Government Intervention and Agricultural Performance in China

by

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Dedicated to the memory of
Mr. Gao Xiaomeng (1952-93)

Declaration

This dissertation was written while I was studying in the Australia-Japan Research Centre at the Australian National University. The opinions expressed are my own, unless otherwise indicated.

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Abstract

This study reassesses agricultural performance in China during the economy's transition from a centrally planned system to one increasingly reliant on the market mechanisms.

The essence of economic reform was to reduce direct intervention by the government in the operation of the economy and to allow more decision-making autonomy to economic agents. But the process of reform is not yet complete. The Chinese economy today is neither a perfectly free market nor a stylized central planning system.

The central argument is that the agricultural sector is being increasingly integrated with the rest of the Chinese economy, and the world economy through the process of economic liberalization. Economy-wide policies and changes elsewhere are as important as sector-specific policies in affecting agricultural performance. At the same time, restrictions on factor movements and price distortions remain and affect agriculture's response to exogenous changes. Agriculture's response to initial reforms has been seen as a 'miracle'; growth jumped to 7 per cent between 1979 and 1984. The relative contraction of agricultural production in 1985 and years after is less clearly understood.

A simple illustrative model is constructed for theoretical analysis. This framework is applied to understand agricultural growth in China and it is found that dramatic changes in farmers' feasible choice set were dominant factors determining agricultural growth and contraction in the second half of the 1980s. This case underlines the importance of restrictions on factor mobility in the Chinese economy. Changes in factor markets may sometimes offset changes in price structure and require particular attention in analysis.

Price policies for grain in China were endogenously determined through bargaining between farmers and the state. In the early stages of economic development under a repressive and vindictive central state system, farmers tend to be weak in the state-farmer policy game. This study develops a state-farmer agricultural policy game framework.

Farmers' relative bargaining power is negatively correlated with agriculture's share in the economy and the share if agricultural population, and positively correlated with income per capita and the market price of grain. Farmers in China were still relatively weak in policy game with the government. But it can be expected that farmers' bargaining power will continue to increase as the economy develops. There is a danger that with growing bargaining position demand for agricultural subsidies will grow.

Farmers' production decisions are guided by a combination of policy regulations and market signals, but their behaviour can be modelled by profit maximization framework given careful data adjustment. Supply elasticities estimated through an application of the McFadden unit profit function indicate that continuation of grain self-sufficiency will be both difficult and costly.

To understand both direct and indirect effects of policy on agriculture, a computable general equilibrium model is built. A set of experiments including changes in the world market, economic reforms such as tariff reduction, variation in macroeconomic policies and a rapid expansion of rural industry are undertaken. The Chinese economy and the agricultural sector adjust to exogenous change but the adjustment is smaller than it would be in the case of perfect factor mobility. Money becomes non-neutral in the presence of price distortion in Chinese economy.

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Analysis of Agricultural Policy in the Post-Reform Chinese Economy: Some Issues

Chinese agriculture has experienced more than a decade of economic reform. The government has made significant efforts during this period to eliminate inappropriate administrative restrictions and to allow markets to guide economic activities. Chinese farmers are now freer than at any time in the past forty years to pursue their own objectives. Policy intervention, however, still occurs in a wide range of economic activity, including restrictions on factor mobility and through state control of some agricultural products. At the same time, agriculture is being integrated more and more with the rest of the economy through the process of economic liberalization and development. Agricultural policy analysis should provide insights into the dynamics of economic change in a reforming economy.

The mechanics of a reforming economy are different from those of a stylized market economy or a typical centrally-planned system. It is therefore of interest to investigate how government policies are affecting agricultural performance in China today.

Despite the incompleteness of the reform process and the many unsolved problems and difficulties that China faces, it is evident that the achievements of economic development, no matter whether they are measured by growth rates or structural transformation, are remarkable (Perkins 1988; Johnson 1988; Garnaut 1989).[1] China's recent success is becoming a frequently cited case in the economic literature. Economic growth is

[1] For discussions of the problems and difficulties that China is encountering in economic reform see Kojima (1990), Johnson (1988) and Perkins (1988).

improving the welfare of more than one billion people or nearly a quarter of the world's population.[2]

There are many myths surrounding how this outcome is being delivered and how policy changes are contributing to increased output and raised productivity. Controversy surrounds some policy issues and reform strategies (Sung and Chan 1987; Jackson 1991). But the Chinese experience illustrates a feasible path for the transformation of a centrally-planned economy into a market economy, particularly in contrast to the more problematic big-bang type of reform being attempted in East Europe and the former Soviet Union (McMillan and Naughton 1991).

Rapid economic growth in China has been closely associated with an increasing degree of openness. Both growth and structural change have resulted in higher capacity to export and higher demand for imports and Chinese economic growth is having significant effects on other economies. Because China is such a very large country, any increase in its exports and imports has important implications for international markets and thus for both exporting and importing countries (Drysdale 1988; Drysdale and Elek 1991; Lardy 1992). East Asia or the Western Pacific is a new growth pole in the world economy. Rapid economic growth in Japan, in the newly industrialized economies, and, more recently in Indonesia, Malaysia and Thailand, has greatly changed the global pattern of economic growth. The ascendancy of China adds significant weight to this global change (Drysdale 1988; Garnaut 1989).

China's Agricultural Performance

Economic reform in China was initiated in agriculture at the end of the 1970s. Agricultural performance over the past decade has been unique and interesting (Table 1.1). Before economic reform, agricultural growth was sluggish because of policy discrimination and inappropriate institutional arrangements (Lin 1991c). In the first half

[2] The success or failure of economic development in China is a significant dummy variable in the global welfare function.

of the 1980s, China experienced dramatic growth in agricultural production in response to the increases in procurement prices and the introduction of the household responsibility system (HRS). This period of agricultural success impressed the world and was regarded as some kind of 'miracle' (Longworth 1989). China's agriculture was feeding 24 per cent of the world's population from 7 per cent of the world's arable land (Drysdale and Elek 1991). But the situation changed quickly. From 1985, agricultural production, grain in particular, dropped into a so-called stagnant phase, a state in which it remained for the following three years (Niu 1989; Anderson 1990a; Lin 1992). Criticisms of agricultural reform policies were widely expressed by both government officials and economists (Niu 1989).[3] At the end of the 1980s and the beginning of the 1990s, following a set of policy adjustments, agricultural production began to recover (Table 1.1). This extraordinary development path has encouraged much analysis and speculation, with a considerable literature developing around the controversy over government policies towards agriculture (McMillan et al. 1989; Lin 1992; Huang 1992; Du 1992).

Table 1.1 Annual growth rates of agricultural output in China, 1978-90 (per cent)

	Agriculture	Farming	Grain	Livestock
1978	8.1	9.4	7.8	4.9
1979	7.5	7.2	9.0	14.6
1980	1.4	-0.5	-3.5	7.0
1981	5.8	5.9	1.4	5.9
1982	11.3	10.3	9.1	13.2
1983	7.8	8.3	9.2	3.9
1984	12.3	9.9	5.2	13.4
1985	3.4	-2.0	-6.9	17.2
1986	3.4	0.9	3.3	5.5
1987	5.8	5.3	2.9	3.2
1988	3.8	-0.2	-2.2	12.7
1989	3.9	1.8	3.4	5.6
1990	7.6	8.6	9.5	7.0

Source: State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing:318, 346.

[3] There were a few exceptions in 1985 and 1986. Some researchers, mostly in the Research Centre for Rural Development (RCRD) of the State Council in China, presented a different argument (Gao 1987; Huang 1988a).

The Central Hypothesis

There are opposing arguments in the literature about the impact of agricultural policy in the 1980s in China. Some economists criticize policy change because of the agricultural stagnation in 1985 (Niu 1989). Others recognize the success of economic reform because of the rapid increase in farmers' real income during this period (Huang 1992; Ma and Garnaut 1992). Again, some economists praise agricultural policy during 1989-91 because of the recovery of grain and other agricultural outputs (Ye 1992). Others worry that farmers' real income only increased at an annual average of 0.7 per cent during 1989-91 (Huang 1992; Du 1992). Perceptions of the impact of policy lead to quite different policy recommendations. Hence, there is considerable merit in a reassessment of the China's agricultural reform policies.

The resolution of these policy questions requires investigation of the political economy of policy formulation, and a thorough exploration of the mechanisms by which both sector-specific and economy-wide policies affect agriculture and the economy. An understanding of China's agricultural development will contribute to the development of a better framework for future agricultural policy analysis.

From these perspectives, this study seeks to formulate and test a central hypothesis that economy-wide policies and changes are as important as sector-specific policies in affecting agricultural performance. At the same time, some restrictions on factor movements and price distortions remain and affect the response of the agricultural sector to exogenous changes.

An Analytical Framework

The most important characteristic of the Chinese economy today is that it is neither a stylized market economy nor a typical centrally-planned economy. This presents some problems for agricultural policy analysis. Farmers in China may respond sensitively to market changes as a consequence of profit maximizing behaviour, but they may also be subject to constraints such as limited resource mobility and state purchase quotas.

Given these particular features of the agricultural economy, a parallel-line framework is proposed and applied in this study. One line is the incentive structure and the other is the feasible choice set (or the area within which farmers can freely re-allocate production resources). In conventional economic analysis, incentive structures are stressed because the feasible choice set does not expand or contract significantly in a mature market economy. In an economy undergoing a process of dramatic transformation, the feasible choice set of farmers can expand rapidly within a short period. Changes such as the abolition of all controls over agricultural products in 1985 in China had an impact on farmers' feasible choice set (Huang 1992). The feasible choice set therefore plays a role in influencing agricultural performance of potentially equal to the incentive structure.

The incentive structure of agricultural production is a core concept. According to Schultz (1978), incentives consist of economic information that farmers use in calculating their expected costs (including costs associated with risk) against the returns they expect to receive. The incentive structure is, in the first place, determined by policies specific to agriculture, including price, marketing, input, credit, mechanization, land reform, research and irrigation policies (Ellis 1992). It is also influenced by the trade regime, monetary and fiscal policy and policies targeted at industries, particularly rural industries (Krueger et al. 1988; Mundlak et al. 1989). In Chinese agriculture, most commodities have now been allowed to respond to market forces. Intervention, however, remains in a range of agricultural markets including those for grain, wool and cotton. This system generates a special pattern of price asymmetry. The prices of fully liberalized commodities quickly respond to changes in demand and supply, while prices of other products exhibit very different responses depending on the degree of control.

The effectiveness of the incentive structure, however, depends on factors affecting factor mobility or the farmers' feasible choice set. In a market economy, all markets are assumed to be competitive and resources are therefore perfectly mobile within the economy. In a centrally-planned economy, no resource movements can occur other than those administered by the government. The Chinese economy today sits between these two extremes. Restrictions on factor mobility remain in many areas. There is limited

mobility of labour between rural and urban areas.[4] Labour movement between agriculture and industrial activities in the rural sector are, nonetheless, both quick and strong in response to changes in the environment. This limitation of the feasible choice set and the limited factor mobility in the Chinese economy have important implications for the process of economic adjustment in the farm sector.

In most previous studies of Chinese agriculture, two extreme assumptions have been made concerning the interaction between agriculture and the rest of the economy. Some assume that agricultural resources can only be used for agricultural production, implying that resource movement between agriculture and industry does not exist. Others assume perfect factor mobility. Sicular (1988a) explicitly incorporates perfect factor (labour) mobility into a general equilibrium framework.[5] If limited factor mobility was a feature of the Chinese economy in the 1980s and early 1990s either of these assumptions leads to biased analysis.

By applying a new analytical framework to examine the impact of policy on Chinese agriculture, this study seeks

- to clarify changes in the agricultural sector during the reform period
- to study theoretically the significance of these changes to agricultural policy analysis
- to understand the unexpected pattern of agricultural performance in the second half of the 1980s by applying the analytical framework developed in the study
- to explore current agricultural price policy and its endogeneity
- to construct a quantitative framework incorporating the special features of the economy
- to measure empirically various policy influences on agriculture.

[4] The volume of labour movements, particularly into the cities, has been increasing in recent years.

[5] The third good in the Sicular model of the Chinese economy incorporates elements of both the market and plan systems and is referred to as human time or labour/leisure. All goods, including labour, can be traded on markets (Sicular 1988a:294).

Methodology

One most important feature of this study is its economy-wide perspective on agricultural policy analysis. It is increasingly recognized that changes in macroeconomic policies have had important effects on agricultural performance (Krueger et al. 1988). Interaction between different parts of the economy, including feedback effects, can be captured in an economy-wide framework. Direct effects are only a part of the policy story in a real economy; some indirect or second-round impacts are equally important. Indirect effects become more important as the Chinese economy becomes increasingly integrated through the process of economic reform. Interactions within the economy resulting from exogenous shocks, including policy changes, constitute another important part of the policy story. Assessing agricultural performance from an economy-wide perspective may also lead to different conclusions from those derived from an agriculture fundamentalist perspective. This is one of the reasons for the emergence of quite different views on agricultural policies in the past decade in China (Garnaut and Ma 1992).

Although an economy-wide perspective is always kept in mind throughout the analysis, the methodology applied in the study combines both partial and general equilibrium frameworks. In testing the different hypotheses in the literature about agricultural stagnation after 1985 (Chapter 4), in investigating the endogeneity of policy change (Chapter 5) and in estimating production elasticities of the Chinese agriculture (Chapter 6), a partial equilibrium framework is useful.

A general equilibrium framework, on the other hand, allows a more thorough exploration of policy consequences. A general equilibrium model is constructed. The usual computable general equilibrium model assumes competitive factor and product markets. While competitiveness of product market is acceptable in modelling as an approximation to reality, competitive factor markets can hardly be accepted as a reasonable assumption in the case of China in the 1980s. Innovation in this respect can contribute to both theoretical modelling and practical policy analysis.

Structure of the Study

A review of economic reform identifies the characteristics of the reformed Chinese economy and the special conditions imposed on agricultural policy analysis (Chapter 2). While a higher degree of economic integration requires that agricultural performance should be examined from an economy-wide perspective, continued government intervention necessitates particular caution in analysis.

The two most important characteristics identified in Chapter 2 are then examined in a theoretical framework in order to establish their effects on economic structure and on the way in which the economy responds to exogenous changes (Chapter 3).

There are two types of direct incentive policy in Chinese agriculture. One involves the existence of a low state purchase price alongside the free market price (the two-tier price system) such as in the case of grain, and the other is the state monopoly of the purchase of agricultural products, such as in the case of cotton and wool. Sicular (1988a), through application of a simple general equilibrium framework, demonstrates that, in the case of a two-tier price system, the level of the state price does not affect the levels of current production and consumption. Lin (1993) in a recent study argues that, if the quotas are endogenous, the state price does have an important effect on farmers' production decisions. These arguments are re-examined in the light of the findings of this study. Attention is then given to how changes in monetary policy affect agriculture. Because of special features of the Chinese economy, money is non-neutral. The likely relationship is explored, this should contribute to a better understanding of agricultural performance by bringing macroeconomic changes into the picture.

Limited labour mobility between rural and urban areas is another important characteristic of the Chinese economy. The impact of labour mobility is examined by introducing economy-wide disturbances including changes in macroeconomic and trade policies. This is important to testing the central idea in the study: economy-wide policies are having more important effects on the agricultural sector than at any time in the previous forty years, but these effects are still constrained because of limited labour mobility.

The theoretical framework is then applied to examining agricultural development in the second half of the 1980s (Chapter 4). Various explanations have been advanced for the relative contraction in agricultural production after 1985 including worsening agricultural terms of trade, completion of the household responsibility system reform in 1983, adverse weather and the Rybczynski theorem. However, none of these can be regarded as dominant. Based on the broad framework developed in this study, an alternative feasible choice set hypothesis is presented and tested. This empirical analysis should reinforce the importance of the parallel-line analytical framework.

The endogeneity of government policy is explored, particularly in relation to incentives to grain production (Chapter 5). In most studies of agriculture, government policies are treated as exogenous. Any changes in policies are assumed to be driven by known or unknown outside forces. This treatment fails to rationalize the motivation behind policy changes. In particular, if changes in policy are in fact a result of interaction between different economic factors, the feedback from the real economy to policy making is neglected. In the literature on endogenous government behaviour, policy changes are usually treated as the result of a complicated economic and political process. Individuals are organized into different interest groups which bargain with each other (or bargain with politicians). Economic policies characterize the equilibrium point at which the marginal benefit of a policy equals the marginal cost of lobbying or bargaining for it. In most studies related to agricultural policies, consumers and farmers are classified as two important counterparts in the economy, bargaining with each other for a particular level of subsidy or tax on agriculture. Such models do not clearly reflect the real story of agricultural policy in China. This study seeks to establish a new framework which accommodates the grain policy issue. The model is estimated empirically to reveal quantitatively the factors underlying changes in grain policy. The results seek not only to contribute to a better understanding of policy changes, but also to improve the quality of policy analysis through the incorporation of this framework into a general equilibrium model.

Production interactions in the semi-liberalized farming sector in China are estimated in Chapter 6. Supply elasticities for Chinese agriculture in other studies, whether estimated (Carter and Zhong 1988) or adopted (Gunasekera et al. 1991; Tyers and Anderson 1992), were all very low, in the main lower than 0.5. Low responsiveness of agricultural supply due to natural constraints may be one explanation. However, as the Chinese data do not distinguish state and market prices, and production quota and market supply, estimations using these aggregate data may lead to biased results. The existing data are manipulated and elasticity estimates which reflect farmers' actual market behaviour are obtained. These estimates provide a partial picture of the effects of incentives on the structure of agriculture and they are later applied in CGE modelling. The estimation of supply elasticities is given special attention because both price and quantity data presented in the Chinese statistical publications reflect government intervention.

In Chapter 7 an economy-wide model for China (China model) is constructed using a CGE framework. This China model incorporates policy intervention in grain, wool and cotton markets and some special features of the Chinese economy. Restrictions on labour movements between urban and rural industries are captured. Non-agricultural sectors are separated into rural and urban industries (nine each). An attempt is made to show the impact of limited labour mobility on the Chinese economy. Agriculture, as the main focus of the model, is disaggregated into four sectors (farming, livestock, forestry and fishing) and nine commodities (rice, wheat, other grains, cotton, other crops, wool, non-wool livestock products, forest products and fish). In total, the model contains twenty two sectors and eighteen commodities.

The China model is applied in Chapter 8 and several simulations are run for empirical analysis. The selection of simulations focuses on several crucial exogenous changes, such as changes in world market prices of grain (wheat). In particular, this study introduces some changes in economy-wide policies (such as monetary change) and changes in industrial sectors. The purpose of these simulations is to demonstrate that economy-wide policies and non-agricultural policies can have important effects on agricultural

performance. The effects would be even stronger if there were no restrictions on labour flows between rural and urban areas.

The final chapter summarizes the findings and policy implications of the study, and discusses the problems encountered and study's shortcomings. Directions for future research are identified.

2

Characteristics of Chinese Agriculture

Although many planning functions have already been replaced by market mechanisms, it is obviously too early to describe the Chinese economy as a market economy. The impact of agricultural policies in such an economy may therefore differ from those in stylized economic analysis. To identify how the Chinese economy is close to, or different from, a market economy is the first step for this study.

The economic system established by the Chinese government in the 1950s, particularly after 1952, derived largely from the Soviet system. Two of the basic characteristics of the economy were public ownership and central planning. In the urban sector, most industries were owned by the state with only a very limited number of collectively-owned small-scale enterprises. In the rural sector, industrial production was, generally, prohibited. Through socialist transformation in the 1950s, communes were created for agricultural production throughout the countryside by the end of 1958 (PLDRD 1989). Supported by public ownership of the economy, state plans strictly controlled all economic activities, including production, allocation and consumption. Economic plans were designed to facilitate the heavy-industry oriented development strategy (Lin 1991c). The combination of public ownership and central planning left little room for firms and individuals to make their own production and consumption decisions independently. Market mechanisms did not play an important role in the economy.[1] Macroeconomic policies, such as fiscal and monetary policies, were not used to influence

[1] Free markets, in general, did not exist in the pre-reform Chinese economy. In some particular years, free exchange of small-amount unimportant agricultural products was permitted. This did not have any significant impact on the rural economy since production structure was strictly controlled by economic plans.

activities; rather, they were applied as measures to allocate resources and accommodate plans.

Economic reforms have brought dramatic changes to the Chinese economy. Reform, initiated in 1979, started in the rural economy. Achievements of reform in rural areas are regarded as the most remarkable (Perkins 1988; Longworth 1989; Du 1992). Great changes, however, have since taken place in every part of the economy (Rawski 1992; McMillan and Naughton 1992). Economic reforms in China involve three interrelated aspects: microeconomic reform, macroeconomic reform and re-introduction of free market. All three serve the purpose of economic reform: reducing direct intervention and administrative regulation and giving a greater role to the market. In this sense, economic reform in China can be viewed as economic liberalization.

Microeconomic Reform in the Rural Economy

Microeconomic or institutional reforms created greater incentives for firms and individuals to respond to changes in the economic environment. The key role that microeconomic reform plays in economic liberalization is to generate closer or more direct linkages between effort and returns.

Problems with the Commune System

Prior to the introduction of reforms, apart from a few state farms, the commune system dominated agricultural production. A commune was usually organized at three levels: commune, brigade and production team. The production team consisted of about thirty households, which served as the basic unit of production and accounting. All production activities, such as land allocation, the application of inputs and labour use, were decided by the team leader. In effect, because these decisions were largely constrained by government regulations and restrictions, team leaders had little decision-making autonomy. Each team member's effort was related to payment through a working-point system. Members who presented themselves in the field obtained a certain number of working points per day. Daily working points were democratically determined at an

annual member meeting. At the end of the year, each member got his/her income according to the share of his/her accumulated working points in the team's total accumulated working points. The failure of this system was the difficulties experienced in monitoring agricultural production activities (Lin 1988). High costs of monitoring meant that members who presented themselves in the field but made no effort could usually get their working points. Each member therefore had to share his/her marginal product of effort with other members of the team whether or not the others chose to shirk. The consequence of this was the encouragement of universal shirking (Putterman 1987 and 1990; Lin 1988).

This widespread incentive problem, together with low state prices and rigid plans, created difficulties for agricultural development.[2] In the second half of the 1970s, not only was it extremely hard for agriculture to provide sufficient food to feed the rapidly increasing population, but it became the source of a bottleneck to overall economic growth. This is the background to agricultural reform.

The Household Responsibility System Reform

The government, at the beginning of the reform program, only intended to encourage agricultural production by raising state purchase prices, increasing state investment in agriculture and improving management of the commune system. Any initiatives which disrupted collective production were strictly prohibited. Farmers in poor regions, however, such as Anhui province, secretly experimented with household-based production responsibility systems. Good harvests by teams which adopted the experiment attracted others to experiment in the next year. In 1979, only 1 per cent of all production teams adopted the household responsibility system. The acceptance rate grew to 14 per cent in 1980 and to 45 per cent in 1981. Finally, it was officially recognized at the beginning of 1980s when the household responsibility system was implemented as a

[2] During 1959-61, when the commune was just compulsorily implemented, the dramatic reduction in agricultural outputs resulted in a severe famine. Aston et al. (1984) estimated that this famine resulted in excess of thirty million deaths.

national policy. Nearly 98 per cent of production teams had adopted the household responsibility system by the end of 1983 (Table 2.1).

Under the new household responsibility system, land is theoretically owned by the collective and contracted to households. The land-leasing contract usually requires households to fulfil a certain amount of the state procurement quota for a product, and to deliver a levy to the collective. Households are free to decide on their resource allocation and production structure provided these requirements are fulfilled. One of the crucial differences between the household responsibility system and the commune system is that returns are now more closely and directly related to the effort. Farmers, pursuing maximum profits or net income, have the incentive to adjust their behaviour in response to changes in economic signals.

Table 2.1 The household responsibility system reform and development of the rural township, village and private non-agricultural sector

	HRS adoption rate by production teams (%)	Number of TVP enterprises (million)	Number of TVP employees (million)
1978	0	1.5	28.3
1979	1	1.5	29.1
1980	14	1.4	30.0
1981	45	1.3	29.7
1982	80	1.4	31.1
1983	98	1.3	32.3
1984	99	6.1	52.1
1985	99	12.2	69.8
1986	99	15.2	79.4
1987	99	17.5	88.1
1988	99	18.9	95.5
1989	99	18.7	93.7
1990	99	18.5	92.6

Note: Numbers of the township, village and private firms and employees before 1984 only cover those firms at township and village levels, while the numbers from 1984 contain all township, village and private firms (including rural private firms). In the table, HRS refers to the household responsibility system and TVP refers to the township, village and private enterprises.
Sources: Lin (1992a), 'Rural reforms and agricultural growth in China', *The American Economic Review*, 82(1):37-38; State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing:377.

The household responsibility system reform finished in 1983. Its contributions to economic reform and growth in China are not restricted to establishing the direct linkages between effort and returns for agricultural farmers. It was the primary reason for

the continued increases in the state purchase prices of agricultural products during 1979-84, the re-introduction of free markets after 1985, the rapid development of the rural industries and the effectiveness of indirect macroeconomic policies.

Development of Township, Village and Private Enterprises

The other important part of the rural economy, is the newly-developed rural industry as a result of economic reform. Rural industry includes township, village and private enterprises. As these firms were established by farmers or collectives, mostly after 1983, they are less restricted by administrative regulations compared to the urban industrial sector. Of course, these firms also receive less assistance from the government. The formation of this special industrial and commercial sector in China was largely a result of the household responsibility system, increases in agricultural surpluses and segmentation between urban and rural areas. After the introduction of the household responsibility system, both agricultural productivity and output increased rapidly. Farmers are therefore interested in investing the agricultural surpluses on non-agricultural activities which have higher returns. As it is difficult to invest in the urban industry because of the segmentation between rural and urban economies, farmers established their own industrial and commercial enterprises in the rural areas (Du 1992). Free market opportunities outside the central plan created an environment in which this non-state sector could grow. Hence, these firms, from their inception, were more market-oriented compared to the state-enterprises.

Re-Introduction of Free Markets

Gradual abolition of controls over free markets is another very important aspect of economic reform in China. In the planned economy prior to reform, nearly all the real and nominal variables were set by plans, though some of the planned goals were often not achieved. Prices were largely fixed by the government and did not play a role in regulating demand and supply. Instead, the most important function of prices involved their use as an accounting measure.

The Development Strategy and the Unified Purchase and Marketing System

Like many other agricultural problems in both pre- and post-reform China, government intervention in agricultural markets had its roots in the development strategy adopted in the early 1950s.[3] In the early 1950s in China, heavy industry was seen as a key to economic modernization. Development of heavy industry, of course, requires tremendous amounts of capital investment. China at that time was largely an agricultural economy.[4] As in other under-developed economies, capital was very scarce. The only source of investment in the early stages of development was agriculture (Timmer 1988). Agricultural surpluses can be channelled into the industrial sector in two ways: first, through high rates of agricultural taxes, and second, through depressed agricultural prices.

The Chinese government adopted low agricultural prices to transfer resources from agriculture to industry (Ji and Lu 1980; Lin 1991c; Gao 1992). To facilitate rapid capital expansion, low wages for industrial workers were instituted so that state enterprises could generate large profits for investment in infrastructure and capital construction. This policy required that prices for food and other necessities, cotton, transportation and other raw materials were kept low. A set of agricultural policies, which included three main measures, was shaped to facilitate resource movements from agriculture to industry. The first included the abolition of free markets for most agricultural products and the introduction of a unified purchase and marketing system; the second involved the establishment of a state price for each product usually lower than the corresponding free market or shadow price; and the third covered the collectivization of agricultural production in the 1950s and the commune system thereafter. Flows of productive factors across regions and industries were prohibited.

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[3] Lin argued that the agricultural problems prior to the 1979 reforms stemmed from the development strategy adopted by the Chinese government in the early 1950s, and that the post-reform problems also have their roots in the early development strategy (Lin 1991c:2).

[4] According to Lin (1991), in 1949, 89.4 per cent of the population resided in rural areas and industry accounted for only 12.6 per cent of national income.

Lardy (1983a) argued that the prices implicit in this set of policies were expected to perform functions that government tax and expenditure policies facilitate in most market economies. Prices in China in the pre-reform period were largely set with a view towards determining the allocation of resources between individuals and the state, between industry and agriculture, and among different regions. The other reason the government wished to control the price was to preserve price stability.[5]

The government controls over agricultural products, however, varied between products. A three-category system was established for product management according to the importance of product to the national economy and to industrialization (Lardy 1983a; Sicular 1988b). The first category contained grain, edible vegetable oils, oil crops and cotton — products considered crucial to national welfare. The procurement quotas and prices for these products were centrally determined within the unified purchase and marketing system, and any non-official transaction of these products was strictly prohibited. Most other agricultural products, including hogs, cattle, eggs, fish, tea, tobacco, sugar crops and medicinal herbs, fell into the second category. The procurement quotas and prices were also determined by the state, but more independence and flexibility was granted to the local government.[6] In some cases, it was permissable to sell production above state quota on the free markets. The third category included all other agricultural products which were not subject to state procurement plans and could be exchanged in the market.[7]

Products in the first category were subject to 'unified procurement', and products in the second category to 'designated procurement'. Four sets of prices for agricultural products existed before and in the early stage of economic reform. State quota

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[5] While stability is a common reason for governmental intervention, it is critical in China. The high priority attached to this objective in China reflected China's very unhappy experience with hyperinflation in the late-1940s. Price stability had been an important component of the Communist Party's claim for popular support (Lardy 1983a).

[6] Production quotas and prices for products belonging to the second category were usually determined by the local governments, such as provincial or county governments.

[7] According to Lardy (1983a), there were over a hundred products in the second category and hundreds of distinct subsidiary and native products in the third category.

procurement of most agricultural products occurred at 'quota prices', which were established by the state plan. For procurement above the state quota 'above-quota prices' applied, which added a 30-50 per cent premium to the procurement prices. There were also 'negotiated prices' which were mutually agreed upon by producers and the state commercial department.[8] The final set was 'free market prices' in rural and urban markets. Price data provided by Lardy (1983) illustrate the differences between the four prices. In 1980, for paddy rice, the state quota purchase price was 0.23 yuan per kilogram, the above-quota price 0.35 yuan, the negotiated price 0.55 yuan, the rural market price 0.55 yuan and the urban market price 0.62 yuan.[9]

Adjustments of State Prices

The function of the market increased as the reform process progressed and narrowed the room in which the plan could operate. The aim of this was to provide correct signals for firms and individuals in decision-making. This re-introduction of the market in China involved two elements. One is price adjustment in the initial stage of reform and the other is the introduction of free markets.

The purpose of both price adjustment and abolition of controls over the free market in China is to get pricing right and to enable price signals to reflect closely the demand and supply relationship. Price adjustments in the early stage of the reform process, though they did not involve free markets, were targeted at correcting price distortions. This can therefore be regarded as the first step towards market mechanism. Price adjustment, in fact, was the most important component of the 1979 reform. At the end of the 1970s, the Chinese government realized that the low prices of agricultural products seriously discouraged agricultural growth and hindered overall economic development. To encourage agricultural production, upward price adjustments were announced at the end of 1978 and began to be implemented in 1979. Quota prices were increased by 20.9 per

[8] In practice, negotiated prices were often lower than market prices due to the monopoly power of the state commercial departments.

[9]. The rural market price for milled rice was 0.78 yuan per kilogram. It was converted, for the sake of consistency, to the price for paddy rice by assuming a 70 per cent milling rate.

cent for grain, 23.9 per cent for oil crops, 17 per cent for cotton, 21.9 per cent for sugar crops and 24.3 per cent for hog meat (Lin 1991c). The average increase for the quota prices was 17.1 per cent. Premiums paid on above-quota delivery of grain and oil crops was raised from 30 per cent to 50 per cent of the quota prices, and a 30 per cent bonus was introduced for above-quota delivery of cotton. The average increase in state procurement prices was 22.1 per cent. The weighted average procurement price, which includes both quota and non-quota procurement, increased 21.5 per cent for wheat in 1979, 20.7 per cent for paddy rice, 20.5 per cent for corn and 17 per cent for cotton, while the price for wool remained unchanged (Table 2.2). At the same time, retail prices of some agricultural products, excluding basic necessities as grain and edible oils, were also raised in 1979.[10] A lump sum of 5-8 yuan per month was paid to each urban resident as compensation (Lin 1991c).

Price policies for grain and natural fibre products have been further revised several times since 1979. The wheat quota price was reduced by 4.6 per cent in 1980, soybean quota price was raised by 50 per cent in 1981 when its above-quota bonus was eliminated. In 1984, the soybean price dropped by 13.3 per cent.

Another important instrument for grain policy is the procurement quota. In 1979, alongside the price increase, the procurement quota was reduced by 5.9 per cent to 35 million tonnes. This quota was further reduced to 34 million tonnes in 1980, and to 30 million tonnes in 1981.

In 1985, schemes were introduced for most agricultural products. A voluntary procurement contract and proportionate pricing were implemented for rice, wheat and corn.[11] The contract procurement level was about 70.5 million tonnes (Sicular 1988b). Following the decline of grain production in 1985 and stagnation thereafter, contracts were again made mandatory in 1986 (Lin 1991c). In 1986, apart from several price

[10] Retail prices were raised by 33 per cent for pork, 32 per cent for eggs and 33 per cent for fish (Lin 1991c).

[11] The proportional price adopted in 1985 was computed as a combination of 30 per cent of the quota price and 70 per cent of the above-quota price in the previous year.

adjustments, the procurement quota was reduced to 55 million tonnes and further to 50 million tonnes in the following year. A new award system (*san guagou*) for fertilizer, diesel oil and cash advance was introduced for grain deliveries.

Table 2.2 Price indexes for grain and natural fibre products (1978=100)

	Wool	Cotton	Wheat	Rice	Corn
1965	41.11	78.40	87.04	86.01	84.34
1970	64.12	88.54	100.00	98.98	100.00
1971	64.12	89.62	100.00	99.08	100.00
1972	88.24	91.42	100.00	99.08	100.00
1973	90.00	91.42	100.00	99.08	100.00
1974	90.00	91.42	100.00	99.47	100.00
1975	90.00	91.42	100.00	100.00	100.00
1976	90.00	91.42	100.00	100.00	100.00
1977	90.00	91.42	100.00	100.00	100.00
1978	100.00	100.00	100.00	100.00	100.00
1979	100.00	117.00	121.51	120.71	120.51
1980	100.88	128.96	121.65	120.80	120.65
1981	102.36	128.96	121.65	120.80	120.65
1982	105.30	128.96	121.65	120.80	120.65
1983	107.65	128.96	121.65	120.80	120.65
1984	109.71	125.07	121.65	120.66	120.65
1985	148.33	155.69	121.79	122.95	122.94
1986	176.77	154.90	127.04	130.69	141.99
1987	184.86	162.10	131.37	147.93	147.80
1988	267.48	176.15	151.35	177.21	1[illegible].76
1989	266.80	216.13	184.48	231.62	203.98
1990	195.24	279.03	169.70	214.47	199.08

Source: State Statistics Bureau, *China Price Statistical Yearbook*, various issues, China Statistics Press, Beijing.

Cotton prices were further increased by 10 per cent in 1980 and 1.2 per cent in 1981, following the general increase in 1979. In 1984, a contract procurement system with proportionate pricing was introduced.[12] This contract price for the northern region was adjusted in 1985 and 1986.[13] A similar award system for fertilizers, diesel oil and cash advance as used for grains was introduced in 1986, while the contract procurement was also made mandatory (Lin 1991c).

[12] The proportional price for cotton in 1984 was computed as a combination of 60 per cent of the quota price and 40 per cent of the above-quota price in the previous year.

[13] Weights used to compute the proportional price changed to 30 per cent of the quota price and 70 per cent of the above-quota price in 1985, and they were changed back to 40 and 60 per cent, respectively, in 1986.

The price of wool was not raised in the 1979 reform. During the reform period before 1985, wool prices increased at a much slower pace than either grain and cotton prices. Wool output grew slowly as a consequence (Watson and Findlay 1992). According to Watson and Findlay, apart from the change in relative prices of wool to those of grain and meats, another important reason for slow growth was the lack of an effective market at the margin for wool. The combination of constraints on production and a rapid growth in demand resulted in the 'wool war' during 1985-88 in China (Watson and Findlay 1992). Market prices rose dramatically during this period (Table 2.2). In 1985, there was also a change in the marketing arrangements for raw wool. The unified procurement system was replaced by purchase through contract or through the market (Zhang, et al 1991). The state, however, found it difficult to obtain the wool it wanted and the state purchase price rose. The wool war lasted through to the start of 1989.

Re-introduction of Free Markets

Accompanying adjustment in state prices to market determination during 1979-84, local free markets and fairs were gradually given permission to re-open as an outlet for farm surpluses. The number of rural fairs increased from 37,890 in 1980 to 41,184 in 1982 and 50,356 in 1984. The number of urban fairs for agricultural products increased from 2,919 in 1980 to 6,144 in 1984 (Table 2.3).[14] For many agricultural products, output could be exchanged in the free markets after the fulfilment of the state procurement quotas. Before reform, the only organizations that were permitted to purchase grain were state commercial enterprises and supply and marketing cooperatives. Before 1978, all purchase of grain was by the state. In 1979, state purchases accounted for 95.8 per cent of total grain purchases. This share dropped to 91.7 per cent in 1984. These data presented here do not accurately reflect the proportion of state and non-state purchases. A proportion of the agricultural products purchased by state departments in the later period was not part of the state procurement quota, such as purchase of grain at

[14] The numbers of rural and urban fairs increased to 59,473 and 13,106, respectively, in 1990 (State Statistics Bureau, *China Statistical Yearbook 1991*:605).

negotiated prices by the state commercial department. A large part of the procurement was done at prices close to market determination.

Alongside the growth of markets, the function of the economic plan weakened in the process of economic reform. The number of production planning categories had been 21 before 1978, and was reduced to 16 in 1981 and to 13 in 1982. The number of planning targets had been 31 before 1978, and was reduced to 20 in 1981 (Wu 1983). Areas in which markets were established expanded accordingly.

Table 2.3 Growth of markets in rural China, 1978-84

Year	Number of rural fairs	Number of urban fairs	Grain purchase state/total (%)	Agricultural Procurement state/total (%)
1978	..	..	100.0	82.4
1979	..	..	95.8	82.2
1980	37890	2919	93.1	80.4
1981	..	..	92.4	80.1
1982	41184	3591	92.4	79.0
1983	43515	4488	94.4	77.5
1984	50356	6144	91.7	74.3

Source: State Statistics Bureau, *China Statistical Yearbook*, various issues, China Statistics Press, Beijing.

Although radical introduction of free markets did not occur until the second half of the 1980s, permitting market exchange of agricultural products at the margin during that period was very significant for rural development. In adjusting agricultural prices, the government not only considered market conditions for particular products, it was also constrained by many other factors. To raise agricultural prices, the government had to take into serious account consumers' income, the state budget balance and policy priorities. Most state prices of agricultural products in the first half of the 1980s were still far below their free market levels. But free markets at the margin generated the right incentives for farmers and resources were relocated according to the real market conditions.

There were also some problems when free markets only existed at the margin. Since a large part of the agricultural products was still exchanged through state channels at low prices, the prices formulated by the free markets at the margin were often substantially

distorted.[15] Prices still did not accurately reflect the real opportunity costs of the economy. Since the free markets at the margin were only very small and were still influenced by governmental administration, farmers were not always able successfully to access free markets. Many farmers still do not regard free market prices as effective marginal signals in guiding production decisions.

In 1985, a package of reform policies was implemented to re-introduce a free market for most agricultural products. For grain and cotton, mandatory quotas were to be eliminated and replaced by a combination of contract and market purchases. The state would sign contracts with farmers voluntarily before planting seasons (Sicular 1988a; Huang 1991). For the other products, such as vegetables, fish and meat, government regulations were abolished and the state department would buy and sell in the markets. This reform fundamentally changed the mechanisms whereby the economy operated.

Macroeconomic Reform

Economic reform at the macro level aims at building an economic management mechanism with less direct and more indirect interventions. Macroeconomic policies change from direct resource allocation measures to indirect management instruments. One important step taken in macroeconomic reform was decentralization of decision making powers by the central government.

Decentralization was first reflected in the decline of central government's share in total government revenue. A salient feature of the role of the government since the beginning of reforms has been the continuous decline of its total revenue as a proportion of GNP, from 34 per cent in 1978 to 25 per cent in 1986 and to 21 per cent in 1989 (Blejer et al. 1991). The level of government revenue relative to national income was higher in China in 1988 than in countries with comparable per capita income, although the difference had

[15] The impact of low state prices on free market prices through income effect on the consumer side was one of the reasons for this.

narrowed considerably after the late 1970s.[16] On the other hand, compared with other centrally planned economies (CPEs), China's revenue was substantially lower. The relative decline in government revenue share in China implies that more autonomy was given to enterprises. In addition, local governments had an increasing share of total revenue as well as more responsibility for regional development (Table 2.4). The ability of central government to control economic activities has consequently been reduced. The declining revenue share also reduced government capacity to influence the level of domestic spending (Findlay et al. 1992). Local governments are now more powerful and interested than ever in shaping regional production, taking local conditions such as resource endowment, infrastructure and comparative advantage into account. This also partially explains why local government-oriented enterprises developed so rapidly during the reform period.[17]

Controls over trade were also decentralized. As the role of the trade plan has been decreased, direct controls over exports and imports have been exercised increasingly through a licensing system. Competition in the trade system was increased by abolition of the monopoly powers of the central foreign trade corporations and by allowing provincial authorities to establish their own trading corporations.

Since decision making was decentralized, monetary policy was required to play an increasingly important role in macroeconomic management. In January 1984, the People's Bank of China was transformed into a separate central bank focusing on monetary policy and macroeconomic monitoring. Its commercial operations were transferred to the newly-established Industrial and Commercial Bank of China. Separate

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[16] The revenue share in GNP in China was 34 per cent in 1978 and 19 per cent in 1988, while it was 16.7 per cent in low-income countries, 25 per cent in middle-income countries, 33.9 per cent in industrial economies, and 50-80 per cent in centrally planned economies (Blejer et al. 1991). Obviously, Blejer and others believed that income levels in China were comparable to those in low-income countries. However, in a recent study, Ma and Garnaut (1992) argued that income levels in China have been substantially underestimated, and that actual income should be multiplied by two or three. If their proposition is true, it implies that China should be relocated into the middle-income country group. If this is the case, China's revenue share of 21 per cent in 1989 seems very close to that of the average for the middle-income countries (25 per cent) since its income should be in the lower-middle level.

[17] Probably this is also the cause of problems in economic structure, such as repeated construction of textile industries (Findlay 1992).

banks operating in specific sectors of the economy were re-established, such as the Agricultural Bank of China handling the agricultural sector. Since 1986, two universal banks, the Bank of Communications and the China International Trust and Investment Company Bank, have been allowed to compete with the specialized banks in all areas of activity and a number of new banks at the provincial level have been established.

Table 2.4 Government expenditure in the reform period

	Government expenditure				Agricultural investment as a share of total government investment (%)
	Total (billion yuan)	By central (%)	By local (%)	Price subsidy (%)	
1978	111.1	..	..	1.0	10.6
1979	127.4	..	..	6.2	11.1
1980	121.2	..	..	9.7	9.3
1981	111.5	54.0	46.0	14.3	6.6
1982	115.3	49.9	50.1	14.9	6.1
1983	129.3	49.7	50.3	15.2	6.0
1984	154.6	47.8	52.2	14.1	5.0
1985	184.5	45.4	54.6	14.2	3.3
1986	233.1	41.3	58.7	11.0	3.0
1987	244.9	42.1	57.9	12.0	3.1
1988	270.7	39.2	60.8	11.7	2.9
1989	304.0	36.3	63.7	12.2	3.3
1990	345.2	39.8	60.2	11.0	4.1

Source: State Statistics Bureau, *China Statistical Yearbook*, various issues, China Statistics Press, Beijing.

The financing of the operations of enterprises began to be shifted from direct grants from the state budget to loans extended by specialized banks in 1984. The issuance of securities started in 1981 with the forced sale of treasury bonds to local governments and enterprises. Sales of treasury bonds were extended to individuals in 1982 on an involuntary basis. Recently, these bonds have been made exchangeable in the market. In China, monetary policy is implemented through a dual control system that relies on both direct credit controls and indirect levers affecting the coexistence of planning controls and market mechanisms in the economy. Under the credit plan, credit ceilings are established for each specialized and universal bank, and the banks, in turn, allocate ceilings to their local branches.[18] In the second half of the 1980s, efforts were made to

[18] The extent to which the credit ceiling has been enforced has varied considerably. At the end of 1984 and the beginning of 1985, for instance, an explosion of credit restraint resulted in a dramatic

place greater reliance on indirect instruments of monetary control, especially reserve requirements, interest rates, and central bank lending to banks. The central bank's control over credit was frequently limited, however, by the ability of local governments to put pressure on its own branches to extend credit to banks to enable them to meet regional credit needs (Blejer et al. 1991).

New Characteristics of Chinese Agriculture

Economic reforms have brought dramatic changes to the Chinese economy. Real GDP grew at an average rate of 8.5 per cent annually during 1979-90. The reformed Chinese economy, being different from both a market economy and a centrally planned economy, is showing a higher degree of economic integration in the process of economic reform. Since domestic reforms were accompanied by the open-door policy, the Chinese economy is now being increasingly integrated into the rest of the world. The share of exports in GDP increased from 2.45 per cent in 1978 to 4.41 per cent in 1984 and to 7.86 per cent in 1990.[19] These suggest that the share of exports in GDP in China is increasingly approaching the normal level for very large countries (Perkins and Syrquin 1988). Lardy (1992) provide another measure to show an increasingly important role played by trade in the Chinese economy. Supposing that the ratio of trade to GNP in 1978 was 100, Lardy suggested that the ratio was 128 in 1990 (Lardy 1992:154).

China is also becoming more crucial in international markets, particularly for particular products. China's trade with the world only accounted for 0.58 per cent of the world's total trade in 1970. It increased to 0.96 per cent in 1980 and 2.09 per cent in 1990 (IEDB).

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growth of money supply. When monetary policy was being tightened, on the other hand, credit ceilings were enforced more strictly.

[19] These data are calculated from *China Statistical Yearbook 1991*. Both exports and GDP were valued by RMB yuan. These shares are, however, much lower than those calculated from international data sources, such as the World Bank and the International Monetary Fund. According to Drysdale and Elek (1991), the share of exports in GDP was 13.38 per cent in 1989, while in Chinese statistics it was 5.67 per cent in the same year. Perkins' (1988) estimates for 1978 and 1984 also seem much higher than the data provided here.

