports would rise to about 60 million mt in 2005 if the grain market were liberalized. Among these, 40 million mt or two-thirds of the imported grains are maize.

Our study also concludes that maize, the third major crop just behind rice and wheat, will soon increase over rice and wheat, and become a top crop in terms of the quantity of its domestic consumption (demand), and also it will soon become the number one imported crop product in China. China will likely be one of the world's largest importers of maize in the coming years if the market were fully liberalized. In contrast to what many scholars believe, while trade liberalization will raise wheat import in the short run, the wheat import will soon decline after the initial shock of trade liberalization. China will become nearly self-sufficient in wheat in the long term (by 2020).

On the other hand, China is likely to be one of the major exporters of livestock products in the world. Pork and poultry exports will expand profoundly with trade liberalization. Trade liberalization will tend to raise domestic animal product prices to levels in the world market. The interesting point is that feed grain consumers are the animal product producers. Thus, the producers of animal products will have double gains (lower production costs as the feed price declines and higher meat price) with a more liberalized economy. Consequently, there will be an expansion in the production of animal products, particularly the production of pork and poultry, in China after trade liberalization.

In relation to food security and grain self-sufficient issues, our study shows that a completely liberalized economy in the short term will challenge the current food security goal defined by the government. China's grain self-sufficiency rate will decline rapidly from 98% in the mid-1990s to less than 90% in 2005 if the free trade regime is assumed by the year 2005. However, it is worth noting that this is an extreme case, representing a maximum impact of trade liberalization on China's grain economy. The actual impacts of China's joining the WTO will be lower than the results from this free trade scenario.

There are also other factors which may keep China from becoming too large an importer in the world grain markets:

- In response to large Chinese imports world grain prices would certainly rise to and might go much beyond our projections. This would dampen Chinese grain demand and stimulate domestic supply.
- There may be major foreign exchange constraints to importing such large quantities of grain annually. Either government policy makers will not allocate foreign exchange for additional grain imports, or exchange rate movements will discourage imports.
- Limitations on the ability of China's ports and other parts of the nation's transportation and marketing infrastructure to handle large quantities of grains may constrain import levels in the short term.
- If massive grain imports threaten China's food security, China might reduce livestock product exports and therefore reduce grain (i.e. maize) import.
- Because the extent of the shock to China's grain economy from trade liberalization will largely depend on the length of the transition period, China could minimize this short term shock through the minimal market accession, setting a reasonable level for

the above quota tariff, and other measures that could be adopted under the WTO framework.

In the long term, our study shows that the most effective policy that could improve China's food security and raise the grain self-sufficiency level is to increase agricultural productivity enhancement investment such as agricultural R&D and rural and agricultural infrastructure and irrigation. If these policies are formulated properly, China could achieve its grain self-sufficiency target in the second decade of the next century even if the grain market is completely liberalized in 2000-2005.

4.2.2 Welfare and employment

The welfare analysis of this study reveals that trade liberalization will generally be unfavorable to grain producers but favorable to the livestock and fish producers in China. In terms of consumers, trade liberalization will raise their welfare in grain, while reducing their welfare in the meat sector. For overall social welfare, our study shows that the social welfare gained from liberalization within the agricultural sector is minimal, but the welfare changes differ significant among agricultural products, between producer and consumer, and over time.

The impacts of trade liberalization on agricultural employment in this study are surprisingly lower than those found in other studies for China, but they are consistent with the actual employment changes observed in Mexico and other developing countries during the period of liberalizing their economies. But a significant impact of the trade liberalization is found for maize and wheat. Maize production would lose employment by more than 2.3 million man-years and wheat by 1.14 million man-years in 2000-2005. Employment expansion in the rice and livestock sector will not be able to fully offset the decline in employment in the crop sector. For agriculture as a whole, a rough estimate of 2.5 million man-years will be lost in the period of 2000-2005.

4.2.3 Local farmer's income

The impacts of trade liberalization at the local farm level are examined for rice, wheat and maize, the three most important crops in China. The results show that rice farmers in China will be one of a few winners within the agricultural sector in the process of trade liberalization. The gains come essentially from a rise in the domestic rice price and decreasing production cost, as most agricultural input prices will fall with trade liberalization. These gains from the liberalization are found for all rice producers in China, but the gains vary among provinces and by variety.

The partial budget analyses also demonstrate that wheat and maize production would be much less profitable after trade liberalization. Farmer's income from wheat and maize production will decline significant with trade liberalization as the large decline in output prices could not be compensated for by the cost reduction from cheaper imported agricultural inputs. Most maize and wheat farmers in southern China might record a negative profit if opportunity costs of family labor are accounted for in crop production.

4.3 Policy implications

Policy implications from the findings in this study are straightforward. Some of the most important policy issues that require immediate action if China decides to further liberalize its economy include continually reforming both domestic marketing and the external trade system, refining food security or grain self-sufficiency goals, increasing investment in agricultural research, extension and infrastructure, improving tax and income redistribution policies, alleviating unemployment problems for those who will be severely affected by trade

liberalization (particularly the poor), and creating awareness of the impacts of trade liberalization on China's economy.

China should allow a greater role for the market to determine trade patterns in order to reap comparative advantage gains. This would probably mean increased overall agricultural trade and a shift towards importing more land-intensive agricultural products and exporting more labor-intensive agricultural products. Policy steps to achieve comparative advantage gains might include removing implicit taxes on farmers and reforming the domestic grain pricing and marketing systems. In the past, China's agricultural policy on domestic agricultural product marketing was biased against producers. Domestic prices and marketing prices have consistently represented a tax on farmers in most periods. Moreover, the most heavily taxed commodities are the exportable agricultural commodities.

Further commercialization of the state trading system to improve the efficiency of foreign trade under a more liberalized economy is essential for China to maximize its potential gains in some sectors and/or to minimize its likely losses in other sectors of the economy due to trade liberalization. Limited grain handling and internal transport capacity and inadequate port capacity to deal with the increasing external trade will be some of the constraints shaping China's economy.

China will face great challenges in meeting its grain (including food and feed grain) self-sufficiency goal defined by the government. China's grain self-sufficiency rate will decline significantly with trade liberalization, and the grain import (mainly feed grain) will surge within a relative short time period. But it is interesting to note that the shocks from trade liberalization on China's grain balance differ largely between food and feed grains. Maize will be the major imported grain, and our study shows that a large part of the imported maize will be used in producing additional livestock products for export. Therefore, if a food grain (rice and wheat) self-sufficiency concept, instead of the total grain self-sufficiency concept, could be adopted by policy-makers, China would benefit greatly from realizing its full gain in trade liberalization by shifting more land from the production of feed grain to exportable products (i.e., horticultural products).

The extent of the shock to China's agriculture from trade liberalization varies between the short and the long term. Given the scarcity of land resources in China, to maintain a high level of food security and keep the comparative advantage of China's agriculture from declining over time, China has to raise its investment in agricultural research and extension, irrigation, and other productivity-enhancing activities. This will be one of the most effective measures to reduce China's grain imports and expand labor intensive agricultural product export. If these policies are formulated properly, China could achieve its grain self-sufficiency target in the second decade of the next century, even if the grain market is completely liberalized in 2000-2005.

However, the recent decline of the government's budgetary commitment to research has weakened the system. The agricultural technology extension system needs to be strengthened. Development of an efficient seed industry is not without roadblocks, as appropriate supporting institutions (i.e. eliminating entry barriers, allowing the market to set prices, phasing out subsidies, and developing intellectual property rights) take time to mature. A better incentive system is needed to encourage both public and private investment in agriculture.

In the short term, there are also a number of policies available for China to maximize its gains and minimize its losses from trade liberalization. Because the extent of the shocks to China's grain economy from trade liberalization will largely depend on the length of the transition period, China could minimize this short term shock through the minimal market accession, setting a reasonable level for the above quota tariff, and other measures that could be adopted under the WTO framework.

China's domestic currency has appreciated by about 30% since 1994. A recent study (Huang et. al.1999) found that that a moderate depreciation of the domestic currency by 10%-

15% would completely offset the external shocks on China's grain balance even if China fully liberalizes its grain economy in the next few years.

The impacts of trade liberalization on welfare distribution, on the poor and rural labor employment and income, and social stability will be other important policy issues for China's government to consider in the years to come. New policies are required to minimize any adverse impact of trade liberalization on farm employment, income and welfare re-distributions among farmers and regions, particularly the poor.

While the overall reduction of employment in the agricultural sector is only estimated to be 2-3 million man-years due to trade liberalization, the number of rural labors required to shift from one sector (or commodity) to another could be several times higher than this figure due to structural adjustment within the agricultural sector. The transfer of agricultural labor from one sector to the other is not cost free, particularly the transfer of the poor.

It is true that the poor who have a higher consumption rate of purchased grain will gain from trade liberalization. But those poor whose income has mainly depended on crop products are likely to be affected most. Different production sectors require different production skills. Even within the agricultural sector, transferring from crop farming to animal raising is not as difficult as from an unskilled job to a highly skilled job, but it still involves a period of learning and training to acquire the necessary skills. Access to credit and market information is the other important factor that will help farmers to obtain re-employment in other sectors.

Animal raising is more capital intensive than crop farming. Currently, the shares of large scale specialized animal production are 30% for pork production, 75% for beef production and 90% for poultry production. The tendency towards large scale specialized animal production is increasing. Therefore, the initial capital for undertaking animal production will be relatively high. This higher initial capital requirement would impose financial difficulties for some farmers especially the poor and, therefore, might prevent them from engaging in animal production.

Finally, further efforts should be made to assess the impact of trade liberalization on China's agricultural sector and farmer's income, to increase the awareness of policy-makers and farmers on these impacts, and to create a better trade environment before and during trade liberalization.

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Appendix Tables

Appendix Table 1 Crop area response elasticities in 1996.

Variable	Rice	Wheat	Maize	Sweetpotato	Potato	Other CG	Soybean	Cotton	Oil Crop	Sugar	Vegetable	Other Crops	Fertilizer	Labor	Land	Total
Rice	0.180	-0.024	-0.020	-0.004	-0.002	-0.005	-0.005	-0.005	-0.006	-0.004	-0.008	-0.012	-0.021	-0.040	-0.025	0
Wheat	-0.026	0.250	-0.035	-0.005	-0.003	-0.005	-0.010	-0.010	-0.008	-0.003	-0.008	-0.021	-0.031	-0.056	-0.030	0
Maize	-0.026	-0.042	0.260	-0.008	-0.003	-0.015	-0.010	-0.005	-0.008	-0.001	-0.010	-0.018	-0.028	-0.056	-0.030	0
Sweetpotato	-0.021	-0.024	-0.032	0.220	-0.025	-0.020	-0.015	-0.005	-0.010	-0.005	-0.015	0.033	-0.005	-0.040	-0.035	0
Potato	-0.017	-0.024	-0.020	-0.041	0.290	-0.020	-0.025	-0.005	-0.005	-0.005	-0.020	-0.034	-0.005	-0.040	-0.030	0
Other CG	-0.016	-0.015	-0.038	-0.012	-0.008	0.270	-0.015	-0.008	-0.015	-0.010	-0.015	0.002	-0.010	-0.065	-0.045	0
Soybean	-0.021	-0.040	-0.033	-0.012	-0.013	-0.020	0.260	-0.005	-0.025	-0.005	-0.008	-0.009	-0.010	-0.030	-0.030	0
Cotton	-0.033	-0.063	-0.026	-0.006	-0.004	-0.016	-0.008	0.250	-0.010	-0.001	-0.005	0.000	-0.020	-0.030	-0.028	0
Oil crop	-0.015	-0.019	-0.016	-0.005	-0.002	-0.012	-0.015	-0.004	0.260	-0.010	-0.010	-0.049	-0.025	-0.045	-0.035	0
Sugar crop	-0.068	-0.048	-0.013	-0.016	-0.010	-0.053	-0.020	-0.003	-0.068	0.390	-0.005	-0.015	-0.020	-0.025	-0.025	0
Vegetable	-0.024	-0.023	-0.023	-0.009	-0.007	-0.014	-0.006	-0.002	-0.012	-0.001	0.340	-0.090	-0.040	-0.055	-0.035	0
Other crops	-0.035	-0.060	-0.043	0.019	-0.013	0.001	-0.007	0.000	-0.060	-0.003	-0.092	0.382	-0.020	-0.040	-0.030	0

Sources: Huang and Rozelle 1998; Huang and Li 1999.

Appendix Table 2 Crop yield response elasticities in 1996.

Variable	Rice	Wheat	Maize	Sweetpotato	Potato	Other CG	Soybean	Cotton	Oil Crop	Sugar	Vegetable	Fertilizer	Labor	Res Stock	Irr Stock
Rice	0.1015											-0.062	-0.040	0.310	0.080
Wheat		0.142										-0.093	-0.049	0.345	0.172
Maize			0.1418									-0.084	-0.058	0.416	0.181
Sweetpotato				0.11								-0.050	-0.060	0.350	0.150
Potato					0.11							-0.050	-0.060	0.350	0.150
Other CG						0.13						-0.080	-0.050	0.350	0.141
Soybean							0.0675					-0.038	-0.030	0.350	0.100
Cotton								0.11				-0.100	-0.010	0.243	0.356
Oil crop									0.11			-0.100	-0.010	0.243	0.356
Sugar crop										0.09		-0.080	-0.010	0.243	0.350
Vegetable											0.11	-0.100	-0.010	0.243	0.350

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Appendix Table 3 Supply response elasticity of agricultural research stock.

Commodity	1996-2000	2001-2005
Rice	0.295	0.275
Wheat	0.344	0.305
Maize	0.425	0.425
Sweetpotato	0.425	0.385
Potato	0.425	0.385
Other CG	0.300	0.250
Soybean	0.350	0.350
Cotton	0.243	0.220
Oil Crop	0.243	0.220
Sugar Crop	0.243	0.220
Vegetable	0.300	0.250

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Appendix Table 4 Livestock supply elasticities.

										Feed Efficiency Gain	
Commodity	Pork	Beef	Mutton	Poultry	Egg	Milk	Fish	Maize	Labor	1996-2000	2001-2005
Pork	0.45							-0.3	0	0.039	0.038
Beef		0.38						-0.1	0	0.055	0.045
Mutton			0.38					-0.1	0	0.045	0.043
Poultry				0.55				-0.3	0	0.055	0.050
Egg					0.5			-0.3	0	0.050	0.050
Milk						0.5		-0.2	0	0.080	0.070
Fish							0.55	-0.05	0	0.075	0.065

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Appendix Table 5 Demand elasticities in rural China, 1996.