One interesting feature of China's trade is that it is more concentrated on trade with Asia-Pacific countries[20]. In 1970, trade with Pacific countries accounted for 52 per cent of its exports and 51 per cent of its imports. This rose to 72 per cent for exports and 64 per cent for imports in 1990. As the Chinese economy is becoming more integrated into the world economy, it has to pay more attention to changes in international markets and to its comparative advantages in shaping the pattern of production.

The degree of economic integration within the Chinese economy has also increased. At the beginning of reform, the pursuit of regional self-sufficiency of grain was abandoned and producers are now freer to consider local conditions. Specialization of production is encouraged. Therefore, regional trade and resource flows have occurred. Though official segmentation between the urban and rural sectors has not been abolished, factor flows, such as labour flows, are frequently observed. An increasing amount of rural labour entered cities to find jobs as baby sitters, shoe-repairers, private-retailers and causal workers in urban enterprises. Farmers are also often organized into construction teams to contract with urban firms or departments. On the other hand, experienced workers, retirees, and technicians, attracted by higher payments, joined township, village and private enterprises.

The most important form of economic integration, for farmers, is the rapid expansion of the rural industrial sector during the reform period (Table 2.1). Before and in the early stage of economic reform, farmers had few opportunities to avoid risks by diversifying into other activities. The rapid growth of the rural industrial sector provided farmers with more employment and investment opportunities. Township, village and private enterprises (TVPs) grew during the reform period, particularly during 1984-90 when the number of these enterprises tripled and the number of employed workers nearly doubled. The real value of gross output of the rural industrial sector increased at an average annual rate of 21 per cent during the same period. In 1990, TVPs output accounted for

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20 The Pacific countries include Australia, New Zealand, Japan, Korea, Indonesia, Philippines, Singapore, Thailand, China, Hong Kong, Taiwan, the United States and Canada.

22 per cent of GDP and 35 per cent of national industrial output. As a result, farmers' income sources have been diversified, as have their investment and employment opportunities. In 1990, 37 per cent of farmers' net income came from township and village enterprises.[21] According to Jiang and Luo (1988:176-7), 8 per cent of farmers' net income was extracted from non-agricultural activities in 1978. This share rose to 14 per cent in 1982 and 25 per cent in 1986. Farmers' investment in the non-agricultural sector was much higher than in the agricultural sector in most years of the reform period (Huang 1992). Employment in township, village and private enterprises accounted for 24 per cent of total rural labour in 1988, but that share dropped slightly to 22 per cent in 1990.

Farmers no more only undertake agricultural activities. They are increasingly involved in industry, commerce, transportation and other service sectors. As a result, the share of agriculture declined even within the rural economy, alongside the growth of agricultural outputs (Table 2.5).

Table 2.5 Structural change of the rural economy in China (%)

	Agriculture	Industry	Construction	Transportation	Commerce
1980	68.9	19.5	6.5	1.7	3.5
1983	66.7	20.0	7.8	2.0	3.5
1984	63.4	22.9	7.3	2.6	3.7
1985	57.1	27.6	8.0	3.0	4.3
1986	53.1	31.5	7.8	3.2	4.3
1987	49.6	34.8	7.7	3.6	4.4
1988	46.8	38.1	7.1	3.5	4.5
1989	45.1	40.7	6.4	3.6	4.3
1990	46.1	40.4	5.9	3.5	4.1

Source: State Statistics Bureau, *China Statistical Yearbook*, various issues, China Statistics Press, Beijing:315.

After ten years of reform, the Chinese economy is much more flexible and free to adjust its economic structure in response to changes in incentive structure. Trade flows, factor movements, resource relocation and production adjustments have all occurred, though not perfectly. Every part of the economy increasingly interacts with each other.

[21] This share does not include income from private enterprises,. so the share of farmers' income from rural industry must be higher than that given here.

Economic integration is important to the application of a general equilibrium framework in this study. In a highly segmented economy, there would not be much room for sectoral interactions or indirect policy effects to play a significant role. In the current Chinese economy, farmers behaviour is not only subject to sector specific policies, such as procurement price and input policy, but is also affected by the other sectors of the economy and their feedbacks.

Limited Factor Mobility or Limited Feasible Choice Set of Farmers

Economic integration helps to raise the degree of factor mobility for farmers. Within agriculture, farmers are now free to decide on resource allocation and production structures conditional only on the fulfilment of certain government purchase quotas. A large amount of agricultural resources, including land, labour and capital, has moved from agriculture to industry, particularly rural industry, in the past decade. The number of employees in the township and village enterprises, mostly local farmers, rose from 28.3 million in 1978 to 92.6 million in 1990 (*China Statistical Yearbook 1991*:377).

Factor mobility, however, is still subject to many non-economic constraints. Important production factors include capital, land and labour. Land in the rural areas is legally owned by the collectives (or, previously, by production teams). In most cases, farmers are not allowed to transfer or sell the piece of land they farm nor can they use it for other purposes.

Capital movements are limited in China. When the TVP enterprises were beginning in early years, they usually bought old machines from urban industries. Capital is, however, by no means mobile, not only because capital movements between different urban industries are not allowed, but also because farmers cannot move their capital into the cities even if higher profitability exists in the urban areas. There is a certain degree of capital mobility between agriculture and the rural industry. It is commonly observed, for instance, that farmers buy tractors for ploughing during planting seasons and for transportation throughout the rest of the year.

The limited mobility of capital and land is not so significant in this study since a short-run analytical framework is applied. Capital and land are assumed to be fixed in this framework. The more important factor is labour. Labour mobility has improved alongside increasing economic integration but is limited by two kinds of restrictions or constraints: one on labour flows between rural and urban areas, and the other on labour flow between agriculture and rural non-agricultural industries.

Labour flows from rural to urban areas are still discouraged by the government as it attempts to regulate the scale and stability of cities (White 1988; Meng 1993). Regional labour flows are rare, not only because the movements between rural and urban areas are largely restricted, but because most of the rural industries aimed at absorbing local agricultural surplus labour. According to a sample survey on labour force, in 222 surveyed villages, only about 3 per cent of the total labour force migrated permanently, and 11 per cent seasonally to the urban areas and other rural areas (Table 2.6).[22] Labour inflows are even smaller. Within the rural areas, about 80 per cent of township and village enterprises employees are from the same township and only about 5.0 per cent of employees are from the other counties and provinces (Meng 1993).

Even within the local rural areas, labour is not perfectly mobile. Earnings of agricultural farmers are still significantly lower than those employed by the rural industry. In 1985, the average wage of agricultural production was 4.7 yuan per day, while that of non-agricultural production was 10.7 yuan per day (Huang 1992). Even in 1990, the average yearly income of total farmers, including agricultural farmers and rural industry employees, was 630 yuan, and that of rural industry employees was 655 yuan.[23] This suggests that there are still many farmers who failed to find jobs in industry even though they wanted to.[24] Most rural industrial employees are assigned administratively rather

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22 This data derives from a nation-wide labour force survey of a hundred villages (Meng 1993).

23 State Statistics Bureau, *China Statistical Yearbook 1991*:377-379; *China Agricultural Statistical yearbook 1991*:206.

24 In development economics, the existence of a gap between agricultural and non-agricultural wages could be an equilibrium result when farmers' risk factors, such as unemployment in the urban sector, are incorporated (Harris and Todaro 1970). This argument might be applied to analysis of labour movements between urban and rural areas in China, incorporating some modifications (Anderson 1990).

than through markets, and wage determination in rural industry is influenced by local government (Meng 1993).

Table 2.6 Labour outflow and inflow in 222 sample villages, 1986

	Amount (1,000 person)	Proportion (%)
Total labour	189,006	100.00
Total outflow	26,993	14.30
permanent	5,596	2.96
seasonal	21,397	11.32
To urban areas	12,394	6.56
permanent	3,303	1.75
seasonal	9,091	4.80
To other rural areas	14,599	7.72
permanent	2,293	1.20
seasonal	12,306	6.51
Total inflow	7,793	4.10
permanent	4,086	2.20
seasonal	3,707	2.00
from urban areas[a]	733	0.40
from other rural areas	7,060	3.70

Note: [a] Labour moved from the urban areas to the rural areas consists mostly of retirees from urban industries and employed by the township and village enterprises as technicians or technical consultants.
Source: Meng (1993), *Individual wage determination in township, village and private enterprises in China*, unpublished PhD dissertation, Australian National University, Canberra.

Policy Intervention

Asymmetric price control is another important characteristic of the current Chinese economy, particularly agriculture. While most direct intervention in product markets has been gradually eliminated, interventionist policies continue to effect some agricultural products. As discussed above, during the pre-reform period, the state directly controlled the pricing and exchange of most agricultural products. Demand and supply were pre-determined in detail by economic plans, though this approach was hardly successful. Through the process of economic reform, direct intervention in the regulation of demand and supply was gradually replaced by market mechanisms.

However, it is hardly true for the case of labour movements from the agricultural sector to local rural industry.

The effects of continuing intervention in Chinese agriculture are visible at two levels. First, some domestic product markets remain insulated from the international market — for example, the grain markets.[25] Second, the state prices are substantially biased away from the market equilibrium for some agricultural products such as wool and cotton.

The insulation of the domestic agricultural product markets from the international market has two causes: trade barriers and exchange rate controls. Barriers to trade employed by the Chinese government not only prevent foreigners from freely entering the domestic market, they also make it very difficult for home producers and consumers to access the international market. Because the exchange rate is artificially set by the government and not as a result of free interaction between market forces, any change in one market cannot be transmitted to the other sensitively. In particular, when monetary movements occur in the domestic economy, such as an increase in money supply, one possible consequence is an inflationary effect. Market prices for all non-price controlled commodities will increase. Under a free exchange rate regime, this would not affect the relative price of Chinese commodities in the international market as the exchange rate would adjust accordingly. When the exchange rate is rigid, Chinese exports in the international market tend to become more expensive.

Distortion of agricultural product prices away from domestic market equilibrium prices occurs in two major forms. One is the so-called two-tier price system. For grain, a fraction of commodity output must be transacted at the state-determined price. Output above this amount can be freely exchanged in the market. The other involves strict prohibition of free market transactions: all output must be purchased and allocated by the state according to economic planning. This second form of distortion currently applies to cotton and wool. At first glance, one would gain the impression that this form of distortion is exactly the same as the pre-reform 'unified purchase and marketing

[25] In some regions of China, such as in Guangdong province, grain imports started to be managed by local governments. The Chinese grain market as a whole, however, is still insulated from the international market.

system'.[26] As this study shows later, however, after ten years of reform the implementation and consequences of this interventionist policy are rather different.

The two forms of intervention have quite different effects on agriculture and other economic activities. For grain, there was a two-tier price system.[27] Some economists argue that, because a free market exists alongside government intervention, the distortions created by grain incentives do not directly affect consumption and production behaviour (Sicular 1988). The only effects are second-round income effects. These are minor according to some economists (Martin 1990). Lin (1993), on the hand, argues that state prices do have important effects on farmers' production decision if state purchase quotas are endogenously determined. For wool and cotton, although only one state price exists, the operation of the demand and supply sides of the market is differs significantly from the pre-reform regime. On the supply side, wool and cotton are produced by millions of farm households. However, because wool and cotton are, in principle, not directly consumable, farmers are less able to sell their products at higher prices outside governmental channels. It is easier to detect and penalize non-government organizations transacting wool and cotton with small-scale farmers. Therefore, farmers, in general, are still subject to the state price. On the demand side, however, second market transactions occur frequently, explaining how many township and village enterprises are able to continue producing textile products. The hypothesis to the wool and cotton exchange is the separation of the producer and user prices. Because state prices are set too low, farmers do not have an incentive to produce higher output. Surplus demand exists for wool and cotton. User prices are pushed up (due to rent-seeking) until demand and supply are equal.

State intervention in grain and natural fibre production can be measured at two levels, according to the references used (Table 2.7). There are also some other measures of the

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[26] The unified purchase and marketing system was adopted in 1952 in China for most agricultural products, under which the free market is closed and the state is the only agent involved in exchange transactions.

[27] This study does not discuss the situation after April 1992, from which the two-tier price system was officially abolished.

effects of intervention on agriculture. Anderson and Tyers (1987) present ratios of domestic producer prices to border prices for a few grain commodities. The ratio for rice was unstable over the period 1955-83. For wheat and corn, the ratios rose over the same period. Webb (1989) estimated producer subsidy equivalents (PSEs) for the period 1982-87. It was found that PSEs due to procurement policy for grain products declined dramatically during this period. PSEs due to border policy vary over time. While the PSEs for rice were quite stable (around -60 per cent), wheat producers switched from being net beneficiaries to net losers (Webb 1989).

Table 2.7 Intervention in grain and natural fibre markets, 1979-90

	Due to procurement policy[a]			Due to border policy[b]			
	Grain	Cotton	Wool	Grain	Cotton	Wool[c]	Wool[d]
1979	0.64	0.00	0.00			0.84	0.83
1980	0.68	0.00	0.00	1.99		0.77	0.49
1981	0.67	0.00	0.00	0.94		0.62	0.86
1982	0.68	0.00	0.00	0.90	1.31	0.63	0.90
1983	0.68	0.00	0.00	0.99	1.31	0.68	0.94
1984	0.70	0.00	0.00	0.84	1.00	0.58	0.77
1985	0.78	0.00	0.00	1.17	0.95	0.68	0.85
1986	0.85	0.00	0.00	1.18	1.17	0.69	0.81
1987	0.85	0.00	0.00	1.54	0.96	0.50	0.57
1988	0.85	0.00	0.00	1.54		0.43	0.66
1989	0.89	0.00	0.00			0.45	0.65
1990	0.93	0.00	0.00			0.36	0.50

Notes: [a] Data on distortions due to procurement policy measure the ratio of procurement to free market prices;

[b] Data on distortions due to border policy measure the ratio of domestic to international prices. Two measures are presented in the table for the distortions in wool price due to border policy;

[c] This column uses Australian auction prices as the international price; and

[d] The last column uses New Zealand's auction prices.

Sources: The distortion indexes are calculated from State Statistics Bureau, *China Statistical Yearbook*, various issues; *China Price Statistics Yearbook*, various issues; China Statistics Press, Beijing; Australian Bureau of Agricultural and Resource Economics, *Commodity Statistics Bulletin 1992*, Canberra.

A New Scene

The Chinese agricultural sector has been semi-marketized in the past decade of reform bringing important new dimensions to its development performance. Agriculture in China is now integrated, to a certain degree, with the rest of the Chinese economy and the world economy. This provides the motivations and possibilities for farmers to adjust their

resource allocation behaviour and production structure as a means to maximize their profits.

Profit-maximizing resource allocation is, however, restricted by the limited factor mobility. Furthermore, some agricultural activities are still subject to direct government intervention, such as the state purchase prices and procurement quotas for grain, cotton and wool. These would prevent farmers from maximizing profits.

Therefore, these two characteristics are important in analysing agricultural policies in China and are significant in formulating the methodology for policy analysis. Not only should they be carefully examined, they must also be appropriately accommodated in analytical framework. These require theoretical developments as well as empirical investigation.

3

Farmers' Production Decisions: A Theoretical Analysis

Two characteristics — the limited feasible choice set of farmers and price distortion — were important mechanisms for agricultural and economic changes in China. This chapter develops a more detailed and consistent framework for understanding the ways in which, and the extent to which, these two characteristics have distorted economic equilibrium and production/consumption decisions. A perfect competition model is first used as a reference point in the argument. This necessitates a set of simplified and stringent assumptions. Economic equilibrium and production decisions are analyzed by introducing price distortion and a limited feasible choice set. The results are compared with those in the case of perfect competition. The response of the economy to changes in economy-wide policies is then examined.

A Perfect Competition Model

Assume an economy comprising two consumers, one urban and one rural, and two producers, one industrial and one agricultural. Both the urban and rural consumer have an initial factor endowment, labour for instance ($\overline{X}_U$ for urban consumer and $\overline{X}_R$ for rural consumer). Consumers sell their labour at market wages and buy commodities for consumption. Producers, on the other hand, buy labour as the only input to production and sell their products on product markets.

Optimization Behaviour of Consumers and Producers

> **Assumption 1**: Consumers and producers are assumed to be rational agents. Consumers maximize their utility levels, subject to market prices and the budget constraint. Producers maximize their profits, given technology and market prices.

The two producers are distinguishable in the sense that they produce different products using different technologies. The industrial producer produces an industrial product (y_I) and the agricultural producer produces an agricultural product (y_A). Production of both goods uses labour (x) as the only input and there are no intermediate goods. Production technologies are defined as

$$y_i = f_i(x_i) \tag{3.1}$$

where $i = A$ is for agricultural production, $i = I$ for industrial production, and $f_i(x_i)$ satisfies all normal conditions of a production function. Marginal product is always greater than zero and decreases with respect to input levels.

$$f_i(0) = 0,\ \frac{\partial f_i}{\partial x_i} > 0 \text{ and } \frac{\partial^2 f_i}{\partial x_i^2} < 0 \tag{3.2}$$

Industrial producers make optimal input demand and output supply decisions by solving the following profit maximization problem

$$\begin{aligned} &Max \quad P_I y_I - W_I x_I \\ &st \qquad y_I = f_I(x_I) \end{aligned} \tag{3.3}$$

where P_I is the market price for industrial product, y_I is output of the industrial product, and W_I and x_I are the market price for, and the amount of labour used by, the industrial producer. Maximum profit is achieved when marginal revenue equals marginal cost, which implies

$$P_I \frac{\partial y_I}{\partial x_I} = W_I \text{ or } \frac{\partial y_I}{\partial x_I} = \frac{W_I}{P_I} \tag{3.4}$$

The solution to the problem or the optimal choices of labour demand (x_I^*) and output supply (y_I^*) can be expressed as

$$\begin{aligned} x_I^* &= x_I^*(P_I, W_I) \\ y_I^* &= y_I^*(P_I, W_I) \end{aligned} \tag{3.5}$$

which have the properties

$$\frac{\partial x_I^*}{\partial P_I} > 0; \frac{\partial x_I^*}{\partial W_I} < 0; \frac{\partial y_I^*}{\partial P_I} > 0; \frac{\partial y_I^*}{\partial W_I} < 0 \tag{3.6}$$

Similarly, the agricultural producer's profit maximization problem can be described as

$$\begin{aligned} &Max \;\; P_A y_A - W_A x_A \\ &st \qquad y_A = f_A(x_A) \end{aligned} \tag{3.7}$$

where P_A is the market price for agricultural product, y_A is the agricultural output, W_A and x_A are the market price for, and the amount of labour used by, the agricultural producer, and $f_A(x_A)$ is the production function for agricultural activity. Again, the condition for profit maximization is

$$\frac{\partial y_A}{\partial x_A} = \frac{W_A}{P_A} \tag{3.8}$$

Optimal choices of input demand (x_I^*) and output supply (y_I^*) can be solved and expressed as

$$\begin{aligned} x_A^* &= x_A^*(P_A, W_A) \\ y_A^* &= y_A^*(P_A, W_A) \end{aligned} \tag{3.9}$$

These optimal labour demand and output supply relationships have the same properties as those derived for industrial producers' optimal choices (Equation (5.6)).

Consumers derive utility from consumption of the two goods and their utility functions are defined by[1]

$$U_j = U_j(c_{jA}, c_{jI}) \tag{5.10}$$

where $j = U, R$ refers to urban and rural consumers, respectively, c_{jA}, c_{jI} are amounts of goods A and I consumed by j, and the utility function U_j satisfies normal conditions

[1] In this study, consumers' utility does not involve consumption of leisure time. Because the supply of labour is assumed to be fixed, the level of the wage rate does not affect factor supply and, so, the leisure-labour decision.

$$U_j(0)=0;\ \frac{\partial U_j}{\partial c_{ji}}>0;\ \frac{\partial^2 U_j}{\partial c_{ji}^2}<0;\ \frac{\partial^2 U_j}{\partial c_{ji}\partial c_{jh}}>0\ (i\neq h);\quad j=R,U;\ i,h=A,I \quad (3.11)$$

The utility maximization problem for consumers can be formulated as

$$\begin{aligned} &Max\ \ U_j=U_j(c_{jA},c_{jI}) \\ &st\qquad P_A c_{jA}+P_I c_{jI}=W_j\overline{X}_j \end{aligned} \quad (3.12)$$

where W_i is the wage rate paid to consumer j. Neither consumer receives income from any source other than wage payments. Maximum utility is achieved when the following condition is satisfied

$$\frac{\partial U_j/\partial c_{jA}}{\partial U_j/\partial c_{jI}}=\frac{P_A}{P_I} \quad (3.13)$$

and optimal consumption demands are functions of prices and income

$$c_{ji}^{*}=c_{ji}^{*}(P_A,\ P_I,\ W_j)\quad j=R,U;\ i=A,I \quad (3.14)$$

which have the properties

$$\frac{\partial c_{ji}}{\partial P_i}<0;\ \frac{\partial c_{ji}}{\partial P_h}>0\ \ (i\neq h);\ \frac{\partial c_{jh}}{\partial W_j}>0\qquad (j=R,U;\ i,h=A,I) \quad (3.15)$$

Perfect Factor Mobility

Decisions by individual producers and consumers are inter-related. In particular, they depend on how market prices and wage rates are determined and how the fixed supply, say of labour, is allocated between different production activities.

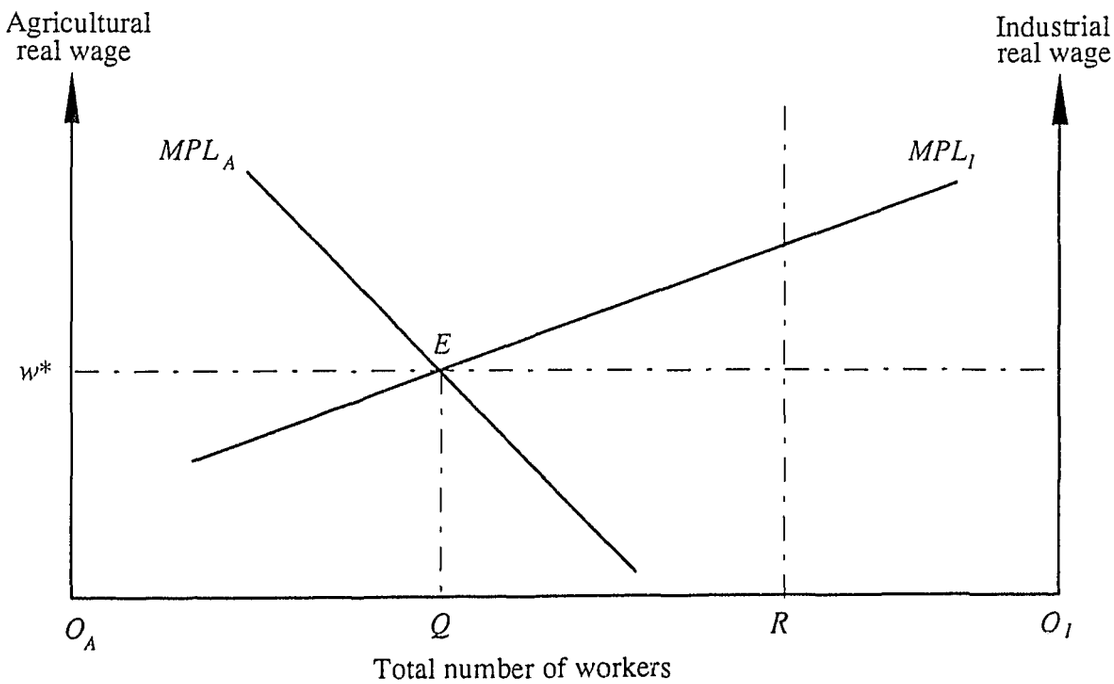
> **Assumption 2**: There is one unified factor market in the economy. Both producers can buy factors from rural and urban consumers. There will be one market equilibrium price (W) for factors depending on input demand in the two production activities, that is $W=W_R=W_U=W_A=W_I$. Further, we assume full employment of the production factor ($\overline{X}=\overline{X}_U+\overline{X}_R$).

Perfect factor mobility within the economy implies that both (urban and rural) consumers can be employed in either agricultural or industrial sectors. Denoting the feasible choice sets of rural and urban consumers by F_R and F_U, respectively,

$$A,I \in F_R, \quad A,I \in F_U \tag{3.16}$$

A simple diagram can be used to illustrate how a unique wage rate is achieved and how labour is allocated between agriculture and industry (Figure 3.1). The left vertical axis represents real wages in agriculture and the right vertical axis, real wages in industry. The horizontal axis represents $\overline{X}$, the fixed supply of labour in the economy. Of the total quantity of labour in the economy ($O_A O_I$), $O_A R$ is the labour endowment of the rural consumer and RO_I is the labour endowment of the urban consumer. Demand for labour in agriculture is captured by the schedule MPL_A, the graphic representation of equation (3.8). Schedule MPL_I illustrates the corresponding labour demand relationship for industry, equation (3.4). Labour employed in agriculture is measured to the right from O_A along the horizontal axis and in industry, to the left from O_I.

Figure 3.1 Market equilibrium in the unified factor market



Equilibrium between labour allocation demand and the wage rate is determined by the

intersection of the two marginal product schedules (point E). At this point, the marginal product of labour in both sectors is equalized

$$P_A \left.\frac{\partial f_A}{\partial x_A}\right|_{x_A=x_A^*=O_AQ} = P_I \left.\frac{\partial f_I}{\partial x_I}\right|_{x_I=x_I^*=QO_I} \tag{3.17}$$

and the equilibrium wage rate is W^* (equilibrium real wage rate w^*).

Mathematically, the equilibrium wage rate is solved by equating labour demand to supply

$$x_A(P_A, W) + x_I(P_I, W) = \overline{X} \tag{3.18}$$

The equilibrium wage rate is therefore a function of the two output prices

$$W^* = W^*(P_A, P_I) \tag{3.19}$$

The above equilibrium wage function has the properties

$$\frac{\partial W^*}{\partial P_A} > 0; \frac{\partial W^*}{\partial P_I} > 0 \tag{3.20}$$

Thus, the supply functions in equations (3.5) and (3.9) can be rewritten as

$$\begin{aligned} y_A^* &= y_A^*(P_A, P_I) \\ y_I^* &= y_I^*(P_A, P_I) \end{aligned} \tag{3.21}$$

with properties

$$\frac{\partial y_A^*}{\partial P_A} > 0, \frac{\partial y_A^*}{\partial P_I} < 0; \frac{\partial y_I^*}{\partial P_A} < 0, \frac{\partial y_I^*}{\partial P_I} > 0 \tag{3.22}$$

At the equilibrium, O_AQ of total labour is employed in agriculture and QO_I is employed in industry (all urban labour (RO_I) is employed in the industrial sector, of total rural labour O_AR, O_AQ is employed in the agricultural sector and QR in industrial sector).[2]

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[2] Abandoning the assumption that urban labour is not employed in the agricultural sector does not alter the equilibrium point. As long as no transaction costs are involved, it does not matter who is employed in which sector. Given fixed factor supply and marginal products of labour in the two sectors, each labourer always gets the same wage rate wherever he/she works.

Proposition 1: In a two-sector economy with perfect mobility of factors of production, the equilibrium wage rate and factor allocation are uniquely determined given fixed factor supply, production technology and product prices.

Proof of Proposition 1 is provided in Appendix 3A.

Open Economy

In this model, both products are tradable. They can either be imported when there is excess demand in the domestic market or exported when there is excess supply. Non-tradables are not considered in this model. The economy is assumed to be small and open, with a free trade regime. The potential impact of trade and current account imbalances is ignored. Furthermore, government budget constraints are not incorporated.

Assumption 3: The country, a small and open economy, is a price-taker in the world market. Domestic prices of commodities are therefore not affected by changes in domestic supply and demand. Consumers thus face an inelastic supply curve while producers face an inelastic demand curve.

The essence of this assumption is that prices are determined in the international market. This allows focus on the impact of any exogenous changes on production decisions, without analysing in detail the demand side of the economy.

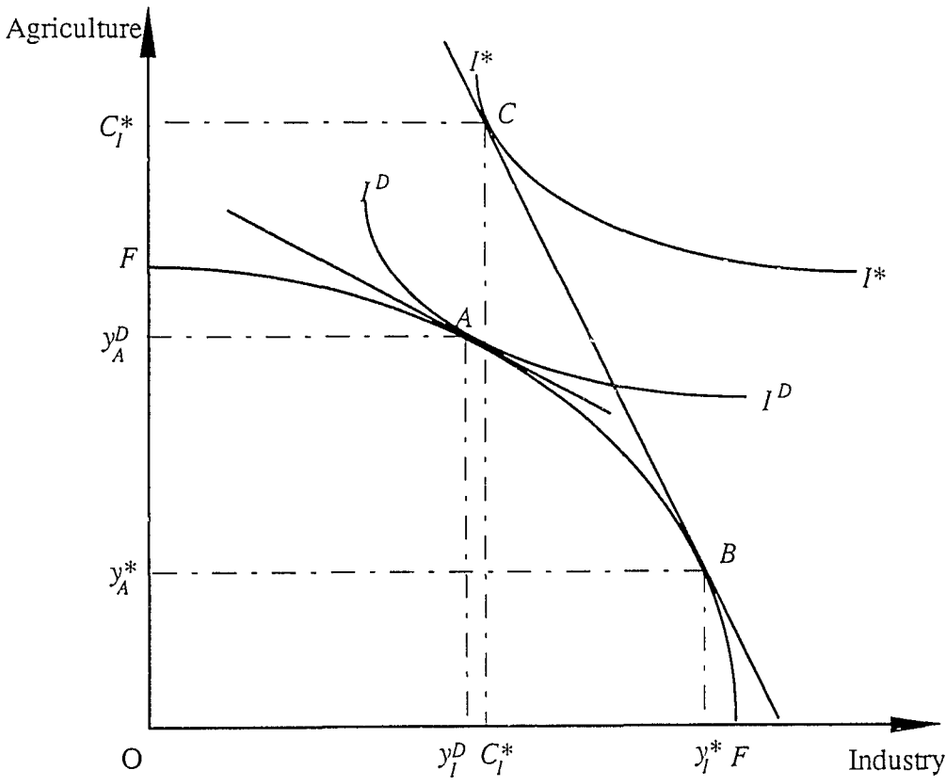
To solve for the general equilibrium of the economy, it is essential to combine the optimal choices of producers and consumers. In an autarky, demand must equal supply for each factor and commodity.

$$\begin{aligned} y_A^* &= c_{RA}^* + c_{UA}^* \\ y_I^* &= c_{RI}^* + c_{UI}^* \\ x_A^* + x_I^* &= \overline{X}_R + \overline{X}_U = \overline{X} \end{aligned} \tag{3.23}$$

For an open economy, however, the first two conditions of (3.23) are not necessary. Differences in commodity demand and supply can be balanced by international trade.

The differences between autarky equilibrium and free trade equilibrium can be illustrated using Figure 3.2. The vertical axis in the diagram represents agricultural production, and the horizontal axis represents industrial production. Given fixed factor supply ($\overline{X}$) and prevailing production technologies, a production possibility frontier, *FF*, is determined. The area under curve *FF*, above the horizontal axis and to the right of the vertical axis is the production possibility set. With no inefficiency in production, the economy thus always operates on the frontier. I^*I^* and I^DI^D represents consumers' aggregate indifference curves: the higher the curve, the higher the aggregate utility level.

Figure 3.2 Production and consumption in autarky and free trade



In autarky, all consumed goods are domestically produced. Equilibrium would only occur when the indifference curve is tangential to the production possibility frontier, at which point domestic demand equals domestic supply for each commodity (point *A*). At this autarky equilibrium, demand for and supply of, the agricultural good are y_A^D and those of the industrial good are y_I^D. The aggregate utility level is I^DI^D and the domestic relative price is p_D. The equilibrium for this economy is determined by both the shape of

the production possibility frontier, FF, and the indifference curve, I^*I^*. Whenever there is a change in consumer preferences, both domestic relative price and production decisions will be affected.

In an open economy, however, the relative price (p_W) is determined in the international market, exogenous to the domestic economy. Both producers and consumers will make their decisions according to this pre-determined relative price. Production will be at point $B(y_I^*, y_A^*)$ and consumption at point $C(C_I^*, C_A^*)$ ($C_I^* = c_{RI}^* + c_{UI}^*$ and $C_A^* = c_{RA}^* + c_{UA}^*$). The economy now will import agricultural goods ($C_A^* - y_A^*$) and export industrial goods ($y_I^* - C_I^*$). The new aggregate utility level is at I^*I^*. The welfare improvement from I^DI^D to I^*I^* is known as the gains from trade. Production decisions are relatively independent of consumer preferences. Given technology and product prices, the economy achieves full employment through adjustment of the wage rate in the factor market (Appendix 3B discusses this equilibrium mechanism). Consumers, on the other hand, use this wage income for consumption given relative prices and their own preferences.

Limited Feasible Choice Set of Farmers

The perfect competition model does not capture the real story of the Chinese economy. To investigate what the actual equilibrium is in the presence of the two characteristics of the Chinese agriculture, some of the crucial assumptions of the perfect competition model must be relaxed.

Impact of Factor Market Segmentation

The first assumption that does not apply in the Chinese economy is perfect factor mobility. Significant restrictions still exist on factor (labour) flows between rural and urban areas (Chapter 2). Urban industrialization therefore does not absorb surplus rural labour due to factor market segmentation. This immobility was one of the main reasons for the growth of rural industrialization from the early 1980s. The government has not officially lifted the embargo on labour movement between rural and urban areas.

Continuing restrictions on factor movements call for revision to the factor mobility assumption of the perfect competition model.

> **Assumption 4**: Labour is not only immobile between different countries, it also cannot move between rural and urban areas within the economy. There are two segmented labour markets, one rural and one urban. Within each market, however, labour is assumed to be perfectly mobile between different regions and different industries.

This revision to the previous assumption (Assumption 2) may not be entirely appropriate to modelling in the Chinese economy. First, labour flows from rural to urban areas, particularly temporary movements, have occurred occasionally. Second, labour movement between different regions and different industries within rural and urban areas is still largely restricted. The analysis behind Assumption 4, however, provides indications of the impact of factor market segmentation. The consequences of further restrictions within rural and urban areas can be inferred from this analysis. Labour market segmentation has resulted in the development of a rural industry alongside the urban industry.

> **Assumption 5**: The industrial sector is separated into two parts, urban (I_U) and rural (I_R) industries, which produce an identical industrial product using the same technology.

Technically, urban and rural industrial products can be differentiated and the two industries assumed to use different production technologies, as is more likely the case in China. But this does not improve the analytical results significantly.[3]

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[3] As discussed previously, goods prices are determined by the world market. If it is assumed that different products are produced by urban and rural industries using different technologies, the market condition for one product is only affected by another when the situation in the world market changes. Domestically, it does not matter whether the two industrial products are identical or different, changes in domestic demand for or supply of one good would not have any influence on the other. Furthermore, identical or different technologies used by the two industries do not affect the results as long as they can adjust the wage rate in the segmented market to achieve maximum profits (for the marginal revenue equalling marginal cost condition to hold).

To extend the analysis, three producers (agricultural, rural and urban industrial), two consumers and two commodities can be considered. Urban consumers can only be employed in urban industry, and rural consumers can only be employed in agriculture and rural industry.

$$A, I_R \in F_R, \quad I_U \in F_U \tag{3.24}$$

Not only is the farmers' feasible choice set limited, but the feasible choice set of urban residents is also restricted, to urban industries. In other words, given labour market segmentation, urban workers can only be employed in urban industry, while rural workers can only be employed by rural industry or agriculture. Although equilibrium still occurs in each of the urban and rural labour markets under the assumption of full employment, the two wage rates do not necessarily equalize

$$W_{I_U} \neq W_A = W_{I_R} \tag{3.25}$$

Assumption 6: The number of rural workers exceeds the optimal demands by agriculture and rural industry in the perfectly competitive case, $\overline{X}_R > x_A^*(W^*) + x_{I_R}^*(W^*)$. And the number of urban workers is less than the optimal demand by urban industry in the competitive case, $\overline{X}_U > x_{I_U}^*(W^*)$.

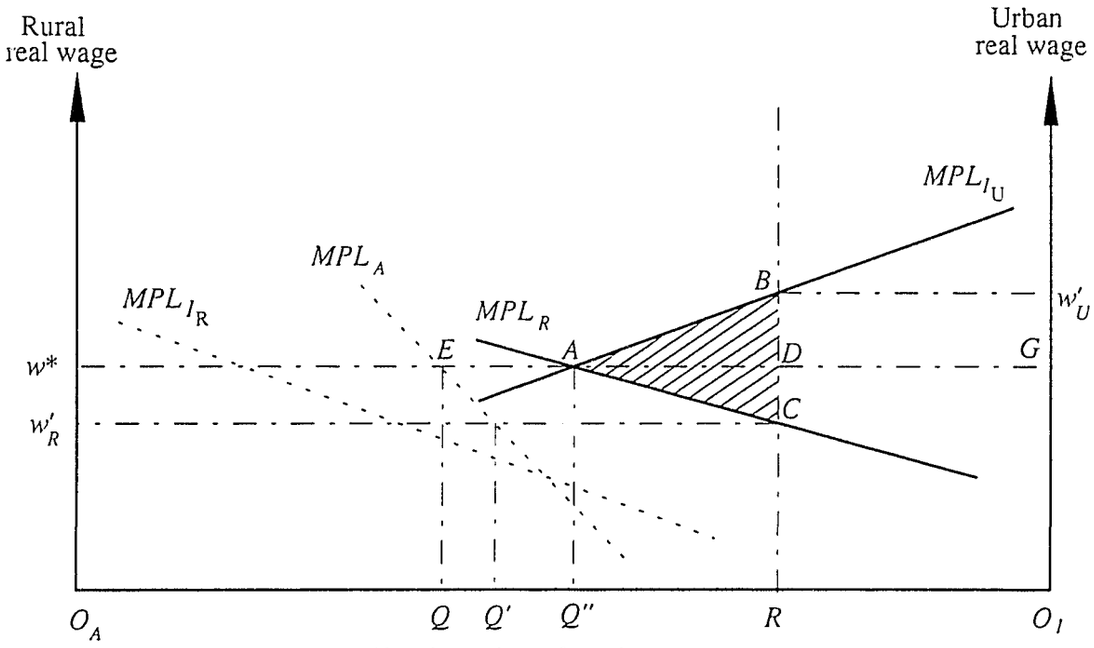
Assumption 6 seems to be arbitrary, but it captures the reality of the Chinese economy. Before industrialization, China was an agricultural economy and most labour worked in agriculture, a situation similar to that experienced by most developing economies. Because urban industrialization in China was unable to draw on surplus agricultural labour, rural labour was in excess supply. The relationship between the relevant wages is

$$W_U' > W^* > W_R' \tag{3.26}$$

where W^* is the equilibrium wage rate with perfect mobility, and W_U', W_R' are equilibrium wage rates in the segmented urban and rural labour markets. The allocation of labour and the determination of wage rates is illustrated in Figure 3.3, which is slightly different from Figure 3.1. In Figure 3.3, the vertical axis on the left represents the real rural wage

rate (instead of the agricultural real wage in Figure 3.1) and the axis on the right represents the urban real wage (instead of the industrial real wage). The upward sloping schedule on the right in the diagram now represents the marginal product of labour in urban industry (MPL_{I_U}) (note that MPL_{I_U} locates lower than the original MPL_I).[4] The two dotted downward sloping lines are marginal products of labour in agriculture (MPL_A) and rural industry (MPL_{I_R}). The solid downward sloping line MPL_R is the aggregate marginal product of the rural economy (the horizontal sum of agriculture and rural industry). If there are no restrictions on the movement of labour between urban and rural areas, equilibrium should be at A, when the equilibrium wage rate (W^*) and labour allocation between agriculture and industry (rural plus urban industries) remain the same as in the perfect competition model.

Figure 3.3 Segmented urban and rural factor markets



Because of labour market segmentation, rural consumers have to be employed by either agriculture or rural industry. Through adjustment of the rural wage rate to W'_R full

[4] The reason for a lower schedule of marginal product of labour in urban industry is that the original marginal product of labour in industry is the horizontal sum of schedules for urban and rural industries.

employment is achieved in rural areas (the mechanism is discussed in Appendix 3B). At the same time, the urban wage rate is pushed up to W_U'.[5] Relative to the competitive case, agriculture employs more of the production factor (QQ') because

$$\frac{\partial x_i(P,W)}{\partial W} < 0, \; i = A, I_U, I_R \tag{3.27}$$

In terms of wage income, rural consumers lose a total income of $w^* w_R' DC$ and urban workers get an excess payment of $Bw_U' GD$, compared to the competitive case. Urban industrial production is reduced by $ABRQ''$ due to the decrease in employment ($Q''R$). Rural production is increased by $ACRQ''$. The shaded area ABC is the net loss of total output, which is the deadweight loss created by labour market segmentation.

> **Proposition 2**: Given labour market segmentation between urban and rural areas, if labour is restricted to the rural areas, as in China, the rural wage rate will be pushed down. The agricultural sector expands, compared to the case of perfect competition, but rural workers incur a wage income loss. The restriction also results in a loss of output (or inefficiency).

Proposition 2 is supported by the empirical evidence. Although the share of industry in the Chinese economy rose from 55 per cent in the early 1950s to 80 per cent at the end of the 1970s in the process of urban industrialization, the share of rural labour in the total labour force fluctuated around 80 per cent (Table 5.1). During 1952-90, the average annual growth rate of the rural labour force was 2.2 per cent, only slightly lower than that for the total labour force (2.7 per cent) (*China Statistical Yearbook 1991*:95). Agricultural and other rural industries employed too many workers, and the marginal product of labour and wage rates were depressed. Net income per worker in rural areas has been lower than in the urban areas (Table 3.2).

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[5] This does not contradict the impression that China implemented a low wage policy in urban industry, because the low wage policy is accompanied by a complete set of subsidy policies, such as those for housing, food and medical care, to which rural residents were not entitled. The actual payments received by urban workers are much higher than the nominal wage.

Table 3.1 Changes in industrial output and the rural labour force, 1952-90

	Industrial share in gross output (%)	Total and rural labour force in China		
		Total (million)	Rural (million)	Rural/total (%)
1952	54.6	207	182	88.0
1955	59.4	223	195	87.5
1960	82.9	259	198	76.4
1965	69.1	287	235	82.1
1970	73.1	344	281	81.7
1975	76.6	382	299	78.5
1978	79.6	402	306	76.3
1980	77.5	424	318	75.2
1985	78.2	499	371	74.3
1990	79.8	567	420	74.0

Note: Industry includes industry, construction, transportation and commerce in both rural and urban areas. Rural industries only developed rapidly after the mid-1980s. Before that time most industries in China were concentrated in urban areas.
Source: China Statistical Bureau, *China Statistical Yearbook 1991*, China Statistical Press, Beijing:50; 95.

Table 3.2 Average yearly wage rates of urban and rural workers in China (yuan)

	Urban worker (yuan per labour)	Rural worker (yuan per labour)	Rural/urban (%)
1978	615	344	56
1980	762	477	63
1985	1148	866	75
1986	1329	905	68
1987	1459	964	66
1988	1747	1120	64
1989	1935	1222	63
1990	2140	1261	59

Note: Wage rates for rural workers are calculated from average net income per capita according to the information on rural population and rural labour. This calculated wage rate is probably higher than the actual wage rate since net income could also include returns to capital and labour in rural production.
Source: China Statistical Bureau, *China Statistical Yearbook 1991*, Beijing, China Statistical Press: 79; 95; 130; 295.

Should Restrictions on Labour Movement Be Maintained?

The above analysis suggests that restricted labour movement between urban and rural areas causes inefficiencies. According to the theorem of factor price equalization in the theory of international trade, as long as the output market is well developed, restrictions on factor mobility between different countries do not cause any inefficiency. Under a free trade regime, each part of the world economy develops according to its comparative advantage. Factor prices finally equalize across countries, and movement of the

production factors is not necessary. The practical implication concerns whether or not China could eliminate current inefficiencies by concentrating on the development of the product market but retaining current restrictions on factor flows.

Assuming no change in production technologies and product demand, the output market structure would change due to wage differentials so long as the product market was well developed. If rural and urban industries produce the same or differentiated products, rural industry can expect a continuous expansion due to competitiveness resulting from low production costs. The rural aggregate marginal product curve would therefore shift to the right. Urban industry may contract due to its high production costs, and so shift the marginal product curve for urban industry to the right. Equilibrium would occur when the two new marginal product curves intersect at point *D* (Figure 3.3). Real wage rates are thus equalized across the two sectors without relocating labour between urban and rural areas. This is standard international trade theory and partly reflects changes in China in the past decade.

Economic reform in China since 1979 has not removed restrictions on labour movement between urban and rural areas. The rapid development of rural industry is a passive response to these restrictions. Before economic reform, there was little rural industry. The rural aggregate marginal product curve sat far to the left of the position illustrated in Figure 3.3. Rural wage rates were therefore much lower than the current distorted rural wage rates. The development of rural industry, taking advantage of cheap labour in rural areas, gradually shifted the marginal product curve to the right and raised the rural wage rate.

Theoretically, therefore, there is a path which will lead the Chinese economy to an efficient equilibrium even with constrained factor movements. In other words, even under the current restrictions, there is room for China to reduce inefficiency.

In practice, however, there are several qualifications to this conclusion. The theory of factor price equalization relies on a set of restrictive assumptions, including identical

technology (or free access to technology information), free trade and no transportation and transaction costs. These assumptions are too restrictive and factor price equalization never occurs in the real world. Efficiency improvement with rural-urban factor segmentation can only be achieved in the longer term in China. Because rural firms locate in villages around the country, their cost of access to new technology and economic information will not be the same as that for urban enterprises, even when all rural and urban firms face the same competitive market (all firms are therefore price-takers). The revenue received by rural firms is less than that by urban firms because of higher transportation costs. Marginal returns to labour and the wage rate in rural firms are lower. If these workers were able to find the same jobs in urban areas, they would receive higher wage rates. Realization of perfect factor mobility (particularly labour mobility) is the best means of achieving global efficiency.

Price Distortions

The other assumption that does not apply to the Chinese economy is the competitiveness of the product market. Agricultural prices, in some cases, are distorted by government policy. There are two important forms of price distortion — state controlled prices (the cases of wool and cotton) and the two-tier price system (the cases of rice and wheat) (see Chapter 2).

Government Monopoly

First, the controlled price for an agricultural product without secondary a free market is considered.

> **Assumption 7**: While free trade applies for most products, the government controls the price of one agricultural product (wool as the example in this case) ($\overline{P}_W$) set lower than its market equilibrium price. Any secondary market for this product is strictly prohibited.

To explore the effects of this price control, wool must be separated from other agricultural products.

Assumption 8: Agricultural producers produce two products: wool (W) and other agricultural produce ($-W$).