Variable	Rice	Wheat	Maize	Sweetpotato	Potato	Other CG	Soybean	Sugar	Pork	Beef	Mutton
Rice	-0.290	0.060	0.004	0.002	0.003	0.005	0.002	0.001	0.002	0.001	0.001
Wheat	0.058	-0.275	0.011	0.005	0.005	0.011	-0.005	-0.003	-0.004	-0.001	-0.001
Maize	0.082	0.147	-0.250	0.010	0.010	0.050	0.000	0.002	-0.004	0.000	-0.001
Sweetpotato	0.186	0.356	0.065	-0.250	0.010	0.050	0.000	0.000	0.000	0.000	0.000
Potato	0.186	0.362	0.073	0.011	-0.250	0.005	0.005	0.000	0.010	-0.050	-0.010
Other CG	0.087	0.132	0.042	0.006	0.001	-0.250	-0.001	0.002	0.022	0.001	0.001
Soybean	0.075	-0.159	-0.006	-0.001	0.002	-0.009	-0.301	0.002	0.008	0.004	0.007
Sugar	-0.030	-0.242	-0.002	-0.003	-0.002	-0.003	0.001	-0.600	0.020	0.005	0.005
Pork	-0.063	-0.075	-0.014	-0.003	-0.001	-0.012	-0.002	0.001	-0.538	0.013	0.009
Beef	-0.089	-0.115	-0.017	-0.003	-0.014	-0.019	-0.001	0.001	0.114	-0.755	0.097
Mutton	-0.087	-0.110	-0.018	-0.003	-0.005	-0.019	0.001	0.002	0.097	0.122	-0.803
Poultry	-0.092	-0.132	-0.020	-0.003	-0.002	-0.024	-0.001	0.001	0.142	0.045	0.036
Egg	-0.039	-0.094	-0.010	-0.002	-0.002	-0.011	0.001	0.002	0.101	0.021	0.013
Milk	-0.184	-0.171	-0.014	-0.005	-0.003	-0.027	0.001	0.000	-0.027	-0.013	-0.011
Fish	-0.115	-0.155	-0.021	-0.004	-0.002	-0.025	0.000	0.000	0.023	-0.006	-0.005
Edible oil	-0.063	-0.032	-0.008	-0.003	0.001	-0.010	-0.002	-0.002	0.059	0.007	0.006
Fruit	-0.098	-0.106	-0.010	-0.004	0.000	-0.012	-0.002	0.003	-0.076	-0.013	-0.011
Vegetable	-0.033	-0.068	-0.009	-0.002	-0.004	-0.011	-0.001	0.002	0.020	-0.002	-0.001
Other food	-0.131	-0.133	-0.019	-0.003	-0.002	-0.024	-0.004	-0.001	-0.045	-0.001	-0.001
Non-Food	-0.314	-0.316	-0.039	-0.008	-0.008	-0.046	-0.007	-0.004	-0.182	-0.018	-0.014
Cournot	0	0	0	0	0	0	0	0	0	0	0

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Continued ……

Appendix Table 5 Demand elasticities in rural China, 1996 (continued).

Variable	Poultry	Egg	Milk	Fish	Edible Oil	Fruit	Vegetable	Other Food	Non-Food	Income	HOMO
Rice	0.001	0.001	0.000	0.002	0.001	0.005	-0.005	0.002	0.005	0.200	0.0
Wheat	-0.004	-0.006	0.000	-0.005	0.006	0.004	-0.021	0.003	0.021	0.200	0.0
Maize	-0.003	0.001	0.002	-0.001	0.007	0.013	-0.003	0.006	0.052	-0.120	0.0
Sweetpotato	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	0.020	-0.085	-0.350	0.0
Potato	-0.005	-0.005	0.000	0.000	0.030	0.020	-0.100	0.020	-0.353	0.050	0.0
Other CG	-0.003	0.002	0.001	0.000	0.008	0.014	-0.002	0.007	0.079	-0.150	0.0
Soybean	0.008	0.013	0.005	0.028	0.002	0.011	0.002	0.003	0.159	0.150	0.0
Sugar	0.010	0.010	0.002	0.010	-0.020	0.030	0.015	0.002	-0.007	0.800	0.0
Pork	0.031	0.018	0.002	0.019	0.015	-0.006	-0.007	0.002	-0.037	0.650	0.0
Beef	0.087	0.036	-0.003	-0.013	0.013	-0.024	-0.047	0.011	-0.113	0.854	0.0
Mutton	0.087	0.026	-0.003	-0.013	0.013	-0.024	-0.047	0.011	-0.081	0.854	0.0
Poultry	-0.763	0.086	-0.003	0.037	0.033	0.026	-0.037	-0.004	-0.179	0.854	0.0
Egg	0.086	-0.758	0.049	0.012	0.010	0.006	-0.018	0.014	0.109	0.512	0.0
Milk	-0.026	0.287	-0.905	-0.023	-0.031	-0.044	-0.086	0.003	-0.171	1.450	0.0
Fish	0.020	-0.003	-0.001	-0.666	0.009	0.021	-0.048	-0.002	-0.071	1.050	0.0
Edible oil	0.029	0.005	-0.002	0.023	-0.713	0.002	-0.046	0.013	0.085	0.650	0.0
Fruit	0.019	-0.007	-0.006	0.027	-0.009	-0.781	0.239	-0.007	-0.251	1.103	0.0
Vegetable	0.000	-0.002	0.000	0.001	-0.009	0.087	-0.547	0.011	0.218	0.350	0.0
Other food	-0.006	-0.008	0.001	-0.003	-0.007	-0.003	-0.042	-0.612	-0.080	1.124	0.0
Non-Food	-0.040	-0.030	-0.005	-0.046	-0.035	-0.045	-0.087	-0.093	-1.014	2.349	0.0
Cournot	0	0	0	0	0	0	0	0	0	1	1

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Appendix Table 6 Demand elasticities in urban China, 1996.

Variable	Rice	Wheat	Maize	Sweetpotato	Potato	Other CG	Soybean	Sugar	Pork	Beef	Mutton
Rice	-0.200	0.080	0.003	0.002	0.003	0.003	-0.002	-0.005	-0.030	-0.003	-0.002
Wheat	0.083	-0.250	0.003	0.003	0.003	0.003	-0.003	-0.003	-0.025	-0.006	-0.004
Maize	0.116	0.126	-0.280	0.005	0.005	0.020	0.000	0.002	0.011	0.005	0.003
Sweetpotato	0.199	0.231	0.011	-0.250	0.002	0.020	0.000	0.000	0.000	0.000	0.000
Potato	0.051	0.041	0.002	0.000	-0.200	0.030	0.002	0.000	0.020	-0.050	-0.010
Other CG	0.094	0.102	0.016	0.007	0.058	-0.280	-0.001	0.002	0.021	0.006	0.004
Soybean	-0.043	-0.062	0.000	0.000	0.002	-0.001	-0.250	0.002	0.019	0.002	0.006
Sugar	-0.171	-0.086	0.001	0.000	-0.001	0.001	0.002	-0.600	0.020	0.005	0.005
Pork	-0.043	-0.034	-0.001	0.000	-0.001	-0.001	0.000	0.000	-0.519	0.029	0.023
Beef	-0.041	-0.045	-0.001	0.000	-0.012	-0.001	-0.001	0.000	0.156	-0.774	0.137
Mutton	-0.039	-0.041	-0.001	0.000	-0.004	-0.001	0.000	0.001	0.155	0.170	-0.814
Poultry	-0.046	-0.041	-0.001	0.000	-0.002	-0.001	-0.001	0.000	0.011	0.049	0.039
Egg	-0.024	-0.026	0.000	0.000	-0.001	0.000	0.000	0.001	-0.007	0.006	0.002
Milk	-0.046	-0.041	-0.001	-0.001	-0.003	-0.002	-0.001	-0.001	-0.032	-0.010	-0.008
Fish	-0.038	-0.033	-0.001	0.000	-0.002	-0.001	0.000	0.000	0.030	-0.006	-0.005
Edible oil	-0.013	-0.005	0.000	0.000	0.002	-0.001	-0.001	-0.001	0.050	0.010	0.008
Fruit	-0.034	-0.035	-0.001	-0.001	-0.001	-0.001	-0.002	0.000	-0.055	-0.014	-0.011
Vegetable	-0.039	-0.024	-0.001	0.000	-0.007	-0.001	0.000	0.001	0.051	-0.002	-0.001
Other food	-0.039	-0.035	-0.001	0.000	-0.002	-0.001	-0.002	-0.001	-0.042	-0.005	-0.004
Non-Food	-0.042	-0.038	-0.001	-0.001	-0.003	-0.002	-0.002	-0.001	-0.058	-0.011	-0.009
Cournot	0	0	0	0	0	0	0	0	0	0	0

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Continued …….

Appendix Table 6 Demand elasticities in urban China, 1996 (continued).