Because a secondary market for wool is assumed away and the government insulates the domestic market for wool from international markets, the marginal price for the producer is the state price $\overline{P}_W$. If the consumer price is also set at the state price, there will be excess demand in the insulated domestic market because the state price is set lower than the market equilibrium price. The government has two methods available to deal with supply shortage while maintaining the state price. One is to import wool at world prices and sell it to domestic consumers at the state price, thus providing a price subsidy. The other is to ration consumption. Whichever method is adopted by the government, there will be no significant effects on production because the model does not specify the government budget.

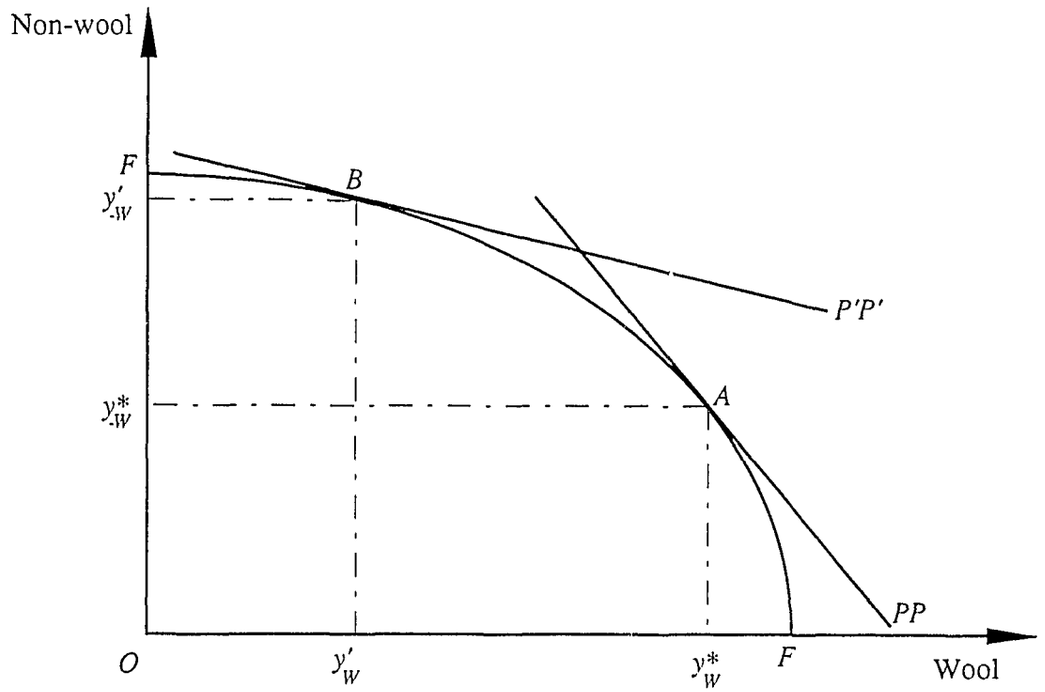
On the producer's side, a lower price for wool implies a fall in the price of wool relative to other products. The agricultural producer would then produce relatively more non-wool agricultural products and less wool, compared to the perfectly competitive case. The effect of a lower state price for wool on the structure of output is shown in Figure 3.4.[6] The diagram illustrates the agricultural producer's decision on supply. The horizontal axis represents the amount of wool produced and the vertical axis indicates the amount of non-wool agricultural products produced. Given technology and production resources, the production possibility frontier is FF. The relative price, PP, is given by non-distortion market prices P_W and P_{-W}. Optimal supply will be at $A(y^*_W, y^*_{-W})$ (at the tangency between FF and the relative price line PP) given relative price PP.

The introduction of the lower state price ($\overline{P}_W$) changes the relative price as P_{-W} is fixed. The relative price line therefore becomes flatter (from PP to $P'P'$). The new level of optimal supply is at $B(y'_W, y'_{-W})$. Compared to the case of perfect competition, wool

[6] This can also be shown using properties of supply function (Equation (3.21)) $\frac{\partial y_W(P_W, P_{-W}, P_{I_k})}{\partial P_W} > 0$. A lower state wool price therefore generates a fall in wool output.

output decreases by $y_W^* - y_W'$ and output of the other agricultural product increases by $y_{-W}' - y_{-W}^*$. This is easy to understand because the equilibrium condition for profit maximization requires equalization of the value of marginal products of all outputs produced. A drop in one product price will push down its value of marginal product at a given output level. At the original equilibrium point A, the value of the marginal product of wool is now lower than that of non-wool production. The way to re-establish equilibrium of the two marginal products (or to achieve maximum profit) is to reduce wool output and increase non-wool output.[7]

Figure 3.4 Lower state price and changes in supply

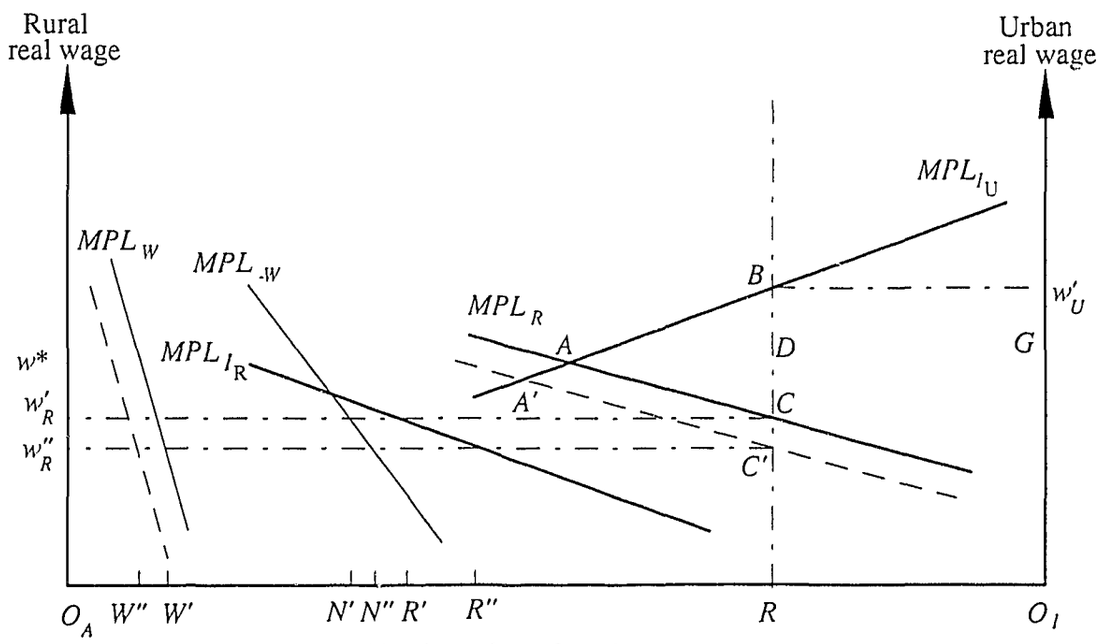


The impact of a lower state price for wool, however, goes beyond agriculture because labour is mobile within the rural economy. Rural industrial production is also affected by changes in wool prices through adjustments in the rural labour market. A lower state price for wool, *ceteris paribus*, results in a fall in wool output and an increase in both non-wool agricultural and rural industrial outputs. This can be clearly illustrated in a

[7] This is because we have $\frac{\partial^2 y_W}{\partial x_W^2} < 0$.

factor relocation diagram. In Figure 3.5 agricultural production is further decomposed into wool and non-wool agricultural production. Under the assumption of labour market segmentation and no price distortion, the marginal product curves for wool and non-wool agricultural products are MPL_W and MPL_{-W}, respectively. Their sum gives the marginal product curve for agriculture (MPL_A in Figure 3.3). The equilibrium rural wage is W_R', labour employed in wool production equals O_AW', in non-wool agricultural production O_AN', and employed by rural industry is O_AR' ($O_AW' + O_AN' + O_AR' = O_AR$).

Figure 3.5 Effects of a low state price for wool on labour market



The lower state price for wool implies a downward shift of the marginal product curve for wool production (from the solid line to the dotted line) because

$$\overline{P}_W \frac{\partial f_W}{\partial x_W} < P_W \frac{\partial f_W}{\partial x_W} \tag{3.28}$$

Consequently, the aggregate marginal product curve for the rural economy also moves downward. The equilibrium rural wage rate is pushed down from W_R' to W_R''. At this new

wage, the labour employed in wool, non-wool agricultural and rural industrial production would be $O_A W''$, $O_A N''$ and $O_A R''$, respectively, that is

$$\frac{\partial x_W^*}{\partial P_W} > 0, \frac{\partial x_{-W}^*}{\partial P_W} < 0, \frac{\partial x_{I_R}^*}{\partial P_W} < 0, \frac{\partial x_{I_U}^*}{\partial P_W} = 0 \tag{3.29}$$

The share of wool production in total production falls while the shares of other agricultural and rural industrial production rise. The net change to agriculture's share in the rural economy is ambiguous depending on the magnitudes of changes in wool and non-wool production,

$$\frac{\partial y_W^*}{\partial P_W} > 0, \frac{\partial y_{-W}^*}{\partial P_W} < 0 \text{ and } \frac{\partial y_A^*}{\partial P_W} = \frac{\partial y_W^*}{\partial P_W} + \frac{\partial y_{-W}^*}{\partial P_W} \tag{3.30}$$

Urban industry is insulated from the rural shocks because of labour segmentation. There is no change to its output level, employment or wage rate. Looking at the economy as a whole, however, deadweight loss increases from ABC to $A'BC'$.

> **Proposition 4**: Given labour market segmentation between rural and urban areas, the introduction of a lower state price for wool will depress rural wage rates, decrease the share of wool production in employment and total output in the rural economy, and increase the shares of other agricultural and rural industrial production. The price distortion (the low state price for wool) would enlarge the deadweight loss from the labour segmentation policy but net changes to the share of agriculture as a whole are uncertain. The urban industry does not enter this adjustment story.

The Two-Tier Price System

The other important price distortion is the dual-price system where prices are determined both officially and unofficially. In a centrally planned economy, such as the case of China before economic reform, the government controls almost all economic activities. Markets may still occur or exist at the margin. As Panagariya (1990) demonstrates, if private producers can operate more efficiently than state enterprises, a parallel market will emerge in centrally planned economies. The effect of the parallel market will be to expand consumption and, hence, to raise welfare. This analysis reveals the impact of the

appearance of a secondary market in a centrally planned economy. During the reform period in China, markets were introduced into most areas of the economy and the market mechanism now works nearly everywhere. The government, however, maintains interventionist policies in some of the markets, such as for grain.

Analysis of China's dual-price system was first tackled by Byrd (1987) in a study of the market mechanism and economic reform in Chinese industry. A simple general equilibrium model was constructed to analyse static resource allocation and efficiency properties of the state-owned industrial sector. The model involves a set of important assumptions.[8]

Byrd distinguishes theoretically unconstrained and constrained equilibria in the Chinese economy. An unconstrained equilibrium is one in which no agent is plan-constrained. Each agent is participating in the market, at least at the margin, for all inputs and outputs that it actually purchases or produces. This implies that the model is characterized by complete markets. A constrained equilibrium is one in which at least one agent is plan-constrained for some goods, but there are still active markets for all goods with non-zero plan targets and allocations. It can be shown that unconstrained equilibria are always at least potentially Pareto-superior to constrained equilibria (Byrd 1987, 1989).

The most interesting application to the current study concerns the irrelevance of planning. Changes in output plan targets, input allocations and prices have no effect on production or usage of intermediate inputs by any enterprise. Changes in plan parameters have an impact on the unconstrained equilibrium solution of investment only if they affect the distribution of the 'real value' of total net profits among different investors.[9] If there are no distributional effects within or between the two components of final demand (consumption and investment), then changes in plan parameters for any goods will not

[8] Byrd assumes that factors of production (including labour) are exogenously fixed. At the same time, wage rates are assumed to be set exogenously in nominal terms.

[9] The reason for this, as argued by Byrd (1987), is that changes in plan parameters for investment goods do change the cost of purchasing a given package of investment goods, but at the same time they generate an equal change in total net enterprise profits.

affect production or demand by any agent, and hence the equilibrium outcome in terms of production and use of all commodities will remain the same and market prices will be unchanged.

Sicular (1988a), in a study on planning and markets in China's agricultural commerce, deals with the same issue. Applying a general equilibrium-type approach, she presents a model of the Chinese economy. State commerce is introduced as well as market exchange, and the plan is specified exogenously. For any set of planned prices and quotas, the model yields equilibrium market-clearing prices, levels of production, income and consumption, and levels of state stockpiles and net budgetary revenues. The government sets prices for each of the goods and fixes ration quotas and procurement quotas.[10]

Maximization conditions are applied to each of the agents, the aggregate rural household, the urban producer and the urban consumer. The results show that if all state prices are less than market prices, then state-planned prices and quotas will not directly affect levels of production and consumption. They can have indirect effects on these variables, however, because they change incomes by lump-sum transfers and so alter equilibrium market prices. Quotas will affect each agent's level of trade with the state and the market. Levels of trade with the state will exactly equal quota levels, and market trade for each agent will equal its excess demand minus the ration quota, or plus the procurement quota.

The above theoretical result, however, contradicts practical experience in China. It is well-known that whenever the state price was too low, grain production stagnated, and whenever the state price was raised grain output would be raised, given the operation of the free market alongside the state plan system.

[10] The state does not sell manufactured goods to the urban producer, agricultural goods to the rural household, or labour to either the urban consumer or rural household.

Lin (1993) recently argued that the Byrd-Sicular thesis only holds when the procurement quota and state price are set exogenously. In China, however, Lin (1993) shows that procurement quotas for grain are endogenous. Two cases of endogenous quotas are modelled: (1) as a function of output and (2) as a function of the quota in the previous period. It is demonstrated that, in both cases, the marginal prices received by farmers are affected by the state price and that production decisions will change accordingly.

The difference between the analysis of Byrd-Sicular and Lin can be shown using the framework suggested earlier in this study. Another product, grain (G), is separated from other agricultural products. The economy now produces four products: wool, grain, other agricultural ($-WG$) products and industrial products. To introduce the dual-price system for grain, the third assumption of the model has to be further revised.

> **Assumption 9**: Transactions in grain are subject to a dual-price system. The government purchases a quota (q_G) forcefully from the agricultural producer at a low state price ($\overline{P}_G$). Production beyond that quota for grain is traded at market prices (P_G).

Production decisions are made according to the condition that marginal revenue equals marginal cost. To investigate the impact of the state grain price, grain is separated from other agricultural produce.

> **Assumption 7**: The agricultural producer now produces three different products, grain (G), wool (W) and another agricultural product ($-GW$). The producer sells all other agricultural products in the market and all wool output to the state. A part of grain is sold to the state while the rest is sold on the market.

Agricultural producer's total revenue (R_G) and total cost (C_G) of grain production are

$$\begin{aligned} R_G &= P_G(y_G - q_G) + \overline{P}_G q_G \\ C_G &= W_R x_G \end{aligned} \tag{3.31}$$

where $\overline{P}_G < P_G$ according to assumption. The marginal revenue and marginal cost are

$$\frac{\partial R_G}{\partial x_G} = P_G(1-\frac{\partial q_G}{\partial y_G})\frac{\partial y_G}{\partial x_G} + \overline{P}_G \frac{\partial q_G}{\partial y_G}\frac{\partial y_G}{\partial x_G} = [P_G - (P_G - \overline{P}_G)\frac{\partial q_G}{\partial y_G}]\frac{\partial y_G}{\partial x_G} \qquad (3.32)$$
$$\frac{\partial C_G}{\partial x_G} = W_R$$

The marginal cost function does not change compared to the non-distorted case. Whether or not the marginal revenue function remains unchanged depends on the way the quota is set. If the procurement quota is set exogenously, as assumed by Byrd (1987) and Sicular (1988a),

$$\frac{\partial q_G}{\partial y_G} = 0 \qquad (3.33)$$

The above marginal revenue function, therefore, becomes

$$\frac{\partial R_G}{\partial x_G} = P\frac{\partial y_G}{\partial x_G} \qquad (3.34)$$

which is exactly the same as in the non-distorted case. Production decisions are thus not affected by the state price. This conclusion has been widely accepted (Martin 1990).

If, however, the procurement quota is endogenously assigned, as noted by Lin (1993) in the case of grain in China,

$$P_G\frac{\partial y_G}{\partial x_G} > \frac{\partial R_G}{\partial y_G} = [P_G - (P_G - \overline{P}_G)\frac{\partial q_G}{\partial y_G}]\frac{\partial y_G}{\partial x_G} > \overline{P}_G\frac{\partial y_G}{\partial x_G} \qquad (3.35)$$

because $P_G > \overline{P}_G$ and $1 > \partial q_G/\partial y_G > 0$. And

$$\frac{\partial(\partial R_G/\partial y_G)}{\partial \overline{P}_G} = \frac{\partial q_G}{\partial y_G}\frac{\partial y_G}{\partial x_G} > 0 \qquad (3.36)$$

that is, the higher the state price for grain, the higher the marginal revenue farmers receive from grain production.

This implies that a lower state price reduces marginal revenue. The marginal product curve of grain production with a dual-price system therefore locates lower than that in the competitive case (given by P_G) but higher than in the strictly controlled case (given

by $\overline{P}_G$) (as in the case of wool). The dual-price system of grain would therefore have a similar impact to the case analysed above for wool, but with small magnitudes.

> **Proposition 5**: Whether or not the state price in the dual-price system affects production decisions depends on the way that the quota is set. If the quota is exogenously set, there would be no direct impact. If the quota is endogenously assigned (for example, as a function of output), marginal revenue would be altered. A lower state price for grain would result in a contraction of grain production, an expansion of other rural production activities and a fall in rural wages.

In the case of an exogenous quota (Byrd 1987, 1989; Sicular 1988a), the function of the state price and quota is the same as that of a lump-sum tax, while in the case of an endogenous quota (Lin 1993), the function of the state price and quota is the same as that of a proportional tax.

Sectoral Impact of Economy-Wide Policies

The above analysis shows how the two special characteristics of Chinese agriculture can distort farmers' production decisions and the country's economic structure. The peculiarities of these two characteristics lie not only in the fact that they change economic equilibrium (disequilibrium), but also in the fact that they alter the way an economy responds to exogenous shocks, including changes in economy-wide policies. The latter is particularly important when a general equilibrium perspective is applied in analysis with special interests in interactions between different parts of the economy. Government subsidies, import tariffs and the money supply are economy-wide policies considered here.

Marketization of State Industry

In the Chinese economy, urban industry consists mainly of state enterprises, and rural industry comprises mainly township, village and private firms. The two industries are different not only in terms of firm location and ownership, but also in the different roles that the market and the plan play in input and output decisions. State industry is given

preferential treatment, including subsidized bank loans, soft budget constraints and cheap raw materials. At the same time, the output of state enterprises is also more strictly controlled. Product of state enterprises, or at least a part of their product, has to be sold to the state at state prices usually lower than the market price. Rural industrial firms, on the other hand, are mostly set up by farmers. They are usually unable to enjoy the preferential policies extended to state enterprises. But production decisions and product selling are also less constrained by the state plan.

> **Assumption 10**: Before economic reform, the state bought all output produced by urban industry (like the previous case of wool) at a low state price but allowed rural industry to sell its product at the market price. Economic reform is assumed to liberalize sales procedures for urban industry output. Urban industry thus also receives the market price for its product after reform.

The effect of intervention is the same if the enterprise is subject to a strictly controlled system (as in the case of wool) or a dual-price system (as in the case of grain). There is, however, a difference in magnitudes.[11]

Let the solid upward sloping line MPL_{I_U}, in Figure 3.6, be the marginal product of the urban (state) industry at the state price for industrial product ($\overline{P_I}$), and line MPL_{I_R} be the marginal product of rural industry at market price for the industrial product (P_I) before economic reform. Point A is the equilibrium point in a purely competitive labour market model. Given restrictions on labour flows between rural and urban areas, labour employment in rural and urban economies is fixed (and equals fixed supplies). The equilibrium urban wage rate is $W_U^{'}$ ($W_U^{'} > W^*$) and the rural wage rate is $W_R^{'}$ ($W_R^{'} < W^*$). There is a gap between rural and urban wage rates ($W_U^{'} - W_R^{'}$) because of the segmentation of the labour market.

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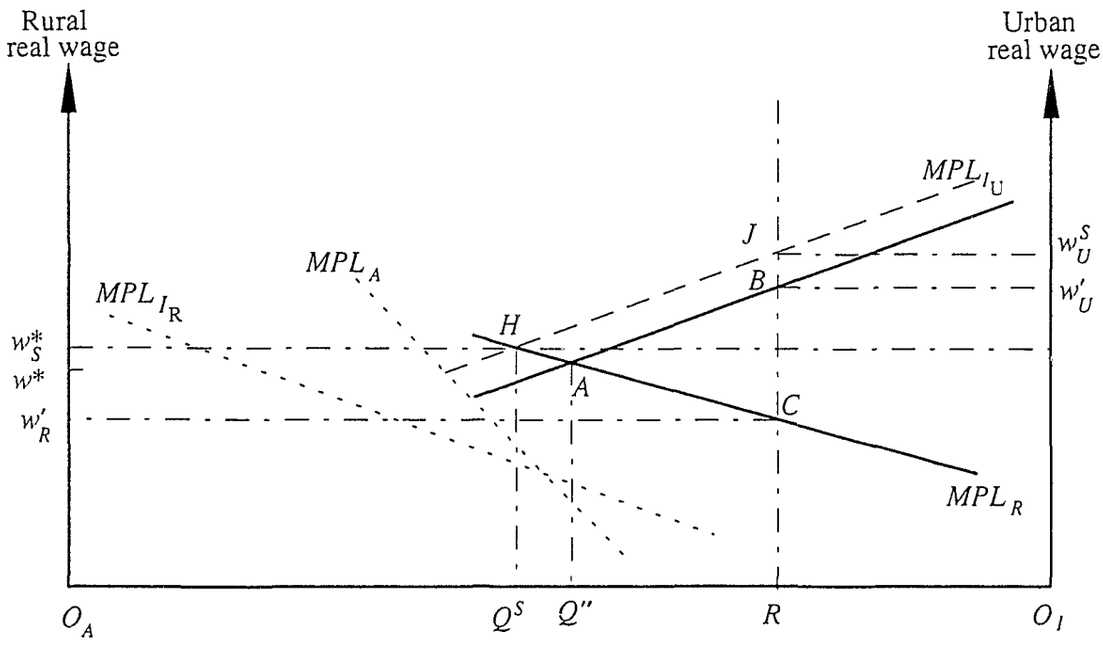
[11] The above assumption implies that rural and urban industrial products receive a different price, although the products are identical. To understand the possibility of such a system, imagine that the economy has a market for industrial products. The state sector, however, is prohibited from selling into this product market. The government buys all outputs from the state enterprises at a state price and sells directly to consumers. Rural industrial firms are not regulated by the government, and therefore sell their products in the market at market prices.

During the reform period, especially after the mid-1980s, the state industrial sector has become gradually liberalized. It is of great interest to see how one or two of these changes in state industries affect agricultural and rural industry. One example of the changes is marketization. Although the introduction of market prices and the abolition of the state price is in reality a gradual process, an analysis of a once-for-all change (holding all other conditions constant) provides an indication of possible effects.

Figure 3.6 Effects of marketization of the state industry



After the abolition of state prices for products of state industries, state enterprises also receive market prices for their output (as do rural enterprises). A higher price (P_{I_U}) implies an upward shift of the marginal product curve (MPL_{I_U}). The marginal product curves for rural industry and agriculture remain unchanged.

In the case of free labour movement, the upward movement of the marginal product curve for state industry would shift the equilibrium point from A to H. No output loss or inefficiency occurs, in the labour market, both before and after the liberalization of state industry. If the equilibrium wage rate rises from W^* to W_S^*, some labour moves from the rural industry and agriculture to urban industry. Urban (state) industry expands as a

result of liberalization, while rural industry and agriculture contract. Economic structure changes and, in particular, agriculture's share of output falls.

In the case of labour market segmentation between rural and urban areas, liberalization of state industrial product again causes an upward shift in the marginal product curve for state industry. Labour relocation does not occur because of the segmentation. Urban industry still employs the same amount of labour ($Q'R$) under the full employment assumption. The urban wage rate is pushed up from $W_U^{'}$ to W_U^S. The marginal product curve for the rural economy remains unchanged, but the deadweight loss increases from *ABC* to *HJC*.

> **Proposition 6**: The rural economy is insulated from urban changes because of labour market segmentation. The liberalization of urban industrial products not only increases the gap between rural and urban wage rates, but also increases the deadweight loss. Economic structure is not affected by this liberalization, given the assumption of full employment.

Reduction of the Tariff on Industrial Product

China was a closed economy before the 1980s. One important component of economic reform was to open up the Chinese economy to the outside world. Recently, China has been seeking membership of GATT. To qualify China has to introduce more reform measures, including reduction of import tariffs for a set of commodities including textiles and automobile products. Further reforms will significantly change China's economic structure. Trade policies for agricultural products and grain in particular also have to be reformed. The question here is how import tariff reform for an industrial product would affect agricultural production.

> **Assumption 11**: Assume a tariff on an industrial product. The domestic market price (P_I) therefore contains a component of tariff, t. The supposed tariff reform abolishes this tariff on industrial imports.

The abolition of the import tariff implies a fall in the domestic market price. The peculiarity of this reform is that it affects rural, as well as urban, industry. The

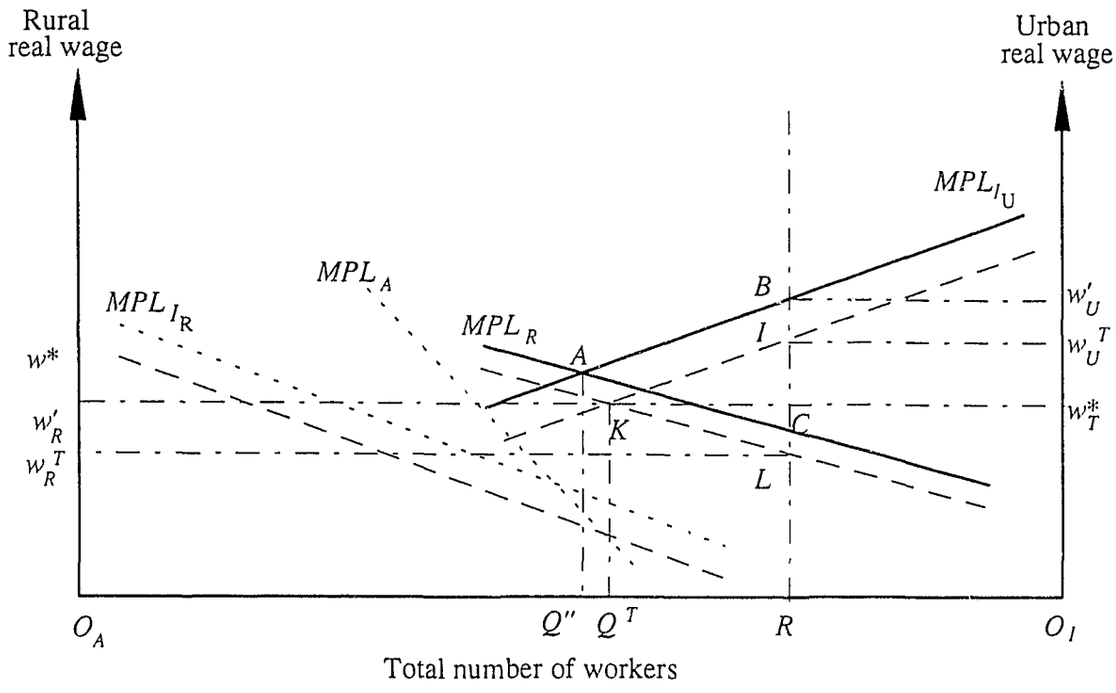
competitive case is considered first. A reduction in the tariff rate for industrial product or a decrease in its domestic market price pushes down the marginal product curves for both urban and rural industries (Figure 3.7). The new equilibrium point for labour allocation would therefore move from A to K. The equilibrium wage rate falls from W^* to W_T^* as a result of tariff reform for an industrial product. Labour employed by both urban and rural industry drops, and thus a certain amount of labour would flow from urban to rural areas ($Q''Q^T$) (or from industries to agriculture). The agricultural sector expands because it becomes relatively more profitable.

Changes discussed here indicate that industrial protection distorts the equilibrium wage. Reduction in the tariff rate for an industrial product would allow the Chinese economy to take advantage of its comparative advantage in cheap labour. The economy may have to reduce output of this protected product. But it will become clearer, in a further detailed multiple-product framework, that the sectors producing and exporting other labour-intensive commodities are expanding rapidly.

If the labour market is segmented, a reduction in the tariff rate would cause labour relocation, and structural change would still occur between rural industry and agriculture but by smaller magnitudes because the urban and rural labour markets are separated. After a reduction in the industrial tariff rate and downward shifts of the marginal product curves for rural and urban industries, the urban industrial wage would drop from $W_U^{'}$ to W_U^T, with the urban employment levels and total sectoral output unchanged. In the rural sector, however, labour would be reallocated from rural industry to agriculture because of changes in relative prices. Rural wages would also drop from $W_R^{'}$ to W_R^T. Rural industry would reduce its employment and output levels, while agriculture would expand.

> **Proposition 7**: In an economy with labour market segmentation between urban and rural areas, reduction of the tariff rate for an industrial product would result in falls in both urban and rural wage rates, expansion of agricultural production and contraction of industry. The effects are smaller in magnitude compared to the perfectly competitive case.

Figure 3.7 Effects of tariff reduction for industrial products on wages



The consequences in the distorted economy are similar to those in the case of perfect competition. Total output of the protected product would decrease following the reduction of the protection rate. Wage rates would drop, creating favourable conditions for labour-intensive production. Outputs and exports of labour-intensive commodities will increase in line with China's comparative advantage. Structural adjustment in the distorted economy is likely to be smaller because the effects on urban industry are not transmitted to the rural sector. In the purely competitive case, the resulting fall in equilibrium wage is $W^* - W_T^*$. In the case of labour market segmentation, the urban wage drops from $W_U^{'}$ to W_U^T (the magnitude of the drop is greater than $W^* - W_T^*$). The fall in rural wage is less than $W^* - W_T^*$, weakening labour relocation between rural industry and agriculture. Change in the deadweight loss on the labour market is expected to be negative because of the greater fall in the urban wage ($S_{KIL} < S_{ABC}$).

Increase in the Money Supply

Macroeconomists usually agree that money is neutral, at least in the longer term. This argument may not be true in an economy with distorted prices, and the consequences may differ even further with a segmented labour market.

In an economy with price distortion but perfect labour mobility, an increase in money supply will cause all market-determined prices to rise by the same margin except for the controlled prices. retaining the neutrality assumption of money. Suppose that market prices increase by α, the new equilibrium price, P_i^M $(i = W, G, -WG, I_R, I_U)$, would change at the same rate

$$P_i^M = (1+\alpha)P_i \tag{3.37}$$

If the economy is perfectly competitive, every price will rise by the same margin, including the equilibrium wage rate. Relative prices would therefore remain unchanged and there would be no effect on the real variables such as input demands and output supply. The first case discussed here, however, involves price distortions to wool and grain. State prices for wool and grain are controlled by the government and, adjustment usually occurs with a delay of one or two periods. Because, it is assumed that there is no market price for wool, the relative price of wool would decrease by α, shifting the marginal product curve for wool downward (by α) (Figure 3.7). The story for grain is complicated as there is also a market price. If Lin (1993) story holds, changes in the state price will affect the marginal product curve.

The nominal marginal product for grain is

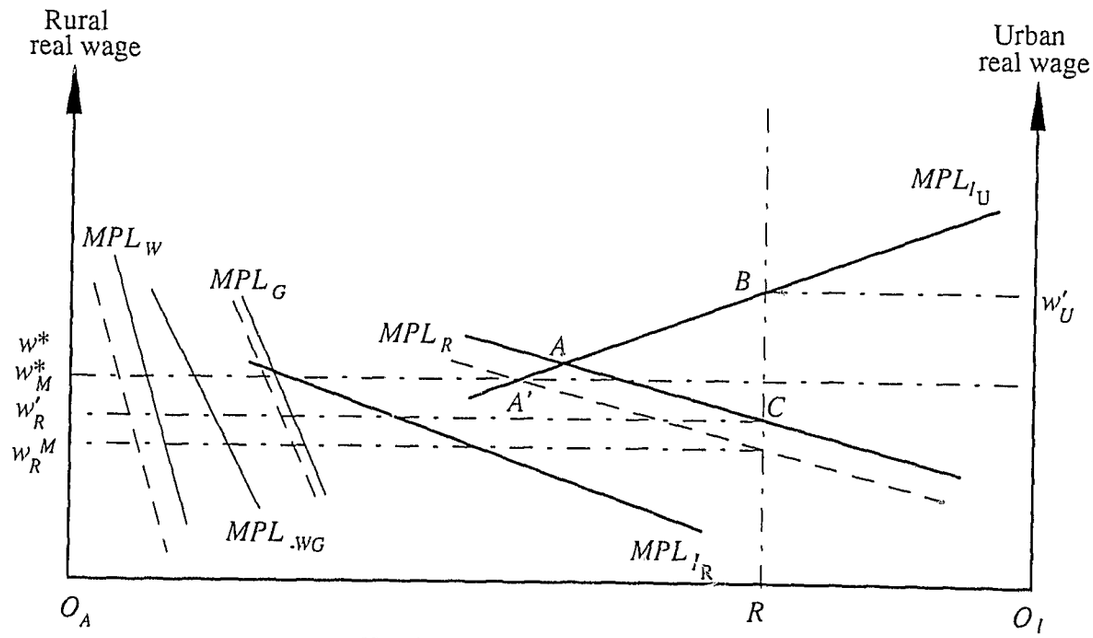
$$P_G - (P_G - \overline{P}_G)\frac{\partial q_G}{\partial y_G} \tag{3.38}$$

Following the monetary expansion, the market price of grain P_g increases by α per cent and the state price $\overline{P}_g$ remains unchanged. Therefore, change of the marginal revenue is greater than zero but smaller than α, implying that the real marginal product curve for

grain would move downward (but less than α). Movements of the curves for wool and grain thus push down the rural aggregate marginal product curve to the dotted line, MPL_R, as shown in Figure 3.8.

In the case of labour mobility between rural and urban areas, the new equilibrium would move from A to A', leading to labour relocation from the rural to the urban sector. Because some agricultural prices are fixed, the marginal product of the urban sector is relatively greater following the monetary expansion. Real wage rates increase from W^* to W_M^*. In other words, nominal wages increase by less than aggregate price level (α). For similar reasons, employment in rural industry will rise, while labour employed in grain and wool production will decrease because of lower profitability.

Figure 3.8 Effects of an increase in money supply



The case of labour market segmentation between urban and rural areas is now considered. The only difference is that labour allocation between rural and urban economies (at point R) will not change. Therefore, employment and real wage rates in urban industry are not affected by an increase in money supply because the marginal product curve for urban industry has not moved. In the rural sector, however, the aggregate marginal product curve moves downward. Given the fixed labour supply

$(O_A R)$, real wages drop significantly from $W_R^{'}$ to W_R^M. Rural industry expands and wool production contracts, while changes to grain production are ambiguous, depending on changes in real wage rates and the price elasticities of demand for labour. Considering that wool production is a very small sub-sector in Chinese agriculture, grain production would normally contract as a result of monetary expansion.

> **Proposition 8**: Given price controls for some agricultural products, an increase in the money supply has structural effects on the economy. Nominal wage rates increase but real wages fall. Production of controlled agricultural products contracts, while production of other agricultural and industrial products expands. In the case of labour market segmentation, structural change would still occur within the rural economy but leave the urban economy unaffected in real terms.

Some Qualifications

The analysis in this chapter reveals many important influences that price distortion and the limited feasible choice set of Chinese farmers have on production decisions. A lower state price, in both the strictly controlled case or the dual-price system, tends to reduce production and decrease the share of this product in total output. The restriction on labour movement between urban and rural areas insulates one from shocks to the other. The structure of the whole economy turns out to be more rigid because the scale of economic adjustment is largely limited by this restriction. The two characteristics further alter the response of the economy to changes in economy-wide policies.

These conclusions are based on the model assumptions. Some assumptions are, in fact, very restrictive.

The model assumes one production factor (labour) and full employment of this labour. In reality, production activities usually also use intermediate inputs as well as at least two production factors (such as labour and capital). Using only one factor in the model simplifies analysis but also sacrifices some interactions between changes in different

factors. Similarly, the full employment assumption ignores changes in labour application and total output levels.

The assumption of price-taking for the Chinese economy may be correct for some products, but not for others such as wool. As China now imports about one-sixth of total world imports of wool, it is a large country in this particular market. In other words, changes in its import demand affect world prices. If non-tradables are ignored in the model, very important linkages are missed between consumer and producer behaviour, leading to misinterpretation of changes in production and consumption of tradables.

While the theoretical model in this chapter provides very important indicators of economic equilibrium and production decisions in China, a more sophisticated quantitative framework is needed to capture more accurate and detailed results.

Appendix 3A

Proof of Proposition 1

The uniqueness of the equilibrium wage rate and labour allocation in a perfect competition model.

Proof: Suppose another equilibrium real wage rate, w^s, which is higher than w^* (nominal wage rate W^s) for instance (Figure 3A1). The optimal demands of producers for labour inputs are determined by the condition that marginal product equals marginal cost. Given this new wage rate, labour demanded by agriculture would be $O_A S_1$ and by industry $S_2 O_I$, which is smaller than their optimal demands at wage rate W^*.

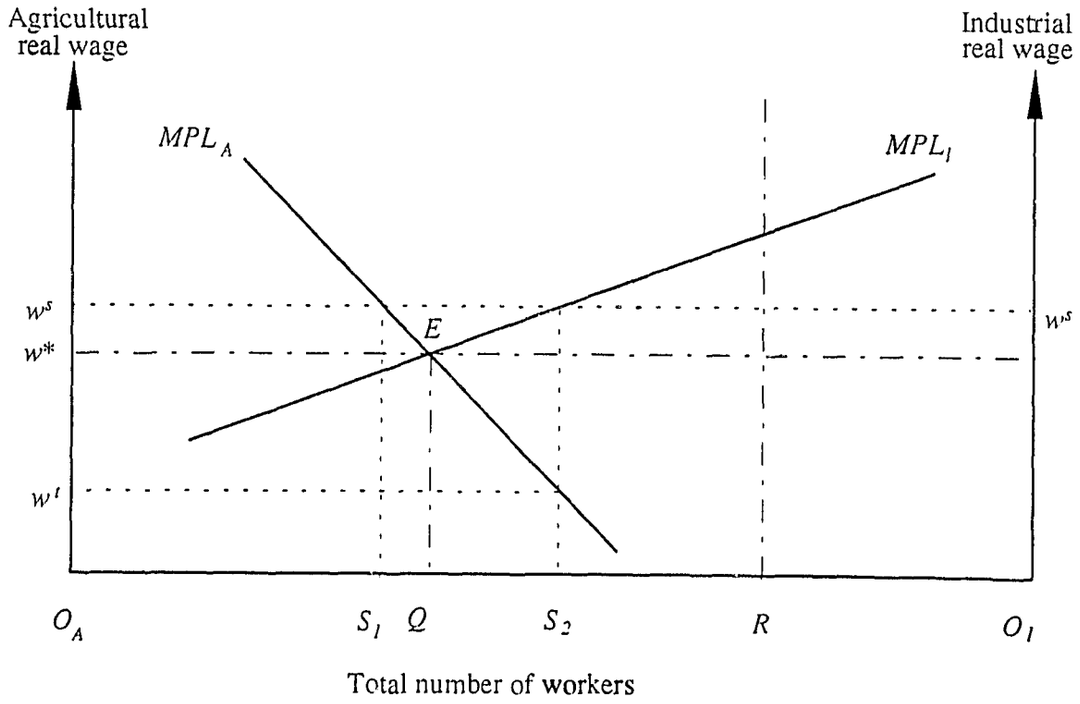
$$\begin{aligned} O_A S_1 &= x_A^*(P_A, W^s) < x_A^*(P_A, W^*) \\ S_2 O_I &= x_I^*(P_I, W^s) < x_I^*(P_I, W^*) \end{aligned} \tag{3A.1}$$

because $\dfrac{\partial x_i^*}{\partial W} < 0 \quad (i = A, I)$ and $W^s > W^*$.

But this creates unemployment of $S_1 S_2$

$$S_1 S_2 = \overline{X} - x_A^*(P_A, W^s) - x_I^*(P_I, W^s) = O_A O_I - O_A S_1 - S_2 O_I \tag{3A.2}$$

Figure 3A.1 Uniqueness of labour market equilibrium



This contradicts the assumption of full employment. Therefore, to eliminate the unemployment, the equilibrium wage rate has to fall. As the wage rate falls, points S_1 and S_2 both move towards Q, indicating increases in employment in both agriculture and industry. Unemployment will only be completely eliminated when S_1 and S_2 converge at point Q with equilibrium wage rate W^* (or real wage rate w^*). The above analysis shows that an equilibrium wage could not be higher than W^*. Similarly, it can be proved that an equilibrium wage rate lower than W^* is not possible. Therefore, W^* is unique.

To prove the uniqueness of equilibrium labour allocation at point Q, suppose that there is another equilibrium allocation point, S_2, for instance. At this point the agricultural sector employs more labour than the original equilibrium ($O_A S_2 > O_A Q$) while the industrial sector employs less ($S_2 O_I < Q O_I$). At this new allocation point, industry is willing to pay a higher wage because of the higher marginal product of labour, whereas the agricultural sector is only willing to pay a lower wage rate because of the lower marginal product of labour. Yet this generates a discrepancy between the industrial wage (w^s for $S_2 O_I$) and the agricultural wage (w^t for $O_A S_2$).

This allocation cannot be maintained in the economy if the government places no embargo on labour movement between the two sectors. Under the assumption of perfect labour mobility, some labour employed in agriculture would move to industry in pursuit of higher income. This movement is also beneficial to society because economic output would increase by $w^s - w^t$ for each labourer who moved from agriculture to industry. This movement would continue until the marginal products in the two sectors were equalized. In other words, any further movement of labour would not produce any benefit. This occurs when S_2 moves to Q. It can also be proved that equilibrium labour allocation cannot be at a position to the left of Q.

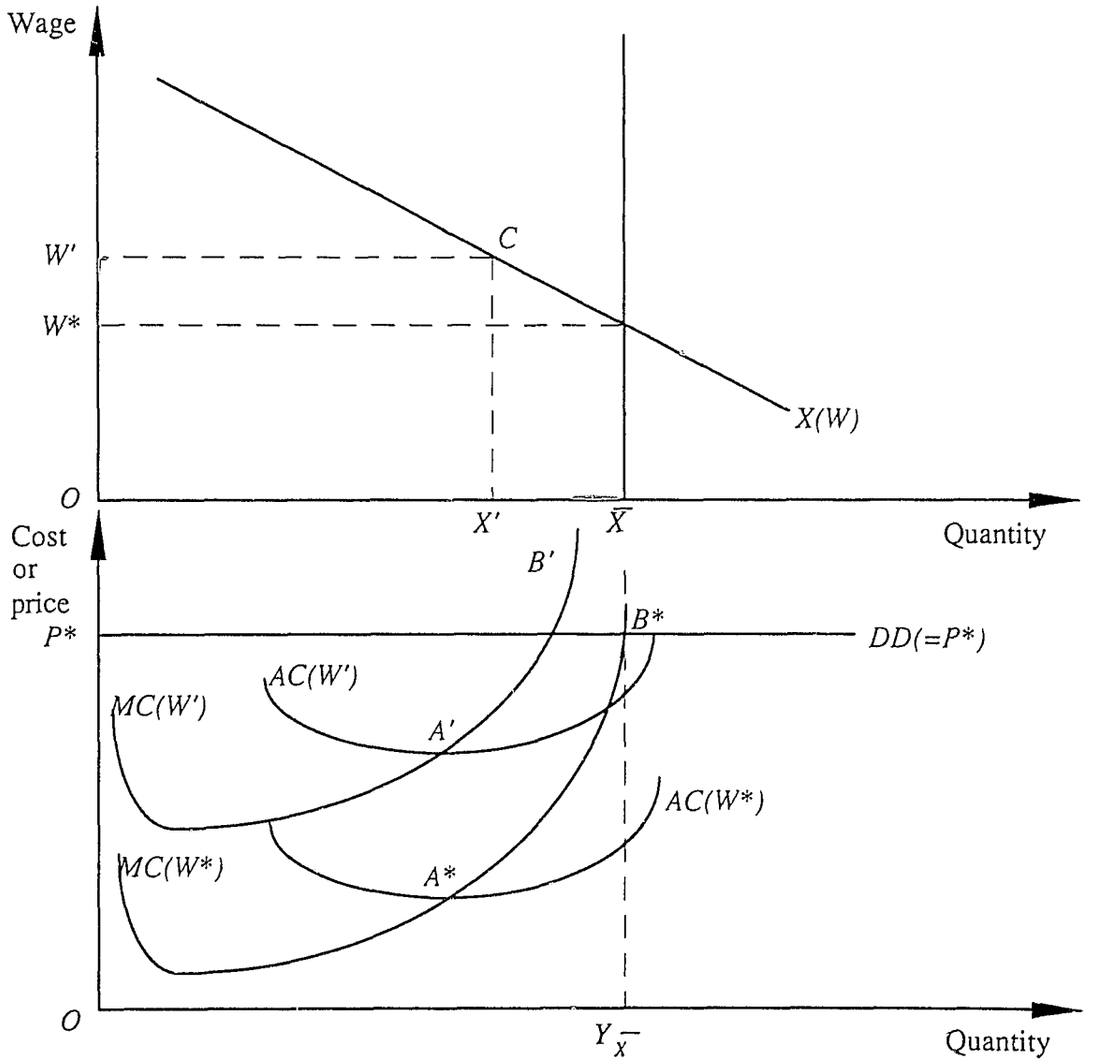
Appendix 3B

The Economic Mechanism of Full Employment

The assumption of fixed labour supply simplifies the analysis in the sense that the relationships between labour supply, wage rates and consumer preferences do not have to be discussed.

For producers, output prices and production technologies are given. In commodity markets, they face an inelastic demand curve, *DD* (Figure 3A.2).

Figure 3A.2 Full employment and wage rate adjustment



The above diagram shows aggregate labour markets in the economy. There is a fixed supply of labour ($\bar{X}$) and a downward sloping demand curve *X(W)* which is the sum of labour demands from the two sectors ($x_A(W)+x_I(W)$). Assume that the wage rate is *W'*. From the demand curve it can be seen that the two sectors will only employ *OX'*.

There will be unemployment of $X'\bar{X}$. To achieve full employment, the wage rate has to fall from W' to W^*.

In the product market, as shown in the lower diagram, the horizontal line DD is the inelastic aggregate demand curve faced by the economy. The average and marginal cost curves derived from the total cost function ($TC = W^* X$) are $AC = TC/Y = WX/Y$ and $MC = \partial TC/\partial Y = W\,\partial X/\partial Y$. Both are positive functions of the wage rate. $AC(W')$ and $AC(W^*)$ are the average cost curves, and $MC(W')$ and $MC(W^*)$ are the marginal cost curves when the wage rates are W' and W^*, respectively.

Theoretically, there are two adjustment mechanisms available to the economy. If the wage rate is fixed, the employment level has to adjust. There will be unemployment (as long as $W'>W^*$) and output will be below the full employment level ($Y_{\bar{X}}$).

To achieve full employment the wage rate has to adjust downward. From the marginal cost function, the lower the wage rate, the lower the cost curve. There will be an equilibrium wage rate (W^*) at which not only [illegible] but the supply curve just cuts the intersection between the [illegible]he vertical full employment output line.

This mechanism is important, p[illegible] segmented labour market. Given technology [illegible] economy or any part of the economy can al[illegible]ion (marginal revenue equals marginal cost) by

4

Farmers' Feasible Choice Set and Agricultural Performance

Among the two distinguishing characteristics of Chinese agriculture, policy intervention in agricultural markets and price distortion for agricultural products in particular, and their impact on economic development, are easily observed. Effects of dramatic changes in the feasible choice set, however, are not so straightforward. The literature on economic development does not discuss this issue in detail, since dramatic changes in the feasible choice set, such as occurred in the post reform period in China, are not common phenomena in other economies where the feasible choice set is usually stable within a certain period and changes slowly. This study coins the term 'the feasible choice set of farmers' as an important economic concept in analysis of agricultural policy in China. It is necessary to establish its significance empirically as well as theoretically. The following analysis applies the concept to show the impact that changes in the feasible choice set of farmers have had on agricultural development in China in the past decade.

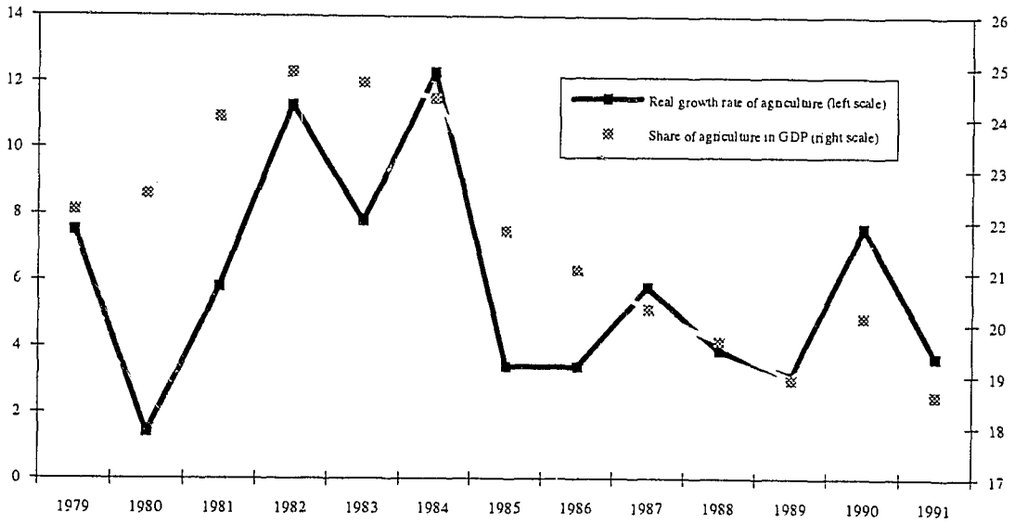
China's agricultural development in the past decade has been remarkable. The growth rate and output share of agriculture increased significantly between 1978 and 1984 (Figure 4.1).[1] However, both dropped, surprisingly, from 1985. Then, in 1990, agriculture began to recover. Debate continues about what influenced resource movements during this period.

Various explanations of agricultural performance in the second half of the 1980s have been advanced:

[1] In Chinese statistics, agriculture includes farming, animal husbandry, forestry, fishing and some small-scale side-line production.

- Worsening agricultural terms of trade (Niu and Calkins 1986; Gunasekera et al. 1991);
- completion of the household responsibility system (HRS) reform in 1983 (Gunasekera et al. 1991; Lin 1992a);
- adverse weather (Chai 1991; Gunasekera et al. 1991); and
- differential changes in technologies in agricultural and non-agricultural sectors, and changes in relative factor endowments (Ma and Garnaut 1992).

Figure 4.1 Agricultural growth rates and agriculture's share in the national economy, 1979-91



Source: State Statistics Bureau, *China Statistical Yearbook 1992*, China Statistics Press, Beijing: 49-50.

While some of these factors may have contributed in part to variations in agricultural growth, they do not appear to be dominant causes of the dramatic resource re-allocation behind agricultural performance. The sharp change in the farmers' feasible choice set after 1985 was the most important influence on the sudden decline and growth of agriculture in China. Economic reforms significantly changed the farmers' feasible choice set, which in turn redefined the area within which farmers could relocate their resources to maximize profits. Apart from changes in the price structure, a higher degree of

economic integration and limited factor mobility also contributed to the pattern of agricultural development during this period.

The alternative feasible set hypothesis is presented in a simplified two-sector model. Agricultural growth in the second half of the 1980s is revisited. Changes in marginal productivities of agricultural and non-agricultural activities are examined empirically in support of the feasible set hypothesis.

Explanations of the Agricultural Stagnation after 1985

During the period from the early 1950s to the late 1970s, two agricultural policies — low agricultural prices and collectivization — were consistently implemented to facilitate national development through the expansion of heavy industrial production.[2] Pre-reform agricultural policies were largely unsuccessful in promoting development.[3] The long period of sluggish growth turned agriculture into a 'bottleneck' for economic development necessitating revision of development policies.[4] From the late 1970s, agricultural reform was geared towards higher growth.

Agricultural reform in the past decade is usefully divided into two stages: the first being 1979-84, and the second 1985-90. In the first stage of reform, agriculture grew at 7.6 per cent annually. This achievement is generally viewed as an economic 'miracle' (Longworth 1988). There is little controversy, among economists, about what contributed to this rapid agricultural growth. The explanation lies in the success of the HRS reform (Johnson 1988; McMillan et al. 1989; Lin 1992a). Increases in the purchase

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[2] For detailed discussion of how agricultural policies were set to accommodate the heavy-industry-oriented development strategy, see Lin (1991), and Lin, Cai and Shen (1989).

[3] In the early stage of compulsory collectivization, during 1959-61, the agricultural crisis resulted in 30 million extra deaths (Lin 1990). In the period 1959-78, the average annual growth rate of agriculture was only 2.6 per cent. The period 1976-77 was seen as another agricultural crisis, when real agricultural output decreased by 0.4 per cent in both years.

[4] For a chronology of the evolution of agricultural policy, see Ash (1988). For a detailed chronology of the price reforms after 1979, see Sicular (1988a). Discussion of reform measures also appears in many papers, such as Lin (1992a), Anderson (1989) and Perkins (1988).

prices of agricultural products and in the use of inputs are also regarded as important contributing causes (McMillan et al. 1989; Fan 1991; Lin 1992a).

The reforms adopted in the second period, starting from 1985, accelerated the growth of the rural economy even more. The average annual growth rate in real terms was 10.9 per cent. Within the rural economy, however, the growth of agriculture slowed to an annual growth rate of 4.5 per cent. Grain output, for instance, dropped from the peak in 1984 and did not recover to its 1984 level until 1989. The relative stagnation of the agricultural sector was accompanied by significant decreases in inputs to agricultural production. Lin (1992a) found that the growth rate of chemical fertilizer inputs dropped from 8.9 per cent per year in 1978-84 to 3.7 per cent in 1984-87 and the annual growth rate of the agricultural labour force declined from 2.3 per cent to -8.6 per cent in the same period. Niu and Calkins (1986) also pointed out that the availability of physical inputs did not increase and that some were even cut back. This decline in the relative growth of agriculture in the second stage has been the subject of much discussion.

Worsening Agricultural Terms of Trade

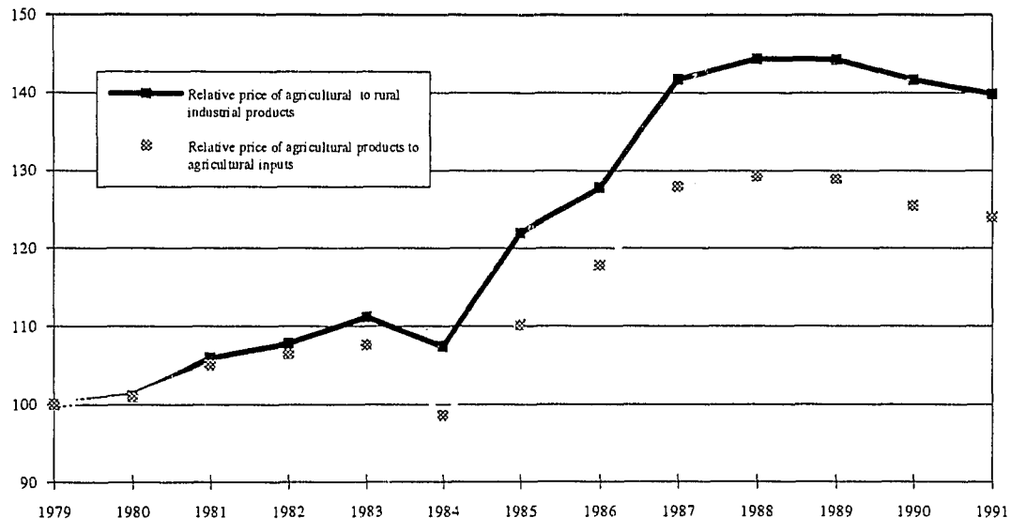
Changes in relative prices are generally used to explain agricultural stagnation in China after 1985 (Niu and Calkins 1986; Gunasekera et al. 1991; and Chai 1991). Of five reasons for agricultural stagnation given in Niu and Calkins' analysis, three are related to the worsening agricultural terms of trade (Niu and Calkins 1986). Their argument has been echoed by some other economists (Chai 1991; Gunasekera et al. 1991).

The statistics, however, suggest a different story. Figure 4.2 plots agriculture's market prices relative to the prices of rural industrial products and agricultural inputs.[5] Before 1989, both ratios were increasing except for a small drop in 1984. Agriculture's share in the national economy and its growth rate, however, dropped dramatically from 1985 until 1989 (see Figure 4.1). As farmers usually take the market prices of the previous

[5] Market prices of agricultural products are calculated following Lin (1992a). For a detailed explanation, see Lin (1992a).

year as a guide to expected prices for production decisions in the following year, the fall in relative prices of agriculture in 1984 is a possible reason for agricultural contraction in 1985. However, the agricultural growth rate dropped significantly from 12.3 per cent in 1984 to 3.4 per cent in 1985, while agricultural market prices fell only 3 per cent, relative to prices of rural industrial product and 8 per cent, relative to prices of agricultural inputs. In particular, changes in relative prices cannot explain the opposite movements between relative prices and agricultural growth rates and between the relative prices and the share of agriculture in the national economy during 1985-90 (see Figures 4.1 and 4.2).[6]

Figure 4.2. Relative market agricultural prices, 1979-91



Source: State Statistics Bureau, *China Statistical Yearbook*, 1992, China Statistics Press, Beijing. Lin, J.Y., 1992, "Rural Reforms and Agricultural Growth in China", *American Economic Review*, vol. 82, no. 1, March 1992:34-51.

The Completion of HRS

Many economists noted that the more immediate productivity-increasing effects of the HRS are likely to have been fully exploited after the completion of the HRS reform in

[6] By simply regressing agriculture's share on its relative price to industry, the relationship is shown to be significantly positive in 1978-84 and significantly negative in 1985-90.

1983 (Lin 1992a; Gunasekera et al. 1991). Studies by Lin (1992a) and McMillan et al. (1989) reveal significant contributions by HRS reform to rising agricultural output and productivity during 1979-84. The completion of the HRS reform in 1983 would have also contributed to the stagnation of agriculture after 1985. (Table 4.1). However, if technologies for agricultural and industrial production were relatively stable, the completion of the HRS reform might have slowed down the growth rate of agriculture but should not have dramatically changed agriculture's share in the rural economy.[7] In fact, outputs of many agricultural products, including grain and cotton dropped in 1985. In particular, this hypothesis cannot explain why in 1985-88 the labour force shifted from agriculture to industry while agriculture's relative price was increasing and in 1989-90 the labour force moved from the industrial sector to agricultural sector when agriculture's relative price was declining (see column 4 in Table 4.1).

Table 4.1 Some important variables affecting agricultural performance: 1978-90

Year	HRS adoption rate by production team (%)	Fertilizer application growth rate (%)	Non-TVP rural labour (in person)	Deviation from mean affected by natural disaster (1978-90 mean=1)
1978	0	9.0	278.1	1.2
1979	1	22.9	281.7	0.9
1980	14	16.9	288.4	1.1
1981	45	5.2	297.0	1.0
1982	80	13.4	307.5	0.8
1983	98	9.7	314.6	0.8
1984	99	4.8	307.6	0.8
1985	99	2.1	300.9	1.1
1986	99	8.7	300.5	1.1
1987	99	3.6	302.0	1.0
1988	99	7.1	305.2	1.2
1989	99	10.1	315.7	1.1
1990	99	9.9	327.5	0.9

Source: State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing; Justin Yifu Lin, 1992, "Rural reforms and agricultural growth in China", *The American Economic Review*, 82(1), March 1992:34-51.

[7] Differential changes in productivities of non-agriculture to agriculture could explain the outflow of agricultural resources being induced by the completion of the HRS reform. Suppose that the completion of the HRS reform stopped agricultural productivity improvement and that industrial productivity continued to increase rapidly, the ratio of marginal products of the two sector would thus change dramatically. Factors would move quickly from agriculture to industry to achieve a new economy-wide equilibrium. This possibility, however, can be ruled out for this case.

Adverse Weather

A run of unfavourable seasons has also been frequently cited as a contributing factor to the slowdown of agricultural development. Weather conditions were significantly correlated with agricultural performance in the past decade in China (Gunasekera et al. 1991; Chai 1991). Except for 1980 , the period of 1979-84 was reported to be one of good weather, this time was also a period of rapid agricultural growth. During the period of agricultural stagnation in 1985-1988, the weather was reported to remain unfavourable for agricultural production. The deviations from the mean in arable land areas affected by natural disaster, for the period 1978-90, followed the pattern of agricultural growth (Table 4.1).

In agricultural production, however, the weather only affects immediate actual output levels. Since weather is an on-going process, significant resource re-allocation can not be explained by changes in weather conditions. For cross-sectional data, this kind of linkage might be detected, since the weather pattern may impact on the optimal mix of inputs. For instance, because of rich rainfall, Southeast China may use more labour and fertilizer inputs than the dry Northwest region of China. Over years, however, a strong relationship between contraction or expansion of the agricultural sector and temporary weather change has not been evident. Lin (1990) found that weather is often used by Chinese authorities as an excuse for crop failures caused by other reasons.

The Relative Rates of Technological Change and the Rybczynski Effect

In the long-run, changes in relative factor endowments of an economy or differential changes in production technologies can result in the re-allocation of resources between sectors regardless of the changes in the relative prices. Suppose there is much faster improvement in non-agricultural technology than in agricultural technology, marginal productivities in the non-agricultural sectors would therefore be higher than in the agricultural sector. Even if there is no change in (or there is a small increase in) the relative price of agricultural to non-agricultural products, factors would move from

agriculture to non-agricultural sectors (Ma and Garnaut 1992). In the period 1985-90, however, there is no evidence supporting the hypothesis of dramatic technology changes in the Chinese economy. The Rybczynski theorem, on the other hand, describes the relationship between changes in output structure and relative factor endowments regardless of changes in relative prices. It is suggested that a rise in the endowment of one factor to the other will increase the output of the good using that factor intensively relative to output of the other good (Rybczynski 1955; Jones 1956). There are two qualifications to this application of the Rybczynski theorem to the Chinese rural economy First, while the Rybczynski theorem refers to a long-term changes, what is relevant here is a short-term phenomenon. Second, the dramatic increase in investment and capital stock in the rural industries around the mid-1980s and the increase in industrial output in the rural economy in 1984-88 was consistent with the Rybczynski hypothesis. However, the hypothesis fails to explain the increase in agriculture's share in 1990, when the capital-labour ratio was still rising.

Policy-Truncated Production Frontier and Farmer's Resource Allocation

The efficient functioning of any price structure in guiding an agricultural household's resource allocation depends on two assumptions apart from rationality. First, global equilibrium exists before relative price changes; and second, production activities are not constrained by non-economic forces, such as government policies, and resources can freely move between different sectors. The argument is best demonstrated by the following model. Suppose, with given quantities of endowments $\overline{X}$, a household can produce either agricultural products (good 1) or industrial products (good 2). The prices for agricultural products and industrial products, P_1 and P_2, are given to the household.

The optimal resource allocation between these two sectors can be obtained by solving the following equation:

$$\underset{X_i}{Max}\ \Pi = P_1 f_1(X_1) + P_2 f_2(\overline{X} - X_1) \qquad (4.1)$$

where f_i is the production function for good i and X_i refers to the resources allocated to the production of good i. The production functions are assumed to be well-behaved. The first order condition for optimality requires

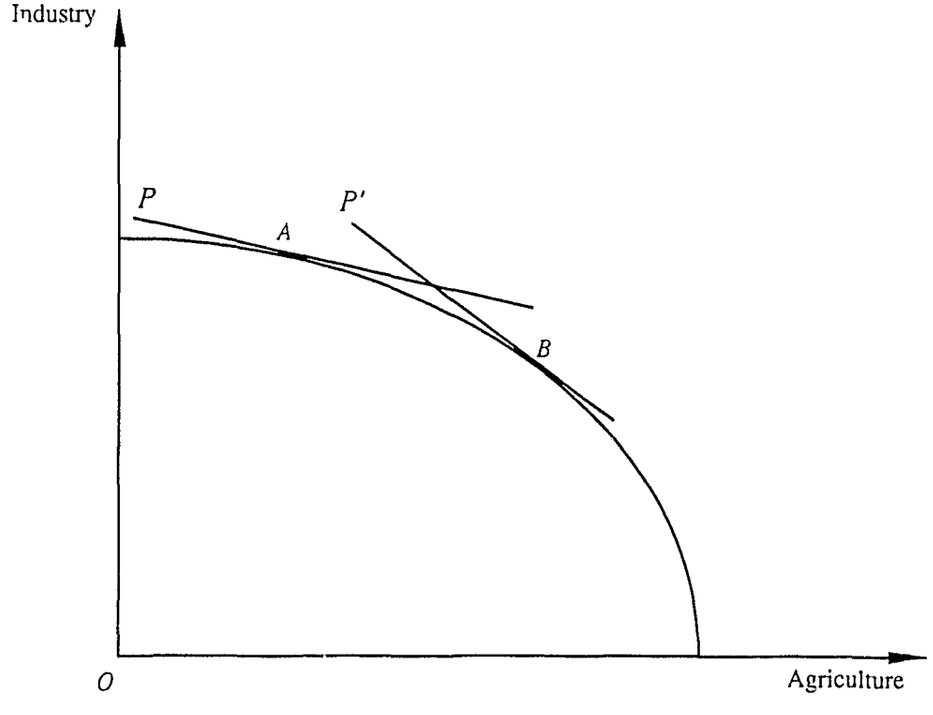
$$P_1[\partial f_1/\partial X_1] = P_2[\partial f_2/\partial X_2] \tag{4.2}$$

That is, resources are allocated to the production of good 1 and good 2 to the point where the values of marginal product of good 1 equals the value of marginal product of good 2. Expression (2) can also be expressed in the following way

$$[\partial f_1/\partial X_1]/[\partial f_2/\partial X_2] = P_1/P_2 \tag{4.2'}$$

This condition can be shown diagrammatically at A, where the production possibility frontier is at a tangent to the relative price line (Figure 4.3).

Figure 4.3 Relative price and production decisions

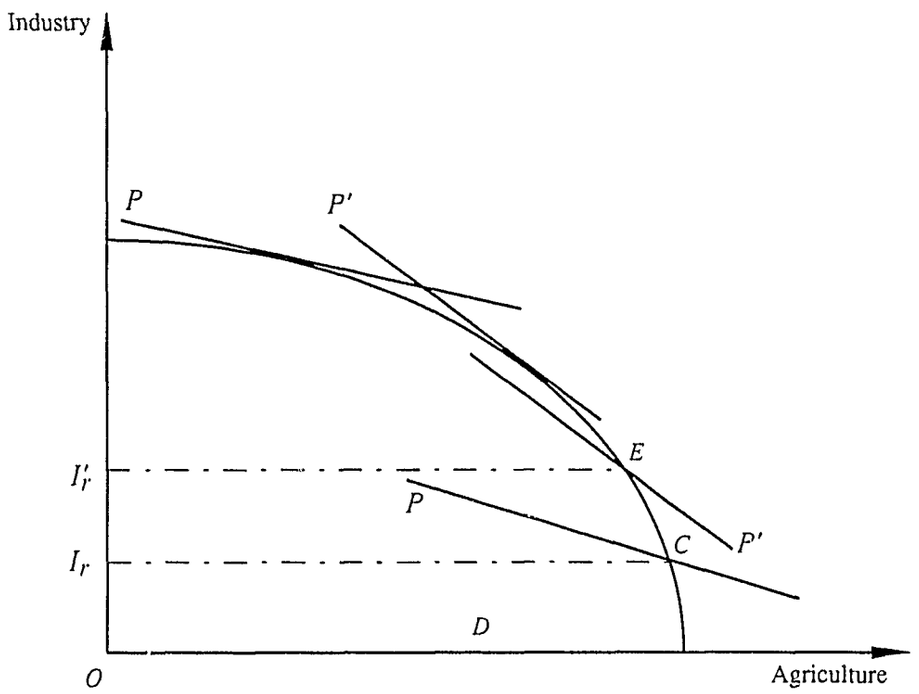


If no restriction exists on the production of good 1 and good 2, then changes in relative prices will result in the re-allocation of resources from the good with declining relative

prices to the good with increasing relative prices along the curve of the production frontier. For example, the change of relative price from line P to P' will result in the shift of the equilibrium production point from A to B. Therefore, the changes in the relative prices will indicate both the direction of resource movements and the relative growth of these two goods.

However, under the traditional heavy industry-oriented development strategy, production in rural areas was largely confined to agriculture, especially grain (Lardy 1983; Lin, Cai, and Shen 1989). Production activity in the industrial sector was limited by government policies. In other words, the production frontier the farmers faced was truncated (Figure 4.4).

Figure 4.4 Policy restriction and truncated production possibility frontier



Industry production is restricted to a level no larger than I_r. With relative prices represented by line P, production will locate at C, a corner solution.[8] At this point, the

[8] For a detailed discussion of the truncated production frontier model, see Appendix 4A. The actual production may locate at some point within the frontier, such as D, due to incentive issues, which are

necessary condition for optimality will not hold. Instead of the equality of Equation 2, the following condition may exist

$$P_1[\partial f_1/\partial X_1] < P_2[\partial f_2/\partial X_2] \tag{4.3}$$

That is, the agricultural product's value of marginal product is lower than that of the industrial product. A re-allocation of resources from agricultural to industrial production will increase the agricultural household's income. However, such a re-allocation is prohibited by the policy restriction on industrial production. As long as the changes in the relative prices do not upset the inequality in Equation (4.3), the changes in the relative prices will not cause the re-allocation of resource between these two productions. Moreover, if the production constraint was shifted, some abnormal re-allocation of resource and sectoral growth may be accompanied by changes in relative prices. For example, consider the case where the relative prices are changed from P to P' (see Figure 4.4). If there are no constraints on the movement of resources, the change in relative prices will signal the growth of the agricultural sector and the decline of the industrial sector with resources flowing from the industrial sector to the agricultural sector. Nevertheless, under the truncated production frontier case, if the constraint on industrial production is shifted from line I_r to I_r', the production point will change from point C to E. The result is opposite to what one would expect for relative price changes. The opposite scenario, the expansion of agricultural production with a worsening of agricultural term of trade, can be derived easily from the shift of policy constraint from I_r' back to I_r.

Change in the policy constraints on industrial production in the truncated production frontier is the main cause for the puzzling pattern of agricultural growth after 1984. The trend of agriculture's relative prices and the trend of agriculture's relative share are negatively correlated (Figure 4.4). This policy constraints hypothesis is further confirmed

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discussed in Lin (1988). However, we will ignore this complication and assume that the production locates on the frontier.

by the employment of labour in the rural township and village enterprises. In 1989 and 1990, the relative price of industrial to agricultural products was increasing, but employment in rural industry declined absolutely (see column 3 in Table 4.3). There are two implications of this hypothesis:

> First, if the hypothesis is valid, the marginal productivity of labour in the agricultural sector must be lower than that in the industrial sector. The same is true for other inputs.
>
> Second, the re-allocation of labour from the agricultural to the industrial sector will reduce the gap of labour's value in marginal product in these two sectors, whereas the re-allocation of labour from the industrial sector back to the agricultural sector will enlarge the gap. The same is true for other inputs.

China's Agricultural Performance in the 1980s Revisited

Farmers' feasible production choice in the truncated production frontier was changed dramatically by the process of economic reform (Table 4.2).

Before economic reform started at the end of 1978, Chinese farmers were largely restricted to growing a small number of crops, such as grain and cotton. Production of cash crops and livestock products was not allowed except in areas allowed in the state plan. Non-agricultural production activities were prohibited, in general, at that time.[9]

The initial reforms were mainly aimed at raising agricultural output. The experimentation with and, later on, the nation-wide implementation of the HRS gave households

[9] There were a few commune and brigade industrial enterprises which received encouragement under particular policies for short periods. During the second half of the 1950s, to achieve the national steel output target (which had been set far too high), small steel plants were set up all over the countryside. Labour was diverted to very inefficient steel production. Later, in the mid-1970s, for the purpose of realising agricultural mechanisation, small factories producing and repairing farm machines were again established everywhere. Since both targets were inappropriate and inefficient, most these small enterprises were shut down shortly after establishment.

relatively more freedom to make production decisions within agriculture. Farmers' feasible production choice set expanded. Production of cash crops and livestock increasingly became an important part of the agricultural economy. However, government restrictions on rural industries, in general, remained unchanged. The relative price of agriculture to industry was therefore irrelevant to the allocation of resources between the agricultural and industrial sectors.[10] The energies released and created by reform could only be allocated to agriculture.

Table 4.2 The feasible choice set for a typical Chinese farmer, 1978-90

	Government policy and objectives	Feasible choice set: economic activities			
		Grain crops	Cash crops	Animal husbandry	Rural industry[a]
Before 1978	To facilitate industrialization and to pursue grain self-sufficiency	compulsory[b]	restricted	restricted	no
1979-80	To raise the purchase price for agricultural products and to increase agricultural investment	yes	restricted (loosened)	restricted (loosened)	no
1981-84	HRS and price reform to induce agricultural development	yes	yes	yes	restriction loosened[c]
1985-88	Marketization and encouragement of rural industrial development	yes	yes	yes	encouraged
1988-90	Monetary contraction and policies favouring agriculture	yes	yes	yes	yes (partly restricted)

Notes: [a] The classification of rural industry here does not include some industries that provide necessary support to daily life and production, such as grain mills.
[b] Economic activities are defined by several classifications according to accessibility by farmers. 'Compulsory' implies that the production activity was assigned by the government; 'yes' means farmers can freely decide whether or not to be involved in that production activity; 'restricted' means that farmers can sometimes produce those products subject to various policy restrictions; 'no' implies that farmers cannot enter that production area; and 'encouraged' for rural industry in 1985-88 refers to a period when different policies favouring rural industry were implemented to facilitate rural industrialization.
[c] In some areas at a later stage this was actually encouraged by (local) government.

[10] For a farmer with only one feasible economic opportunity, such as grain production, he may choose to consume leisure if profitability of grain production was too low. So that, the increase of purchase price may induce more time to be converted from leisure to labour input over time.

Mid-1980s was the time when the Chinese economy experienced dramatic policy changes and expanding farmer's production possibility frontier through

- the adoption of the fiscal responsibility system (Blejer et al. 1991);
- banking system reform at the end of 1984 (Wulf and Goldbrough 1986; Peeble 1990);
- liberalization of rural product and factor markets at the beginning of 1985; and
- encouragement of the development of rural industries through the introduction of low taxes and subsidized bank loans.

The adoption of the fiscal responsibility system gave local governments strong incentives to find ways to increase their tax base. Because of the distorted price structure, industry enjoyed much higher profit margins than agriculture. Therefore, instead of suppressing industrial production, many local governments adopted low taxes and subsidized bank loan policies, to encourage the development of rural industries. Restrictions on industrial production was removed. The expansion of rural industry was also facilitated by banking system reform and the liberalization of factor and product markets. One direct result of the banking system reform was the explosion of bank loans in the fourth quarter of 1984 and at the beginning of 1985 (Wulf and Goldsbrough 1986; Kojima 1989; Blejer et al. 1991). A large part of this extra credit went to rural industries. Bank loans for township, village and private enterprises (TVP) rose by 97.9 per cent in 1985. The TVP's share in total state capital application increased from 2.2 per cent in 1983 to 3.5 per cent in 1987 (Table 4.4). A large number of TVPs was established from the second half of 1984 and at the beginning of 1985. The number of TVP enterprises increased by 38.4 per cent in 1984, and doubled in 1985 (State Statistics Bureau *China Statistical Yearbook 1991*).[11] At the same time, employment in TVP enterprises increased by 23.1 per cent in 1984 and 34.0 per cent in 1985 (Table 4.3). Finally, the liberalization of factor markets and

[11] In *China Statistical Yearbook 1991*, the numbers before 1983 are enterprises at the township and village levels while the numbers from 1984 are all township and village enterprises. The latter, apart from the enterprises at the township and village levels, also include rural cooperative and private enterprises.

product markets facilitated the re-allocation of resources between different sectors and between different regions.

Table 4.3 Development of the TVP sector in China, 1984-90

	Number of enterprises (million)	Number of employees (million)	Rural industry price index (1985=100)	Real value of total output (1985 price)	Growth of output value (%)
1984	6.1	52.1	92.3	185.3	..
1985	12.2	69.8	100.0	272.8	47.2
1986	15.2	79.4	106.0	334.1	22.5
1987	17.5	88.1	113.7	419.0	25.4
1988	18.9	95.5	134.8	481.9	15.0
1989	18.7	93.7	158.8	467.8	-2.9
1990	18.5	92.7	162.1	522.0	11.6

Source: State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing:230, 377-78.

Experiences of 1989 and 1990 in China led to a different story of changes in policy constraints and farmers' production possibility frontier. To overcome the overheating of the economy, a package of adjustment policies was implemented from October 1988 and, most effectively, in 1989. A credit squeeze was one of the important measures, and was targeted, in particular, at the rural industries (World Bank 1990). The growth rate in bank loans to the TVP sector dropped from 17.7 per cent in 1988 to 3.2 per cent in 1989 and 14.5 per cent in 1990, compared to 97.9 in 1984 and 52.2 in 1986 (Table 4.4). Inflation was 18.5 per cent in 1988 and 17.8 per cent in 1989, so the real growth of loans to the TVP sector was negative, particularly in 1989. Though the government did not restore administrative restrictions on farmers' economic opportunities in rural industries, the farmer's production possibility frontier, at least for some farmers, contracted. Both the numbers of enterprises and employees in the TVP sector decreased in 1989 and 1990 (see Table 4.3). Real output of the TVP sector declined in 1989 by 2.9 per cent. At the same time, total profits of the TVP sector in nominal terms dropped from 25.9 billion yuan in 1988 to 24.0 billion yuan in 1989, and to 23.3 billion yuan in 1990.

Table 4.4 State bank loans to TVP and agricultural sectors, 1978-90

	TVP loans		agricultural loans		total capital application	
	bn yuan	growth(%)	bn yuan	growth(%)	bn yuan	growth(%)
1978	2.1	..	9.4	..	187.7	..
1979	3.8	79.3	9.9	4.6	216.3	15.3
1980	5.3	39.5	12.3	24.5	262.4	21.4
1981	6.2	17.4	12.8	3.7	307.5	17.2
1982	7.3	18.0	13.9	9.1	361.8	14.1
1983	8.0	9.0	15.1	8.7	412.5	14.0
1984	15.8	97.9	20.9	38.2	537.0	30.2
1985	18.9	19.4	22.8	8.9	637.5	18.7
1986	28.8	52.2	28.3	24.2	811.1	27.3
1987	34.9	21.1	33.7	19.1	987.0	21.7
1988	41.1	17.7	40.3	19.9	1148.5	16.4
1989	42.4	3.2	47.1	16.8	1356.2	18.1
1990[e]	48.8	14.5	55.0	16.8	1683.8	24.2

Note: [e] Numbers for 1990 are estimates.
Source: State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing:52-53.

This contraction in the TVP sector forced some farmers to retreat to the agricultural sector. Given that there was a minimum scale of investment,[12] monetary contraction resulted in a loss of the job opportunities in the TVP sector. As a result, resources moved back to the agricultural sector. The number of employees in the TVP sector dropped by 1.9 per cent in 1989, and declined further by 1.1 per cent in 1990. At the same time, the total rural labour force increased by 2.2 per cent in 1989, and 2.6 per cent in 1990 (*China Statistical Yearbook 1991*:95). Therefore, there was a substantial increase in agriculture's labour force in the two years. Furthermore, starting from 1988, more investment was directed to agricultural production. Investment in non-agricultural production dropped in 1989, in particular.[13]

[12] This minimum scale could vary across sectors and regions. However, as the TVP sector grows and technology develops, the likely trend is that the minimum scale will rise.

[13] Since most rural investment is realised in the short term, newly increased capital stock can proxy the investment in a particular year. The newly formed capital stock per farm household for agricultural production, from 1986 to 1990, was 7.0, 32.9, 63.4, 55.7 and 65.0 (yuan), respectively; while that for non-agricultural production were 42.5, 44.2, 60.6, 37.3 and 66.4 (yuan), respectively (*China Statistical Yearbook* 1991). More investment was directed to the agricultural sector by farm households at the end of the 1980s because of the minimum scale of industrial investment. The possibility of obtaining bank loans decreased significantly, and farmers' own funds could not reach the minimum scale for industrial investment. As an alternative, they had to invest their own funds in agriculture.

In short, the monetary and other contractionary policies of the austerity program at the end of 1988 once again aimed to restrict the expansion of rural industry. The farmer's production possibility frontier was truncated again. The relative increase in factor supplies for agricultural production eventually led to the recovery of agricultural growth and agriculture's share in the national economy in 1990.

Changes in Marginal Productivity: A Test

The analysis so far has shown that the variations in the farmers' feasible choice set and the movement of resources during 1985-90 were consistent with predictions from the hypothesis set out above. Changes in the values of marginal product in agricultural and non-agricultural sectors also throw light on developments in this period. In the following empirical case study, the agricultural sector and TVP sectors are chosen since, for Chinese farmers, they best illustrate resource movements and changes in the feasible choice set. One of the weaknesses in choosing the TVP sector is the dramatic change it was undergoing during 1985-90. The marginal productivity of the TVP sector might therefore overvalue that for the whole non-agricultural sector of the economy. The marginal productivities of labour in the two sectors are considered, but capital is not.[14]

The following production functional form is adopted for both sectors:

$$\ln(Y_i) = \alpha_i + \sum_k \beta_{ik} \ln(X_{ik}) + \gamma_i T + \sum_{l=1}^{5} \delta_{il} D_l + \varepsilon_i \qquad (3.5)$$

Estimations were run separately for the agricultural and the TVP sectors using a panel data set consisting of 28 provinces and 6 years from 1985 to 1990 (for a discussion of this exercise see Appendix 4B).

[14] There are two reasons for ignoring marginal productivities of capital. First, in the data set, capital stock in the two sectors is measured differently. While for agriculture it is the amount of Watt, the measure for the TVP is yuan, thus making it difficult to compare their marginal productivities. Second, capital stock, in the case of rural China, is relatively less mobile than labour.

Estimation results are reported in Table 4.5 and values for the marginal product of labour can be derived from these production functions.

Table 4.5 Estimation results of production functions for agriculture and TVP

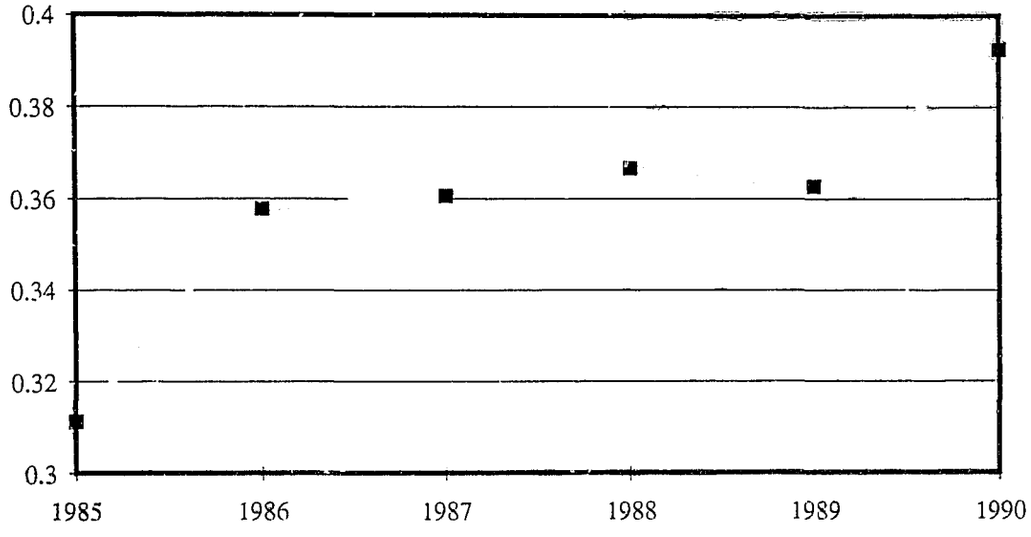
	Agriculture	TVP sector
Constant	-0.70	-0.72
	(-3.37)	(-1.48)
Labour	0.26	0.45
	(4.82)	(2.11)
Capital	0.62	0.47
	(10.58)	(2.16)
Land	0.03	
	(0.50)	
Time trend	0.02	-0.04
	(1.50)	(-0.95)
Regional Dummies		
North	-0.07	0.01
	(-1.01)	(0.02)
Northeast	0.37	-0.20
	(4.92)	(-0.71)
Southeast	0.47	-0.026
	(5.83)	(-0.09)
Central	0.50	0.07
	(5.76)	(0.25)
Southweat	0.50	-0.08
	(5.30)	(-0.29)
$\overline{R}^2$	0.94	0.62

Note: Numbers in parentheses under coefficient estimates are related t-ratios.

The estimated ratio of marginal products of the two sectors during 1985-90 confirm two of the working hypotheses developed earlier in this chapter (Figure 4.5). First, the marginal product of labour in the agricultural sector was significantly lower than in the TVP sector, reinforcing the dramatic movement of resources across sectors in the second half of the 1980s. Even in 1990, the marginal product of labour in agriculture was less than half that in the TVP sector. Further flows of labour can be expected. Second, regardless of the big gap, the marginal products of labour in the two sectors are converging. This supports the hypothesis derived from the theoretical model.[15]

[15] According to the theoretical results derived in this study, the ratio of marginal productivities of labour in agriculture and the TVP sector should continue to fall in 1990 since labour flew back to agriculture. The actual rise of relative marginal productivity in agriculture is a result of the sharp rise of agricultural prices in that year (see Figure 4.2).

Figure 4.5 Ratio of marginal productivities of labour in agriculture and the TVP sector, 1985-90 (TVP=1.0)



Source: The ratios are calculated from the estimations results presented in Table 3.B1 of Appendix B.

This estimation is consistent with wage and income data. In 1985, the average wage in agriculture was 4.7 yuan per day, while that in non-agricultural production was 10.7 yuan per day.[16] These figures suggest that the agricultural wage was only about 40 per cent of non-agricultural wage, while the ratio estimated by our analysis for the marginal productivities is more than 30 per cent.[17] Furthermore, while the average per capita income of all farmers was 545 yuan, 602 yuan and 630 yuan in 1988, 1989 and 1990 per capita wage income in the TVP sector was 567 yuan, 620 yuan and 655 yuan, respectively, for the same years (*China Statistical Yearbook 1991*:377-379; *China Agricultural Statistical Yearbook 1991*:206).[18] Though income data cannot reflect changes in marginal productivities of labour, these data reveal that not only was income

[16] These average wage rates are calculated according to the data provided in footnote 19.

[17] The two possible reasons for the gap between the suggested ratios are: (1) the average wage calculated as the simple mathematical average rather than the weighted average; and (2), as the capital in the agricultural sector is not appropriately priced, labour might be priced at average productivity instead of marginal productivity.

[18] The average per capita income of farmers also includes farmers who worked in TVP enterprises.

in the agricultural sector still lower than in the non-agricultural sector, but the gap between the sectors was gradually narrowing.

Combining marginal productivity and income information with the resource flows during 1985-90, it can be concluded that the relocation of resources from agriculture to non-agriculture during 1985-88 was largely a result of the farmers' profit (income) maximizing behaviour following the marketization of the rural economy and the expansion of farmers' feasible choice set. Again, in 1989-90, factors of production moved towards the agricultural sector where both marginal productivities and returns to factors were low. The relative contraction of the agricultural sector during 1985-88 actually stemmed from the success of marketization reflecting a more optimal allocation of limited resources and higher income of farmers. On the other hand, the boom in the agricultural sector in 1989-90 was a forced result. Farmers' economic opportunities in the non-agricultural sector contracted and the agricultural boom occurred at the cost of recession in industry, at least in rural industry.

This conclusion is further supported by the evidence of changes in farmers' real income throughout the period. In 1985 farmers' real per capita income increased dramatically in 1985 by 4.6 per cent, when the agricultural sector stagnated. Real income continued to increase in 1986 and 1987 with growth rates at 1.7 per cent and 2.7 per cent, respectively. In 1989, real income dropped by 6.8 per cent, and although it increased slightly in 1990, it was still 5.4 per cent lower than that in 1988 (*China Statistical Yearbook 1991*:295; Jiang and Luo 1988).

Reappraisal of Agricultural Policies

This analysis has sought to explain changes in the pattern of agricultural growth during 1985-90 in China. It argues that changes in relative prices of agricultural products explain some of the changes but fail to provide convincing explanations for the dramatic contraction and expansion of the agricultural sector in the second half of the 1980s.

Other explanations such as the impact of completion of the HRS and adverse weather, may have contributed in part. But none can be seen as dominant explanations.

In the mid-1980s, due to marketization and monetary expansion, the farmers' feasible choice set expanded suddenly. Market expansion led to more optimal factor allocation and higher total income. Farmers reallocated resources from agriculture to non-agriculture in the pursuit of higher income. At the end of the 1980s, because the rural industries were seriously hit by contractionary policies, the feasible choice set of farmers outside agriculture was affected. Some production factors flowed back to agriculture. The two turning points of agricultural performance in 1985-90 can be explained by the feasible choice set hypothesis. The hypothesis was further supported by the changes in the relative marginal productivities of labour in agricultural and non-agricultural sectors.

Appendix 4A
Resource Allocation in a Two-Sector Model

Assume an economy with two sectors, sector 1, agriculture and sector 2, industry, with perfect factor mobility across sectors. Each sector produces one product using the common factors in production, while the endowment of factors in the economy is fixed. Profit maximization can be achieved by solving

$$\begin{aligned} Max \quad & P_1Y_1 + P_2Y_2 - W_1X_1 - W_2X_2 \\ \text{st} \quad & Y_1 = f_1(X_1) \\ & Y_2 = f_2(X_2) \\ & \overline{X} = X_1 + X_2 \end{aligned} \tag{4.A1}$$

where Y_i and X_i are quantity vectors of outputs and inputs for the two sectors, P_i and W_i are price vectors of outputs and inputs, $\overline{X}$ is the vector representing the total endowment of production factors, and $f_i(.)$ is the production function with $f_i' > 0$, $f_i'' < 0$ and $f_i(0) = 0$. Solving problem (1) leads to the condition for profit maximization

$$P_1 \frac{\partial f_1}{\partial X_1} - W_1 = P_2 \frac{\partial f_2}{\partial X_2} - W_2 \tag{4.A2}$$

For perfect factor mobility, $W_1 = W_2$, so that

$$P_1 \frac{\partial f_1}{\partial X_1} = P_2 \frac{\partial f_2}{\partial X_2} \tag{4.A3}$$

or

$$\frac{P_1}{P_2} = \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \tag{4.A4}$$

which implies that the value of marginal product in the two sectors should be the same in equilibrium. For further simplicity, we can assume that both activities use only one factor, labour, in production.

If the relative price of product 1 to product 2 increases given the production technologies, disequilibrium would occur if there were no factor relocation

$$\frac{P_1}{P_2} > \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \tag{4.A5}$$

To retain equilibrium, the marginal product of sector 2 has to rise relative to that of sector 1. According to the properties of the production technologies, this requires that more factors are allocated to sector 1 and less to sector 2.

To apply this framework to Chinese farmers, some assumptions must be relaxed. Before marketization, the agricultural and the industrial sectors were highly segmented. The above profit maximization problem is broken down into two separate problems. In each sector, profit maximization requires that marginal product equals marginal cost.

$$P_1 \frac{\partial f_1}{\partial X_1} = W_1 \tag{4.A6}$$

$$P_2 \frac{\partial f_2}{\partial X_2} = W_2 \tag{4.A7}$$

For further simplicity, we now only consider the case of one input, labour. As the flow of labour from agriculture to industry is restricted, it is possible that

$$W_1 << W_2 \tag{4.A8}$$

from which it is clear that

$$P_1 \frac{\partial f_1}{\partial X_1} << P_2 \frac{\partial f_2}{\partial X_2} \tag{4.A9}$$

or

$$\frac{P_1}{P_2} << \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \tag{4.A10}$$

In other words, because agriculture employs too much labour compared to the no-restriction case, the marginal product of labour is lower in agriculture than in industry according to the properties of the technologies.

The administrative restrictions on labour flows, however, were gradually relaxed along with economic reform, particularly in the period after 1985. In the second half of the 1980s, both the relative price of agricultural products and the feasible choice set of farmers underwent a process of change.

The expansion of farmers' feasible choice set causes factor relocation and convergence of factor prices. There are five possible movements given different changes in the relative price.