Variable	Poultry	Egg	Milk	Fish	Edible Oil	Fruit	Vegetable	Other Food	Non-Food	Income	HOMO
Rice	-0.010	-0.003	0.001	-0.003	0.005	0.012	-0.020	0.015	0.130	0.025	0.00
Wheat	-0.011	-0.009	0.001	-0.004	0.008	0.006	-0.012	0.010	0.107	0.100	0.00
Maize	0.006	0.010	0.003	0.002	0.009	0.018	-0.005	0.018	0.127	-0.200	0.00
Sweetpotato	0.000	0.000	0.000	0.000	0.000	0.000	-0.002	0.020	-0.131	-0.100	0.00
Potato	-0.005	-0.005	0.000	0.000	0.030	0.020	-0.100	0.020	0.054	0.100	0.00
Other CG	0.006	0.011	0.001	0.002	0.009	0.018	-0.005	0.018	0.111	-0.200	0.00
Soybean	0.004	0.009	0.005	0.028	0.003	0.011	0.008	0.001	0.156	0.100	0.00
Sugar	0.010	0.010	0.002	0.010	-0.020	0.030	0.015	0.002	0.216	0.550	0.00
Pork	0.008	-0.006	0.001	0.023	0.018	-0.010	0.019	-0.016	-0.092	0.600	0.00
Beef	0.107	0.008	-0.003	-0.014	0.016	-0.029	-0.018	-0.010	-0.226	0.750	0.00
Mutton	0.107	-0.002	-0.003	-0.014	0.016	-0.029	-0.018	-0.010	-0.224	0.750	0.00
Poultry	-0.693	0.058	-0.003	0.037	0.036	0.021	-0.008	-0.025	-0.179	0.750	0.00
Egg	0.055	-0.578	0.033	0.021	0.021	0.011	0.008	-0.015	-0.003	0.500	0.00
Milk	-0.022	0.095	-0.856	-0.029	-0.030	-0.062	-0.038	-0.044	-0.119	1.250	0.00
Fish	0.026	0.009	-0.004	-0.667	0.012	0.013	-0.013	-0.028	-0.142	0.850	0.00
Edible oil	0.042	0.024	-0.005	0.026	-0.711	-0.001	-0.023	-0.002	0.052	0.550	0.00
Fruit	0.003	-0.012	-0.013	0.001	-0.016	-0.646	0.172	-0.042	-0.462	1.170	0.00
Vegetable	0.004	0.011	-0.002	0.003	-0.012	0.221	-0.618	-0.010	0.047	0.380	0.00
Other food	-0.014	-0.022	-0.002	-0.016	-0.014	-0.011	-0.028	-0.444	-0.416	1.100	0.00
Non-Food	-0.023	-0.025	-0.002	-0.024	-0.016	-0.039	-0.029	-0.116	-0.857	1.297	0.00
Cournot	0	0	0	0	0	0	0	0	0	1	1

Sources: Huang and Rozelle 1988; Huang and Li 1999.

Table 7. Welfare gains (billion yuan in 1995 prices) under the baseline scenario, 2000-2005.

	2000	2001	2002	2003	2004	2005	Total 2000-2005
Producer welfare gains	31.5	29.1	26.4	26.6	26.6	26.8	167.0
Grain	12.7	11.1	9.5	9.0	8.3	7.7	58.3
Rice	4.3	3.1	1.9	1.5	1.0	0.5	12.3
Wheat	1.6	1.4	1.2	1.4	1.5	1.4	8.4
Maize	5.3	5.3	5.1	5.1	5.0	5.1	30.9
Soybean	0.4	0.4	0.5	0.5	0.5	0.5	2.8
Sweet potato	0.6	0.6	0.5	0.4	0.2	0.1	2.3
Potato	0.3	0.2	0.2	0.1	0.1	0.0	0.9
Other grains	0.1	0.1	0.1	0.1	0.1	0.1	0.7
Animal products	18.8	18.0	16.9	17.6	18.3	19.1	108.7
Pork	8.8	8.2	7.4	7.7	7.9	8.1	48.1
Beef	1.3	1.3	1.3	1.3	1.4	1.5	8.1
Mutton	1.0	1.0	1.0	1.0	1.0	1.1	6.1
Poultry	2.3	2.3	2.3	2.4	2.5	2.7	14.5
Egg	1.9	1.8	1.7	1.8	1.8	1.9	11.1
Milk	1.1	1.1	1.1	1.1	1.2	1.3	6.9
Fish	2.3	2.3	2.2	2.3	2.4	2.5	14.0
Consumer welfare gains	87.9	88.4	80.6	85.8	91.2	96.2	530.1
Grain	17.9	19.1	14.7	16.1	17.5	18.6	104.0
Rice	5.1	6.6	4.4	5.5	6.7	7.5	35.9
Wheat	8.6	8.2	6.3	6.3	6.3	6.3	41.9
Maize	-0.4	-0.5	-0.7	-0.7	-0.7	-0.7	-3.6
Soybean	2.6	2.8	2.8	3.0	3.1	3.2	17.6
Sweet potato	1.0	1.1	1.2	1.4	1.5	1.6	7.9
Potato	0.3	0.2	0.2	0.3	0.3	0.3	1.6
Other grains	0.7	0.7	0.4	0.4	0.4	0.3	2.8
Animal products	70.0	69.3	65.9	69.7	73.6	77.5	426.1
Pork	30.7	30.9	29.1	30.8	32.7	34.4	188.5
Beef	3.8	3.6	3.4	3.6	3.8	4.0	22.2
Mutton	2.4	2.4	2.3	2.5	2.6	2.8	15.0
Poultry	7.7	7.4	7.2	7.6	8.0	8.4	46.1
Egg	6.3	6.3	6.2	6.5	6.8	7.0	39.0
Milk	3.2	3.2	2.9	3.1	3.3	3.5	19.3
Fish	15.9	15.6	14.8	15.6	16.5	17.4	95.9
Sum of P. & C. welfare gains							
Grain	30.6	30.2	24.2	25.2	25.9	26.4	162.3
Rice	9.5	9.7	6.3	7.0	7.6	8.0	48.1
Wheat	10.1	9.5	7.5	7.6	7.7	7.8	50.3
Maize	4.9	4.9	4.4	4.4	4.4	4.3	27.3
Soybean	3.1	3.2	3.3	3.5	3.6	3.7	20.3
Sweet potato	1.7	1.7	1.7	1.7	1.7	1.7	10.2
Potato	0.5	0.4	0.4	0.4	0.4	0.4	2.5
Other grains	0.8	0.8	0.5	0.5	0.5	0.5	3.5
Animal products	88.9	87.3	82.8	87.3	91.9	96.6	534.8
Pork	39.5	39.1	36.5	38.5	40.5	42.5	236.6
Beef	5.2	4.9	4.7	4.9	5.2	5.4	30.2
Mutton	3.4	3.4	3.3	3.5	3.7	3.9	21.1
Poultry	10.0	9.6	9.4	10.0	10.5	11.1	60.6
Egg	8.2	8.1	7.9	8.3	8.6	8.9	50.1
Milk	4.3	4.3	4.0	4.2	4.5	4.8	26.2
Fish	18.3	17.9	17.0	17.9	18.9	19.9	109.9
Total welfare gains	119.4	117.5	106.9	112.5	117.8	123.0	697.1

Note: consumer welfare gains for feed grains are not included in grain consumption, but in the animal sector.
Source: Authors' estimates.

Appendix Table 8 Welfare gains (billion yuan in 1995 prices) under the free trade scenario, 2000-2005.