(1) The feasible choice set expands while the relative price remains unchanged; in this case, the ratio of marginal products in the two sectors would move towards the relative price. To obtain this, the marginal product in industry must be reduced while that in agriculture must be increased. This requires a relocation of factors from sector 1 to sector 2. Assuming that (X_1^*, X_2^*) is the factor allocation set for the two sectors after the factor movements, this relocation gives

$$\frac{P_1}{P_2} = \frac{\partial f_2}{\partial X_2^*} \Big/ \frac{\partial f_1}{\partial X_1^*} \tag{4.A11}$$

(2) The feasible set expands and the relative prices of the agricultural product increases by a small margin. In this case, the increased relative price would still not alter the previous disequilibrium condition, that is

$$\frac{P_1^*}{P_2^*} < \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \tag{4.A12}$$

Thus, further factor movements from agriculture to industry would still be required to achieve the equilibrium

$$\frac{P_1^*}{P_2^*} = \frac{\partial f_2}{\partial X_2^*} \Big/ \frac{\partial f_1}{\partial X_1^*} \qquad (4.A13)$$

(3) The feasible set expands and the relative price of the agricultural product increases by a sufficient margin, so that

$$\frac{P_1^*}{P_2^*} > \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \qquad (4.A14)$$

In this case, factors should be relocated in the opposite direction, from sector 2 to sector 1, to reach an equilibrium.

(4) The feasible set expands and the relative price of the agricultural product increases at the exact rate, so that

$$\frac{P_1^*}{P_2^*} = \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \qquad (4.A15)$$

Then no factor movement would occur. This, of course, is a very unusual case.

(5) The feasible set expands and the relative price of agriculture declines, which results in

$$\frac{P_1^*}{P_2^*} < \frac{\partial f_2}{\partial X_2} \Big/ \frac{\partial f_1}{\partial X_1} \qquad (4.A16)$$

In this case, a large flow of factors from agriculture to industry would be required.

Case (2) is the situation directly related to the feasible choice set hypothesis discussed in the text.

Appendix 4B
Data and Estimation for the Values of Marginal Productivities

The simple translog production functional form adopted for agriculture and rural industry (TVP) is

$$\ln(Y_i) = \alpha_i + \sum_k \beta_{ik} \ln(X_{ik}) + \gamma_i T + \sum_{l=1}^{5} \delta_{il} D_l + \varepsilon_i \qquad (4.B1)$$

where Y_i (i=1: agriculture and i=2: TVP) represents the net revenues of agriculture and TVP, X_{ik} are the production factors (labour and capital for both sectors and arable land for agriculture), T is the time trend, and D_l (l=1, 2, 3, 4, 5) are regional dummies representing the North, Northeast, Southeast, Central and Southwest regions, respectively. A dummy for South region is omitted from the regression equation. The data used are a panel data set consisting of 28 provinces and 6 years from 1985 to 1990. The regression results are presented in Table 4.5 in the text.

The value of marginal product (MPL_i) of labour (L_i) can be represented as

$$MPL_i = P_i \frac{\partial Y_i}{\partial L_i} = P_i \frac{\partial \ln(Y_i)}{\partial \ln(L_i)} \frac{Y_i}{L_i} \qquad (4.B2)$$

which can be rewritten as

$$MPL_i = \beta_{iL} P_i \frac{Y_i}{L_i} \qquad (4.B3)$$

since $\frac{\partial \ln(Y_i)}{\partial \ln(L_i)} = \beta_{iL}$ according to Equation (4.B1). The ratios of marginal products between agriculture and rural industry are shown in Figure 4.5.

5

State-Farmer Policy Game and China's Grain Policy

Government intervention in agricultural markets is a common phenomenon (Schultz 1978; Anderson 1989). Rich countries tend to subsidize agricultural production more than industrial production effectively taxing food consumption, while poor countries tend to protect industrial producers and food consumers at the expense of farmers (Timmer 1988; Tyers and Anderson 1992). China had been a centrally-planned and developing economy since the early 1950s. Both a heavy industry-oriented development strategy and socialist ideology shaped policy towards agriculture (Lin 1991c). State grain prices have been substantially depressed in the post-reform period, as they were during the pre-reform period (Lardy 1983a and 1983b; Webb 1989; Tyers and Anderson 1992). The significance of these distortions for the performance of the agricultural sector and the economy as a whole has been analyzed in several studies (Sicular 1988b; Tyers and Anderson 1992).

In most studies of agricultural distortions, government intervention is taken for granted (Houck and Ryan 1972; Kehoe and Serra-Puche 1986; Sicular 1988b). Distortions are often explained by the distinction between private and social valuation of economic activities (Stenvens and Jabara 1988; Schultz 1978).[1] Yet another branch of literature has been developed on endogenous government behaviour (Downs 1957; Stigler 1970, 1971; Jessop 1977; O'Connor 1973; Peltzman 1976). Policy decisions result from the lobbying activities of different interest groups, politicians' optimization behaviour in

[1] As argued by Stenvens and Jabara (1988), divergence between private and social valuation may occur if market-determined prices do not reflect scarcity values, because the markets for products, inputs, or financial services do not function well (market failure); or market prices do not reflect scarcity values that are consistent with a society's or a government's development objectives and social goals.

maximizing political support, or a bargaining outcome between interest groups and bureaucrats (Rausser, Lichenberg and Lattimore 1982).

The mechanism of endogenous government behaviour in the case of agricultural policy in China has not been investigated in the literature. This chapter explores the question of why agricultural policies evolved as they did in China or what were the determinants of the policy scenarios. Important assumptions about the democratic process lie behind analysis in the literature of distortions in the agricultural economy. Either the political leaders are elected by voters or democratic bargaining channels between different interest groups are well established. These assumptions may not be satisfied in many developing and socialist countries, including China. Hence, a new formulation, that of the state-farmer framework, is developed as an appropriate framework within which to analyze Chinese grain policy formulation. This formulation focuses on the relationship between the government and farmers. A cooperative game-theoretic model can be applied and the empirical results of this exercise should contribute to an understanding of past and future policy changes.

The Evolution of Grain Policy in China

Grain policy was one of the most important agricultural policies in pre-reform China. There were three acknowledged objectives for grain policy. First, grain policy was instituted to facilitate industrialization. Lin (1991c) argues that many agricultural problems in both pre- and post-reform China had their roots in the development strategy adopted in the early 1950s. China at that time was largely an agricultural economy. According to Lin (1991b), in 1949, 89.4 per cent of the population resided in rural areas and industry accounted for only 12.6 per cent of national income. Heavy industry was seen as a key to economic modernization. Developing heavy industry, however, requires tremendous amounts of capital investment. The only source that could contribute to industrialization in its early stages was agriculture (Timmer 1988). The Chinese government, therefore, implemented low agricultural (including grain) prices to transfer

resources from agriculture to industry (Lin 1991b; Ji and Lu 1980).[2] Prices, in this set of policies, were expected to fulfil many of the functions that government tax and expenditure policy perform in most market economies (Lardy 1983a and 1983b). Prices in China in the pre-reform period were set largely with a view to determining the allocation of resources between individuals and the state, between industry and agriculture, and among different regions.[3]

The second purpose was for the government to preserve price stability. While stability is a common reason for governmental intervention, it is critical in China. The high priority attached to this objective in China reflected China's very unhappy experience with hyper-inflation in the late-1940s. Price stability had been an important component of the Communist Party's claim for popular support in the revolutionary period (Lardy 1983a; Chui 1988).

The third objective of grain policy was to secure grain self-sufficiency. A growing industrial sector and increasing population dramatically raised domestic demand for grain. This placed great pressure on domestic grain production since China's limited foreign exchange reserves could not be used for importing grain.

To achieve these objectives, a set of agricultural policies included three main policy measures: abolition of the free markets for most agricultural products and the introduction of a unified procurement and sale system; determination of a state price for every product usually lower than the corresponding free market or shadow price; and collectivization of agricultural production in the 1950s and implementation of the

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[2] There are two simple ways through which agricultural surpluses are channelled to the industrial sector. One is through high rates of agricultural taxes (such as were used in Japan in the early stages of modernization) and the other is through depressed agricultural prices. The difference between these two simple methods lies in the fact that high (lump-sum) taxes do not distort farmers' marginal revenue or significantly affect agricultural output, while low price policy does.

[3] According to one calculation, if farmers' contribution through low state prices is measured as a share of budget revenue, the share was 44.5 per cent in 1957, 54.4 per cent in 1965, 33.9 per cent in 1971 and 27.5 per cent in 1978. (These figures are calculated by the Department of Policy Research, the Ministry of Agriculture in China. Data was personally provided by Guo Shutian.)

commune system. All non-official factor flows across regions and industries were prohibited.

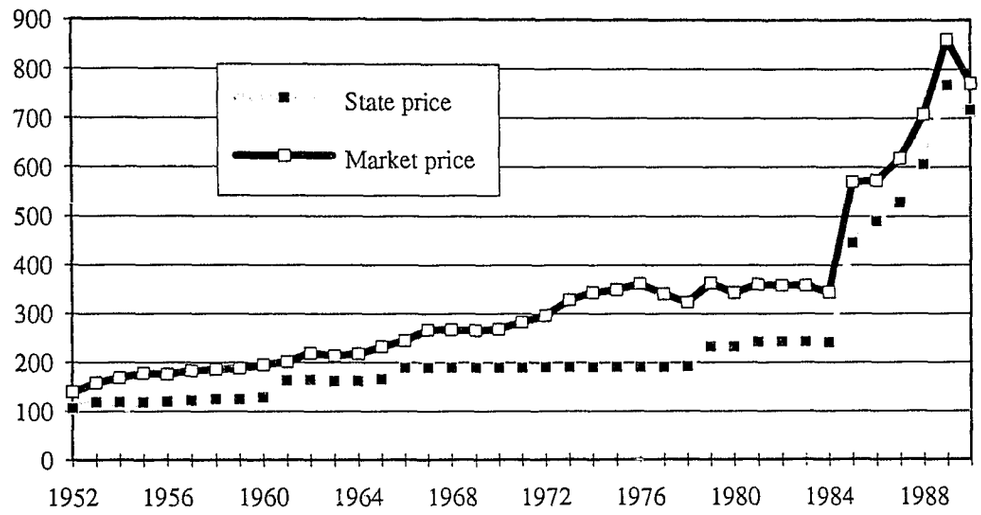
For the purchase and marketing of grain and other agricultural products, a three-category system was established according to each commodity's importance (Lardy 1983a; Sicular 1988b). The first category included grain, edible vegetable oils, oil crops and cotton, which were thought to be crucial to national welfare. The procurement quotas and prices for these products were set at the central level within the unified procurement and sale system, and non-official transactions of these products was strictly prohibited. Most of the other products, such as pigs, cattle, eggs, fish, tea, tobacco, sugar crops and medicinal herbs fell into the second category. The procurement quotas and prices were also determined by the state, but more independence and flexibility was granted to the local government. In some cases, produce above state quotas would be sold freely. The third category included other minor agricultural products not subject to state procurement plans. These could be exchanged on the market. According to Lardy (1983a), there were over a hundred products in category two and hundreds of distinct subsidiary and native products in category three.

The government, in each year, purchased grain from production teams according to procurement quotas and state prices, and then sold it to urban consumers according to a ration system. State purchase prices for grain were significantly lower than free market prices, even during the reform period (Figure 5.1). Grain production was discouraged because of the lack of price incentive. During 1952-78, grain production increased by 2.4 per cent per year, only 0.4 per cent above the population growth rate for the same period (Lin 1991c). As a result, the ratio of state purchases to total output dropped from 24-31 per cent in 1953-57 to 20 per cent in 1976-78 (*China Statistics Yearbook 1991*:589).[4]

[4] There was no non-state purchase of grain from farmers before 1978.

State grain prices were adjusted upward several times even before economic reform, but this did not prevent agriculture from becoming a bottleneck to economic development in the 1970s (Lin 1991c).[5]

Figure 5.1 State and market prices of grain in China, 1952-90 (yuan/ton)



Note: Rural retail prices are only proxies. Grains are measured by tradable units (*maoyi liang*) and all prices are mixed average prices.
Source: China State Statistics Bureau, *China Statistical Yearbook*, various issues; *China Price Statistical Yearbook*, various issues, China Statistics Press, Beijing.

An important characteristic of grain transactions in China involves the 'dual market system'. On the one hand, the state controls a certain amount of grain through compulsory procurement at state prices. On the other hand, a parallel free market exists for grains. This system was in operation for some years before economic reform. Price distortions to grain, therefore, can be decomposed into two parts: divergence between the state and the domestic market prices and between the domestic and international prices (Table 5.1).[6] Distortions due to procurement policies which more closely reflect

[5] Purchase prices for paddy rice were adjusted upward nine times during 1950-79; wheat prices were adjusted thirteen times, nine of which were upward and four, downward (*Chinese Agricultural Yearbook 1980*:379-380). Mao and Hare (1989) argued that distorted prices in China not only resulted in inefficient decisions, but also impeded the market mechanism, even when economic choices were made correctly.

[6] There are other measures of the incentive distortion to agriculture. Anderson and Tyers (1987) present ratios of domestic producer prices to border prices for a few grain commodities. For rice, the ratio rose from 0.49 in 1955-59 to 1.06 in 1970-74 and then dropped to 0.76 in 1975-79. The ratio was 0.92 in 1980-83. For wheat, the ratio rose from 0.72 in 1955-59 to 1.51 in 1980-83, and the ratio for

the changes in government policy making are the focus of this study. This type of distortion has been eliminated since reform started, particularly since 1985. In 1990, the gap between the average state purchase price and the free market price was very small (7 per cent). State procurement quotas have been decreasing steadily. But until 1992, the government had not significantly adjusted retail prices to urban consumers since the early 1950s. This created an increasing gap between state and market retail prices. This gap was balanced either by farmers (through low state purchase price) or by the government budget (through price subsidy).

Table 5.1 Grain price distortions due to policy intervention in China, 1971-90

Year	Ratio of the state price to the domestic market price	Ratio of the domestic market price to the international price
1971	0.67	1.00
1972	0.64	0.81
1973	0.58	0.46
1974	0.55	0.71
1974	0.54	0.91
1976	0.53	1.11
1977	0.56	0.75
1978	0.59	0.93
1979	0.64	0.94
1980	0.68	0.80
1981	0.67	0.89
1982	0.68	0.90
1983	0.68	0.81
1984	0.70	0.70
1985	0.78	1.03
1986	0.85	1.27
1987	0.85	0.74
1988	0.85	1.09
1989	0.89	1.18
1990	0.93	1.05

Note: Distortions in the table are measured by ratios of the price concerned to the reference prices. For instance, distortions due to procurement prices are the ratios of average state purchase prices to free market prices, and distortions due to border prices are the ratios of domestic market prices to international grain prices (given the official exchange rates).

Sources: Data are from State Statistics Bureau, *China Statistical Yearbook*, various issues, *China Price Statistics Yearbook*, various issues, Beijing: China Statistics Press. Australian Bureau of Agricultural and Resource Economics, *Commodity Statistics Bulletin 1992*, Canberra.

corn rose from 0.50 to 1.31 during the same period. Webb (1989) estimates producer subsidy equivalents (PSEs) for the period 1982-87. It was found that PSEs due to procurement policy for grain products declined dramatically during this period (from -19.93 per cent to -5.26 per cent for rice, from -21.63 to -2.35 for wheat, and from -24.54 to -4.59 for corn). PSEs due to border policy vary over time. While the PSEs for rice were quite stable (and remained at around -60 per cent), wheat producers switched from being net beneficiaries to net losers (Webb 1989).

It is important, both theoretically and practically, not only to know the policy impact, but also to investigate the mechanism determining changes in policy variables.

Explanations of Government Intervention in Agriculture

Government intervention in agriculture is often treated as an exogenous variable in economic studies (Houck and Ryan 1972; Sicular 1988b). A set of explanations for these interventions can be found in the current literature. The predominant argument lies in the distinction between private and social valuation of economic activities (Stenvens and Jabara 1988). Economic efficiency in agricultural production is, in many respects, inconsistent with welfare maximization (Schultz 1978). Divergence between private and social valuations may occur in various ways (Abel 1978).

This exogenous treatment of government policy is, however, inappropriate in the sense that it neglects interactions between the government and the private sector, particularly in the long run.[7] Interactions between government and private sectors exist even in the short run (Rausser, Lichenberg and Lattimore 1982). Endogenous government intervention in agriculture has been one persistent interest in economic studies in the past decades.

Paradigms of Endogenous Government Behaviour

A number of alternative paradigms which address the fundamentals of endogenous government behaviour have been developed by economists.

The first formulation is the liberal-pluralist framework which identifies the relationship between policy-makers and voters as central. Several classes of models have been developed within this group. Many of these models assume that individuals have a potential demand for redistribution of income towards themselves (Stigler 1970). The self-interest coalition models argue that politicians are motivated by votes and thus

[7] By treating intervention as given, the results obtained from these analyses represent only the conditional response of the private sector.

attempt to satisfy such demand in order to increase their probability of re-election (Downs 1957; Buchanan and Tullock 1962). The prediction made by this type of model is that, over the long run, society continually moves in the direction of greater equality of income distribution. The median model of self-interest, however, argues that, presuming that preferences for distribution towards oneself are single-peaked with respect to income, the median voter predominates and preferences for such redistribution are satisfied through the political process. This model predicts income redistribution from high-income and low-income families towards middle-income families (Stigler 1970). The Pareto-optimal income redistribution formulation transforms issues of distribution into a question of efficiency (Hochman and Rodgers 1969). One variant of this formulation specifies that donors of taxes derive utility from the income levels of transfer recipients. This framework predicts redistribution of income from high-income to low-income individuals.

The second paradigm is the theory of the state. It challenges the liberal-pluralist formulation by arguing that government institutions emerge because one dominant interest group has significant monopoly power (Jessop 1977; O'Connor 1973; Roemer 1978). This theory is based on groups of agents called classes rather than individual economic agents. The dominant class, usually the capitalist class, makes use of its monopoly power to direct or control the resources of the state. Over time, income becomes increasingly concentrated and as the observed income distribution becomes more unequal, the non-dominant classes, usually the working class, the unemployed and farmers, threaten to remove their support of the state and to delegitimatize the government. In the face of extreme social discontent, vocal opposition to the state and the threat of possible revolution, the government is presumed to respond by providing a range of social services and income supplements.

The third paradigm is the theory of economic regulation. Political leaders adopt policies with the aim of maximizing their chances of remaining in office (Stigler 1971; Peltzman 1976; Tyers and Anderson 1992). The regulator, therefore, desires to maximize the 'majority', defined as the number of potential voters in the beneficiary group times the

probability that a beneficiary will grant support less the number of potential voters in opposing groups times the probability those whose are 'taxed' will oppose. Interest groups that expect to gain from a potential policy change seek its adoption by investing in lobbying, while those opposed to the policy lobby against it. Both parties invest until the expected marginal return is zero (Tyers and Anderson 1992).

Anderson (1989) outlines three reasons why the government in a poor country is unlikely to raise the incomes of the farm majority by taxing the non-farm minority. First, the fiscal problems of collecting tax revenue from the non-farm minority to pay even a small subsidy to each farmer would be enormous given the high costs of tax collection and revenue dispersion. Second, the often better-educated, politically more articulate minority is located in urban areas and so is likely to be able to lobby the government at a much lower cost than could farmers. Third, the non-farm minority includes employers of unskilled labour, the wages for whom depend both directly and indirectly on food prices. These ideas have been developed and rationalized through application of computable general equilibrium models incorporating representative parameters to demonstrate the income distribution effects of different patterns of price distortions. The results show that, on a per capita basis, the losers lose little relative to benefits to gainers (Anderson 1989; Tyers and Anderson 1992).[8]

The fourth paradigm is known as the theory of rent-seeking interest groups and conflict resolution. This formulation explicitly incorporates both economic and political markets, and a process for resolving conflicting goals (Krueger 1974; Zusman 1976, 1977). Brock and Magee (1978, 1979) present a general equilibrium framework which assumes an economy consisting of individual agents, politicians, firms and goods which are produced and either consumed or used as inputs. In this framework, government intervention generates losses for some agents who would be willing to pay up to a certain amount to prevent the intervention, while the gainers would be willing to offer a certain amount in

[8] This idea was first demonstrated by Peltzman's result that losers must be taxed less than the interest of the winners would dictate (Peltzman 1976).

order to secure the intervention. Brock and Magee (1978, 1979) employed a non-cooperative game theoretic framework with politicians acting as Stackelberg leaders. Competing politicians attempt to maximize their probability of re-election. These probabilities are functions of campaign contributions from lobby groups and the politician's intervention position.[9]

Empirical Studies of Agricultural Policy

The setting of policy and its instruments can be divided into two stages: the first involves the legislative choice process and the second, the bureaucratic choice process. Although the concept of an interest group is extremely important in analyzing agricultural policy, few studies have empirically investigated the legislative choice process of government intervention in agriculture. Agricultural interests are too specialized to affect the election of all politicians and are probably insufficient to make most electoral frameworks coherent with respect to agricultural policy (Rausser, Lichenberg and Lattimore 1982).[10]

While the general objectives of agricultural policy might be determined by the legislative choice process (Brock and Magee 1978, 1979; Tyers and Anderson 1992), the bureaucratic choice process is more important in determining the particular policy instruments adopted and the ways in which they are implemented (Zusman 1976; Zusman and Amiad 1977; Beghin 1990; Beghin and Karp 1991).

A cooperative game theoretic framework is employed by Zusman (1977) and Zusman and Amiad (1977) in their studies of Israeli sugar and dairy policies, respectively, and by Beghin (1990) and Beghin and Karp (1991) in examining Senegalese agricultural price policy.

Zusman (1976) assumes an additive utility function for each interest group: the government; the Israeli labour federation (representing consumers); and sugar producers.

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[9] In Brock and Magee's analysis, tariffs are used throughout as the exemplary redistribution policy (Brock and Magee 1978, 1979).

[10] There are some exceptions, though, in the world such as the cases in Japan and France.

Each of these three groups are assumed to have a utility function which is separable in the benefits and costs imposed by the sugar subsidy and in the cost of exerting effort to influence the level of this subsidy. The concept of equilibrium employed in this game is Harsanyi's generalization of the Nash cooperative game solution to an *n*-person game (Harsanyi 1963). The solution concept implies that the entire cooperative game is broken down into two distinct components. The first is a non-cooperative subgame in which agents bargain to arrive at a division of the final payoff. The division arrived at is determined by the relative bargaining strengths of the agents and the coalitions they form. These, in turn, arise out of the pressure which can then potentially be brought to bear on competing agents and coalitions. In the second cooperative subgame, all agents jointly strive to maximize the size of the total payoff as this will maximize each agent's and/or coalition's share. At equilibrium, the payoff is divided according to the results of the first subgame.[11]

Beghin (1990) and Beghin and Karp (1991), in examining Senegalese agricultural price policy, also apply an *n*-person cooperative game framework by using a reference point solution (Thomson 1981). Reference points are pay-offs which players refer to when they evaluate pay-off proposals.[12] The Nash conflict point (*d*) and the point of minimum expectation (*mex*) are examples of reference pay-offs.

For a two-player game, u_d^* and u_{mex}^* are two corresponding solutions on the frontier (*H*) of the pay-off set (*P*). Any convex combination of these two reference points can be another reference point, the solution of which lies on the frontier between u_d^* and u_{mex}^*. Once the conflict point is known, the original Nash solution is unique, whereas many reference point solutions are possible. This approach avoids the imposition of unnecessary rigidity of the model. It is also assumed that the pay-off set and its frontier change with the economic environment. Hence players' pay-offs, their bargaining power

[11] For a summary of the approach employed by Zusman (1976) and other frameworks, see Rausser, Lichenberg and Lattimore (1982).

[12] The reference point, however, is not explicitly identified in the empirical work by Beghin (1990) and Beghin and Karp (1991).

and equilibrium strategies are influenced by exogenous shocks (for instance, changes in world prices and exchange rates) (Beghin 1990).

State-Farmer Framework For Grain Policy

The State Grain Market

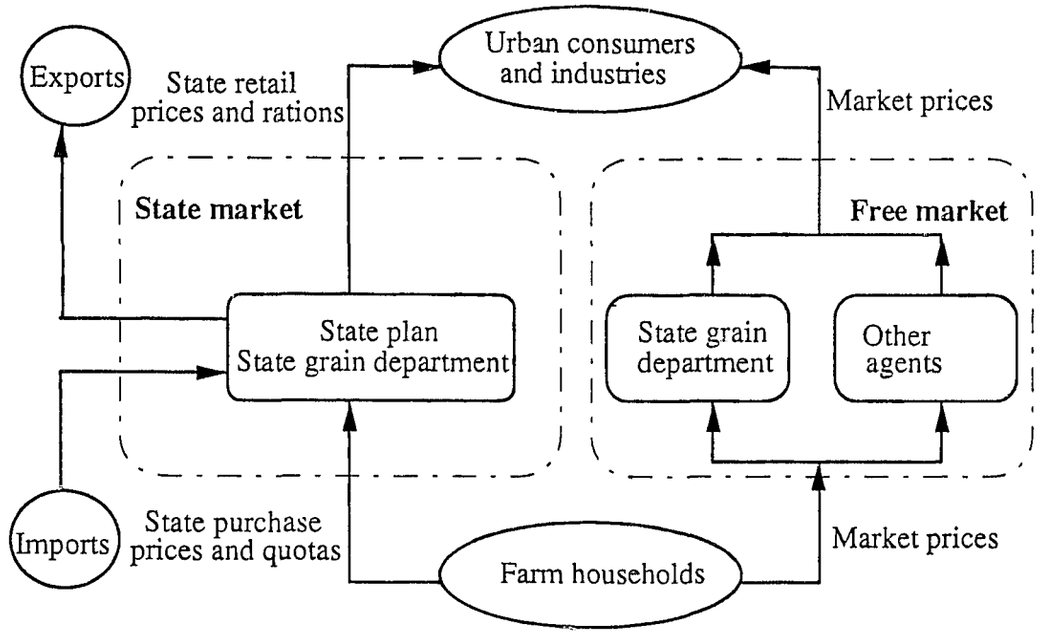
The paradigms reviewed above are inappropriate to analysis of grain policy issues in China for two reasons. First, mechanisms within which different parties bargain with each other on policy measures have not yet been well developed in China. Second, state retail policies for grain changed little over the past forty years. Policy measures on the consumption side are fixed, introducing difficulties for both theoretical and empirical analysis.

Grain transactions in China operate in a dual market system (Figure 5.2). This system existed before economic reform and was officially recognized at the beginning of 1985 as a part of the rural marketization scheme. Within the state plan, government agents — the State Grain Department — purchase grain from farmers according to state purchase prices and procurement quotas, and then sell grain to urban consumers and industries according to state retail prices and retail rationing. The state budget subsidizes the Grain Department if losses occur due to price differences, processing and transportation cost or inefficient management. A limited volume of exports (of rice and coarse grain) and imports (of wheat) is incorporated within the economic plan. On the free market, farmers may sell their surpluses at market prices to either the State Grain Department or other agents.

As a counterpart of the free market, grain transactions managed by the state are defined as the state market in this study. Sicular (1988b) argued that, in a dual market system, the policies implemented in the state market do not directly affect production and consumption decisions but do have an income effect. The significance of this income effect depends on levels of quotas and gaps between the state prices and market prices. Lin (1993), on the other hand, argues that state prices may directly affect production and

consumption decisions if the state procurement quotas are endogenously set (either as a function of the output level or as a function of the quota in the previous period).

Figure 5.2 The dual-market system for grain in China



Note: In the diagram, market exchange of grain between farmers is ignored for simplicity. Other agents refers to newly emerged non-state organizations doing business on grain. It also covers the case when farmers sell grain directly to urban consumers or industrial enterprises.

To analyze the reasons for grain policy changes in China a realistic framework is required. The state-farmer framework, developed in this study, focuses on the interactions between farmers and the government. Because the retail policies for grain were unchanged in the past decades (until 1992), we leave consumers out of this game framework. As the government has to finance the gap between purchase and retail prices, the higher the purchase price, the heavier the pressure on the state budget, given a retail price level. The government thus has an incentive to depress procurement prices or to minimize the total cost of grain purchases. This objective is, however, constrained by another policy goal — grain self-sufficiency. The farmers' objective, on the other hand, is to maximize total revenue from grain production or to minimize losses from state grain purchasing.

Demand, Supply and Government Monopsony on the State Market

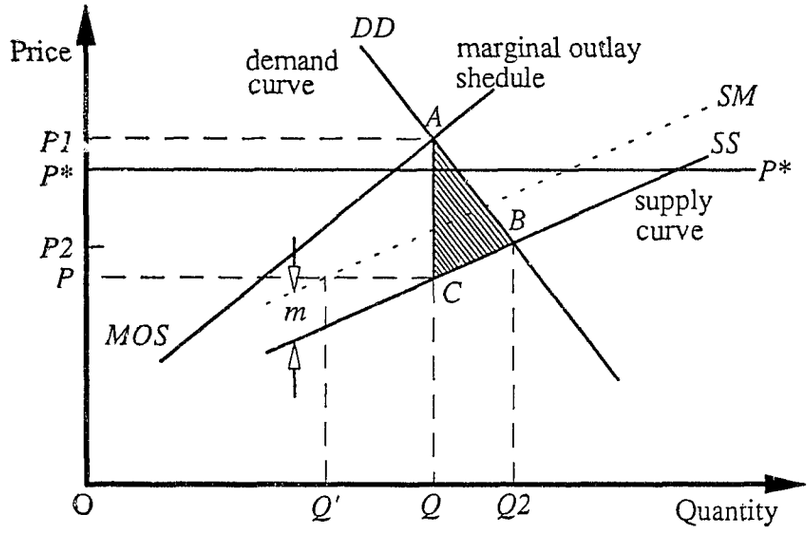
Grain transactions on the state market can also be characterized by demand and supply behaviour (Figure 5.3). The demand curve reflects the government's marginal valuation of grain purchases (*DD*). In the extreme case, if the constraint that the government faces in grain procurement is complete grain self-sufficiency, the demand curve is vertical. In other words, whatever the price, the government has to buy a fixed amount of grain which equals (a part of) the estimated domestic demand by urban consumers and industries.[13] In the case of China, however, the demand curve is downward sloping. Though estimated domestic demand is fixed, government's demand for grain in the state market is price elastic as China also trades in the international grain market. The Chinese government pursues 'basic self-sufficiency' which requires that a dominant part of domestic demand be met by domestic supply. However, it also has some limited flexibility to switch between domestic and international supply sources. When domestic supply is severely short or the domestic purchase price becomes too high because domestic demand becomes fully reliant on domestic sources, the government may substitute international trade for domestic procurement. The demand curve on the state market is therefore downward sloping but very steep (Figure 5.3).

The farmers' supply curve of grain is given by the segment of the marginal cost curve above its intersection with the average cost curve (*SM* in Figure 5.3). The supply curve for the state market, however, is slightly different from the definition for free market. The special characteristics of the buyer — in other words, the government — must be taken into account. There are two ways for the government to push down the farmers' grain supply curve in the state market. The first is to restrict the farmers' non-grain production opportunities (or to narrow the farmers' feasible choice set). By controlling all the farmers' production factors (labour, capital and land) in grain production, the government is able to depress factor prices. The marginal cost of grain production can

[13] How big a part of urban grain demand is satisfied by the government through the state system is another policy issue which is implicitly incorporated in the determination of the demand curve on the state market.

thus be lowered. This was one of the policies adopted by the Chinese government to enforce low prices for agricultural products.

Figure 5.3 Government monopsony in the state grain transaction



On the other hand, the government is able to impose penalties on farmers who fail or refuse to fulfil the state procurement quotas (at low state prices). It can close down the free markets for grain and other products (as it did many times) whenever there is difficulty in fulfilling the state purchase quota. The government can also create difficulties for 'troublesome' farmers with their children's education, purchase of agricultural inputs, access to other public goods and employment opportunities in township and village enterprises, and in other ways. Through levying these penalties, the government is able to sufficiently reduce all or some of farm households' income and welfare. From the farmers' point of view, these penalties can be converted into a monetary value, m, for each unit of grain supplied to the state.[14]

Facilitated by these potential penalties, the government is able to push down the farmers' grain supply curve in the state market. Suppose that the marginal cost to produce one unit of grain is c, a farmer will only be happy to supply this unit of grain if the market

[14] For instance, if the government restricts 'troublesome' farmers from employment by the township and village enterprises, the money measure of this penalty (m) is defined as the difference between the farmers' potential wage rates in the rural industry and their current income levels.

price P is as high as the marginal cost ($P = c$). Further assume that the government assigns this farmer a quota of one unit of grain, the farmer has two choices: either to sell the unit of grain to the state at a low state price ($\overline{P}_s$) or to sell it to the market instead at the market price (P_m, $P_m > \overline{P}_s$) but incur penalties of m. The two choices are equivalent if $P_m - m = \overline{P}_s$. In other words, farmers would be happy to supply grain to the state as long as the state price is at least as high as ($P_m - m$). The supply curve in the state market (SS) is therefore normally lower than its counterpart in free markets (SM).

Given supply (SS) and demand (DD) curves, equilibrium would occur at their intersection (B) in a competitive market, with price P_2 and quantity Q_2 (Figure 5.3).

In the state market, however, the State Grain Department is the only grain buyer as other agents are prohibited. The government therefore possesses monopsony power. The more the state buys the higher the price it has to pay. Curve MOS is the government's marginal outlay schedule (Carlton and Perloff 1990). The amount the government buys is determined by the supply curve and MOS. The new equilibrium is at $C(P,Q)$. Compared with the equilibrium point B, the introduction of monopsony power into the market reduces both equilibrium quantity and price. The area P_1PCA represents rent the government captures from its monopsony power and the shaded area ABC is the deadweight loss.

Dynamics of the State-Farmer Game

The essence of this game between the state and farmers relates to how the two parties share the gaps of grain prices (between market and state retail prices), as a low grain supply price to urban consumers and industries was a pre-set policy condition (Lin 1991c). The state-farmer formulation presented in this study is obviously a state-dominant framework. Nonetheless, the extent to which the government can distort the farmers' supply curve and how much rent it can extract depends on the relative strengths

of both parties in the game.[15] The relative strengths, in turn, are determined by the destructive powers both parties possess and the costs to each in implementing these powers. The government punishes farmers who refuse to deliver grain to the state by reducing their income and welfare. To impose these punishments, however, involves a cost. Farmers, for their part, are not purely passive in this framework. They can choose not to plant grain at all, thus they will not be greatly affected if the government closes down the grain market as long as they themselves can survive. This, however, is an extremely serious strategy for the government, particularly if farmers adopt it collectively.

In early stages of economic development under a repressive and vindictive central state system, farmers tend to be weak in the state-farmer policy game, particularly when infrastructure is poorly developed. As agriculture is the major industry of the economy and farmers are the dominant group of the population, farmers cannot be subsidized in any transactions with the government. Any small marginal benefit to farmers could entail a very significant loss to the other members of society and a severe burden on the state budget (Brock and Magee 1980).[16] The government therefore is willing to give up relatively large amounts of resources to implement its policies as the opportunity benefit tends to be large. Farmers, however, are unable to exercise any significant destructive strategy on the government collectively because of the distances of their residences and poor communication and transportation conditions. It is impossible to inform every farmer about new policy developments and lobbying. The destructive power of a few farmers refusing to deliver grain is very limited. Such a strategy could cause significant negative consequences for the farmers involved.

As the economy develops, however, these relationships would change. Economic development is sometimes characterized by diversification in the structure of economic

[15] The rent that the government extracts from grain purchases can also be negative; farmers are thus subsidized, as is the case in Western Europe and the United States.

[16] What usually happens is that the minority of the population is able to demand a policy favourable to it as the larger benefit to this minority only imposes a small loss on other groups in the economy.

activity and a fall in the population involved in agriculture (Timmer 1988; Tyers and Anderson 1992). Sources of government revenue are diversified and revenue from grain production becomes a very small part of total revenue collected. The government, therefore, has less interest than before in agricultural revenue, or in other words, it is only willing to incur a smaller cost to prevent the rise of state purchase prices or the fall of budget revenue from agriculture.[17] Even if the government contemplates punitive action, the significance of its destructive power has decreased dramatically and the costs of implementation have risen sharply. In a grain dominant rural economy, the government only had to close the free market for grain as one penalty, but it now has to close hundreds of free markets.

As the number of farmers falls and rural infrastructure (transportation and communication conditions) improves, it becomes easier and less costly for farmers to organize to lobby for a favoured policy. Their destructive power rises accordingly, particularly if the government is still stuck with a grain self-sufficiency constraint. The negative consequences of the government's potential penalties are reduced significantly. If farmers are unhappy with the state purchase policy, they can choose to quit grain production as many more non-grain and non-agricultural opportunities are available to them. If farmers are restricted from entering the township and village enterprises, they still have the choice of joining rural private firms or establishing one themselves.

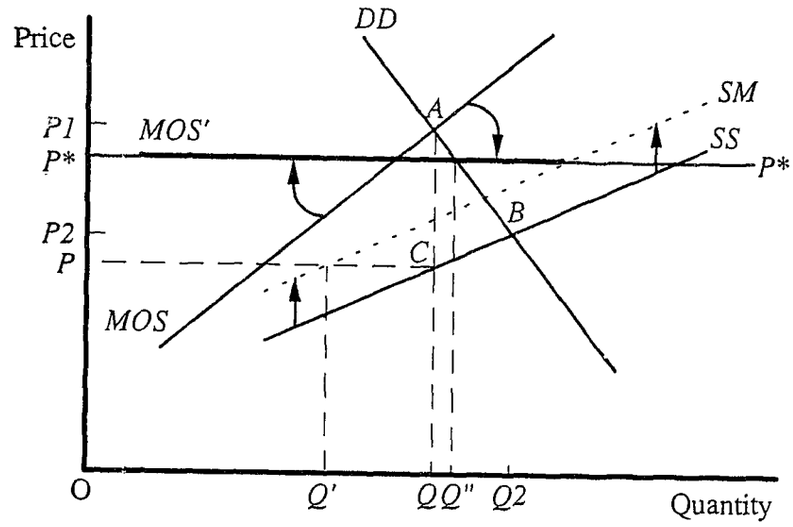
All these factors cause the relative bargaining strengths of players in the state-farmer game to change. Farmers may become relatively stronger and the state relatively weaker as economic development progresses. These have two types of consequences for the state grain market.

The first type of effect is that the potential penalty consequences (m) will decrease. Farmers thus tend not to accept even small gaps between the state price and the marginal cost of grain production (as $m \rightarrow 0$). This change results in an upward shift in the supply

[17] This does not necessarily mean that the cost the government is willing to incur is smaller than before in absolute terms. It is, however, always true to a relative measure.

curve in the state market and this continues during the process of economic development until state and free market supply curves coincide (farmers operate on their actual marginal cost schedule) (Figure 5.4).[18]

Figure 5.4 The state and free markets for grain



The second type of effect is that the government finds it increasingly difficult to exercise monopsony power in the procurement of grain. Lower state prices encounter stronger resistance from farmers who demand a market price for the grain they deliver to the state. Due to the loss of the monopsony power in the state market, the government gradually becomes a common buyer in the free grain market. As a competitive buyer, it can no longer affect the market equilibrium price. In Figure 5.4, this is captured by the clockwise rotation of the *MOS* curve to a horizontal position (*MOS'*, which is the same line as the market equilibrium price *P*P**). The government will now purchase an amount of *OQ"* grain and pay the market price *P**.

[18] In the extreme, the supply curve in the state market may move above the actual marginal cost schedule. This study will not consider this situation.

A Cooperative Game-Theoretic Model

Deriving the Model

As both parties in the state-farmer formulation have destructive powers over their counterparts' welfare or income and these relative powers change over time, state purchase policy for grain has to be adjusted frequently. This formulation can be well accommodated by a cooperative game-theoretic model. Actual policy can thus be thought of as an equilibrium outcome from a bargaining process between the government and farmers.

There are two players, the government and the representative farmer, and two policy instruments, state purchase price and procurement quotas. Both players bargain on the policy instrument setting to maximize their own utility. As discussed above, the government tries to minimize total expenditure on state grain purchases constrained by the 'basic self-sufficiency' condition. The farmer tries to maximize total revenue or minimize total losses from selling grains to the state.

From the possible solution concepts, the reference point solution is chosen for use in this study (Thomson 1981) following Beghin (1990), and Beghin and Karp (1991). Reference points are pay-offs players refer to when they evaluate pay-off proposals. The Nash conflict point, d, is an example of a reference pay-off, which is on the frontier (H) of the pay-off set (P). This approach avoids imposing unnecessary rigidity on the model. It is also assumed that the pay-off set and its frontier change with the economic environment. Hence players' pay-offs, their bargaining powers, and equilibrium strategies are influenced by exogenous shocks (Beghin 1990).

Thomason (1981) and Friedman (1986) present the four axioms underlying the game. These are analogous to the axioms underlying the Nash game (Nash 1953) but are defined with respect to a reference point rather than conflict point. The axiom of joint efficiency, or strong rationality, requires that the solution to the game, $U^* = (U_1^*, U_2^*, \ldots, U_n^*)$, lies on the upper boundary, H, of the pay-off space, P; U_i^* is

defined as the utility of player i in equilibrium. The axiom of linear invariance states that the solution to the game obtained by a positive affine transformation of players' utility functions is the positive affine transformation of the solution to the original game. The axiom of symmetry insures that indistinguishable players receive the same pay-off. The last axiom, the independence of irrelevant alternatives, says that excluding a point from P other than the solution or the reference point, does not alter the solution to the game.

If the reference point, $g(P,d)$, satisfies certain regularity conditions (Thomson 1981), the solution to the cooperative game maximizes the modified Nash product

$$\Pi_{i=G,F}(U_i - g(P,d)_i) \tag{5.1}$$

where $U = (U_G, U_F)$ is an element of the set $P(z)$; footnotes G and F represent the government and the farmer, respectively. If P is compact and convex, the solution, U^*, is on the frontier, H, and satisfies

$$a(z)_G(U_G^* - g(P,d)_G) = a(z)_F(U_F^* - g(P,d)_F) \tag{5.2}$$

where $a(z)_i = \partial H(U^*,z)/\partial U_i$. The functions $a(z)_i$ denote the bargaining-power coefficients of the players. They are usually normalized to sum to one.

If the pay-off set, P, is convex, maximizing the Nash product is equivalent to maximizing the weighted sum of utilities, W,

$$W = a(z)_G U_G + a(z)_F U_F \tag{5.3}$$

First-order conditions in the strategy space can be derived by maximizing either the welfare function (5.3) or the Nash product (5.1). Defining s_k as the kth strategy available to the players, then the necessary conditions for a solution are

$$\sum_{i=G,F} a(z)_i \frac{\partial U_i}{\partial s_k} = 0 \tag{5.4}$$

for all k (k=1, state price, and k=2, procurement quota).

In the grain policy game, both the government and the farmer seek to maximize their utility. The indirect utility function of the representative farmer is

$$U_F = U_F[\overline{q}, p_s, m_F[\overline{q}, p_s, z_F] - C_F] \tag{5.5}$$

where, $\overline{q}$ is the procurement quota and p_s is the state purchase price. The restricted income function, $m_F[\overline{q}, p_s, z_F]$, minus the cost of implementing conflict strategies, C_F, constitutes the net income of the farmer. At the cooperative solution, C_F is equal to zero since conflict strategies are not used (Beghin and Karp 1991). The cooperative strategy involves political support but no monetary reward is given to the policy-maker. The vector z_F, a subset of z, contains exogenous variables affecting income function. Similarly, the indirect utility function for the government is

$$U_G = U_G[\overline{q}, p_s, m_G[\overline{q}, p_s, z_G] - C_G] \tag{5.6}$$

Measuring the welfare effects of policy changes on the government and the farmer is the difficult part of empirical study. To avoid specifying the utility function explicitly, this study adopts shares of the gains or losses resulting from state grain purchases, in total revenue of the government and the farmer, as approximations to changes of their welfare. This measure, as an approximation, appropriately captures welfare change, and has the additional advantage of ease of use.[19] This gain or loss is calculated from the state and market prices. The underlying rationale is that the governr . would have to buy grain at the market price if there were no state market. The gap ..ween the market and state price is the gain that the government can extract from the policy game, which, on the other side of the coin, is the loss incurred by the farmer. The frontier, H, represents the welfare trades between the two players. A lower state price, for instance, increases the welfare of the government but leaves the farmer worse off.

[19] Income is sometimes used as the simplest measure of welfare (Tyers and Anderson 1992). The share of gains or losses more accurately reflects welfare change, since people with different income levels would of course value a certain amount of gain or loss quite differently.

Empirical Results

The necessary and sufficient conditions for a solution can be empirically estimated. As the pay-off functions and their derivatives are endogenous variables, and both are determined by the equilibrium outcome of the game, they are simultaneously estimated using an instrumental variable technique.

The bargaining coefficients are, in turn, determined by many exogenous variables, such as the share of agricultural population, share of agricultural output, economic growth and market prices. A linear functional form is adopted for the relationship between exogenous variables and the ratio of bargaining coefficients

$$\frac{a(z)_F}{a(z)_G} = a_0 + a_1 S_A + a_2 S_L + a_3 p_m + a_4 M \tag{5.7}$$

where S_A is the share of income from agriculture in farmers' total income, S_L is the proportion of the population reliant on agriculture, p_m is market price of grain and M, is income per capita. The bargaining coefficients are first normalized to sum to one.

$$a(z)_F + a(z)_G = 1 \tag{5.8}$$

Combining Equations (5.7) and (5.8), we have

$$a(z)_F = \frac{a_0 + a_1 S_A + a_2 S_L + a_3 p_m + a_4 M}{1 + a_0 + a_1 S_A + a_2 S_L + a_3 p_m + a_4 M} \tag{5.9}$$

$$a(z)_F = \frac{1}{1 + a_0 + a_1 S_A + a_2 S_L + a_3 p_m + a_4 M}$$

Equations (5.9) are substituted into Equations (5.2) and (5.4) to form the estimated system (Equations 5.10 and 5.11)

$$U_G = (a_0 + a_1 S_A + a_2 S_L + a_3 p_m \div a_4 M)(U_F + b_0) \tag{5.10}$$

$$\frac{dU_G}{ds_k} = -(a_0 + a_1 S_A + a_2 S_L + a_3 p_m + a_4 M)\frac{dU_F}{ds_k}, \quad s_k = p_s, \overline{q} \tag{5.11}$$

The intercept term $a_0 b_0$ includes the reference pay-offs which are not explicitly identified. We are primarily interested in the bargaining-power structure (the bargaining coefficients) which can be recovered without the reference point.

Equations (4.10) and (4.11) are empirically estimated for the case of grain policy in China. The data used are for the period 1971-90. Market prices for grain are derived from the price index for grain in the rural free market. The price levels are calculated by setting the market price in 1952 equal to the purchase price in the same year.

Estimation results derived using the iterative two-stage least squares method are presented in Table 5.2.

Table 5.2 A game-theoretic model of grain policy in China

Estimation of the game (iterative two-stage least square regression)

Parameter	Estimate	Standard error	Asymptotic *t* ratio
a_0 (constant)	0.6756	0.0683	9.89
$a_1(S_A)$	-0.0001	0.00003	3.42
$a_2(S_L)$	-0.4846	0.0910	-5.32
$a_3(M)$	0.00005	0.00002	2.68
$a_4(p_m)$	0.0016	0.00008	19.16
b_0	-0.0080	0.0079	-1.01

Predicted bargaining coefficients and their derivatives

Variable	Mean
$\partial a_f / \partial S_A$	-0.0002023
$\partial a_f / \partial S_L$	-0.2318226
$\partial a_f / \partial M$	0.0000220
$\partial a_f / \partial p_m$	0.0007668
$\partial a_c / \partial S_A$	0.0002023
$\partial a_c / \partial S_L$	0.2318226
$\partial a_c / \partial M$	-0.0000220
$\partial a_c / \partial H_m$	-0.0007668
a_f	0.3040321
a_c	0.6959679

There are some interesting findings. First, there is no strong evidence of a relationship between harvests and the farmers' bargaining power, although it is a common argument

that policy favours farmers relatively when grain is in short supply. From the time-series data analysis, there is no statistically significant relationship.

Second, the higher the farmers' bargaining power, the lower the share of income from agriculture in total income. This income share, on the other hand, portraits negatively changes in the feasible choice set of farmers. The larger the farmers' feasible choice set, the higher the part of income earned from non-agricultural productivity. The negative relationship here is consistent with the theoretical analysis. When the farmers' non-agricultural production opportunities expand, punitive measures by the government have less impact on them.

Third, the share of the agricultural population in total population has a significant but negative impact on farmer's bargaining power. This empirical result for China is consistent with the theory of economic size in the political market. When farmer numbers are smaller, it is easier for them to demand a favourable policy regime since the gain they obtain requires a much smaller loss to consumer. The variable of agriculture's share in national income is, however, not significant in the model, probably because this share increased markedly during the mid to late 1980s while its trend was declining in the longer term.

Fourth, per capita income has a significant positive influence on the farmers' bargaining power. This empirical finding is related to Engel's theorem. In the early stage of economic development, income level is low and a large part is spent on food. Consumers have strong concerns about changes to grain policy. Along with increases in per capita income, however, this share of expenditure on grain will decline. Thus the government becomes less concerned with grain policy.

Fifth, changes in market prices for grain had a positive effect on the farmer's bargaining power. When the market price is higher, the government tends to be willing to offer a higher price for grain.

Sixth, farmers were relatively weak in the period under study compared to consumers. The farmers' power coefficient is only 0.3 while that for consumers is 0.7. The big difference in the coefficients reflects the farmers' relative weakness in the process of bargaining for grain policy settings. This is further evidenced by the unfavourable grain policy faced by farmers throughout the 1970s and the 1980s. The farmer's bargaining power, however, was increasing over time. In particular, a big jump was detected at the beginning of the 1980s when the household responsibility system was introduced.

Findings and Implications

Incentive distortions in agriculture are one of the main policy issues in China. A state-farmer policy game framework is used here to investigate empirically grain policy changes in the Chinese economy. A cooperative game-theoretic model is formulated and estimated. The results suggest that the framework of cooperative game theory is applicable to the post-reform Chinese economy. Consistent with theoretical predictions, a large agricultural population plays a negative, while income level plays a positive, role in the farmers' bargaining power relative to that of the government. Chinese farmers are still relatively weak in grain policy bargaining. Their power, however, has increased throughout the period under study. It is expected that the farmers' bargaining power will further increase as income rises and the share of agricultural population declines.

6

Estimating Supply Elasticities of the Farming Sector

Qualitative analysis of price distortion provides indication of the likely direction of its impact on economic structure and the efficiency with which resources are allocated. This study seeks to supply quantitative estimates of its effects as well as the effects of the limited feasible choice set of farmers. A starting point is the estimation of elasticities of farmers' production decisions with respect to prices and the establishment of an appropriate analytical framework.

There are two essential steps in providing elasticity estimates. First, it is necessary to decide whether or not to apply the usual profit maximization framework to Chinese farmers. This step is closely related to the choice of assumptions and functional forms for modelling. Second, it has to be decided whether or not data from Chinese statistical sources are appropriate for the estimation process.

Quantifying Farmers' Supply Behaviour in China

Choice of specific functional form is usually based on different sets of assumptions and can lead to different elasticity estimates (Alston et al 1990; Huang and Lu 1992). The traditional approach to production behaviour was pioneered by Cobb and Douglas (1928) using the assumption that the production function is additive and homogeneous. The disadvantage of the Cobb-Douglas production function is that restrictions on patterns of substitution among inputs must be imposed (Arrow et al. 1961). This frustrates the objective of determining patterns empirically in econometric models. The constant elasticity of substitution (CES) production function, introduced by Arrow et al. (1961) improves the unity elasticity of substitution and treats the elasticity as an unknown parameter. However, it retains the assumption of additivity and homogeneity

and imposes a stringent restriction on patterns of substitution (McFadden 1963; Uzawa 1962).

Most models of supply response in agriculture focus on aggregate (across commodities) supply or own-price response for a single commodity (Ball 1988). Models that do recognize multiple outputs typically specify *a priori* restrictions on the structure of production (Vincent, Dixon and Powell 1980). The advantage of the recently developed flexible functional forms in empirical studies is that they require no prior restrictions on the parameters. Some elasticities, unlike those estimated by the Cobb-Douglas or CES functions, can vary from observation to observation. There are several flexible forms of profit or cost developed for analysis of multiple products and multiple inputs production issues, such as translog, quadratic and generalized McFadden functions (McKay, Lawrence and Valstuin 1982; Weaver 1983).

The generalized McFadden profit function is applied in this study. The existence of extensive government intervention in agriculture, however, raises questions about the applicability of this methodology to the Chinese economy. This study also attempts to find a way of applying the usual approach to the Chinese agricultural sector, through appropriate data adjustments.

The application first involves data adjustment to eliminate information on activity which did not result from profit maximization behaviour. Having established the quantities of resources and outputs that are determined by the farmers' objective of profit maximization and prices at the margin, an estimation is carried out by applying a restricted profit function to examine production interactions in the Chinese farming sector.

Is the Profit Maximization Framework Applicable to China?

There is a debate among economists on the appropriateness of applying the standard profit function approach to agriculture in developing economies (Junankar 1989, Sevilla-Siero 1991). The necessary condition for the application of the profit maximization

framework is that farmers make their production decisions in accordance with marginal prices. The debate has focused on aspects of the developing economies where some assumptions of profit function approach might be violated. Since various problems afflict this approach including the existence of non-competitive market structures, zero-valued observations, exclusion of relevant variables, lack of participation in output and/or input markets, and endogeneity of input and/output prices (Sevilla-Siero 1991). Junankar (1989) concludes that this analytical approach should be abandoned in favour of an alternative paradigm reflecting market imperfections typical of developing economies and including the role of social and institutional factors as well as concepts of class, power and interlinkages between all of these factors. In a comment on Junankar's criticism, Sevilla-Siero (1991) argues that the impact of these problems on estimation results can be minimised through modifications and adaptations of the standard approach, better specification of the underlying technology, and the use of selected functional forms.

This debate has particular implications for the study of Chinese agriculture because most of the problems discussed by Junankar apply to the Chinese economy. Extra caution is needed in applying an economic approach involving stringent assumptions to explore price responsiveness of Chinese farmers.

What requires further attention for estimation in this study is the fact that China has experienced more than thirty years of central planning, but it has been semi-marketized during the decade of reform. Farmers' economic decision-making is still more or less conditioned by government policy. This peculiarity implies difficulties for any direct application of the dual approach to the Chinese economy.

On a wide range of products, the Chinese government still intervenes in production through quantity and price restrictions. In the case of grain, a two-tier price system applies. Farmers have to fulfil state purchase quotas at state determined prices and only output surplus to this quota can be sold on the free market. The purchase of cotton is monopolized by state agents. Farmers have no alternative in selling their cotton output other than to accept the state price.

Farmers' decision-making in China is influenced by a combination of government policy and market conditions. The former includes a series of requirements and regulations set out in the economic plan,[1] and the other is the normal incentive structure (relative prices at the margin). Farmers have to fulfil policy requirements regardless of the consequences.[2] Having done so, they then try to utilize all remaining resources and market information to maximize their profits. The assumption proposed by this study is that, in a semi-marketized economy like China, the farmers' production activities are guided by a dual system. On one hand, farmers have to fulfil the quantity and price requirements set by the government. On the other hand, they, like any other farmers in the world, respond to changes in marginal prices. Any inefficiencies should be attributed to inappropriate policy intervention rather than to irrationality on the part of the farmers. In this study, an attempt has been made to separate data arising from highly distorted activity from the data set used and to model farmers' decision-making behaviour by applying the dual approach.

Since the program of economic reform was introduced at the end of the 1970s the farm household has become an independent unit managing production and consumption activities. The reform policies implemented have created both necessary and sufficient conditions for the farmers' successful pursuit of maximum profit from production. In some studies of Chinese agriculture, an implicit assumption is that farmers are rational profit maximizers (McMillan et al. 1989; Lin 1992a).

Schultz has hypothesized that farmers in developing economies are no less rational than their counterparts in industrial economies in terms of seeking maximum profit (Schultz 1964). This Schultz hypothesis has been criticized because inefficiencies are often

[1] Economic plans take various forms in China. In the medium term, the government has a Five-Year Plan. Plan indicators related to farm households are made more explicit in the annual plan. Economic plans can also be divided into two types, one set by the central government (such as for grain and cotton) and the other set by various local government (for instance the purchase plan of tobacco announced by some provincial governments each year).

[2] Since the government-set quota and state price are compulsory for farmers, farmers have to fulfil the requirements even if the policy causes them losses. In actual fact, there are some cases in which farmers refuse to fulfil low-price purchase quotas.

detected in the agricultural sector in developing economies (Ellis 1988). Many causes were listed to support the irrational behaviour hypothesis, such as the characteristics of small-scale production and the lack of certain markets. For instance, it may be argued that for an autarkic farm household, production may focus primarily on self-sufficiency instead of profit. This argument hardly applies to Chinese farmers, however, since markets are fairly well developed quite well and farmers are heavily involved in market exchange.[3] In addition, the validity of the rationality assumption depends solely on the behavioural mechanism. Farmers in China react to exogenous changes in exactly the same way as farmers would from other countries if they were placed in the same situation (Zhou 1992).

Methodology

In a multiple product and multiple input framework, the technology is assumed to relate N variable inputs and outputs and R fixed inputs. Denote the vector of variable commodities by:

$$Y = (Y_1 \ldots\ldots Y_n)' \begin{cases} Y_i > 0 & i = 1 \ldots\ldots l \ \ output \\ Y_i < 0 & i = l+1 \ldots n \ \ input \end{cases} \tag{6.1}$$

and the vector of fixed inputs by $-X \equiv (-X_1 \ldots\ldots -X_r) < 0_r$,[4] and let $P \equiv (P_1 \ldots\ldots P_n) >> 0_n$ denote a vector of exogenous prices. Then a restricted profit function can be defined as

$$\pi(P;X) = \underset{Y}{Max}\{P'Y : (Y;-X) \in T\} \tag{6.2}$$

where T is a non-empty, compact and convex set representing all feasible input and output combinations. $\pi(P;X)$ is homogenous of degree one in variable input and output prices and in fixed input quantities, convex in prices and concave in quantities (Diewert 1973). According to Hotelling's lemma,

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[3] For instance, about 36.6 per cent of grain output, 72.4 per cent of edible oil and 90.7 per cent of cotton output was sold to the government or on the free markets in 1990 (*China Statistics Yearbook 1991*:589). Farmers also buy large amounts of consumption goods from markets.

[4] This notation means that each component of the R-dimensional vector X is non negative.

$$\partial\pi(P;X)/\partial P_i = Y_i(P;X) \quad i = 1.....n \tag{6.3}$$

where $Y_i(P;X)$ is the profit-maximising level of output supply (input demand) if i is an output (variable input).

A number of flexible functional forms have been proposed, all locally approximate to an arbitrary function. One popular form is the transcendental logarithmic normalized variable ('restricted') profit (or cost) function (Christensen, Jorgenson and Lau 1973) which has the form:

$$\begin{aligned}\ln(\pi) = a_0 &+ \sum_{i=1}^{n-1} b_i \ln(P_i^*) + \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1} c_{ij} \ln(P_i^*)\ln(P_j^*) + \frac{1}{2}\sum_{i=1}^{n-1}\sum_{k=1}^{r} d_{ik} \ln(P_i^*)\ln(Z_k) \\ &+ \frac{1}{2}\sum_{k=1}^{r}\sum_{m=1}^{r} e_{ik} \ln(Z_k)\ln(Z_m) + \sum_{s=1}^{r} f_{st} \ln(Z_{st}) \\ &+ terms\ with\ dummies\end{aligned} \tag{6.4}$$

where $P_i^* \equiv P_i/P_n$ is the normalized commodity price and Z_i fixed input in production. Appiying the Hotelling-Sheperd Lemma gives:

$$S_i = b_i + \sum_{j=1}^{n-1} c_{ij} \ln(P_j^*) + \sum_{k=1}^{r} d_{ik} \ln(Z_k) + terms\ with\ dummies \tag{6.5}$$

where S_i is the profit (or revenue) share of output i (positive) or cost share of input i (negative). The translog functional forms are widely applied in the study of producer behaviour (McKay et al. 1982; Haughton 1986; Ball 1988).

To derive these elasticities for Chinese agriculture, the flexible functional form applied in this study is the generalized McFadden profit function (Diewert and Wales 1987; Lawrence and Zeitsch 1989; Albacea and Warr 1991). The McFadden unit profit function has the form:[5]

[5] This unit profit refers to profit per unit of land.

$$R(P,N)/N = \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1} b_{ij}(p_i/p_n)(p_j/p_n) + \sum_{i=1}^{n-1} b_i(p_i/p_n) + \sum_{i=1}^{n-1} b_{it}(p_i/p_n)t + \sum_{i=1}^{n-1} b_{it2}(p_i/p_n)t^2 \qquad (6.6)$$

where $R(P,N)$ is profit as a function of prices (P) and fixed land input (N), and $p_1,\ldots p_n$ are prices of outputs and inputs faced by the producer. Relative prices are adopted for the purpose of homogeneity of the unit profit function. Time, t, is usually included as a proxy for technological progress (Albacea and Warr 1991) or productivity (Lawrence and Zeitch 1989). Since the data used in this study are provincial panel data covering only five years (1986-90), the terms containing the variable t are not included in the model.

Because input prices are not available, a unit revenue function similar to (6.6) is constructed as follows

$$R(P,F,N)/N = \frac{1}{2}\sum_{i=1}^{n-1}\sum_{j=1}^{n-1} b_{ij}(p_i/p_n)(p_j/p_n) + \sum_{i=1}^{n-1} b_i(p_i/p_n) + \frac{1}{2}\sum_{i=1}^{n-1}\sum_{v=1}^{r} b_{iv}(p_i/p_n)Z_v + \sum_{v=1}^{r} b_v Z_v \qquad (6.6')$$

where F represents the set of inputs (that is, $Z_v \in F$ which includes labour, capital and fertilizer).

By differentiating this revenue function with respect of the relative prices, we obtain a set of supply equations:[6]

$$X_i/N = b_i + \sum_{j=1}^{n-1} b_{ij}(p_j/p_n) + \sum_{v=1}^{r} b_{iv}Z_{iv} \qquad (6.7)$$

In these equations, the X_i' s are positive and represent quantities of outputs supplied.

[6] Inputs are included in quantity form in the function; price responses of demand for inputs are not of concern in this study.

Chinese agricultural data consists of time-series and cross-section data for five years and twenty-eight provinces. The approach used in dealing with regional variation follows that developed by Fuss (1977) and applied by Lawrence and Zeitsch (1989) and Albacea and Warr (1991). The provinces are grouped into six regions according to the differences in agricultural factor endowments and and economic structure: Northeast, North, Northwest, South, Southwest and Southeast regions. Provinces classified into one region share a common intercept in the model.[7]

Estimates of this multiple product model implicitly assume that the production of these products is weakly separable from the rest of the economy. Production decisions about these products are only influenced by relative prices, not by absolute level of prices. The system equations (6.7) that can be estimated become

$$X_i/N = \sum_{k=1}^{m} c_{ik} D_k + \sum_{j=1}^{n-1} c_{ij} P_j^* + \sum_{v=1}^{r} c_{iv} Z_{iv} \qquad (6.8)$$

$$X_n/N = \sum_{k=1}^{m} c_{ik} D_k + \frac{1}{2} \sum_{i=1}^{n-1} \sum_{j=1}^{n-1} c_{ij} (P_j^*/P_n) + \sum_{v=1}^{r} c_{iv} Z_{iv} \qquad (6.9)$$

(for $i, j < n$)

where $P_j^* = P_j / P_n$ is the relative price and D_k are the regional dummies, k = *NE* (Notheast), *NO* (North), *NW* (Northwest), *SO* (South), *SW* (Southwest) and *SE* (Southeast).

Like other flexible function forms in the dual approach, this profit function (6.6) and the derived output supply functions ((6.8) and (6.9)) provide a second order approximation in prices to an arbitrary function. In estimation, however, this is not regarded as an approximation to an unknown function. Rather, it is assumed to be a true data generating

[7] The Northeast region comprises Liaoning, Jilin and Heilongjiang provinces. The North region covers the provinces of Beijing, Tianjing, Hebei, Shandong, Henan, Shanxi and Shaanxi. The Northwest region includes the provinces/regions Xinjiang, Qinghai, Gansu, Ningxia and Inner Mongolia. The South region comprises Fujian, Guangdong and Guangxi provinces. The Southwest region is comprised of Yunnan, Guizhou and Sichuan provinces, and the Southeast region comprises Hunan, Hubei, Jiangxi, Shanghai, Zhejiang, Jiangsu and Anhui.

function. To keep the model consistent with the flexible profit function (6.6), the following symmetry restrictions have to be satisfied in estimating the system equations:

$$c_{ij} = c_{ji} \tag{6.10}$$

One troublesome property of the profit function is the requirement of convexity, as this is often not satisfied in empirical studies. The profit function is globally convex in prices only if the matrix of estimated quadratic terms $C = [c_{ij}]$ (estimated from equation (6.8)) is positive semi-definite. Applying the Wiley, Schmidt and Bramble (1973) technique of re-parameterization yields a generalized McFadden profit function which is globally convex in prices without loss of the function's characteristic flexibility. The technique involves the replacement of C by the product of a lower triangular matrix and its transposition

$$C = AA^T \quad A = [a_{ij}];\ i = j = 1,\ldots.n;\ a_{ij} = c_{ij} \ \textit{for}\ i \geq j;\ a_{ij} = 0 \ \textit{for}\ i < j. \tag{6.11}$$

The elasticities of output supply can be derived from equations (6.8) and (6.9) using the following formula (Albacea and Warr 1991):

$$E_{ij} = {\partial \ln x_i}\Big/{\partial \ln p_j} = (DP_{ij})\,{p_j}\Big/{x_i} \ \textit{for all}\ i, j \tag{6.12}$$

where DP_{ij} is the second-order price derivative of the variable profit function and x_i is the estimated unit quantity $(\overline{X}_i / N)$ obtained from the system of equations (6.8) and (6.9). In the case of the generalized profit function applied in this study, the second-order price derivatives are given by (based on equations (6.8) and (6.9))

$$DP_{ij} = c_{ij} / p_n \quad \textit{for}\ \ i, j = 1, 2, \ldots. n-1; \tag{6.13}$$

$$DP_{in} = -\sum_{j=1}^{n} c_{ij}\,{p_j}\Big/{p_n^2} = DP_{ni} \quad \textit{for}\ \ i, j = 1, 2, \ldots. n; \tag{6.14}$$

$$DP_{nn} = \sum_{i=1}^{n-1}\sum_{j=1}^{n-1} c_{ij}\,{p_i p_j}\Big/{p_n^3} \quad i, j < n \tag{6.15}$$

The elasticities are then derived at the mean of the exogenous variables.

Data Adjustment

A cross-section and time-series data set at the provincial level is chosen for this study, as price information for agricultural outputs is available from 1986 to 1990 at this level. The selected period, 1986-90, also has the advantage that there were fewer structural changes to the market mechanism after a dramatic reform in 1985. Of the total of thirty provinces in China, Tibet is excluded because of its extraordinary natural and economic structure and Hainan is included in Guangdong province because it was not established as an independent province until 1988.

The study considers only the farming sub-sector of agriculture. The other sub-sectors are excluded by assuming weak separability, which implies that the farmers' decisions on farm production are independent of decisions on other production activities. Within the multiple input and multiple output framework, five outputs and three variable inputs are considered. As the interactions of grain and fibre with other farming production are of concern in this study, outputs are classified as rice, wheat, other grain, cotton and other crops. Variable inputs include labour (number of labourers), capital (including both machinery and draft animals) and material inputs (represented by fertilizer utilization). Land (arable land plus pasture) is treated as a fixed factor of production.

As discussed above, government policy places constraints on farmers' decision-making. Farmers have to fulfil these quotas before they can take any profit-seeking action. When a quota and unique price are set by the state, there are three possibilities for farmers' actual production. At the quota point of production, if the marginal revenue of production exceeds the marginal cost, farmers may choose to produce more to the point where marginal net revenue is zero. If, at the quota point, marginal revenue equals marginal cost, farmers may voluntarily fix their output at the quota level. These two cases are consistent with the market case (the only factor that matters is the marginal price) and can be captured by the dual approach. However, if marginal revenue is less than marginal cost at the quota point, farmers still have to produce the quota, even if this

level of production involves losses. In this third case, the marginal condition of output determination is violated.

Two data adjustments are applied in this study in order to make it possible to use the generalized McFadden unit profit function. One adjustment is made to price data and the other to quantity data. Application of the generalized McFadden profit function requires data on the prices and quantities of rice, wheat, other grain, cotton, other crops, labour, capital, land and fertilizers. The two most severe problems encountered in collecting Chinese data are the lack of price data for inputs and commodity-specific input data. To avoid these problems, the generalized McFadden unit profit function is transformed into a generalized McFadden unit revenue function. Thus, the factors are treated as fixed quantities, avoiding reliance on the availability of the price data for results.[8] Land area is treated as a fixed production factor. The existing data in various statistical sources, however, are not directly suitable for estimation purposes. The crucial requirement of quantity and price data is that prices should be marginal and that quantities should be the result of profit-maximizing (or cost-minimizing) behaviour.

Price data for cotton are provided by the State Statistics Bureau of China (SSB). These data are a mixed average of purchase prices. During the period under study, cotton purchases were monopolized by state agents and only about 5 per cent of cotton was not purchased by the government. State purchase prices of cotton were therefore the marginal prices for farmers' production decisions.

Prices for other crops and other grain are price indices derived from the prices of a large variety of products within these aggregate groups. These indices were calculated from price and quantity data collected from the SSB publications.[9] Some of the price and

[8] Of course, this method also slightly alters the assumption of production. Farmers in reality certainly respond to the changes in input prices. Other than the lack of data, there are two reasons why this method is accepted. One is that fixed factor inputs are not an unrealistic assumption in terms of short-run decision-making. The other reason is that the estimated shadow prices for these inputs did not generate convincing estimates.

[9] Sources used include various issues of *China Statistics Yearbook*, *China Price Statistics Yearbook* and *China Agricultural Yearbook*.

quantity data had to be adjusted. Adjustments to grain price and cotton output are presented below as examples of the method used to adjust the data.

The marketing of grain in rural China involves a two-tier price system. Farmers have to sell a certain amount of grain (quota) to the government at the state determined price. After the fulfilment of the state purchase quota, grain is exchanged in the free market. Usually the market prices are the marginal prices which guide production decisions. The prices (P_a) presented in the price statistical yearbooks (SSB), however, are only mixed averages (of both state (P_s) and market (P_m) prices):

$$P_a = q * P_s + (1-q) * P_m \tag{6.16}$$

where q is the share of quota purchase in total outputs. There is no information about P_s and P_m at provincial levels. Fortunately, the SSB provides ratios (b) of market prices for grain over the state price:

$$b = P_m / P_s \tag{6.17}$$

For instance, national b was 1.915 in 1987. Combining equations (6.11) and (6.12) and given the information on P_a and q, the marginal price of grain in individual provinces and in different years (P_m) can be easily derived.

As cotton transactions were strictly controlled by the government throughout the period under study, forced production, when the marginal cost of production is larger than marginal revenue, is likely. Nevertheless, it is extremely difficult to identify this output from the existing data. Two approaches were adopted to identify forced production. First, historical changes in cotton output, particularly those in recent years, were analyzed. It is most likely that a province has no comparative advantage in producing cotton if the output and purchase quota decrease continuously. Second, output and state purchase data are compared. If production is consistently close to the state purchase quota, or even lower than the quota in some years, production is likely to be forced. When both situations are detected for a province, cotton production in that province is regarded as forced. In this data set, forced production was detected in two provinces,

Shanghai and Hubei. If forced production is detected, the output quantity of this product is set to zero and the resources used for forced production are deducted from the existing data (according to the cost survey information provided in the agricultural yearbook (SSB)). The point which should be kept in mind is that the forced production refers to the province as a whole. It does not necessarily imply that the production of all households in the provinces is forced.

Model Estimates and Comparison with Others

The model system (6.8)-(6.9) is first estimated by ordinary least square (OLS) regression without any restrictions and constraints. The symmetry restriction is then applied by the regression method (SUR), by using the SHAZAM on the UNIX mainframe. All the prices in the system are deflated by cotton prices. As noted above, the curvature of the profit or cost function is usually a problem in empirical studies. Very few studies have found the curvature conditions to be satisfied. In this instance, we adopt the Wiley, Schmidt and Bramble (1973) technique of reparameterization for the restriction of convexity (Table 6.1).

Using equations (6.9) and (6.10), the supply elasticities were derived at the means of the exogenous variables (Table 6.2). Production interactions of China's farming sector are revealed by these elasticities. Rice production has limited responses to price change, probably because technology and land used for producing rice are relatively product specific. The irrigated rice land cannot be easily shifted to wheat or other crop production in the short term. Very small effects can be expected to increase rice output by raising its price (own-price elasticity being 0.2 — Table 6.2).

Production interactions between wheat, other grain and other crops tend to be significant. Own-price elasticities of wheat and other grain are higher than unity (1.1 and 1.5 respectively — Table 6.2), while that of other crops is 0.9. Rises in prices for rice or other grain may also reduce wheat output dramatically (cross-price elasticities being -1.1 and -1.2, respectively, Table 6.2). Output of other grains adjusts sharply in the opposite

direction as changes in prices of wheat (elasticity being -1.2) and other crops (elasticity being -0.9), and in the same direction as changes in prices of rice (elasticity being 1.2).

Table 6.1 The estimated generalized McFadden unit revenue function with symmetry and convexity restrictions

Regressors	Regression equations			
	Rice	Wheat	Other grain	Other crops
Rice price	1.6672	-1.0624	1.3191	-1.5227
	(1.45)	(6.62)	(11.60)	(9.55)
Wheat price	-1.0624	0.6835	-0.8476	0.9896
	(1.37)	(0.52)	(1.01)	(2.03)
Other grain price	1.3191	-0.8476	1.1788	-1.2439
	(1.80)	(0.75)	(3.19)	(0.43)
Other crops price	-1.5227	0.9896	-1.2439	1.6525
	(3.10)	(3.17)	(0.91)	(3.28)
Fertiliser	0.8245	0.2140	0.2182	0.0827
	(2.10)	(2.63)	(3.62)	(0.66)
Labour	1.7852	-0.1240	0.0857	0.1961
	(7.15)	(2.47)	(2.38)	(2.52)
Capital	1.5445	-0.0387	-0.0301	1.84
	(2.37)	(0.30)	(0.31)	(9.10)
Northeast	-0.6776	0.4718	0.3552	0.2015
	(0.84)	(2.73)	(3.04)	(0.98)
North	-3.6316	1.3788	0.0128	-0.1640
	(4.18)	(7.83)	(0.10)	(0.73)
Northwest	-1.9538	1.0204	-0.1712	0.22
	(2.72)	(6.99)	(1.62)	(1.25)
South	1.8546	0.4956	-0.4862	0.5895
	(1.53)	(1.95)	(2.66)	(1.80)
Southwest	-2.5479	0.8537	0.0671	0.1818
	(2.48)	(4.13)	(0.43)	(0.64)
Southeast	3.1020	0.7553	-0.3872	-0.1459
	(2.98)	(3.54)	(2.42)	(0.51)
Adjusted R^2	0.92	0.61	0.53	0.69

Note: The numbers beneath the coefficient estimates are the related t-ratios (the signs are omitted for simplicity).

Table 6.2 Supply elasticities in the Chinese farming sector

	With respect to the price of				
	Rice	Wheat	Other grain	Other grop	Cotton
Rice	0.1963	-0.1885	0.2138	-0.1366	-0.0850
Wheat	-1.0861	1.0528	-1.1928	0.7709	0.4551
Other Grain	1.2302	-1.1910	1.5134	-0.8840	-0.6685
Other Crop	-1.0825	1.0600	-1.2173	0.8952	0.3445
Cotton	-0.0417	0.0387	-0.0570	0.0213	0.0386

Note: The elasticities are estimated, according to the formula provided in the text, at the means of the exogenous variables and predicted dependent variables.

Positive cross-price elasticities were found between several pairs of products, for instance, between rice and other grains, between wheat and other crops, and between cotton and wheat.

Compared with elasticities used in other studies for the case of China, the estimates in Table 6.2 are relatively high. In this study, most products are price elastic with respect to their own and others' prices, with the exception of the elasticities of cotton supply and elasticities associated with cotton prices. This, however, partly reflects heavy intervention by government and the non-existence of a free market for cotton.

Price elasticities of grain used in most other studies are significantly lower than the estimates derived in this study. Carter and Zhong (1988) estimated an elasticity of 0.15 in the winter wheat region and 0.27 in the spring wheat region. The elasticities of grain products used in modelling work by Tyers and Anderson (1992), Roningen and Dixit (1989) (the SWOPSIM model), and Gunasekera et al. (1991) are summarized in Tables 6.3 and 6.4.

In Tyers and Anderson (1992), all the elasticities are small. Most of the elasticities are smaller than 0.1 in absolute terms (many are in fact zero in both the short and the long-run) (Table 6.3). For the own-price elasticities of grain production, the elasticity for rice is less than half of that from the current estimates. Elasticities for wheat and coarse grain are 0.06 and 0.08, respectively, while those from this study are 1.05 and 1.51. Cross-price elasticities of grain production used by Tyers and Anderson are all set to 0.01, representing very minor cross-product effects of price change. Elasticities used by

SWOPSIM (Roningen and Dixit 1989) are all smaller than 0.5 in absolute terms (Table 6.4). Again, the cross-price elasticities are small for crops, particularly in comparison with elasticities derived from this study. The only exception was the own-price elasticity of cotton supply, 0.1, or nearly three times as high as the estimate of this study. The cross-price elasticity of cotton supply in SWOPSIM is set to zero. Gunasekera et al. (1991) adopted a set of relatively higher elasticities. These own and cross-price elasticities of rice supply are quite close to the estimates in this study. Those of cotton supply, however, are much higher. The supply elasticities of other products are still significantly lower than those in Table 6.2. Generally speaking, elasticities adopted by those three studies represent a mechanism of low price effects in economic modelling.

Table 6.3 Price elasticities applied by Tyers and Anderson

	Short-run supply elasticity with respect of price of						
	Rice	Wheat	Coarse grain	Sugar	Dairy	Ruminant meat	Non-ruminant meat
Rice	0.08	-0.01	-0.01*	-0.01	0.00	0.00	0.00
Wheat	-0.01	0.06	-0.01*	0.00	0.00	0.00	0.00
Coarse grain	-0.01	-0.01	0.08*	0.00	0.00	0.00	0.00
Sugar	-0.02	0.00	0.00	0.15	0.00	0.00	0.00
Dairy	0.00	0.00	0.00	0.00	0.15	-0.02*	0.00
Ruminant meat	0.00	0.00	0.00	0.00	0.03*	0.20	-0.05*
Non-ruminant meat	0.00	0.00	0.00	0.00	0.00	0.00	0.30
	Long-run supply elasticity witch respect of price of						
	Rice	Wheat	Coarse grain	Sugar	Dairy	Ruminant meat	Non-ruminant meat
Rice	0.12	-0.01	-0.01	-0.01	0.00	0.00	0.00
Wheat	-0.02	0.10	-0.02	0.00	0.00	0.00	0.00
Coarse grain	-0.02	-0.02	0.16	0.00	0.00	0.00	0.00
Sugar	-0.12	0.00	0.00	0.88	0.00	0.00	0.00
Dairy	0.00	0.00	0.00	0.00	0.80	-0.08	0.00
Ruminant meat	0.00	0.00	0.00	0.00	0.00	0.80	-0.20
Non-ruminant meat	0.00	0.00	0.00	0.00	0.00	0.00	0.60

Notes: The elasticities from Tyers and Anderson (1992) include short-run and long-run elasticities of agricultural supply. The elasticities in the short-run are with a one-year lag except for those with an asterisk which have a two-years' lag.
Source: R. Tyers, and K. Anderson (1992), *Disarray in World Food Market: A Quantitative Assessment*, Cambridge University Press, Sydney.

There are several possible reasons for the difference between elasticities adopted or estimated elsewhere and the estimates in this study, aside from the different data sets used or different functional forms applied (Alston et al. 1990; Huang and Lu 1992).

Table 6.4 Price elasticities applied by SWOPSIM and Gunasekera et al.

	SWOPSIM data set			Gunasekera et al. data set		
	Own-price	Cross price	Aggregate	Own-price	Cross price	Aggregate
Beef	0.21	0.03	0.24	0.35	-0.12	0.23
Pork	0.50	-0.06	0.44	0.65	-0.21	0.44
Mutton and Lamb	0.25	-0.09	0.16	0.45	-0.12	0.33
Poultry meat	0.49	-0.34	0.15	0.65	-0.20	0.45
Milk	0.30	0.06	0.36	0.55	-0.07	0.48
Wheat	0.15	-0.05	0.10	0.50	-0.17	0.33
Corn	0.18	-0.05	0.13	0.60	-0.45	0.15
Other coarse grains	0.15	-0.01	0.14	0.50	-0.39	0.11
Rice	0.15	-0.02	0.13	0.20	-0.07	0.13
Soybeans	0.10	-0.01	0.09	0.25	-0.20	0.05
Soybean meal	0.30	-0.25	0.05	0.30	-0.25	0.05
Soybean oil	0.08	-0.03	0.05	0.45	-0.40	0.05
Other oilseeds	0.10	-0.03	0.07	0.50	-0.11	0.39
Other meals	0.30	-0.25	0.05	0.25	-0.25	0.05
Other oils	0.49	-0.44	0.05	0.84	-0.79	0.05
Cotton	0.10	0.00	0.10	0.70	-0.57	0.13
Sugar	0.15	0.00	0.15	0.70	-0.66	0.04
Tobacco	0.15	0.00	0.15	0.75	-0.31	0.44

Notes: The SWOPSIM stands for the Static World Policy Simulation modelling framework developed in the Economic Research Service of the US Department of Agriculture (Roningen 1986, Roningen and Dixit 1989). The model uses own-price and cross-price elasticities. G nasekera et al. (1991) applied SWOPSIM, and the elasticities are revised by the researchers based on the SWOPSIM's original numbers.

Source: Gunasekera et al. (1991), 'Agricultural policy reform in China', *Discussion Paper 91.4*, Project 6131.104, Australian Bureau of Agricultural and Resource Economics, Canberra; V.O. Roningen and P.M. Dixit (1989), 'How level is the playing field? an economic analysis of agricultural policy reforms in industrial market economies', *Foreign Agricultural Economic Report No. 239*, US Department of Agriculture, Washington DC.

This study focuses on data adjustment. Generally speaking, the state purchase prices and procurement quotas fluctuate less sharply than the market-oriented prices and quantities, both in terms of frequency and magnitude.[10] Movements in the data series would be much smaller without adjustment. Fluctuations in both price and output series tend to be smoothed. Elasticity estimates from the other studies described tend to undervalue the actual responses of production to market signals.[11]

[10] Assuming that total supply consists of state quota and market supply and that the state quotas change less significantly, it is not surprising that movements in total supply must be smaller than those of market supply.

[11] For grain, there are two prices-the state purchase price and the market price. If we look only at the average price, the variation would be much smaller than the changes in market price, assuming the state price remains unchanged or moves in smaller magnitude.

Policy Implications

The elasticities derived in this study have interesting policy implications, particularly in relation to China's grain self-sufficiency policy.[12] China has declared that grain self-sufficiency is one of its national policy objectives, at least for the period 1990-95. Policies target wheat and rice in particular. Currently, China exports rice in exchange for wheat in the international market. Garnaut and Ma (1992) present predictions which indicate that the annual growth of aggregate demand for grain in China will range between 1.9 and 2.7 per cent in the years before the end of this century. Continued pursuit of grain self-sufficiency will place much greater pressure on domestic grain production. Per capita agricultural resources are very limited in China. This will become an increasingly serious constraint for grain production, not only because of continuous demand increases but also because other production activities compete with grain production for land as income rises.

If significant improvements in grain production technology do not occur, there are two ways to secure grain self-sufficiency in China. One is to restore the planning system and force all farmers to produce a sufficient amount of grain to meet national requirements. This, however, is unlikely to happen after ten years of economic reform.[13] The other way is to distort the domestic grain price, following the methods adopted by other East Asia economies like Japan, Korea and Taiwan. But, as evidenced here, the cost of price distortion can be extremely high.

This study provides partial information on this issue. Given that the domestic rice price in China is already very close to the international market price, with an estimated nominal protection rate of -5 per cent in 1990 (Peng 1992), without significant subsidy it may be very difficult for China to continue to export rice in exchange for wheat. The wheat price

[12] This study, focusing on elasticity estimation, can only provide a partial picture of the agricultural policy story. Overall assessment involves a general equilibrium framework, which is the subject of another related study.

[13] Even if the government chooses to do so, the planning system is unlikely to work as effectively as in the past.

in China is already much higher than the world price, with a nominal rate of protection of 30 per cent (Peng 1992). Opportunities for increasing output through adjustment of prices is very limited, unless the government is willing to adopt a policy of substantial grain production subsidization. As pressures on the state budgets have already been a serious problem for the Chinese government, self-sufficiency policies that subsidize grain producers will be more difficult to implement.

The cost of this, however, goes beyond its being a burden on the state budget. Rising grain prices would also tend to distort the domestic economic structure. If a subsidy on rice production were adopted in order to maintain grain self-sufficiency, rice production might be encouraged (own elasticity 0.20 — Table 6.2), and wheat and other crop production would be discouraged but by much larger margins (cross-price elasticities being -1.1 for wheat and other crops, Table 6.2). Not only is grain self-sufficiency an unachievable goal, but the economy may be forced to import other agricultural crops that it exported previously. If prices of grain products are to be subsidized, output of cotton and other crops will drop sharply. The Chinese economy could also become more dependent on international markets compared with the situation where grain production is not distorted because it has to import more cotton and other agricultural products. The distortion to domestic comparative advantage will result in a relocation of the national welfare.

Elasticity estimates throw light on how significantly the Chinese economic structure has been distorted by price policies. Let us take distortions to the price of cotton as an example. According to a sample survey on the textile industry in China (Lu 1992), the average state price of cotton for users was 7,381 yuan per tonne and average market price was 8,984 yuan per tonne. Currently, the marginal price for cotton growers is the state price because growers are unable to access the free market. The output level of cotton is decided by farmers according to this price.

Where there is no price distortion in the case of cotton, the marginal price would be 8,984 yuan instead of 7,381 yuan (an increase of 21.7 per cent). All other prices are

further assumed unchanged. In a static framework, the possible changes in output levels of different commodities, resulting from a 21.7 per cent increase in the price of cotton, can be computed by using the estimated elasticities. Cotton supply is very inelastic with respect to its own price (0.04), and total output would only increase by 0.8 per cent. Cotton output could be raised from the current level of 4.508 million tonnes in 1990 to 4.546 million tonnes. Output of other products would drop. Paddy rice production would fall by 3.5 million tonnes, while production of other grain would fall by 23 million tonnes in the case of 1990.

This example, however, has not considered the case where cotton production is forced by government. Abolition of price control over cotton may also lead farmers to cease production. This would offset rising cotton production and decreasing production of rice and other grains. A number of other important factors are also omitted from the above computation. A more sophisticated examination of the effects of price distortion and other policy interventions on agriculture and other sectors of the economy requires a general framework that accommodates the special features of the Chinese economy.

7

An Economy-Wide Model of China

The effects of agricultural price distortions and the limited feasible choice set of farmers are not confined to agriculture. Their impact on agriculture is large, but they also affect decision-making in other sectors, with spillovers to other parts of the economy and world markets.

The analysis of the effects of government interventions on agriculture and the economy as a whole has so far been within a qualitative or partial equilibrium framework. Here this analysis is extended through a comprehensive quantitative framework.

A computable general equilibrium model for China (the China model), with special focus on the agricultural sector, is constructed. This model is then used as a vehicle for analysing agricultural policies. The model follows the spirit of models by Johansen (1960), Dixon et al. (1982) (the ORANI model of the Australian economy), Clarete and Warr (1992) (the APEX model of the Philippine economy) and Martin (1990) (the Martin model of the Chinese economy). Its extension incorporates the two important characteristics of Chinese agriculture.

Developments in Computable General Equilibrium Modelling

There are a number of quantitative frameworks available for empirical economic analysis. Partial equilibrium models such as those utilizing flexible profit functions and consumer demand systems, are widely used in economic studies because they are easy to establish, to understand and to apply. But deep insights cannot be made through partial equilibrium models. The scope offered is narrow with usually only the production and/or consumption side of one or two commodities being studied. Partial equilibrium models ignore interactions between the sector or commodities being studied and other parts of

the economy. They do not capture any feedback effects of policy changes and are unable to provide economy-wide implications.

Macroeconomic models overcome this weakness of partial equilibrium models by bringing together all sectors and activities into a consistent economy-wide framework. A single change to any sector or activity is quickly transmitted to the other parts of the economy through quantitative relationships between variables specified in the models. The economy adjusts to achieve a new equilibrium (or disequilibrium). Yet macroeconomic models are inappropriate for the purpose of agricultural policy analysis in this study. Macroeconomic models incorporate economic activities at an aggregate level. Without detailed specification for production and consumption of agricultural and non-agricultural products, they can neither accommodate any changes in agricultural policy nor capture the effects of structural change. Furthermore, some *ad hoc* specifications of macroeconomic models lack microeconomic foundation. Unusual specifications such as the inclusion of lagged variables in behavioural equations are often difficult to understand and interpret.

A Computable General Equilibrium (CGE) model was used as the most suitable vehicle for examining agricultural policy issues whilst taking an economy-wide perspective. Although debate continues on the appropriateness of model specifications, parameter choice, disaggregation and the representation of policy measures, CGE models have become a popularly applied quantitative framework in economic analysis (Shoven and Whalley 1992).

Computable general equilibrium models originated in the debate over the feasibility of the centralized computation of Pareto optimal allocation of resources within an economy. The operation of a market economy is specified in considerable detail. The structure of production, consumption, government revenue and expenditure, and foreign trade are modelled. CGE models emphasize the interdependence of decision-making throughout the economy. Whenever the government intervenes in agriculture or an exogenous shock occurs, resources are re-allocated across all markets of the economy, with efficiency and

distributional consequences. A CGE model describes where resources come from, what implications policies have for the rest of the economy and to what extent feedbacks from other sectors impact on agriculture.

To date CGE models fall into two groups according to the way in which they are solved: those that are solved at levels and those that are solved in logarithmic differentials or percentage changes. The first type is used widely by the World Bank (Dervis, de Melo and Robinson 1982), while the second type, pioneered by Johansen (1960), is applied extensively by Australian modellers (Dixon et al. 1982).

The CGE model in its original form incorporates all of the neoclassic assumptions. The behavioural assumptions of the model involve cost minimization by producers and utility maximization by households, and the assumption that there is sufficient competition for unit profits (at market prices) to be driven to zero. There are many successful examples of the application of CGE models to the industrial economies (the ORANI model of the Australian economy, Dixon et al. 1982). Economists working on developing economies have sought to extend CGE modelling in a variety of directions in order to capture 'structural' features of these economies (Robinson 1989). One modification stays within the theoretical structure of the neoclassic model, but specifies limited substitution elasticities in a variety of important relationships. The second modification assumes that various markets do not work properly or are not present at all. Instead, restrictions on factor mobility, rigid prices, rationing and neoclassical disequilibrium in one or more important markets are assumed. Such theoretical development helps greatly in capturing the features of the Chinese economy.

CGE models are usually designed to address three types of economic policy problem. First, they can be applied to the effects of policies and changes at a sectoral level (changes to the variables associated with industries or commodities). Such changes include taxes and subsidies on industry (including agriculture) production, exports and imports, and sector specific technical change. Second, CGE models are useful to explore the consequences of changes which occur at the macroeconomic level, such as changes

in the aggregate level of government spending or in the exchange rate. And third, CGE models are capable of exploring the impact of external shocks, such as changes in the world market, to which the Chinese economy has to respond.

Assumptions and Distinctions of the China Model

Earlier Modelling of the Chinese Economy

Martin's pioneering work on CGE modelling of China examined the impact of exchange rate policy (Martin 1990). His ORANI type model included 27 sectors, 1390 equations and 1390 endogenous variables. In the Martin model, apart from the normal behavioural assumptions of the CGE model, domestic and imported products are treated as imperfect substitutes following Armington (1969). The model is short-run in character, with capital assumed to be fixed in each sector but labour assumed to be perfectly mobile. Another important assumption of the Martin model is that official prices are irrelevant to the behaviour of the model.

Since both the Martin Model (Martin 1990) and this China model belong to the broad ORANI type, they share many characteristics in model specification and structure, such as the assumption of rational behaviour by both producers and consumers. As comparative-static models, both rely on simplifying assumptions, such as fixed quantities of capital stock and agricultural land for each industry.

Martin mainly used the *China Input-Output Table 1981* (World Bank 1985). This model uses the *China Input-Output Table 1987* (China, State Planning Commission and State Statistics Bureau 1991) as its primary database.