	2000	2001	2002	2003	2004	2005	Total 2000-2005
Producer welfare gains	21.8	23.4	27.5	32.6	37.6	42.2	185.0
Grain	3.8	-8.6	-7.2	-5.1	-3.3	-2.2	-22.6
Rice	1.0	4.2	4.6	5.2	5.8	6.2	27.0
Wheat	0.9	-5.4	-5.1	-4.5	-4.1	-3.8	-22.0
Maize	1.8	-5.3	-4.8	-4.2	-3.7	-3.4	-19.7
Soybean	-0.1	-1.4	-1.3	-1.1	-1.0	-0.9	-5.9
Sweet potato	0.2	-0.3	-0.2	-0.2	-0.1	-0.1	-0.7
Potato	0.1	-0.1	-0.1	-0.1	0.0	0.0	-0.2
Other grains	0.0	-0.3	-0.3	-0.3	-0.2	-0.2	-1.2
Animal products	18.0	32.0	34.7	37.7	40.9	44.4	207.7
Pork	8.3	19.3	21.1	23.1	25.2	27.6	124.5
Beef	1.3	1.3	1.3	1.4	1.5	1.5	8.2
Mutton	0.9	0.9	0.9	0.9	1.0	1.0	5.6
Poultry	2.3	4.4	4.8	5.3	5.8	6.3	28.8
Egg	1.7	3.1	3.3	3.5	3.8	4.0	19.5
Milk	1.1	0.1	0.1	0.1	0.2	0.2	1.8
Fish	2.3	2.9	3.1	3.4	3.6	3.8	19.2
Consumer welfare gains	94.9	90.4	78.5	81.5	84.8	88.2	518.3
Grain	21.5	22.3	16.1	15.9	15.7	15.5	107.1
Rice	8.6	0.5	-3.5	-3.6	-3.7	-3.8	-5.5
Wheat	8.0	15.2	13.4	13.4	13.4	13.3	76.6
Maize	-0.1	0.3	0.1	0.1	0.0	0.0	0.4
Soybean	3.1	4.6	4.4	4.3	4.2	4.2	24.9
Sweet potato	1.2	1.2	1.3	1.3	1.3	1.3	7.6
Potato	0.3	0.1	0.1	0.1	0.1	0.1	1.0
Other grains	0.4	0.4	0.3	0.3	0.3	0.4	2.1
Animal products	73.4	68.0	62.4	65.6	69.1	72.7	411.2
Pork	32.9	26.3	22.9	24.1	25.4	26.8	158.3
Beef	3.9	4.5	4.3	4.6	4.8	5.1	27.2
Mutton	2.4	3.1	3.1	3.3	3.4	3.6	19.0
Poultry	7.9	7.1	6.9	7.3	7.7	8.1	45.0
Egg	6.8	6.4	6.1	6.4	6.6	6.8	39.1
Milk	3.3	4.3	3.9	4.1	4.3	4.6	24.6
Fish	16.2	16.3	15.1	15.9	16.8	17.7	98.0
Sum of P. & C. welfare gains							
Grain	25.3	13.7	8.8	10.8	12.4	13.4	84.4
Rice	9.6	4.7	1.0	1.6	2.1	2.4	21.5
Wheat	8.9	9.8	8.3	8.8	9.2	9.5	54.6
Maize	1.7	-5.0	-4.7	-4.1	-3.7	-3.4	-19.3
Soybean	3.0	3.2	3.2	3.2	3.2	3.2	18.9
Sweet potato	1.4	1.0	1.1	1.1	1.2	1.3	7.0
Potato	0.4	0.0	0.1	0.1	0.1	0.1	0.8
Other grains	0.5	0.1	0.0	0.1	0.1	0.2	0.9
Animal products	91.4	100.1	97.1	103.3	110.0	117.1	618.9
Pork	41.2	45.6	44.0	47.2	50.6	54.3	282.9
Beef	5.1	5.8	5.7	6.0	6.3	6.6	35.4
Mutton	3.4	4.0	4.0	4.2	4.4	4.7	24.6
Poultry	10.2	11.5	11.7	12.5	13.5	14.4	73.8
Egg	8.5	9.5	9.5	9.9	10.3	10.8	58.6
Milk	4.4	4.5	4.1	4.3	4.5	4.7	26.4
Fish	18.6	19.3	18.2	19.3	20.4	21.5	117.2
Total Welfare Gains	116.7	113.8	106.0	114.1	122.3	130.4	703.3

Note: consumer welfare gains for feed grains are not included in grain consumption, but in the animal sector.
Source: Authors' estimates.

Appendix Table 9 Partial budget analysis of early indica rice production by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Zhejiang						
a) Gross value	(yuan/ha)	7,911	8,847	9,312	465	5.26
b) Variable cost	(yuan/ha)	5,129	4,832	4,713	-119	-2.47
c) (a)-(b)	(yuan/ha)	2,782	4,015	4,599	584	14.55
Fujian						
a) Gross value	(yuan/ha)	10,171	11,598	12,208	610	5.26
b) Variable cost	(yuan/ha)	5,948	5,568	5,419	-150	-2.69
c) (a)-(b)	(yuan/ha)	4,223	6,030	6,789	759	12.59
Jiangxi						
a) Gross value	(yuan/ha)	7,043	7,868	8,281	413	5.26
b) Variable cost	(yuan/ha)	5,558	5,189	5,070	-119	-2.29
c) (a)-(b)	(yuan/ha)	1,485	2,679	3,211	532	19.88
Hubei						
a) Gross value	(yuan/ha)	7,379	8,253	8,686	434	5.26
b) Variable cost	(yuan/ha)	5,124	4,840	4,729	-111	-2.29
c) (a)-(b)	(yuan/ha)	2,254	3,413	3,958	544	15.95
Hunan						
a) Gross value	(yuan/ha)	7,914	8,857	9,322	465	5.26
b) Variable cost	(yuan/ha)	5,666	5,317	5,190	-127	-2.38
c) (a)-(b)	(yuan/ha)	2,248	3,540	4,132	592	16.73
Guangdong						
a) Gross value	(yuan/ha)	9,223	10,275	10,815	540	5.26
b) Variable cost	(yuan/ha)	7,050	6,595	6,446	-149	-2.26
c) (a)-(b)	(yuan/ha)	2,173	3,680	4,369	689	18.73
Guangxi						
a) Gross value	(yuan/ha)	9,888	11,110	11,694	584	5.26
b) Variable cost	(yuan/ha)	6,401	6,009	5,854	-155	-2.58
c) (a)-(b)	(yuan/ha)	3,487	5,101	5,840	739	14.48

Source: Authors' estimates.

Appendix Table 10 Partial budget analysis of middle season indica rice production by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Jiangsu						
a) Gross value	(yuan/ha)	9,983	11,150	11,736	586	5.26
b) Variable cost	(yuan/ha)	5,970	5,604	5,451	-153	-2.73
c) (a)-(b)	(yuan/ha)	4,012	5,546	6,285	739	13.32
Anhui						
a) Gross value	(yuan/ha)	9,925	11,090	11,672	583	5.26
b) Variable cost	(yuan/ha)	4,435	4,188	4,078	-110	-2.62
c) (a)-(b)	(yuan/ha)	5,491	6,901	7,594	693	10.04
Fujian						
a) Gross value	(yuan/ha)	9,333	10,410	10,957	547	5.26
b) Variable cost	(yuan/ha)	5,203	4,847	4,717	-131	-2.70
c) (a)-(b)	(yuan/ha)	4,130	5,563	6,241	678	12.19
Henan						
a) Gross value	(yuan/ha)	8,587	9,612	10,118	505	5.26
b) Variable cost	(yuan/ha)	3,272	3,113	3,061	-52	-1.67
c) (a)-(b)	(yuan/ha)	5,314	6,499	7,056	557	8.57
Hubei						
a) Gross value	(yuan/ha)	10,467	11,713	12,328	616	5.26
b) Variable cost	(yuan/ha)	6,255	5,911	5,801	-111	-1.87
c) (a)-(b)	(yuan/ha)	4,212	5,802	6,528	726	12.52
Sichuan						
a) Gross value	(yuan/ha)	12,194	13,627	14,343	716	5.26
b) Variable cost	(yuan/ha)	6,248	5,933	5,839	-94	-1.58
c) (a)-(b)	(yuan/ha)	5,945	7,694	8,504	810	10.53
Guizhou						
a) Gross value	(yuan/ha)	13,238	14,830	15,610	779	5.26
b) Variable cost	(yuan/ha)	6,049	5,712	5,610	-102	-1.78
c) (a)-(b)	(yuan/ha)	7,189	9,118	9,999	881	9.66
Yunnan						
a) Gross value	(yuan/ha)	12,095	13,520	14,231	711	5.26
b) Variable cost	(yuan/ha)	5,541	5,249	5,160	-89	-1.69
c) (a)-(b)	(yuan/ha)	6,554	8,272	9,071	799	9.66
Shaanxi						
a) Gross value	(yuan/ha)	10,742	11,988	12,618	630	5.26
b) Variable cost	(yuan/ha)	5,004	4,705	4,642	-63	-1.34
c) (a)-(b)	(yuan/ha)	5,738	7,283	7,976	693	9.52

Source: Authors' estimates.

Appendix Table 11 Partial budget analysis of late season indica rice production by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Zhejiang						
a) Gross value	(yuan/ha)	10,439	11,698	12,313	615	5.26
b) Variable cost	(yuan/ha)	5,455	5,116	4,968	-148	-2.90
c) (a)-(b)	(yuan/ha)	4,984	6,582	7,345	763	11.59
Anhui						
a) Gross value	(yuan/ha)	8,005	8,957	9,428	471	5.26
b) Variable cost	(yuan/ha)	3,596	3,404	3,323	-82	-2.40
c) (a)-(b)	(yuan/ha)	4,409	5,553	6,105	553	9.95
Fujian						
a) Gross value	(yuan/ha)	9,305	10,388	10,934	546	5.26
b) Variable cost	(yuan/ha)	5,778	5,404	5,254	-150	-2.77
c) (a)-(b)	(yuan/ha)	3,526	4,984	5,680	696	13.96
Jiangxi						
a) Gross value	(yuan/ha)	8,453	9,448	9,945	497	5.26
b) Variable cost	(yuan/ha)	5,099	4,750	4,622	-129	-2.71
c) (a)-(b)	(yuan/ha)	3,354	4,698	5,323	625	13.31
Hubei						
a) Gross value	(yuan/ha)	7,853	8,782	9,243	462	5.26
b) Variable cost	(yuan/ha)	5,243	4,948	4,859	-88	-1.79
c) (a)-(b)	(yuan/ha)	2,610	3,834	4,384	550	14.34
Hunan						
a) Gross value	(yuan/ha)	9,307	10,404	10,950	547	5.26
b) Variable cost	(yuan/ha)	5,524	5,191	5,070	-121	-2.33
c) (a)-(b)	(yuan/ha)	3,782	5,213	5,880	667	12.80
Guangdong						
a) Gross value	(yuan/ha)	9,280	10,368	10,913	545	5.26
b) Variable cost	(yuan/ha)	6,875	6,447	6,304	-143	-2.22
c) (a)-(b)	(yuan/ha)	2,405	3,921	4,609	688	17.54
Guangxi						
a) Gross value	(yuan/ha)	8,058	9,032	9,507	475	5.26
b) Variable cost	(yuan/ha)	5,961	5,588	5,439	-150	-2.68
c) (a)-(b)	(yuan/ha)	2,097	3,444	4,069	625	18.14
Hainan						
a) Gross value	(yuan/ha)	5,124	5,808	6,113	305	5.26
b) Variable cost	(yuan/ha)	3,795	3,581	3,492	-89	-2.48
c) (a)-(b)	(yuan/ha)	1,329	2,227	2,621	394	17.70

Source: Authors' estimates.

Appendix Table 12 Partial budget analysis of japonica rice production by province: baseline versus free trade scenarios.

	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Hebei					
a) Gross value (yuan/ha)	15,257	17,058	17,954	896	5.26
b) Variable cost (yuan/ha)	6,807	6,467	6,255	-212	-3.28
c) (a)-(b) (yuan/ha)	8,450	10,591	11,700	1,109	10.47
Shanxi					
a) Gross value (yuan/ha)	12,879	14,397	15,154	757	5.26
b) Variable cost (yuan/ha)	6,644	6,336	6,240	-96	-1.52
c) (a)-(b) (yuan/ha)	6,234	8,061	8,914	853	10.58
Liaoning					
a) Gross value (yuan/ha)	12,213	13,632	14,348	716	5.26
b) Variable cost (yuan/ha)	5,814	5,547	5,394	-153	-2.76
c) (a)-(b) (yuan/ha)	6,399	8,085	8,955	870	10.76
Jilin					
a) Gross value (yuan/ha)	11,405	12,749	13,419	670	5.26
b) Variable cost (yuan/ha)	4,627	4,383	4,249	-134	-3.07
c) (a)-(b) (yuan/ha)	6,779	8,366	9,170	804	9.62
Heilongjiang					
a) Gross value (yuan/ha)	9,283	10,387	10,933	546	5.26
b) Variable cost (yuan/ha)	4,917	4,712	4,602	-111	-2.35
c) (a)-(b) (yuan/ha)	4,367	5,675	6,332	657	11.57
Jiangsu					
a) Gross value (yuan/ha)	12,844	14,344	15,098	754	5.26
b) Variable cost (yuan/ha)	6,316	5,954	5,756	-197	-3.32
c) (a)-(b) (yuan/ha)	6,528	8,390	9,342	951	11.34
Zhejiang					
a) Gross value (yuan/ha)	10,920	12,298	12,945	646	5.26
b) Variable cost (yuan/ha)	5,395	5,064	4,911	-153	-3.02
c) (a)-(b) (yuan/ha)	5,526	7,234	8,033	799	11.05
Anhui					
a) Gross value (yuan/ha)	9,124	10,195	10,730	536	5.26
b) Variable cost (yuan/ha)	4,246	4,027	3,935	-92	-2.28
c) (a)-(b) (yuan/ha)	4,878	6,168	6,795	627	10.17
Shandong					
a) Gross value (yuan/ha)	12,911	14,352	15,106	754	5.26
b) Variable cost (yuan/ha)	6,841	6,485	6,322	-163	-2.52
c) (a)-(b) (yuan/ha)	6,071	7,867	8,784	918	11.66
Henan					
a) Gross value (yuan/ha)	12,525	14,250	14,999	749	5.26
b) Variable cost (yuan/ha)	5,662	5,330	5,179	-150	-2.82
c) (a)-(b) (yuan/ha)	6,863	8,920	9,819	899	10.08
Hubei					
a) Gross value (yuan/ha)	7,264	8,139	8,567	428	5.26
b) Variable cost (yuan/ha)	5,056	4,774	4,667	-107	-2.24
c) (a)-(b) (yuan/ha)	2,208	3,366	3,900	535	15.88
Yunnan					
a) Gross value (yuan/ha)	14,848	16,589	17,460	872	5.26
b) Variable cost (yuan/ha)	7,894	7,464	7,344	-120	-1.60
c) (a)-(b) (yuan/ha)	6,955	9,125	10,116	991	10.86
Ningxia					
a) Gross value (yuan/ha)	14,784	16,582	17,453	871	5.26
b) Variable cost (yuan/ha)	6,769	6,481	6,305	-177	-2.73
c) (a)-(b) (yuan/ha)	8,015	10,101	11,149	1,048	10.38

Source: Authors' estimates.

Appendix Table 13 Partial budget analysis of wheat production in northern China: baseline versus free trade scenarios.

	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value (yuan/ha)	7,383	8,241	6,531	-1710	-20.75
Yield (ton/ha)	4.492	4.971	4.921	-0.05	-1.02
Price (yuan/ton)	1,525	1,539	1,232	-307	-19.93
Output value (yuan/ha)	6,851	7,651	6,063	-1,587	-20.75
By-product (yuan/ha)	532	590	468	-122	-20.75
b) Variable costs (yuan/ha)	4,424	4,221	3,984	-237	-5.62
Seeds and seedlings	547	556	445	-111	-19.99
Organic fertilizer	190	190	190	0	0.00
Chemical fertilizers	1,135	1,035	919	-116	-11.24
Plastic film	12	11	10	-1	-11.11
Pesticides	82	74	66	-8	-11.12
Animal labor	155	155	155	0	-0.02
Machinery	509	512	512	0	-0.07
Irrigation and fuel	321	322	322	0	-0.04
Labor	1,425	1,318	1,318	0	0.00
Other variable costs	48	48	48	0	0.00
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)	2,959	4,020	2,548	-1,472	-36.63

Source: Authors' estimates.

Appendix Table 14 Partial budget analysis of wheat production in southern China: baseline versus free trade scenarios.