The degree of data disaggregation applied depends on the objective of the economic analysis and the availability of information. The basic Martin model was constructed to analyse the foreign exchange rate regime and fibre demands by the textile industry modelling the two-tier exchange rate system and substitution between different types of fibres. In the China model constructed for this study, the three distinct features discussed above also distinguish it from the Martin model.

The Martin model contains twenty-seven sectors, each of which produces a single product. In this China model there are twenty-two industries, two of which are multi-product industries (farming and livestock). Following the specification of ORANI, transformation between different types of commodities within one industry (such as rice, wheat, other grain, cotton and other crops in the farming sector) is introduced for two agricultural industries. In particular, the China model separates rural and urban industries.

In the Martin model, the substitution between domestically produced and imported commodities is modelled at the aggregate level by applying the Armington specification (Armington 1969). In this China model, Armington substitution is modelled at the disaggregated demand level, such as household, investment and government demands. The difference lies in possibilities for variation of Armington elasticities among different types of final demands.

Martin (1992) uses this model to examine the impact of foreign exchange policy on textile industry in China. The model is also used to illustrate the effects of changes in energy variables and other changes on the Chinese economy (Peng and Martin 1991; Peng 1992).

The Martin model was later developed by Findlay et al. (1992) to examine the impact of various exogenous changes. The main development of the model was further disaggregation of agriculture and the inclusion of multi-product agricultural sectors. The so-called 'Dutch Disease' simulation models the intersectoral effects of an expansion in rural industries of the economy. In analysis an expansion in the light industrial sector is designed to capture some of the effects of the rural industrial boom in China.

Another advance was implemented by Gao (1993) in examining the impact of exchange rate policy incorporating the externality of export growth.

Characteristics

Broadly speaking, the China model developed in this study may be classified as an economy-wide, comparative-static computable general equilibrium model of the Johansen type.

The objectives of this study necessitate that the model must be capable of capturing the intersectoral features of the Chinese economy. Although a large part of the economy is substantially simplified in specification, the model is comprehensive in that all sectors of economic activity are included. Projections from the model add up in the sense that outcomes appropriately weighted for each sector are equivalent to outcomes for the relevant macroeconomic variables. Hence, following a change in the incentive structure, the sum of changes of outputs for each sector equals change in the economy's aggregate output.

The model provides projections at only one point in time, the solution year. This solution contains no information about the time path of adjustment as in dynamic models. The comparative-static models of the Johansen type work in percentage changes in variables. Model results demonstrate how much levels of economic activity in China would increase (decrease) as a result of a shock, such as a reduction in incentive distortions to agriculture. Comparative-static models are not specific about timing, although the China model developed in this study is short-run in nature. The time frame reflects the response elasticity estimates incorporated in the model.

Each simulation of the model results in a computable general equilibrium, which refers to the inclusion of a treatment of both production relationships and demand conditions, the interrelationships between them and the simultaneous determination of prices through the interaction of demand with supply in all markets. This does not necessarily imply that all markets must be perfectly competitive. In the China model, a set of rigidities are introduced. All parts of the model, however, are interdependent and reach equilibrium or disequilibrium simultaneously.

The general equilibrium conditions can be written as

$$F(X) = 0 \tag{7.1}$$

where X is the vector of variables included in the model and $F(.)$ is the set of excess demand and unit profit functions of the model (Clarete and Warr 1992). Through an appropriate closure, X may be partitioned into a vector of endogenous variables (Y) and a vector of exogenous variables (Z). Total differentiation of Equation (7.1) with respect to X yields

$$AY + BZ = 0 \tag{7.2}$$

which can be solved for Y

$$Y = -A^{-1}BZ \tag{7.3}$$

The percentage change type model (the Johansen type) has the distinct disadvantage that results are only linear approximations to the non-linear system and hence are strictly valid only for small changes. The model, however, possesses a number of advantages. The solution algorithm is separated from the model and hence unaffected by model design changes which are therefore easier to implement. The mechanisms underlying the results are easier to understand and explain to policy-makers. When there are several policy changes under study the separate effects of each can be decomposed additively (NCDS 1990).

Basic Assumptions

In the designing the China model, crucial assumptions usually made in CGE modelling are followed.

In its treatment of production and demand, the China model incorporates the conventional features of neoclassical microeconomics. It assumes optimizing behaviour on the part of producers (profit maximization and/or cost minimization) and consumers (cost minimization and/or utility maximization) subject to the various constraints in the

economy such as the supply of factors (labour, capital and land), the balance of payments and technology, etc. The resultant equations emphasize the responsiveness of economic agents to changes in relative prices, with the degree of responsiveness imposed dependent on the value assigned to substitution elasticities. All markets are assumed to be competitive, thus no activity earns pure profits. This, obviously, further requires the assumption of constant returns to scale in production activities. Market clearing is assumed in all commodity and factor markets.

The applicability of perfect market assumptions raises questions with respect to modelling the Chinese economy. China has a history of nearly thirty years of central planning. Commodity and factor markets did not operate competitively during that period. After ten years of market-oriented economic reform, the imperfections of the market mechanism still suggest significant differences between the Chinese economy and market economies. Price distortions and limited factor mobility are identified in this study as two important characteristics of Chinese agriculture. Extra caution in applying a CGE approach, and careful assessment of each neoclassical assumption is necessary when building the China model.

The operation of state enterprises raises doubts when specifying the optimization behaviour of industry producers and consumers. Farmers, after the establishment of the household responsibility system, became largely independent producers. Farmers adjusted their resource allocation in the pursuit of maximum income or profits in the second half of the 1980s (see Chapter 4). Lin (1992b) found that, even in nascent factor markets, farmers behave in a rational manner. Another important part of the Chinese economy is the non-state industrial and commercial sectors, which include the TVP enterprises in the countryside and the collective sectors in the urban areas.

The peculiarity of state enterprises' non-profit maximization behaviour is largely ignored for three reasons. First, the state sector no longer dominates Chinese industry, although the industry share of the state sectors varies. Non-state sectors, the rural TVP and urban collective enterprises, operate at the margin and respond to market changes. Second,

after ten years of reform, there is evidence that profit is an increasingly important objective of the state enterprises. And third, the China model primarily relates to the agricultural sector and its interaction with the rest of the economy. This weakness of the model leaves room for further improvement.

The second set of questions relates to how price distortions affect economic structure. Commodities subject to two-tier pricing systems (the coexistence of the state control and a free market), such as grain, are not given particular attention since this kind of distortion does not directly affect production and consumption decisions (Sicular 1988a, Martin 1990). In addition, the gap between the state purchase price and the market price of grain was, in principle, eliminated in April 1992. Price distortions for wool and cotton, however, are incorporated carefully in the China model.

Distinct Features

The model is built to examine the impact of policy changes on agriculture in China. It is therefore important to capture the characteristics of the whole Chinese economy as well as agriculture when establishing the quantitative framework. Compared to similar economy-wide models, in three aspects of structure and specifications distinguish the China model.

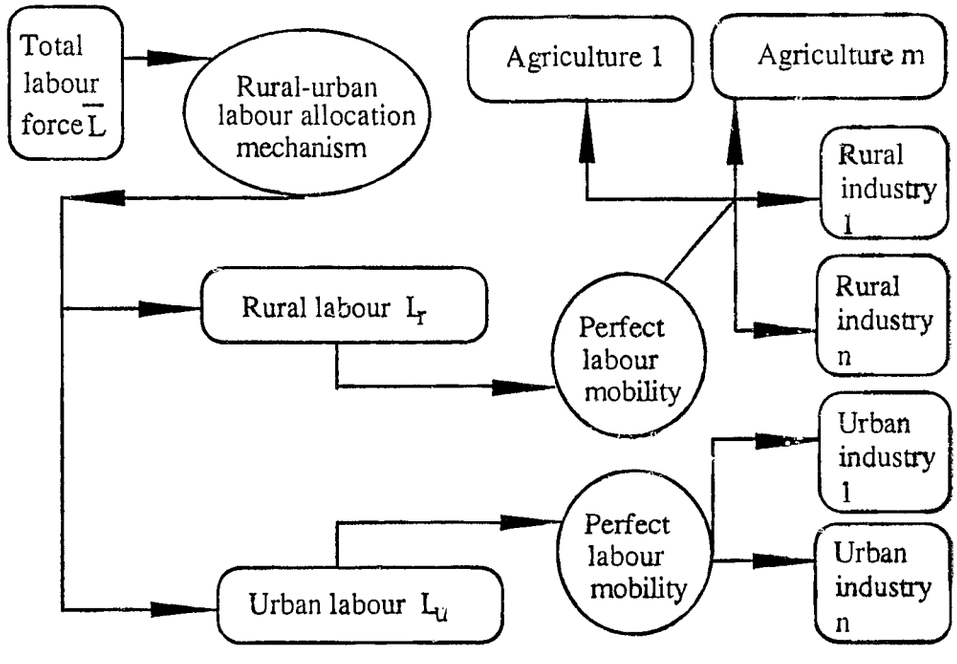
- The China model incorporates labour market segmentation between rural and urban areas. It was found earlier in this study that government policies, including administrative and macroeconomic policies, have significant influence on farmers' feasible choice sets. These, in turn, affect the extent of interaction between agriculture and non-agriculture. Factors (labour, capital and land) are not perfectly mobile in the Chinese economy.

Labour movements between rural and urban areas are strictly regulated. Farmers, born in rural areas, can only be employed in rural sectors including agriculture and rural non-agriculture. Urban residents, on the other hand, can only be employed by urban industries. Due to the constraints of their limited feasible choice sets, farmers' responses to changes in the incentive structure are limited. This study has shown that the limited

feasible choice set significantly affected performance of agriculture and the economy as a whole in the 1980s in China. This is an important issue to consider in building the China model. Since capital stock and land usage are fixed for each sector in the short-run by assumption, limited labour mobility between rural and urban areas was modelled.

The China model contains two separated labour markets, one rural and one urban. The economy's total labour stock is $\bar{L}$, of which L_r and L_u are rural and urban labour, respectively. With perfect labour mobility within each market, labour can move freely between agricultural and rural non-agricultural sectors in the rural labour market, or between urban sectors in the urban labour market (Figure 7.1).

Figure 7.1 Labour market segmentation between rural and urban areas



In the first instance, no labour flow between rural and urban areas is assumed. Labour movements between urban and rural areas are now occurring. Some farmers have moved to cities, either temporarily or permanently, to find jobs as household-help and contracted workers in manufacturing.

It is difficult to characterize a labour allocation mechanism which is neither perfectly mobile nor absolutely limited. Potentially, there are two ways that can be applied to reflect the limited labour mobility. In the first, a fixed volume of labour movement from rural to urban areas is introduced by changing labour quantities in rural and urban areas. For instance, if q farmers move to cities, the assumption of labour market segmentation is not changed. However, the movement is reflected in the changes in labour force. Now rural labour becomes $(L_r - q)$ and urban labour becomes $(L_u + q)$. The other difference is that now q farmers earn an urban wage rate instead of a rural wage rate.

In the second, limited labour mobility is introduced by specifying partial adjustment. Labour movements between rural and urban areas are allowed but the quantity of labour reallocated is always smaller than would be expected of the changes in incentive structure because of certain restrictions.

Simulations undertaken in this study do not involve a limited mobility mechanism. Rather, a perfect mobility mechanism is implemented as an indication of economic equilibrium in ccomparison with that under segmented labour market between rural and urban areas.

- The model incorporates endogenous price distortion for some agricultural products. Incentive distortions to agriculture were made endogenous in this study (Chapter 5). In most CGE models such interventions are modelled exogenously. Those exogenous specifications, however, are particularly weak in that the feedback from economic adjustment to policy change is missing. It is found that the level of incentive distortions to agriculture in China is an equilibrium result of the bargaining process between farmers and government. The equilibrium of this bargaining game depends on the relative bargaining power of both parties. Bargaining power is further determined by the exogenous environments, such as agriculture's share of the national economy, farmers' feasible choice set, and changes in the world market.

The policy game story is intuitively that the levels of incentive distortions are dependent on endogenous economic variables as well as exogenous factors. This policy endogeneity

is incorporated in the China model using the behavioural equation of incentive distortions discussed in Chapter 5. State prices for rice, wheat, other grain, cotton and wool are modelled. The behaviour equation is specified, in general form, as

$$P_i^s = f(s_A, s_r, M, p^*) \tag{7.4}$$

where P_i^s denotes state purchase prices of grain (rice, wheat and other grain), wool or cotton, s_A the share of agriculture in the national economy, s_r is the share of agricultural population in total population, M is average real income per capita and p^* the market price (in the case of grain) or world price (in the case of cotton and wool). Following the Johansen tradition, the variables can be transformed into percentage changes, (7.4) can therefore be expressed in the form of a CGE model equation,

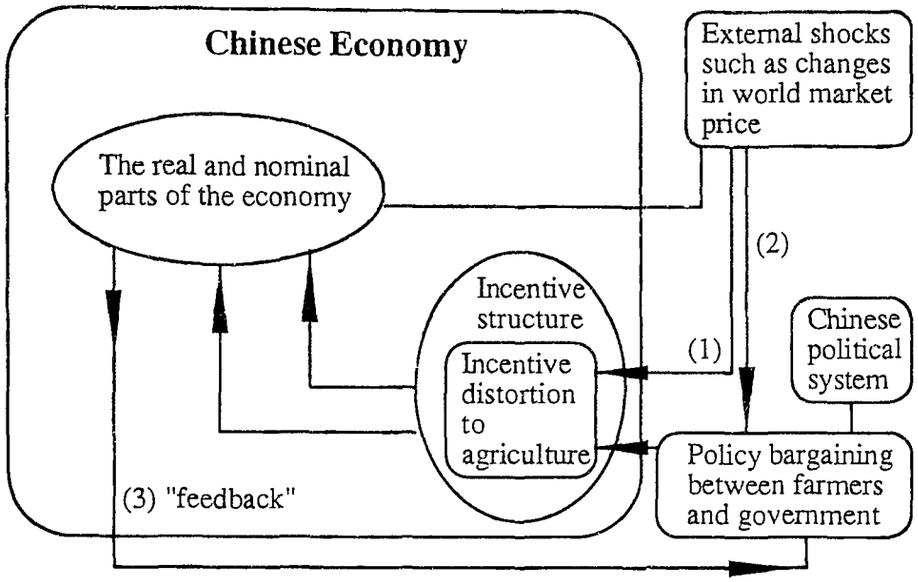
$$p_i^s = \gamma_{(iA)}^{(0)} s_A + \gamma_{(ir)}^{(0)} s_r + \gamma_{(iM)}^{(0)} M + \gamma_{(ip)}^{(0)} p^* \tag{7.4'}$$

where superscript $^{(0)}$ denotes variables or parameters related to production or supply behaviour. $\gamma_{(iA)}^{(0)}$, $\gamma_{(ir)}^{(0)}$, $\gamma_{(iM)}^{(0)}$ and $\gamma_{(ip)}^{(0)}$ are elasticities of changes in $p_i^{(0)}$ (percentage change in state price of i) with respect to changes in s_A, s_r, M and p^* (percentage change in world/market prices), respectively. In this model, state prices for cotton and wool affect directly production decision, while state prices for grains work only as indicators which do not have real effects on the economy following Sicular (1988a) and Martin (1990).[1]

By setting incentive distortions as completely exogenous, no information is revealed about the influence they have. Introducing endogenous policy determination helps to clarify variations in price distortions. External shocks not only directly affect the structure of incentives (path (1) in Figure 7.2), but also influence farmers' and government bargaining powers which, in turn, impact on the incentive structure (path (2)). Finally, any changes in the economic structure determined endogenously, such as the share of agriculture in the whole economy, may also affect the bargaining process (path (3)).

[1] Second round effect of the state grain prices through income effect are not modelled here as they are minor in magnitude (Martin 1990).

Figure 7.2 Endogenous state prices of agricultural products

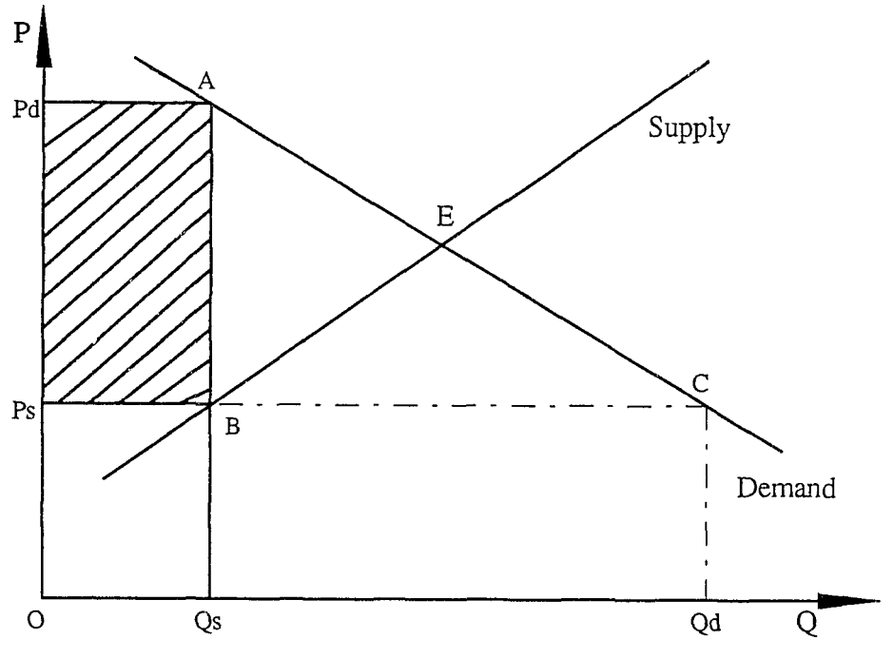


- Price distortions for cotton and wool are explicitly specified in the model. Price distortions for cotton and wool are one of the important characteristics identified in this study. Under the central planning system, the state had absolute control over production, consumption and commodity transactions. If the state set the price for one commodity, such as wool, at P_S, it would be the only price prevailing in the whole economy. Assuming that the state price (P_S) was lower than the equilibrium price (usually the case for agricultural products in China), the amount of wool demanded would be Q_d while the amount supplied would be Q_S (Figure 7.3). The gap between Q_S and Q_d represents the excess demand for wool in the pre-reform Chinese economy.

Marketization of cotton and wool began in 1985. Both (state and non-state) commercial departments and textile industries were involved in purchasing activities. A large number of textile enterprises were established by local governments in the pursuit of more employment opportunities and local budget revenue. State monopoly in the cotton and wool markets, however, was restored in 1986 and 1988, respectively (Lin 1991; Watson and Findlay 1992). A single state price is announced each year. The mechanism through

which the fibre markets operate, nonetheless, has changed. Cotton and wool are produced by thousands of farm households in China. It is rather difficult for farmers to find an illegal buyer. The industry would only choose direct purchase if a certain minimum amount of raw materials was supplied. Sizeable purchases from individual farm households are, however, easily detected by the government. Hence, in most cases, state prices serve as producer prices for farm households.

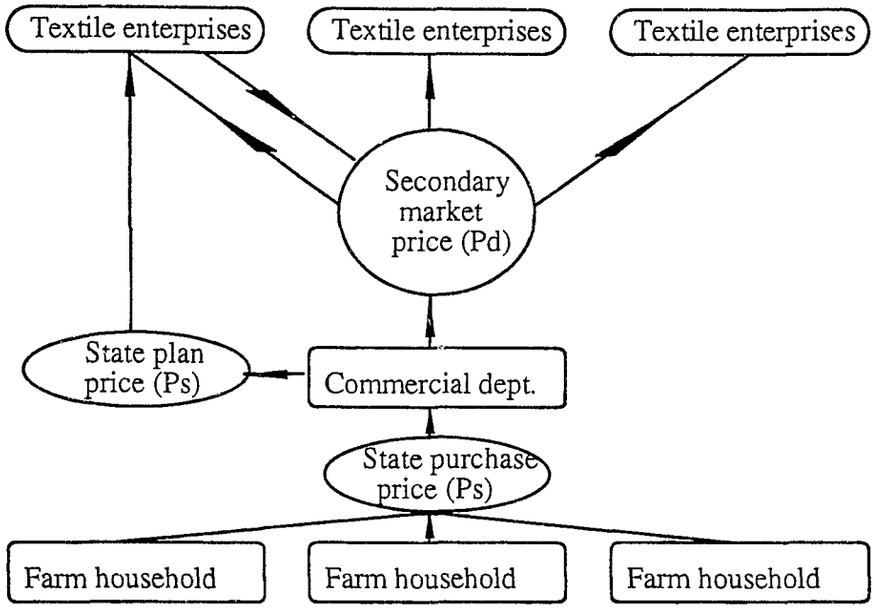
Figure 7.3 Cotton and wool markets in China



Non-official transactions at the commercial and industry levels have become easier, due to significant reductions in transaction costs, and the formation of an effective secondary market. According to government policy, all cotton and wool purchased by the state commercial departments (including rural purchase and marketing corporations for agricultural production materials) should be allocated to state textile enterprises. As there is excess demand, enterprises are willing to pay a higher prices than the state price. Due to the existence of a secondary market price, the commercial departments, driven by economic interests, may sell some cotton and wool at this price. The enterprises which

obtain a quota for raw materials also have a choice between using these low-price materials for own production or selling in the market to make profits (Figure 7.4).

Figure 7.4 Two Levels of Cotton and Wool Transactions



This system of two levels of transactions separates producer prices from user prices for cotton and wool. Given a state price at P_S, the supply level is determined (Q_S). Equilibrium occurs in the secondary market. The user price (P_d), however, is driven up. The gap between the two prices is the rent that both commercial and state enterprises seek.

Sector Detail

One important decision in CGE modelling is the degree to which production is disaggregated. This is a crucial determinant of the model's potential usefulness in policy analysis. Disaggregation and detailed sector structure are distinct features of CGE models, particularly compared with macroeconomic models. This China model uses detailed agricultural sector data since the primary interest lies in the impact of incentive distortions on the sector as a whole and on individual farm commodities. Grain (rice and

wheat), cotton and wool are distinguished from other products. However, disaggregation does not come without cost. A detailed model structure provides insights to structural change, but it demands higher quality inputs as well. CGE models are built on parameters and coefficients characterising behaviour of economic agents. Data availability (both input-output parameters and behavioural elasticities), therefore, is one of the important factors in determining the model's structure. Considering the limited resources available, treatment of the non-agricultural sectors is at an aggregated level. In adding up individual industrial sectors, attention is given to distinguishing export-oriented and import-competing industries (Clarete and Warr 1992) and to separate activities that use different production techniques (input combinations) (NCDS 1990).

The China model contains twenty two sectors, of which four are agricultural and eighteen are non-agricultural sectors (Table 7.1).

Table 7.1 Industries of the China model

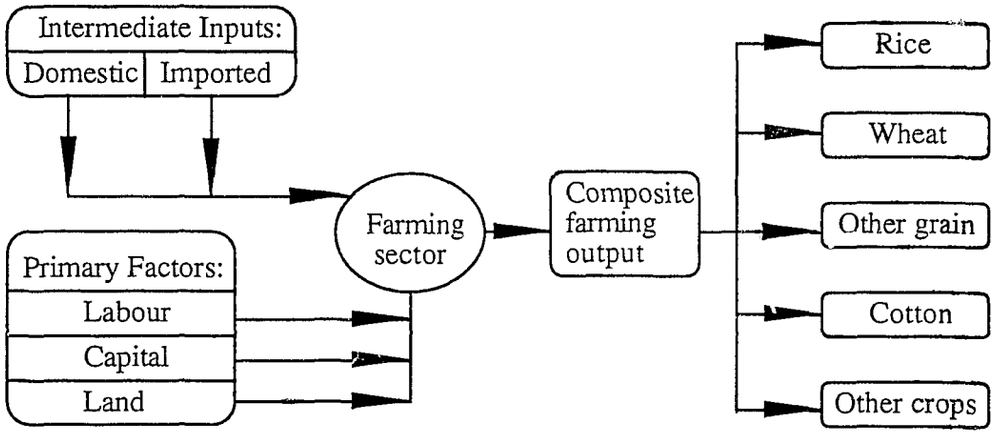
no.	*Industry Description*	*no.*	*Product Description*
1	*Farming*	1	Rice
		2	Wheat
		3	Other grains
		4	Cotton
		5	Other crops
2	*Livestock*	6	Wool
		7	Other livestock
3	*Forestry*	8	Forestry product
4	*Fishing*	9	Fish
5	*Mineral (urban)*	10	Minerals
6	*Mineral (rural)*	10	Minerals
7	*Food processing (urban)*	11	Processed food
8	*Food processing (rural)*	11	Processed food
9	*Textile (urban)*	12	Textile products
10	*Textile (rural)*	12	Textile products
11	*Non-metal manufacture (urban)*	13	Non-metal products
12	*Non-metal manufacture (rural)*	13	Non-metal products
13	*Metal manufacture (urban)*	14	Metal products
14	*Metal manufacture (rural)*	14	Metal products
15	*Electricity (urban)*	15	Water and electricity
16	*Electricity (rural)*	15	Water and electricity
17	*Construction (urban)*	16	Construction
18	*Construction (rural)*	16	Construction
19	*Trade and transportation (urban)*	17	Trade and transportation
20	*Trade and transportation (rural)*	17	Trade and transportation
21	*Service (urban)*	18	Service
22	*Service (rural)*	18	Service

Agriculture is the industry of particular interest in this study. About two-thirds of the value of agricultural production comes from food and other crop production. Over half of this is in the production of food crops, including rice, wheat and other grain crops. A further quarter of the value of agricultural output from livestock production which produces wool and non-wool animal commodities. Forestry and fishing account for about five per cent each of the value of agricultural production.

Agriculture is thus disaggregated into four sectors, *Farming*, *Livestock*, *Forestry* and *Fishing*. Two of the sectors (*Farming* and *Livestock*) are multi-product industries while the other two (*Forestry* and *Fishing*) are single product industries.

In the production process, each agricultural sector uses two categories of production inputs (intermediate inputs and primary factors) to produce either a single output (for a single product industry) or a composite output (for a multi-product industry, Figure 7.5). The composite output is then transformed into individual commodities through a specified mechanism. Intermediate input is distinguished as domestically produced or imported, while primary factors include labour, capital and land.

Figure 7.5 Agricultural production



The key characteristic of the China model is that the rural and urban sectors are separated because of differences in production technology, operating mechanisms and labour and other factor sources.

China has a relatively small mining sector, particularly when compared to resource-rich countries like Australia and the Middle East economies. Its value of output corresponds to about a quarter of that of agriculture. The mining sectors, however, distinguish themselves from other sectors in that they are both resource and capital-intensive (compared to some other industrial sectors) and their outputs are relatively stable (compared to agriculture). In addition, because China is a very large country the performance of its mining sectors are critical to overall growth.

The mining in the China model is aggregated at two sectors: *Mineral (rural)* and *Mineral (urban)*. Both sectors include coal, oil, gas mining, other minerals and their products (or thirteen sub-sectors, Appendix 7A). What should be kept in mind is that the so-called urban mining sector is not necessarily located in urban areas. The urban sector is distinguished from the rural sector in the sense that it is not managed by rural townships, villages or farm households.

Manufacturing has the largest number of sectors (eight) in the China model. The classification of manufacturing sectors clearly reflects the focus of the study.

A more detailed structure was specified for those manufacturing industries heavily dependent on agricultural outputs such as raw materials. The interactions between agriculture and these manufacturing industries are expected to be significant. The upstream or downstream effects of any exogenous changes and their feedback influences are of particular interest. On the other hand, Textile industries — *Textile (urban)* and *Textile (rural)* — not only consume agricultural products directly, such as cotton and wool, but also contributed significantly to export growth. Other manufacturing industries in the model are separated according to production process and exporting/importing behaviour. These include *Food processing*, *Non-metal manufacturing* and *Metal*

manufacturing (each of these sectors is further splited into one rural and one urban subsectors).

The service industry is small in the Chinese economy. A policy was announced recently to encourage the development of the service sector. And the non-state enterprises are becoming increasingly important parts of the service sector.

Six service sectors stand out as requiring particular emphasis in the China model. These are *Construction (urban)*, *Construction (rural)*, *trade and transportation (urban)*, *trade and transportation (rural)*, *Service (urban)* and *Service (rural)*. Definitions of construction appear to be straightforward. Trade and transportation industry contains communications, domestic and foreign trade, marketing and storage, restaurants, and transportation by railway, highway, water, air and pipeline. Other services include public utilities, health, education, scientific services, sports and financial institutions (Appendix 7A).

Theoretical Structure

Production Activities

Since producers are assumed to be price takers in both output and input markets, they choose input levels subject to production technologies to minimize production costs. The industrial technology of current production is illustrated in Figure 7.6. The production function is described in levels 2 and 3. At the third level, effective levels of inputs of commodity g (g=1, 2, ..., 18) are defined as constant elasticity of substitution (*CES*)[2] combinations of domestic supplies and imports of the particular commodity classification, that is, the demand for intermediate input i (i=18) from source s (s=1, domestically produced, s=2, imported) by industry j (j=22), $x^{(1)}_{(is)j}$, can be expressed as:

$$x^{(1)}_{(is)j} = z_j - \sigma^{(1)}_{ij}[p_{(is)j} - \sum_s S^{(1)}_{(is)j} p_{(is)j}] \qquad (7.5)$$

[2] The *CES* (constant elasticity of substitution) production function was developed by Arrow, Chenery, Minhas and Solow (1961).

ignoring the technological factors, $\sigma_{ij}^{(1)}$ the elasticity of substitution between two sources of intermediate inputs. The effective units of primary factors are defined as *CRESH*[3] combinations of fixed capital, labour and agricultural land. The demand for primary factor v by industry j, $x_{vj}^{(1)}$, in the simplest form, is

$$x_{vj}^{(1)} = z_j - \sigma_{vj}^{(1)}[p_{vj}^{(1)} - \sum_{v} S_{vj}^{*(1)} p_{vj}^{(1)}] \tag{7.6}$$

where $\sigma_{vj}^{(1)}$ is the *CRESH* parameter reflecting the degree of substitutability between primary factor v and other primary factors in the production process. Capital and agricultural land are treated as though they are non-shiftable between industries (fixed in modelling). In effect, it is assumed that there is a rental market for the capital and agricultural land of each industry and that each producer in industry j treats the rental prices of capital and agricultural land of type j as given. The rental rates adjust so that for each j, the sum of the demands from all producers in industry j equals the available supplies of capital and agricultural land of type j.

At level 2, effective inputs of each of g of produced commodities and effective primary factor inputs are required for production process in fixed proportion

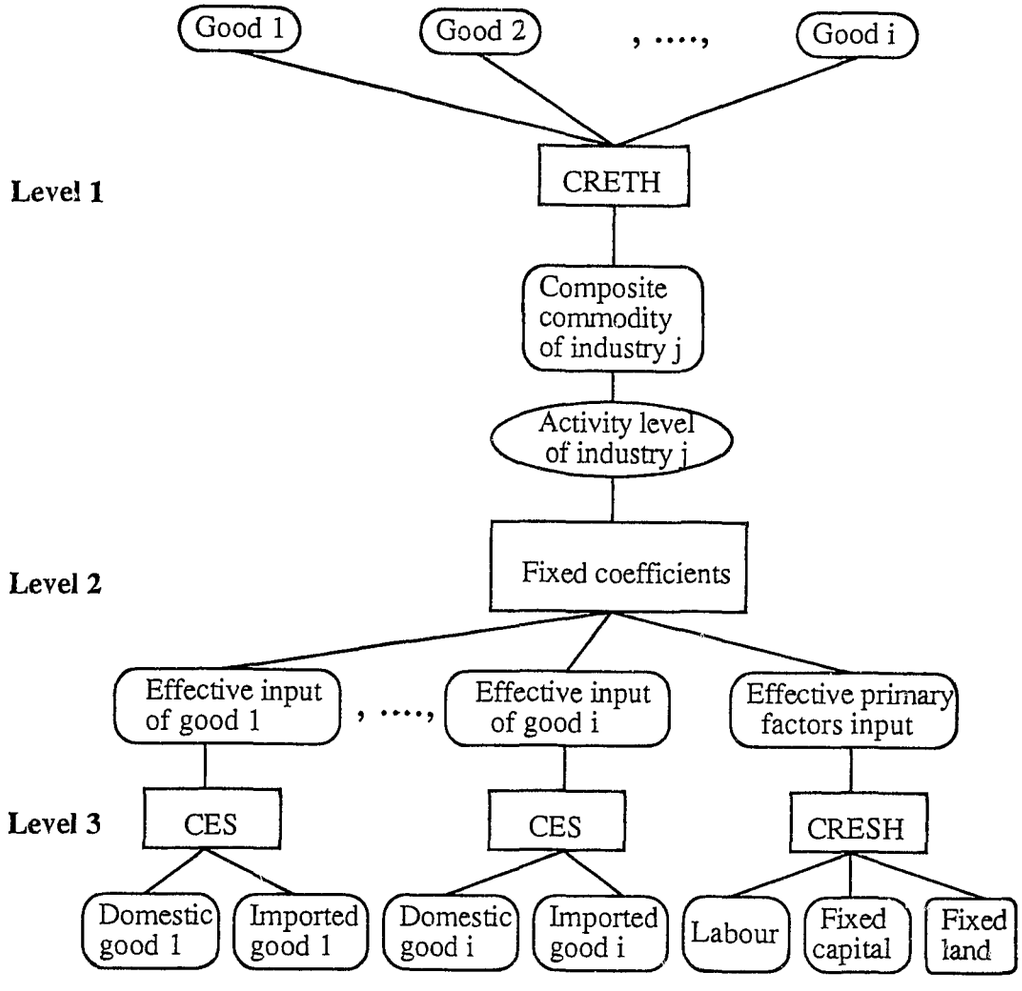
$$z_j = \min\{\frac{X_{1j}^{(1)}}{A_{1j}^{(1)}}, \frac{X_{2j}^{(1)}}{A_{2j}^{(1)}}, \ldots, \frac{X_{gj}^{(1)}}{A_{gj}^{(1)}}, \frac{X_{vj}^{(1)}}{A_{vj}^{(1)}}\} \tag{7.7}$$

The industry is viewed as buying an activity level or general production capacity (z_j). The supply decision (which bundle of commodities to produce) is based on producers' behaviour to maximize total revenue subject to purchased activity level and given technology. A case is the livestock industry in the China model which produces two products: wool and non-wool livestock products (Figure 7.7). The livestock industry purchases the activity level or the production frontier AA. Area OAA represents the feasible production combinations of wool and non-wool products. It is not difficult to

[3] *CRESH* (constant ratios of elasticities of substitution, homothetic) is a generalisation of *CES*, which defines that the ratio of the elasticity between inputs h and j to the elasticity between h and k must be equal to ratio of the elasticities between i and j, and i and k.

determine the output levels for two products (at point X), given the price levels (p_w and p_n).

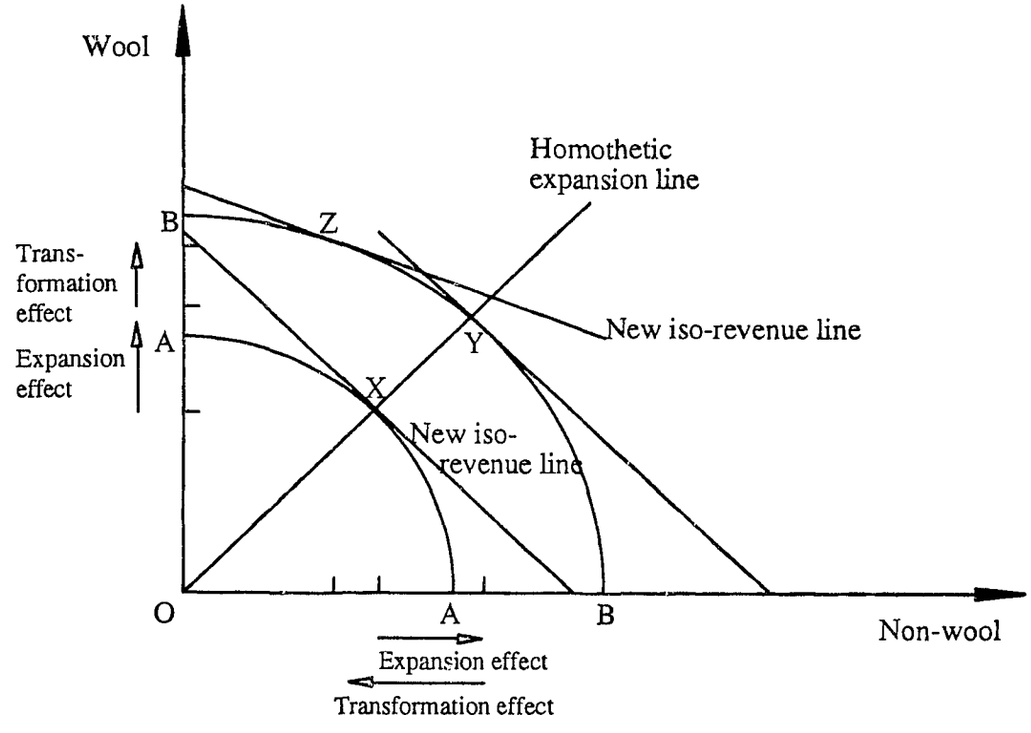
Figure 7.6 Technology of current production



Assuming that the price of wool increases from p_w to p_w' (a rotation from the original iso-revenue line to the new iso-revenue line), a producer will make two adjustments. First, a higher activity level of wool production, z_j', will result due to the higher composite price of wool. The production frontier shifts outward to BB, which is a product-neutral (homothetic) expansion of the old transformation frontier. This is the expansion effect (from point X to Y). Second, the product-mix will change in favour of

wool. Since the relative price of wool to non-wool products increases, product mix will move along the new transformation frontier to Z. This is referred to as the transformation effect.

Figure 7.7 Industry output decisions: the case of the livestock industry



In the model, the supply behaviour is specified as a *CRETH*[4] relation between products

$$x_{ij}^{(0)} = z_j + \sigma_{ij}^{(0)*}[p_i^{(0)} - \sum_i S_{ij}^{(0)*} p_i^{(0)}] \qquad (7.8)$$

where $x_{ij}^{(0)}$ is the supply of commodity i by industry j, $p_i^{(0)}$ is the producer price of good i, $\sigma_{ij}^{(0)*}$ is the *CRETH* parameter reflecting the ease of transformation between commodity i and other commodities in the output bundle of industry j, and $S_{ij}^{(0)*}$ is the modified output share of good i in sector j.

[4] *CRETH* represents a transformation process with Homothetic and Constant Ratios of Elasticities of Transformation.

Household and Other Final Demands

There are two households in the present China model: one urban and one rural, reflecting model structures on the production side and labour market characteristics. All the households within each group are assumed to be homogenous and their behaviour can be characterized by a single representation.

Each household in the model derives its income from returns to factors, capital, labour and land. It is assumed that the household, as a price taker in the market, maximizes a single utility function subject to an aggregate expenditure constraint. Substitutions are allowed between goods (by applying the linear expenditure system) and between sources, domestically produced or imported (through a *CES* mechanism) (Figure 7.8). The effects of changes in household preferences can be simulated via quantity-augmenting variables, $a_i^{(3)}$, with the demand specification

$$x_i^{(3)} = \varepsilon_i * c + \sum_l \eta_{(il)} p_l^{(3)} + a_i^{(3)} + \sum_l \eta_{(il)} [a_l^{(3)} + \sum_s S_{(ls)}^{(3)} a_{(ls)}^{(3)}] \qquad (7.9)$$

in which, a positive value of the quantity-augmenting variable indicates a change in preference in favour of good *i*.

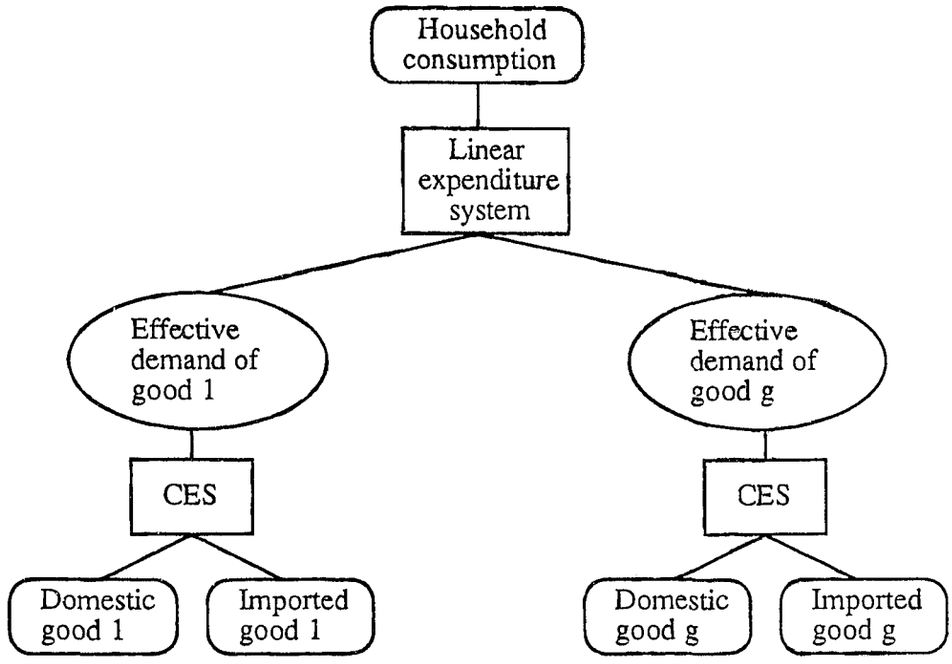
The other final demands include capital investment, stock and government consumption demands (export demand is not discussed here). As a short-run model, these demands are assumed to be changed proportionally to changes in absorption.

External Sector

In this model, the small economy assumption is maintained for the Chinese economy. This is a debatable assumption in the case China, particularly in respect of some products.

The external sector mainly involves two activities, exporting and importing. Import supply of each good to China by the world economy is specified as a function of the importing price with an elasticity set empirically.

Figure 7.8 Household consumption



The export market is separated into two parts, exports from China and exports from the rest of the world. The total world's demand for exported goods from these two regions is elastic to changes in composite exporting prices. Demand is substitutable between alternative sources and the substitution is modelled by a *CES* mechanism.

Equations of the Model

Tables 7.2, 7.3 and 7.4 present the equations, variables and parameters of the China model. All variables in the model are in the form of percentage change, unless otherwise indicated at levels. The equations of the model can be classified into ten groups.

The first group of equations define the input demands (both intermediate inputs and primary factors) of the industry production (Equations in group (I)). Equation (I.1) specifies the demand for intermediate inputs of commodities in the production process. This is derived from the producers' cost minimization problem according to the assumption, with possible technical changes incorporated (Dixon et al. 1982). It is first

assumed that there is no change in relative prices, so a change in z_j will lead to a proportional change in demand for each intermediate input by sector j. This reflects the assumption of constant returns to scale. If there are changes in the relative prices, suppose that the relative price of intermediate input m to n increases, then demand for m would increase less rapidly than z_j. Substitution will occur between the demands for m and n. The strength of this substitution will depend on the value of $S_{ji}^{(1)}$.

Equation (I.2) defines the demands for the primary factors, labour, capital and land, by each industry as a function of the output level in the industry and relative prices of each of the primary factor inputs.[5] The assumption is that factors can be aggregated into a composite primary factor bundle using a *CES* function. This demand equation form is obtained by imposing the first-order conditions for cost-minimization and linearized in percentage changes. Similarly, substitutions between primary factors are assumed and the strength of the substitution depends on the value of $\sigma_{vj}^{(1)}$.

Equations (I.3)-(I.6) give the characteristics of the labour market segmentation between rural and urban areas. Equations (I.3) and (I.4) calculate the composite wage rate in the two broad sectors. Equations (I.5) and (I.6) show how the two labour markets are cleared. Within the rural labour market, labour supply is equalled to total demands by the agricultural and rural industrial sectors, while urban supply of labour is equalled to total demands by urban sectors in the urban labour market.

Equations group (II) deal with commodity supply of the economy. Supply of commodities is modelled at two levels. First, total amounts of a commodity to be produced are determined and then a transformation mechanism is introduced to determine the proportion of output for domestic and export markets. The specification for non-agricultural sectors follows the usual ORANI format (Equation (II.1)). The amount produced depends on activity levels, technical factors and output prices. It is assumed that only its own price and the general price of the group it produces affect the

[5] Labour is assumed to be perfectly mobile within rural or urban areas.

supply level of a particular commodity. For agricultural sectors, individual price elasticities are included in the equation determining output levels (Equation (II.2)). However, since urban and rural industries produce the same products, total supply of one industrial product equals the sum of the outputs produced by both rural and urban industry (Equation II.4). Equation (II.5) specifies the imperfect transformation between domestically produced goods supplied to domestic and export markets. This equation is a linearization in percentage changes of the constant elasticity of transformation (*CET*) function, according Robinson (1988). The interpretation of this equation is similar to previous ones. When there is no relative price change between domestic and exported goods, the amounts supplied to both destinations will change proportionally to that of the total output of the product. Whenever the price for one destination increases relatively, the amount supplied to this destination will rise more rapidly. Finally, Equation (II.6) gives the composite commodity price for producers.

Household income and consumption are characterized in Equation group (III). As assumed, the households receive income from factor return (Equation (III.1)). The functional forms for consumption demand, Equations (III.2) and (III.3), contains two levels. The total demand for one commodity is dependent on income and prices (represented by relevant elasticities) and changes in preference ($a_i^{(3)}$). The distribution between domestic and imported sources of a commodity is determined by the price difference and substitution elasticity ($\sigma_i^{(3)}$ for commodity i).

Other final demands are specified simply in the model (Equation group (IV)). Investment in fixed capital (Equation (IV.1)), investment in stock (Equation (IV.2)) and government consumption (Equation (IV.3)), differentiated by sources of commodities, all keep step with the growth rate of the real absorption. These functional forms are, perhaps, too simplified for any further analysis related to these areas. This study, however, does not intend to make any efforts to investigate in detail the changes in capital stock or government consumption behaviour.

The next foreign trade group involves seven equations (Equation group (V)). Demand for China's export of each commodity of Equation (V.1) is represented applying a *CES* function consistent with the Armington (1969) model. Whether China's exports could grow faster than the rest of the world or not crucially depends on the relative prices of its exports in the world market and the relevant substitution elasticities. Equation (V.2) specifies total world demand, which is specified as a linear function of the weighted average price for the particular good, where the weights are the shares of China and the rest of the world in total exports of this good. Following Martin (1990), supply of imports, in Equation (V.3), is specified as a function of the world price of imports, allowing for the possibility of China being large in particular markets. Equation (V.4) specifies the imports volume by simply summing all the terms of imports together, and Equations (V.5) and (V.6) calculate the foreign currency value of imports and exports. The balance of trade is reflected in Equation (V.7).