	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value (yuan/ha)	5,342	5,951	4,717	-1,235	-20.75
Yield (ton/ha)	3.353	3.701	3.663	-0.04	-1.02
Price (yuan/ton)	1,470	1,484	1,188	-296	-19.93
Output value (yuan/ha)	4,929	5,492	4,352	-1,139	-20.75
By-product (yuan/ha)	413	460	364	-95	-20.75
b) Variable costs (yuan/ha)	4,347	4,070	3,903	-167	-4.11
Seeds and seedlings	349	354	283	-71	-19.97
Organic fertilizer	161	161	161	0	-0.02
Chemical fertilizers	844	767	681	-86	-11.21
Plastic film	1	1	1	0	-11.11
Pesticides	102	92	82	-10	-11.12
Animal labor	115	115	115	0	-0.02
Machinery	182	183	183	0	-0.02
Irrigation and fuel	46	46	46	0	-0.01
Labor	2,486	2,291	2,291	0	0.00
Other variable costs	59	59	59	0	-0.01
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)	995	1,881	813	-1,068	-56.76

Source: Authors' estimates.

Appendix Table 15 Partial budget analysis of wheat production in northern China by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Hebei						
a) Gross value	(yuan/ha)	8,737	9,739	7,718	-2,021	-20.75
b) Variable cost	(yuan/ha)	4,535	4,327	4,089	-239	-5.51
c) (a)-(b)	(yuan/ha)	4,202	5,412	3,630	-1,782	-32.93
Shanxi						
a) Gross value	(yuan/ha)	7,126	7,988	6,331	-1,657	-20.75
b) Variable cost	(yuan/ha)	3,728	3,582	3,399	-184	-5.13
c) (a)-(b)	(yuan/ha)	3,398	4,406	2,932	-1,474	-33.45
Liaoning						
a) Gross value	(yuan/ha)	8,135	9,051	7,173	-1,878	-20.75
b) Variable cost	(yuan/ha)	5,618	5,325	4,989	-337	-6.32
c) (a)-(b)	(yuan/ha)	2,517	3,725	2,184	-1,541	-41.37
Jilin						
a) Gross value	(yuan/ha)	6,600	7,348	5,824	-1,525	-20.75
b) Variable cost	(yuan/ha)	2,913	2,817	2,627	-190	-6.74
c) (a)-(b)	(yuan/ha)	3,687	4,532	3,197	-1,335	-29.45
Inner Mongolia						
a) Gross value	(yuan/ha)	6,193	6,868	5,443	-1,425	-20.75
b) Variable cost	(yuan/ha)	3,520	3,362	3,116	-246	-7.32
c) (a)-(b)	(yuan/ha)	2,674	3,506	2,327	-1,179	-33.62
Heilongjiang						
a) Gross value	(yuan/ha)	4,394	4,901	3,884	-1,017	-20.75
b) Variable cost	(yuan/ha)	2,267	2,211	2,013	-198	-8.96
c) (a)-(b)	(yuan/ha)	2,127	2,690	1,872	-819	-30.43
Shandong						
a) Gross value	(yuan/ha)	8,895	9,936	7,875	-2,062	-20.75
b) Variable cost	(yuan/ha)	4,954	4,712	4,485	-227	-4.82
c) (a)-(b)	(yuan/ha)	3,940	5,224	3,389	-1,835	-35.12
Henan						
a) Gross value	(yuan/ha)	7,841	8,742	6,928	-1,814	-20.75
b) Variable cost	(yuan/ha)	3,844	3,650	3,455	-195	-5.33
c) (a)-(b)	(yuan/ha)	3,996	5,092	3,473	-1,619	-31.80
Shaanxi						
a) Gross value	(yuan/ha)	5,849	6,579	5,214	-1,365	-20.75
b) Variable cost	(yuan/ha)	4,135	3,910	3,755	-155	-3.96
c) (a)-(b)	(yuan/ha)	1,713	2,669	1,458	-1,210	-45.35
Gansu						
a) Gross value	(yuan/ha)	7,106	7,913	6,271	-1,642	-20.75
b) Variable cost	(yuan/ha)	4,776	4,558	4,291	-267	-5.87
c) (a)-(b)	(yuan/ha)	2,330	3,355	1,980	-1,374	-40.97
Qinghai						
a) Gross value	(yuan/ha)	5,896	6,565	5,203	-1,362	-20.75
b) Variable cost	(yuan/ha)	4,608	4,387	4,203	-184	-4.20
c) (a)-(b)	(yuan/ha)	1,288	2,178	1,000	-1,178	-54.08
Ningxia						
a) Gross value	(yuan/ha)	8,368	9,304	7,374	-1,930	-20.75
b) Variable cost	(yuan/ha)	5,181	4,974	4,634	-340	-6.84
c) (a)-(b)	(yuan/ha)	3,187	4,330	2,740	-1,590	-36.72
Xinjiang						
a) Gross value	(yuan/ha)	8,274	9,209	7,299	-1,911	-20.75
b) Variable cost	(yuan/ha)	4,770	4,589	4,307	-281	-6.13
c) (a)-(b)	(yuan/ha)	3,504	4,621	2,991	-1,630	-35.26

Source: Authors' estimates.

Appendix Table 16 Partial budget analysis of wheat production in southern China by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Jiangsu						
a) Gross value	(yuan/ha)	7,024	7,816	6,195	-1,622	-20.75
b) Variable cost	(yuan/ha)	4,430	4,169	3,944	-225	-5.40
c) (a)-(b)	(yuan/ha)	2,594	3,648	2,251	-1,397	-38.29
Zhejing						
a) Gross value	(yuan/ha)	5,050	5,627	4,459	-1,167	-20.75
b) Variable cost	(yuan/ha)	3,923	3,704	3,535	-170	-4.58
c) (a)-(b)	(yuan/ha)	1,127	1,922	925	-998	-51.90
Anhui						
a) Gross value	(yuan/ha)	7,471	8,338	6,608	-1,730	-20.75
b) Variable cost	(yuan/ha)	3,696	3,512	3,297	-215	-6.13
c) (a)-(b)	(yuan/ha)	3,776	4,826	3,311	-1,515	-31.39
Fujian						
a) Gross value	(yuan/ha)	5,804	6,467	5,125	-1,342	-20.75
b) Variable cost	(yuan/ha)	4,944	4,609	4,385	-224	-4.87
c) (a)-(b)	(yuan/ha)	860	1,858	741	-1,118	-60.14
Sichuan						
a) Gross value	(yuan/ha)	5,124	5,703	4,520	-1,183	-20.75
b) Variable cost	(yuan/ha)	4,561	4,263	4,125	-138	-3.24
c) (a)-(b)	(yuan/ha)	563	1,439	394	-1,045	-72.60
Guizhou						
a) Gross value	(yuan/ha)	3,331	3,743	2,967	-777	-20.75
b) Variable cost	(yuan/ha)	2,951	2,770	2,701	-69	-2.50
c) (a)-(b)	(yuan/ha)	381	973	266	-707	-72.68
Yunnan						
a) Gross value	(yuan/ha)	5,517	6,082	4,820	-1,262	-20.75
b) Variable cost	(yuan/ha)	3,915	3,694	3,546	-149	-4.02
c) (a)-(b)	(yuan/ha)	1,602	2,387	1,274	-1,113	-46.63

Source: Authors' estimates.

Appendix Table 17 Partial budget analysis of maize production in northern China: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value	(yuan/ha)	6,759	8,906	6,440	-2,466	-27.69
Yield	(ton/ha)	5.914	6.760	6.605	-0.155	-2.290
Price	(yuan/ton)	1,048	1,208	894	-314	-25.98
Output value	(yuan/ha)	6,198	8,166	5,905	-2,261	-27.69
By-product	(yuan/ha)	561	740	535	-205	-27.69
b) Variable costs	(yuan/ha)	4,012	3,832	3,614	-218	-5.68
Seeds and seedlings		318	368	272	-96	-26.05
Organic fertilizer		125	125	125	0	-0.04
Chemical fertilizers		1,045	958	848	-109	-11.40
Plastic film		65	58	52	-6	-11.13
Pesticides		58	52	46	-6	-11.13
Animal labor		203	204	204	0	-0.06
Machinery		241	242	242	0	-0.08
Irrigation and fuel		220	221	221	0	-0.07
Labor		1,704	1,570	1,570	0	0.00
Other variable costs		34	34	34	0	-0.01
c) "Quasi-revenue" c= (a)-(b)	(yuan/ha)	2,747	5,074	2,826	-2,248	-44.31

Source: Authors' estimates.

Appendix Table 18 Partial budget analysis of maize production in southern China: baseline versus free trade scenarios.

	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
a) Gross value (yuan/ha)	6,861	9,053	6,546	-2,507	-27.69
Yield (ton/ha)	4.688	5.365	5.239	-0.127	-2.361
Price (yuan/ton)	1,325	1,527	1,131	-397	-25.98
Output value (yuan/ha)	6,211	8,193	5,925	-2,269	-27.69
By-product (yuan/ha)	650	860	622	-238	-27.69
b) Variable costs (yuan/ha)	4,806	4,525	4,344	-180	-3.98
Seeds and seedlings	240	278	205	-72	-26.02
Organic fertilizer	273	274	274	0	-0.07
Chemical fertilizers	950	867	769	-98	-11.33
Plastic film	37	34	30	-4	-11.12
Pesticides	57	51	46	-6	-11.12
Animal labor	199	199	199	0	-0.05
Machinery	42	42	42	0	-0.01
Irrigation and fuel	50	51	51	0	-0.01
Labor	2,935	2,707	2,707	0	0.00
Other variable costs	22	22	22	0	-0.01
c) "Quasi-revenue" c= (a)-(b) (yuan/ha)	2,055	4,529	2,202	-2,327	-51.37

Source: Authors' estimates.

Appendix Table 19 Partial budget analysis of maize production in northern China by province: baseline versus free trade scenarios.

	Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Hebei					
a) Gross value (yuan/ha)	7,229	9,528	6,889	-2,638	-27.69
b) Variable cost (yuan/ha)	2,981	2,855	2,687	-168	-5.88
c) (a)-(b) (yuan/ha)	4,247	6,672	4,202	-2,470	-37.02
Shanxi					
a) Gross value (yuan/ha)	6,549	8,650	6,255	-2,395	-27.69
b) Variable cost (yuan/ha)	3,637	3,489	3,312	-178	-5.09
c) (a)-(b) (yuan/ha)	2,912	5,161	2,943	-2,218	-42.97
Inner Mongolia					
a) Gross value (yuan/ha)	7,240	9,627	6,961	-2,666	-27.69
b) Variable cost (yuan/ha)	4,155	3,976	3,738	-238	-5.98
c) (a)-(b) (yuan/ha)	3,085	5,651	3,223	-2,428	-42.96
Liaoning					
a) Gross value (yuan/ha)	5,612	7,466	5,399	-2,067	-27.69
b) Variable cost (yuan/ha)	3,524	3,390	3,158	-232	-6.83
c) (a)-(b) (yuan/ha)	2,088	4,076	2,241	-1,836	-45.03

Jilin						
a) Gross value	(yuan/ha)	5,439	7,179	5,191	-1,988	-27.69
b) Variable cost	(yuan/ha)	3,845	3,713	3,457	-256	-6.90
c) (a)-(b)	(yuan/ha)	1,594	3,465	1,734	-1,732	-49.97
Heilongjiang						
a) Gross value	(yuan/ha)	5,811	7,652	5,533	-2,119	-27.69
b) Variable cost	(yuan/ha)	3,139	3,057	2,840	-216	-7.08
c) (a)-(b)	(yuan/ha)	2,672	4,595	2,693	-1,902	-41.40
Shandong						
a) Gross value	(yuan/ha)	6,837	9,080	6,566	-2,514	-27.69
b) Variable cost	(yuan/ha)	3,980	3,781	3,575	-205	-5.44
c) (a)-(b)	(yuan/ha)	2,857	5,299	2,991	-2,309	-43.57
Henan						
a) Gross value	(yuan/ha)	5,602	7,383	5,339	-2,044	-27.69
b) Variable cost	(yuan/ha)	3,054	2,904	2,751	-153	-5.28
c) (a)-(b)	(yuan/ha)	2,549	4,479	2,588	-1,891	-42.22
Shaanxi						
a) Gross value	(yuan/ha)	4,895	6,415	4,639	-1,776	-27.69
b) Variable cost	(yuan/ha)	3,759	3,573	3,432	-142	-3.96
c) (a)-(b)	(yuan/ha)	1,136	2,842	1,207	-1,635	-57.52
Gansu						
a) Gross value	(yuan/ha)	9,998	13,161	9,517	-3,644	-27.69
b) Variable cost	(yuan/ha)	6,475	6,153	5,814	-338	-5.50
c) (a)-(b)	(yuan/ha)	3,522	7,009	3,703	-3,306	-47.17
Ningxia						
a) Gross value	(yuan/ha)	7,188	9,457	6,838	-2,619	-27.69
b) Variable cost	(yuan/ha)	3,514	3,421	3,181	-240	-7.02
c) (a)-(b)	(yuan/ha)	3,674	6,036	3,658	-2,379	-39.41
Xinjiang						
a) Gross value	(yuan/ha)	9,717	12,732	9,206	-3,525	-27.69
b) Variable cost	(yuan/ha)	4,965	4,828	4,540	-288	-5.96
c) (a)-(b)	(yuan/ha)	4,752	7,904	4,666	-3,238	-40.96

Source: Author's estimate.

Appendix Table 20 Partial budget analysis of maize production in southern China by province: baseline versus free trade scenarios.

		Average of 1996-1997	Baseline Scenario in 2005	Free Trade Scenario in 2005	Difference bet. Baseline & Free Trade Scenarios in 2005	Percentage Change in 2005 (%)
Jiangsu						
a) Gross value	(yuan/ha)	7,349	9,673	6,995	-2,679	-27.69
b) Variable cost	(yuan/ha)	4,878	4,600	4,388	-212	-4.61
c) (a)-(b)	(yuan/ha)	2,472	5,073	2,607	-2,466	-48.62
Anhui						
a) Gross value	(yuan/ha)	6,654	8,805	6,367	-2,438	-27.69
b) Variable cost	(yuan/ha)	2,882	2,754	2,609	-145	-5.27
c) (a)-(b)	(yuan/ha)	3,773	6,050	3,758	-2,293	-37.89
Hubei						
a) Gross value	(yuan/ha)	5,761	7,559	5,466	-2,093	-27.69
b) Variable cost	(yuan/ha)	4,977	4,703	4,517	-185	-3.94
c) (a)-(b)	(yuan/ha)	784	2,857	949	-1,908	-66.79
Guangxi						
a) Gross value	(yuan/ha)	6,292	8,332	6,025	-2,307	-27.69
b) Variable cost	(yuan/ha)	5,323	5,057	4,881	-176	-3.48
c) (a)-(b)	(yuan/ha)	969	3,276	1,144	-2,131	-65.06
Sichuan						

a) Gross value	(yuan/ha)	7,250	9,562	6,915	-2,648	-27.69
b) Variable cost	(yuan/ha)	5,718	5,353	5,171	-181	-3.39
c) (a)-(b)	(yuan/ha)	1,533	4,210	1,743	-2,467	-58.59
Guizhou						
a) Gross value	(yuan/ha)	6,254	8,239	5,957	-2,281	-27.69
b) Variable cost	(yuan/ha)	4,657	4,374	4,225	-148	-3.39
c) (a)-(b)	(yuan/ha)	1,597	3,865	1,732	-2,133	-55.19
Yunnan						
a) Gross value	(yuan/ha)	8,485	11,177	8,082	-3,095	-27.69
b) Variable cost	(yuan/ha)	5,550	5,253	5,031	-223	-4.24
c) (a)-(b)	(yuan/ha)	2,934	5,924	3,052	-2,872	-48.49

Source: Authors' estimates.