The sixth group of equations focuses on the endogenous incentive distortion to agriculture (Equation group (VI)` [illegible] distortions are determined. It is [illegible] distortion in which the level of [illegible] in this case) is dependent on agr[illegible] agricultural population in total popula[illegible] world/market prices.

Equation group (VII) is a set of zero profit conditions. Equation (VI.1) states that the total revenue from production is equal to the intermediate input plus the returns to primary factors. This condition implicitly involves two assumptions, the assumption of constant returns to scale of the technology and that of sufficient competition to drive the pure profit at the margin to be zero. The zero profit in Equations (VI.3) and (VI.4) for importing and exporting are easy to understand and interpret. The only point that needs explanation concerns the conditions for the textile and commerce industry. There exist a gap between producer and user prices due to incentive distortion.

The Equation group of market clearing conditions contains six equations. Equation (VIII.1) tells that the domestic demand for good *i* from domestic sources must equal domestic production for the home market. Similarly, in Equation (VIII.2), the export of good *i* from China must be equal to domestic production for exporting. Equation (VIII.3) implies that the demand for labour by the two broad sectors -- agriculture and non-agriculture -- is equated to the total supply of labour. Equations (VIII.4) and (VIII.5) specify the equilibrium between labour demand and supply with each of the two broad sectors. The stock of capital and that of land in each sector, as we can see from Equations (VIII.6) and (VIII.7), are specified exogenously.

The equations in group (IX) are mostly identities or indexes. Equations (IX.1)-(IX.3) compute domestic absorption, GDP and absorption. Equation (IX.4) is an index of GDP deflator.

The last equation (Equation (X.1)) in group (X) is the equilibrium condition for the money market, with money supply on the left and the money demand on the right. Martin's model adopted a simpler equation for the purpose of price determination. Since Chow (1987) found that a 1 per cent increase in the money supply would raise official prices by one-third of 1 per cent, and if the true inflation in China is 2.5 times the official rate as Chow estimated, Martin argued that using of unity elasticity used in his model was reasonable. In Equation (X.1), a simple money market (money demand equals money supply) is incorporated explicitly to introduce some monetary effects in the Chinese economy.

A Model Closure

The complete model as specified in Table 2 contains (5gh+6h+26g+20) equations and (14gh+15h+33g+21) variables. This implies that the model is closed by assigned values to a selection of (7gh+9h+7g+1) exogenous variables.

The detailed structure of the model provides flexibility for analysing different policy issues, according to different purposes of analysis. The typical closure for the China model analyses incentive distortions to agriculture.

The first set of exogenous variables includes the foreign currency price of imports since the model contains no equations describing foreign supply conditions. Change in the price of imports is one important economic shock being examined in CGE models.

The second set of exogenous variables include tariffs and export taxes. Their exogenous setting allows computation of the effects of protection against imports on the domestic economy.

The other set of exogenous variables include factor endowments, such as labour, capital and agricultural land. Factor endowments largely determine the economic structure and any change in them (they usually do not change or change very slowly in the short run) will bring about economy-wide effects.

Capital and agricultural land are exogenously fixed for each industry. No increase in amount or movement across industries is assumed.

The next group of exogenous variables are quantity-augmenting variables, including those reflecting technical change and preference variations.

Some other policy measures are also set exogenously in this model. These include money supply, nominal exchange rate and the degree of labour stock in rural and urban areas.

State prices for cotton and wool are determined by other factors which, in turn, determine supplies of cotton and wool by farmers. Since demands must be higher than supply given these prices, markets for cotton and wool are finally cleared by pushing up user prices.

Table 7.2 Equations of the China model
(a linear system in percentage changes)

I. Demands for Intermediate and Primary Inputs

I.1 Demands for intermediate inputs, domestic and imported 2gh

$$x^{(1)}_{(is)j} = z_j - \sigma^{(1)}_{ij}[p^{(1)}_{(is)j} - \sum_s S^{(1)}_{(is)j} p^{(1)}_{(is)j}] + a^{(1)}_j + a^{(1)}_{ij} + a^{(1)}_{(is)j} - \sigma^{(1)}_{ij}[a^{(1)}_{(is)j} - \sum_s S^{(1)}_{(is)j} a^{(1)}_{(is)j}]$$

(s =1, domestic; 2, imported)

I.2 Industry demands for primary factors 3h

$$x^{(1)}_{vj} = z_j - \sigma^{(1)}_{vj}[p^{(1)}_{vj} - \sum_v S^{(1)*}_{vj} p^{(1)}_{vj}] + a^{(1)}_j + a^{(1)}_{vj} - \sigma^{(1)}_{vj}[a^{(1)}_{vj} - \sum_v S^{(1)*}_{vj} a^{(1)}_{vj}]$$

(v = labour, capital and agricultural land)

I.3 Composite rural wage 1

$$p^{(1)}_{1A} = \sum_j L^*_j p^{(1)}_{1j}$$

($j \in$ R, rural sectors)

I.4 Composite urban wage 1

$$p^{(1)}_{1N} = \sum_j L^{\#}_j p^{(1)}_{1j}$$

($j \in$ U, urban sectors)

I.5 Rural labour market equilibrium 1

$$l_R = \sum_j L^*_j x^{(1)}_{labour,j}$$

($j \in$ R, rural sectors)

I.6 Urban labour market equilibrium 1

$$l_U = \sum_j L^{\#}_j x^{(1)}_{labour,j}$$

($j \in$ U, urban sectors)

II. Supply of Commodities

II.1 Supply of commodity by non-agriculture, undifferentiated by destinations gN

$$x^{(0)}_{ij} = z_j + \sigma^{(0)*}_{ij}[p^{(0)}_i - \sum_l S^{(0)*}_{lj} p^{(0)}_l] - a^{(0)}_j - a^{(0)}_{ij} - \sigma^{(0)*}_{ij}[a^{(0)}_{ij} - \sum_l S^{(0)*}_{lj} a^{(0)}_{lj}]$$

($l \in$ n, commodities supplied by sector j; $j \in$ N, non-agricultural sectors)

II.2 Supply of commodity by agriculture, undifferentiated by destination gA

$$x^{(0)}_{ij} = z_j + \sum_l \sigma^{(A)*}_{(il)j} p^{(0)}_i - a^{(0)}_j - a^{(0)}_{ij}$$

($l \in$ a, commodities supplied by sector j; $j \in$ A, agricultural sectors)

II.3 Total supply of agricultural commodities 9

$$x_i^{(0)} = \sum_j S_{ij}^{(0)} x_{ij}^{(0)}$$

($j \in A$ agricultural sectors; $i \in a$ agricultural products)

II.4 Total supply of non-agricultural commodities 9

$$x_i^{(0)} = \sum_j S_{ij}^{(0)} x_{ij}^{(0)}$$

($j \in N$ non-agricultural sectors; $i \in n$ non-agricultural products)

II.5 Transformation in production, domestic and export 2gh

$$x_{(id)j}^{(0)} = x_{ij}^{(0)} + \sigma_{ij}^{\tau}[p_{(id)j}^{(0)} - \sum_d S_{(id)j}^{(0)} p_{(id)j}^{(0)}] - a_{(id)j}^{(0)}$$

($d = 1$, for domestic; 2, exporting)

II.6 Producers' commodity price g

$$p_i^{(0)} = \sum_d S_{(id)j}^{(0)} p_{(id)}^{(0)} + \sum_d S_{(id)j}^{(0)} a_{(id)j}^{(0)}$$

($d = 1$, for domestic, and 2, for exporting)

III. Household Income and Consumption

III.1 Consumer nominal income 2

$$c_T = \sum_j \sum_v S_{(vj)T}^{(c)} [p_{vj}^{(1)} + x_{vj}^{(1)}]$$

($T = r$ rural household for which $j \in R$ and $T = u$ urban household for which $j \in U$, and v = labour, capital and agricultural land)

III.2 Household demands for commodities classified by source 4g

$$x_{(is)T}^{(3)} = x_{iT}^{(3)} - \sigma_{iT}^{(3)}[p_{(is)}^{(3)} - \sum_s S_{(is)T}^{(3)} p_{(is)}^{(3)}] + a_{iT}^{(3)} + a_{(is)T}^{(3)} - \sigma_{iT}^{(3)}[a_{(is)T}^{(3)} - \sum_s S_{(is)T}^{(3)} a_{(is)T}^{(3)}]$$

($s = 1$, domestic; 2, imported; T = r, rural household; 2, urban household)

III.3 Household demands for commodities, undifferentiated by source 2g

$$x_{iT}^{(3)} = \varepsilon_{iT} * c_T + \sum_l \eta_{(il)T} p_l^{(3)} + a_{iT}^{(3)} + \sum_l \eta_{(il)T}[a_{lT}^{(3)} + \sum_s S_{(ls)T}^{(3)} a_{(ls)T}^{(3)}]$$

($s = 1$, domestic; 2, imported, $l \in$ g)

III. 4 Total household demand for commodities, differentiated by source 2g

$$x_{is}^{(3)} = \sum_T S_{iT}^{(3)} x_{(is)T}^{(3)}$$

(T = r, rural household; 2, urban household)

III.5 General price of each commodity to households g

$$p_i^{(3)} = \sum_s S_{(is)}^{(3)} p_{(is)}^{(3)} + \sum_s S_{(is)}^{(3)} a_{(is)}^{(3)}$$

($s = 1$, domestic; 2, imported)

IV. Other Final Demands

IV.1 Investment in fixed capital — 2g

$$x_{(is)}^{(2)} = a_R$$

(s = 1, domestically produced; 2, imported)

IV.2 Investment in stock — 2g

$$x_{*(is)}^{(2)} = a_R$$

(s = 1, domestically produced; 2, imported)

IV.3 Government consumption — 2g

$$x_{(is)}^{(5)} = a_R$$

(s = 1, domestically produced; 2, imported)

V. Foreign Trade

V.1 Export demand from China — g

$$x_i^{(4)} = x_{wi}^{(4)} - \sigma_i^{(4)}[p_{(is)}^e - \sum_s S_{(is)}^{(4)} p_{(is)}^e]$$

(s = 1, from China; 2, from the rest of the world)

V.2 World demand for export both from China and the rest of the world — g

$$x_{wi}^{(4)} = \beta_i \sum_s S_{(is)}^{(4)} p_{(is)}^e$$

(s = 1, from China; 2, from the rest of the World)

V.3 Import supply to China by the rest of the world — g

$$x_i^* = E_i p_i^m$$

V.4 Imports volume — g

$$x_{i2}^{(6)} = \sum_j C_{(i2)j}^{(1)} x_{(is)j}^{(1)} + C_{(i2)}^{(2)} x_{(is)}^{(2)} + C_{*(i2)}^{(2)} x_{*(is)}^{(2)} + C_{(i2)}^{(3)} x_{(is)}^{(3)} + C_{(i2)}^{(5)} x_{(is)}^{(5)}$$

(s=2, imported)

V.5 Foreign currency value of imports — 1

$$m = \sum_i [p_i^m + x_{(i2)}^{(6)}] * M_{(i2)}$$

V.6 Foreign currency value of exports — 1

$$e = \sum_i [p_i^e + x_i^{(4)}] * E_{i1}$$

V.7 The balance of trade — 1

$$100 * DB = E * e - M * m$$

VI. Endogenous Incentive Distortion and Rents for Grain, Wool and Cotton

VI.1 Endogenous setting of producers' prices (incentive distortions) 5

$$p_i^s = \gamma_{(iA)}^{(0)} S_A + \gamma_{(iR)}^{(0)} S_R + \gamma_{(iM)}^{(0)} M + \gamma_{(ip)}^{(0)} p^*$$

(i = rice, wheat, grain, cotton and wool)

VI.2 State prices for cotton and wool equal their producer prices 4

$$p_{(id)j}^{(0)} = p_i^s$$

(i = cotton and wool)

VII. Zero Pure Profits in Economic Activities

VII.1 Zero pure profit in production h

$$\sum_i^{N(j)} \sum_d S_{(id)j}^{(0)} p_{(id)}^{(0)} = \sum_i^g \sum_s S_{(is)j}^{(1)} p_{(is)j}^{(1)} + \sum_v S_{vj}^{(1)} p_{vj}^{(1)}$$

(N(j) the number of goods produced by industry j)

VII.2 Zero pure profit for importing g

$$p_{(is)j}^{(1)} = p_i^m + t_i + \phi$$

(s=2, imported)

VII.3 Zero pure profit for exporting g

$$p_{(id)j}^{(0)} = p_i^e + v_i + \phi$$

(d=2, exported)

VIII. Market Clearing Conditions

VIII.1 Market clearing in the domestic market, domestically produced g

$$x_{(id)j}^{(0)} = \sum_j S_{(is)j}^{(1)\#} x_{(is)j}^{(1)} + S_{(is)}^{(2)\#} x_{(is)}^{(2)} + S_{*(is)}^{(2)\#} x_{*(is)}^{(2)} + S_{(is)}^{(3)\#} x_{(is)}^{(3)} + S_{(is)}^{(5)\#} x_{(is)}^{(5)}$$

(d = 1, domestic destination, s = 1, domestic source)

VIII.2 Market clearing of exports g

$$x_{(id)j}^{(0)} = x_i^{(4)}$$

(d = 2, for exporting)

VIII.3 Capital market clearing h

$$x_{2j}^{(1)} = k_j$$

VIII.4 Agricultural land market clearing h

$$x_{3j}^{(1)} = l_j$$

IX. GDP and Real Absorption

IX.1 Domestic absorption of good i from all sources — g

$$x_i = \sum_i \sum_s [\sum_j B^{(1)}_{(is)j} x^{(1)}_{(is)j} + B^{(2)}_{(is)} x^{(2)}_{(is)} + B^{(2)}_{*(is)} x^{(2)}_{*(is)} + B^{(3)}_{(is)} x^{(3)}_{(is)} + B^{(5)}_{(is)} x^{(5)}_{(is)}]$$

($i \in$ g, $j \in$ h, and $s = 1$, domestic, $s = 2$, imported)

IX.2 Total output — 1

$$x^{(0)}_R = \sum_i B^{(0)}_{(i1)j} x^{(0)}_{ij}$$

IX.3 Real absorption — 1

$$a_R = \sum_i A_i x_i$$

IX.4 Price deflator for GDP — 1

$$p^y = \sum_i S^{\#}_i p^{(0)}_i$$

X. Money Market

X.1 Equilibrium in money market — 1

$$m^s = \sigma_{mp} p^y + \sigma_{ma} a_R + \sigma_{mr} r^*$$

Table 7.3 Variables of the Chins model
(all variables are percentage changes)

Variables	Number	Description
z_j	h	Industry activity levels
$x^{(1)}_{(is)j}$	2gh	Demand for inputs (domestic and imported) for current production
$x^{(1)}_{vj}$	3h	Demand for primary factors (labour, capital and agricultural land) for current production
$x^{(0)}_{(id)j}$	2gh	Supply of good *i* by industry *j* (domestic and exporting)
$x^{(0)}_{ij}$	gh	Supply of good *i* by industry *j*, undifferentiated by source
$x^{(2)}_{(is)}$	2g	Demand for investment in capital stock (domestic and imported)
$x^{(2)}_{*(is)}$	2g	Demand for investment in stock (domestic and imported)
$x^{(3)}_{(is)T}$	4g	Household demand for goods by type, source and household
$x^{(3)}_{iT}$	2g	Household demand for goods by type and household
$x^{(3)}_{is}$	2g	Household demand for goods by type and source
$x^{(3)}_{i}$	g	Household demands for goods, undifferentiated by source
$x^{(4)}_{i}$	g	Export demand from China by the rest of the world
$x^{(4)}_{wi}$	g	World demand for export both from China and the rest of the world
x^{*}_{i}	g	Imports supply to China by the rest of the world
$x^{(5)}_{(is)}$	2g	Government demands for goods by type and source
$x^{(6)}_{i2}$	g	Imports volume
$x^{(1)}_{1h}$	2	Labour in agriculture and non-agriculture ($h = A, N$)
$x^{(1)}_{1}$	1	Total supply of labour
$x^{(0)}_{(r1)j}$	h	Total outputs, by industry
$x^{(0)}_{(r1)}$	1	Total output
x_i	g	Domestic absorption of good *i* from all sources
$x^{(0)}_{R}$	1	Total output (GDP)

$p^{(1)}_{(is)j}$	2gh	Purchasers' prices for produced inputs for current production
$p^{(1)}_{vj}$	3h	Purchasers' prices for primary factors for current production
$p^{(0)}_{(id)j}$	2g	Prices of outputs (domestic and export)
p^{s}_{i}	5	State prices for rice, wheat, other grain, cotton and wool
$p^{(3)}_{(is)}$	2g	Consumers' price of good i from source s
$p^{(3)}_{i}$	g	General price of commodity to household
$p^{(4)}_{i}$	g	Local currency price of export (including export tax)
$p^{(0)}_{(i2)}$	g	Local currency prices of imports (including tariff)
$p^{e}_{(is)}$	2g	Foreign currency prices of exports from China and the rest of the world
p^{m}_{i}	g	Foreign currency prices of imports to China
$p^{(0)}_{i}$	gh	Prices of output
p^{y}	1	Price deflator for GDP
$p^{(1)}_{1h}$	2	Aggregate wage rates in agriculture and non-agriculture $(h = A, N)$
$a^{(1)}_{j}$	h	Neutral-input-augmenting technical change
$a^{(1)}_{ij}$	gh	Input - i - augmenting technical change
$a^{(1)}_{(is)j}$	2gh	Input - (is) - augmenting technical change
$a^{(0)}_{j}$	h	Neutral output - augmenting technical change
$a^{(0)}_{ij}$	gh	Output - i - augmenting technical change
a_{R}	1	Growth rate of real absorption
$a^{(3)}_{i}$	g	Commodity - i - augmenting change in households' preference
$a^{(3)}_{(is)}$	2g	Commodity - (is) - augmenting change in households' preference
$a^{(1)}_{1h}$	2	Factor causing - h (A,N) - augmenting change in labour allocation
$a^{(1)}_{vj}$	3h	Factor - v - augmenting technical change
$a^{(0)}_{(id)j}$	2gh	Destination - d - augmenting technical change in transformation

DB	1	The balance of trade (This is the variable in value rather than in percentage change)
k_j	h	Fixed capital stock in industry j
l_j	h	Fixed capital stock in industry j
c	1	Disposable income of urban and rural consumers
m	1	Foreign currency value of imports
e	1	Foreign currency value of exports
t_i	g	Tariff on imports
ϕ	1	Exchange rate
v_i	g	Export tax
m^s	1	Money supply
r	1	Interest rate

Table 7.4 Coefficients and Parameters of the China model

Equation Number	Coefficients or Parameters	Description
(I.1)	$\sigma_{ij}^{(1)}$	Elasticity of substitution between domestic and foreign sources of good i for use as a current input in the production of industry of j.
	$S_{(is)j}^{(1)}$	Share of purchasers-price value of good i from source s (s = 1 for domestic, s = 2 for imports) in industry j's total purchases of good i for use as a current input to production.
(I.2)	$\sigma_{vj}^{(1)}$	CRESH parameter reflecting the degree of substitutability between primary factor v (v = 1 for labour, v = 2 for capital, v = 3 for agricultural land) and other primary factors in the production process if industry j.
	$S_{vj}^{(1)*}$	Modified share of primary factor v in the total cost of primary factors used in industry j, defined as a function of the unmodified shares and the CRESH substitution parameters.
(I.3)(I.5)	L_j^*	Share of labour in each of rural industry ($j \in R$).
(I.4)(I.6)	$L_j^\#$	Share of labour in each of urban industry ($j \in U$).
(II.1)	$\sigma_{ij}^{(0)*}$	CRETH parameter reflecting the ease of transformability between commodity i and other commodities in the output bundle of industry j.
	$S_{ij}^{(0)*}$	Modified share of commodity i in total revenue of industry j defined as a function of unmodified share and the CRETH transformation parameter: $S_{ij}^{(0)*} = \sigma_{ij}^{(0)*} S_{ij}^{(0)} \Big/ \sum_{i}^{N(j)} \sigma_{ij}^{(0)*} S_{ij}^{(0)}$
(II.2)	$\sigma_{(il)j}^{(A)*}$	Price elasticity of supply of agricultural products (i) by agricultural industry (j) with respect to price of agricultural product (l).
(II.3)(II.4)	$S_{ij}^{(0)}$	Share of industry j in total output of i.
(II.5)	σ_{ij}^{τ}	Elasticity of substitution between domestic and export production of good i.
	$S_{(id)j}^{(0)}$	Revenue share of commodity i produced for destination d (d = 1 for domestic market, d = 2 for export) in total revenue derived from the production of commodity i.
(III.1)	$S_{vj}^{(c)}$	Household income share of return from factor v of industry j.
(III.2)	$\sigma_{iT}^{(3)}$	Elasticity of substitution between domestic and foreign sources of good i for use by household T.

	$S^{(3)}_{(is)T}$	Share of the purchasers value of good i from sources s in the total purchases of good i by household T.
(III.3)	ε_{iT}	Household expenditure elasticity of demand for good i from either source.
	$\eta_{(il)T}$	Household elasticity of demand for good i in general with respect to changes in the general household purchasers' price for good l.
(III.4)	$S^{(3)}_{iT}$	Household T's share in total household demand for i.
(III.5)	$S^{(3)}_{(is)}$	Share of good i from source s in total household demand for i.
(V.1)	$\sigma^{(4)}_i$	Elasticity of substitution between Chinese and rest of the world products in world market for commodity i.
	$S^{(4)}_{(is)}$	Share of China and the rest of the world in world export market for commodity i.
(V.2)	β_i	Global elasticity of excess demand for commodity i.
(V.3)	E_i	Elasticity of import supply for commodity i to China.
(V.4)	$C^{(1)}_{(i2)j}$	Share of imports of good i which is absorbed by industry j for purpose of intermediate input.
	$C^{(2)}_{(i2)}$	Share of imports of good i absorbed by fixed capital investment.
	$C^{*(2)}_{(i2)}$	Share of imports of good i absorbed by stock investment.
	$C^{(3)}_{(i2)c}$	Share of imports of good i for the use of households c.
	$C^{(5)}_{(i2)}$	Share of imports of good i for the use of government consumption.
(V.5)	M_{i2}	Share in foreign currency cost of total imports which is accounted for by imports of commodity i.
(V.6)	E_{i1}	Share in total export earnings which is accounted for by exports of commodity i.
(V.7)	M	Aggregate foreign currency value of imports.
	E	Aggregate foreign currency value of exports.
(VI.1)	$\gamma^{(0)}_{(im)}$	Elasticity of change in the incentive distortion of good i (grain, cotton or wool) with respect to change in world market price.
	$\gamma^{(0)}_{(i\varphi)}$	Elasticity of change in the incentive distortion of good i (grain, cotton or wool) with respect to change in farmers' feasible choice set.

	$\gamma^{(0)}_{(iA)}$	Elasticity of change in the incentive distortion of good i (grain, cotton or wool) with respect to change in agriculture's share in the national economy.
	$\gamma^{(0)}_{(ip)}$	Elasticity of change in the incentive distortion of good i (grain, cotton or wool) with respect to change in GDP deflator.
(VII.1)	$S^{(0)}_{(id)j}$	Revenue share of production of commodity i for destination d in total revenue of production of commodity i by industry j.
	$S^{(1)}_{(is)j}$	Cost share of intermediate input i from source s in total cost of production by industry j.
	$S^{(1)}_{vj}$	Cost share of primary factor v in total cost of production in industry j.
(VII.2)	$S^{(0)}_{(h)j}$	Revenue share of rents from transaction of commodity h (cotton or wool) in total revenue of production of commodity i by industry j (textile or commerce industries only).
(VIII.1)	$S^{(1)\#}_{(is)j}$	(For s = 1) Share of commodity i from domestic source used by industry j as intermediate input in total amount of domestic production for domestic market.
	$S^{(2)\#}_{(is)}$	(For s = 1) Share of commodity i from domestic source used for fixed capital investment in total amount of domestic production for domestic market.
	$S^{(2)\#}_{*(is)}$	(For s = 1) Share of commodity i from domestic source used for stock investment in total amount of domestic production for domestic market.
	$S^{(3)\#}_{(is)c}$	(For s = 1) Share of commodity i from domestic source used for consumption by households c in total amount of domestic production for domestic market.
	$S^{(5)\#}_{(is)}$	(For s = 1) Share of commodity i from domestic source used for government consumption in total amount of domestic production for domestic market.
(IX.1)	$B^{(1)}_{(is)j}$	Share of intermediate input i from source s used by industry j in total absorption of commodity i.
	$B^{(2)}_{(is)}$	Share of fixed capital investment i in total absorption of commodity i.
	$B^{(2)}_{*(is)}$	Share of stock investment i in total absorption of good i.
	$B^{(3)}_{(is)}$	Share of household's consumption in total absorption of commodity i.
	$B^{(5)}_{(is)}$	Share of government consumption of good i in total absorption of this commodity.
(IX.2)	$B^{(0)}_{(i1)}$	Share of output i in total output of the economy.

(IX.3)	A_i	Share of good i in real absorption.
(IX.4)	$S_i^{\#}$	Revenue share of good i in total GDP.
(X.1)	σ_{mp}	Price elasticity of demand for money.
	σ_{ma}	Income elasticity of demand for money.
	σ_{mr}	Interest elasticity of demand for money.

Appendix 7A

Construction of a 22-Sector Input-Output Table for China, 1987

This table is constructed on the basis of the China 117-sector input-output table constructed by the State Statistical Bureau and the Office of the National Input-Output Survey (1991). The building of this 30-Sector Input-Output Table takes three steps. The first is to derive new sectors by splitting some of the existing sectors in the larger table according to input-output information; the second is to aggregate the other sectors; and the third is to estimate the value added shares for each primary factor.

Deriving the New Sectors

Some of the sectors required in the 30-sector version do not appear individually in the 117*117 version. For instance, there is only one Grain Cropping Sector in the original table, so we have to split this grain sector into *Rice*, *Wheat* and *Other grains*. Likewisely, *Cotton* and *Other crops* have to be separated from the existing other crop classification. Again, *Wool* has to be derived from the livestock sector.

Martin derived a new sector from an aggregate sector by estimating a gross output value for the new sector using the value of its imports and the ratio of gross output to imports (Martin 1990). In this work, we obtain the gross output value of *Paddy rice*, *Wheat*, and *Other grain* by multiplying the gross output (*China Statistical Yearbook 1988*) and the average prices (*China Price Statistical Yearbook 1988*). The values of imports and exports are obtained from the *China Statistical Yearbook 1988*, and converted from US dollars to RMB yuan, accounting for changes in the exchange rate. In splitting the three grain sectors from an aggregate grain cropping sector, assumptions are made that in general the shares for all intermediate inputs and value adding factors were the same as those for the total grain cropping sector, and that shares of intermediate and final use of each grain were the same. However, the net exports were directly derived from the statistical yearbook, and adjustment was made to the Grain's intermediate use as input of husbandry sector and final use for consumption. In China, very little rice and wheat was used as feed for the livestock production. Since there is no better information, we assume that, of the total amount of grain input to the husbandry sector, 85 per cent was grains other than wheat and rice, 10 per cent was wheat and 5 per cent was rice. The allocation of grain for consumption was also readjusted in association with the above adjustment. This second adjustment is consistent with an increasingly high share of rice and wheat in direct consumption in China. Furthermore, this adjustment guarantees the sums of intermediate and final use of each grain to be consistent with those in the aggregate sector.

The *Wool* sector was derived from the livestock sector in the same manner. However, more adjustments were made to the *Wool* sector since it in general has some differences from the aggregate husbandry sector in the sense of both production inputs and the use of its output. Gross output value and the net exports were obtained from the statistical yearbook. Following Martin, wool input use was allocated to sectors which used animal husbandry inputs. Since, in most cases, these allocations involved very small amounts, with the exception of the textile industry, which was assumed to use more than 90 per cent of total value of wool use. Wool investment into capital formation and stock change were set at zero. For the inputs used in wool production, we apply the same shares of

inputs-gross output value in Martin's table to estimate the production inputs used by wool.

Aggregating Sectors

In the 117-sector version, other agricultural production contains wild plant collecting, wild animal hunting, and small scale handicrafts making and industrial producing. It is difficult to add it to any of the newly created 22 sectors. However, since gross output value was not large (a bit more than 6 per cent of total agricultural output value in 1987), it was added to the sector of other livestock and livestock products.

The other sectors are aggregated to accord with production technology. Caution was also taken to distinguish the export-competing and import-substituting sectors following Clarete and Warr (1992). Table 7A.1 shows the transformation relationship of the 117-sector to 22-sectors.

Estimating Shares of Primary Factors

By deducting the value of intermediate inputs from gross output, we obtain the net revenue for each sector. Following Martin, for the non-agricultural sectors, the return to land was assumed to be zero. So, the return to capital was derived simply by deducting the total wage bill (which was the return to labour) from the net revenue. For 8 agricultural sectors, the situation is complicated since the total wage bill may contain certain parts of the return to labour, profit, returns to capital and land, due to self-employment. The results by McMillan, Whalley and Zhu (1989) are applied, that is, of the total net revenue, factor shares of 59 per cent for labour, 12 per cent for capital and 29 per cent for land.

The derived China 22-sector input-output table is presented in Table 7A.2.

Table 7A.1 Sectors derived from the China 117-sector I/O table

Rice (Paddy rice)
Derived from
01101 Grain crop cultivation (see part 1)

Wheat (Wheat) (see part 1)
Derived from
01101 Grain crop cultivation (see part 1)

Grain (Grain other than wheat and rice)
Derived from
01101 Grain crop cultivation (see part 1)

Cotton (Cotton)
Derived from
01109 Other crop cultivation

Crops (Other crops)
Derived from
01109 Other crop cultivation

Wool (Wool)
Derived from
01300 Livestock production (see part 1)

Animals (Other livestock and livestock products)
Derived from
01300 Livestock production, and adding
01400 Other agricultural production (see part 1)

Forestry (Forestry products)
01200 Forestry

Fishing (Fishery products)
01500 Fishing

Mineral (urban) (Coal, oil, gas and their products and other minerals)
Mineral (rural) (Coal, oil, gas and their products and other minerals)
Derived from
02100 Coal mining
02200 Coal cleaning and screening
03100 Crude petroleum production
03200 Natural gas production
12000 Petroleum refineries
13001 Coking
13002 Manufacture of gas and coal products
04100 Ferrous ore mining
04200 Non-ferrous ore mining
05100 Quarrying of building materials and non-metal minerals
05200 Salt mining
05300 Logging and transport of timber and bamboo
05400 Production and supply of water

Food (urban) (Food processing)
Food (rural) (Food processing)
Derived from
06102 Slaughtering and preparing meat
06103 Manufacture of egg and dairy products
06101 Grain mill products and vegetable oil manufacturing
06104 Fish processing
06105 Sugar refining
06109 Manufacture of food products not elsewhere classified
06201 Wine and spirits industries
06400 Forage manufactures
06209 Manufacture of beverages
06300 Tobacco manufactures

Textile (urban) (Textile goods)
Textile (rural) (Textile goods)
Derived from
07001 Manufacture of cotton textiles
07200 Manufacture of woollen textiles
07003 Manufacture of hemp textiles
07004 Manufacture of silk textiles
07005 Knitting mills
07009 Manufacture of textiles not elsewhere classified
08100 Manufacture of wearing apparel
08200 Leather, fur and their products

Non-metal (urban) (Non-metal manufactured goods)
Non-metal (rural) (Non-metal manufactured goods)
Derived from
09100 Sawmills and manufacture of fibreboard
09200 Manufacture of furniture and other wood products
14300 Manufacture of chemical fibres
10100 Manufacture of paper and paper products
10200 Printing industries
10300 Manufacture of articles for cultural activities. education, sports, arts and crafts
14101 Manufacture of basic chemicals
14102 Manufacture of chemical fertilizers
14103 Manufacture of chemical pesticides
14104 Manufacture of organic chemical products
14105 Manufacture of chemical products for daily use
14106 Manufacture of synthetic chemicals
14109 Other chemical industries
11200 Manufacture of medicines
14401 Manufacture of rubber products for production use
14402 Manufacture of rubber products for daily use
14501 Manufacture of plastic products for production use
14502 Manufacture of plastic products for daily use
15001 Manufacture of cement
15002 Manufacture of cement and asbestos products
15003 Manufacture of bricks, tiles, lime and light-weight building materials
15004 Manufacture of glass and glass products
15005 Manufacture of pottery, china and earthenware
15006 Manufacture of fireproof materials
15009 Manufacture of non-metallic mineral products not elsewhere classified
16100 Primary iron and steel manufacturing

Metal (urban) (Iron, steel, machinery and other metal manufactured goods)
Metal (rural) (Iron, steel, machinery and other metal manufactured goods)
Derived from
16200 Primary non-ferrous metals manufacturing
17001 Manufacture of metal products for production use
17002 Manufacture of metal products for daily use
18001 Manufacture of boilers, engines and turbines
18002 Manufacture of metalworking machinery
18003 Manufacture of special industrial machinery and equipment
18004 Manufacture of agricultural, forestry, animal husbandry and fishing machinery
18005 Manufacture of machinery for daily use
18006 Manufacture of special equipment not elsewhere classified
18009 Manufacture of machinery not elsewhere classified
20001 Manufacture of generators
20002 Manufacture of household electrical appliances
20009 Manufacture of electric machinery not elsewhere classified
21001 Manufacture of computers
21002 Manufacture of electronic appliances
21009 Manufacture of electronic and telecommunication equipment not elsewhere classified
22000 Manufacture of instruments, meters and other measuring equipment
23000 Maintenance and repair of machinery and equipment
24001 Manufacture of products for production use not elsewhere classified.
24002 Manufacture of products for daily use not elsewhere classified
19001 Manufacture of railroad transport equipment
19002 Manufacture of motor vehicles
19003 Ship building
19004 Manufacture of aircraft
19005 Manufacture of transport equipment not elsewhere classified

Electricity (urban) (Electricity, gas and water)
Electricity (rural) (Electricity, gas and water)
Derived from
11000 Electricity, steam and hot water production and supply

Construction (urban) (Construction)
Construction (rural) (Construction)
Derived from
25000 Construction

Trade&trans. (urban) (Trade and transportation)
Trade&trans. (rural) (Trade and transportation)
Derived from
26101 Railway freight transport
26102 Highway freight transport
26103 Water freight transport
26104 Air freight transport
26105 Pipeline transport
26200 Communications
27101 Domestic and foreign trade
27102 Trade of grain and cooking oils
27200 Supply and marketing of materials and storage
28000 Restaurants
29001 Railway passenger transport
29002 Highway passenger transport
29003 Water passenger transport
29004 Air passenger transport

Service (urban) (Private and public services, inclusing housing)
Service (rural) (Private and public services, inclusing housing)
Derived from

30100 Real estate
30200 Public utilities
30300 Services to household
31101 Health service
31102 Sports
31103 Social welfare institutions
31201 Education services
31202 Cultural services, arts, radio and television broadcasting
31301 Research and scientific institutions
31302 General technical services
32001 Financial institutions
32002 Insurance
33000 Public administration

Table 7A.2a 22-sector input-output table for China, 1987: imports (million RMB yuan)

	Agricultural sectors				Mineral		Food processing		Textile		Non-metal		Metal		Electricity	
	Farming	Animals	Forest	Fish	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheat	657	185	0	30	0	0	1042	170	5	2	46	20	0	0	0	0
Grain	133	153	0	4	0	0	149	24	0	0	7	3	0	0	0	0
Cotton	0	0	0	0	3	0	0	0	764	328	59	25	8	2	0	0
Crops	29	16	0	0	0	0	77	13	35	15	13	6	0	0	0	0
Wool	0	0	0	0	0	0	0	0	1365	585	31	13	9	3	0	0
Animals	0	2	0	0	0	0	5	0	2	0	2	0	0	0	0	0
Forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	0	4	0	0	7	1	0	0	0	0	0	0	0	0
Mineral	53	13	6	13	676	138	21	3	16	7	519	223	518	155	397	8
Food	148	308	0	45	2	0	531	87	30	13	110	47	11	3	1	0
Textile	37	24	2	1	44	9	24	4	3035	1301	602	258	291	87	14	0
Non-metal	2841	77	68	36	406	83	552	90	1012	434	6499	2785	3130	935	94	2
Metal	558	115	38	110	1668	342	274	45	460	197	3587	1537	28563	8532	425	9
Elect	11	2	0	0	21	4	4	0	6	2	66	28	58	17	6	0
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trade&trans.	7	3	0	0	5	1	18	3	14	6	19	8	25	7	2	0
Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intermediate	4476	898	117	245	2825	579	2705	440	6746	2891	11560	4954	32613	9742	939	19

Table 7A.2a 22-sector input-output table for China, 1987: imports (million RMB yuan) (continued)

	Construction		Trade&trasn.		Service		Int'diate	Household		Gov't	Investment			Final
	Urban	Rural	Urban	Rural	Urban	Rural	input	Rural	Urban	cons.	Capital	Stock	Import	use
Rice	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wheat	0	0	4	0	16	5	2183	2423	362	3	0	99	5071	2888
Grain	0	0	0	0	2	0	478	145	22	0	0	0	639	167
Cotton	0	0	0	0	13	4	1207	0	0	0	66	588	1861	654
Crops	0	0	9	2	2	0	218	173	136	0	0	0	520	309
Wool	0	0	0	0	0	0	2006	0	0	0	0	0	2004	0
Animals	0	0	1	0	0	0	18	20	6	0	0	2	47	29
Forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fishing	0	0	10	2	0	0	24	25	24	0	0	5	75	54
Mineral	294	109	360	74	146	44	3791	152	115	0	0	0	4038	267
Food	4	2	233	48	34	10	1669	1362	1642	127	0	139	4940	3271
Textile	94	35	200	41	121	36	6261	1737	1394	78	0	441	9910	3649
Non-metal	4767	1763	909	186	2356	704	29731	689	1961	426	89	387	33283	3552
Metal	9245	3419	2080	426	2478	740	64848	5336	4875	148	22926	4177	102311	37463
Elect	11	4	10	2	15	5	276	8	19	0	0	0	300	27
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trade&trans.	14	5	8	2	15	5	169	34	30	15	10	8	266	97
Service	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Intermediate	14429	5337	3826	784	5200	1553	112879	12105	10585	798	23092	5846	165265	52427

Table 7A.2b 22-sector input-output table for China, 1987: Domestic goods (million RMB yuan)

	Agricultural sectors				Mineral		Food processing		Textile		Non-metal		Metal		Electricity	
	Farming	Animals	Forest	Fish	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Rice	9259	850	9	453	0	0	15635	2545	74	32	684	293	0	0	0	0
Wheat	5387	1516	5	248	0	0	8549	1392	40	17	374	160	0	0	0	0
Grain	12443	14301	8	404	0	0	13948	2271	66	28	610	261	0	0	0	0
Cotton	0	0	0	0	22	5	0	0	6182	2649	480	206	62	19	0	0
Crops	6553	3604	88	58	19	4	17513	2851	8068	3458	3017	1293	10	3	6	0
Wool	0	0	0	0	0	0	0	0	[illegible]	394	21	9	6	2	0	0
Animals	1996	4737	113	75	144	29	11416	1858	[illegible]	2068	4662	1998	259	77	18	0
Forest	687	1143	2489	108	555	114	198	32	[illegible]	19	4385	1879	467	140	84	2
Fishing	0	0	0	1099	0	0	1801	293	0	0	51	22	0	0	0	0
Mineral	1390	345	146	348	17827	3651	546	89	411	176	13698	5871	13664	4081	10464	214
Food	5210	10835	10	1573	75	15	18670	3039	1070	458	3864	1656	388	116	35	0
Textile	658	421	39	26	770	158	425	69	53542	22946	10625	4553	5131	1533	248	5
Non-metal	28566	771	688	366	4085	837	5553	904	10179	4363	65345	28005	31476	9402	946	19
Metal	2335	480	160	458	6977	1429	1147	187	1923	824	15001	6429	119452	35680	1776	36
Elect	1545	281	51	66	2894	593	609	99	788	338	9242	3961	8186	2445	876	18
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trade&trans.	5845	2547	379	403	3987	817	14205	2312	11051	4736	14807	6346	19592	5852	1693	35
Service	4953	1686	371	872	1272	261	3814	621	3748	1606	6528	2798	9980	2981	405	8
Intermediate	86826	43519	4558	6558	38628	7912	114028	18563	102932	44114	153394	65740	208673	62331	16552	338

Table 7A.2b 22-sector input-output table for China, 1987: Domestic goods (million RMB yuan) (continued)

	Construction		Trade&trasn.		Service		Int'diate	Household		Gov't	Investment			Final	Total
	Urban	Rural	Urban	Rural	Urban	Rural	input	Rural	Urban	cons.	Capital	Stock	Export	use	output
Rice	0	0	65	13	243	73	30228	30726	4591	39	0	1513	698	37567	67796
Wheat	0	0	36	7	133	40	17903	19874	2970	26	0	816	0	23685	41588
Grain	0	0	58	12	217	65	44693	13540	2023	18	0	-555	1404	16430	61129
Cotton	0	0	0	0	104	31	9758	0	0	0	538	4751	56	5345	15104
Crops	163	60	2047	419	385	115	49734	39388	30947	211	0	-1749	12465	81263	131005
Wool	0	0	0	0	0	0	1352	0	0	0	0	-5	0	-5	1350
Animal	470	174	2303	472	424	127	38246	42834	13527	369	1076	3548	5316	66670	104916
Forest	227	84	146	30	242	72	13148	725	608	0	8181	-979	516	9051	22198
Fishing	0	0	2633	539	222	66	6729	6912	6577	44	0	1473	1747	16753	22486
Mineral	7749	2866	9506	1947	3851	1150	99995	4008	3024	0	0	-525	9005	15512	115528
Food	151	56	8174	1674	1212	362	58642	47862	57691	4474	0	4874	11157	126057	184698
Textile	1649	610	3529	723	2135	638	110432	30642	24580	1367	0	7784	37978	102352	212783
Non-metal	47931	17728	144	1873	23686	7075	298940	6926	19714	4284	898	3892	24641	60355	359294
Metal	38662	14300	8699	1782	10364	3096	271197	22316	20390	620	95879	17468	40095	196767	467963
Elect	1611	596	1467	301	2152	643	38764	1118	2608	0	0	-310	0	3416	42183
Construction	0	0	0	0	0	0	0	0	0	0	243056	0	0	243056	243056
Trade&trans.	10802	3995	6647	1361	11936	3565	132915	27049	23987	11533	7597	6593	0	76759	209674
Service	1366	505	22124	4531	13648	4077	88154	27979	37501	109209	215	-1097	2694	176501	264654
Intermediate	110784	40975	76578	15685	70951	21193	1310830	321898	250739	132194	357440	47492	147772	1257534	2567405

Table 7A.2c 22-sector input-output table for China, 1987: Total (million RMB yuan)

	Agricultural sectors				Mineral		Food processing		Textile		Non-metal		Metal		Electricity	
	Farming	Animals	Forest	Fish	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Rice	9259	850	9	453	0	0	15635	2545	74	32	684	293	0	0	0	0
Wheat	6044	1700	6	278	0	0	9591	1561	45	19	419	180	0	0	0	0
Grain	12576	14454	8	409	0	0	14097	2295	66	28	616	264	0	0	0	0
Cotton	0	0	0	0	25	5	0	0	6946	2977	539	231	70	21	0	0
Crops	6582	3619	89	58	19	4	17590	2863	8103	3473	3030	1299	10	3	6	0
Wool	0	0	0	0	0	0	0	0	2285	979	53	23	14	4	0	0
Animals	1997	4739	113	75	144	29	11422	1859	4828	2069	4665	1999	259	77	18	0
Forest	687	1143	2489	108	555	114	198	32	45	19	4385	1879	467	140	84	2
Fishing	0	0	0	1103	0	0	1808	294	0	0	52	22	0	0	0	0
Mineral	1442	363	152	361	18503	3790	567	92	427	183	14217	6093	14182	4236	10860	222
Food	5358	11141	10	1617	77	16	19201	3126	1100	471	3974	1703	399	119	36	0
Textile	695	445	42	28	814	167	449	73	56577	24247	11227	4812	5422	1620	262	5
Non-metal	31407	848	756	403	4491	920	6105	994	11192	4796	71843	30790	34607	10337	1040	21
Metal	2893	595	199	568	8645	1771	1422	231	2383	1021	18588	7966	148015	44212	2201	45
Elect	1556	283	51	66	2915	597	613	100	794	340	9308	3989	8244	2463	882	18
Construction	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trade&trans.	5853	2551	380	404	3992	818	14223	2315	11065	4742	14826	6354	19617	5860	1696	35
Service	4953	1686	371	872	1272	261	3814	621	3748	1606	6528	2798	9980	2981	405	8
Intermediate	91301	44417	4674	6803	41453	8490	116733	19003	109678	47005	164954	70695	241286	72073	17491	357
Factor returns																
Labour	132839	36491	10339	9253	11843	2426	6299	1025	11780	5048	23476	10061	30011	8964	2524	52
Capital	27018	7422	2103	1882	42592	8724	35808	5829	27491	11782	63076	27033	89035	26595	21324	435
Land	65464	17936	5082	4548												
Total cost	316622	106266	22198	22486	95888	19640	158840	25858	148948	63835	251506	107788	360332	107631	41339	844

Table 7A.2c 22-sector input-output table for China, 1987: Total (million RMB yuan) (continued)

	Construction		Trade&trans.		Service		Int'diate	Household		Gov't	Investment		Foreign trade		Final	Total
	Urban	Rural	Urban	Rural	Urban	Rural	input	Rural	Urban	cons.	Capital	Stock	Import	Export	use	output
Rice	0	0	65	13	243	73	30228	30726	4591	39	0	1513	0	698	37567	67796
Wheat	0	0	40	8	149	45	20086	22297	3332	29	0	915	5071	0	26573	41588
Grain	0	0	59	12	219	65	45171	13685	2045	18	0	-555	639	1404	16597	61129
Cotton	0	0	0	0	116	35	10965	0	0	0	604	5339	1861	56	5999	15104
Crops	164	61	2055	421	387	115	49952	39561	31083	212	0	-1749	520	12465	81572	131005
Wool	0	0	0	0	0	0	3358	0	0	0	0	-5	2004	0	-5	1350
Animals	470	174	2304	472	425	127	38264	42854	13533	369	1077	3550	47	5316	6698	104916
Forest	227	84	146	30	242	72	13148	725	608	0	8181	979	0	316	9050	22198
Fishing	0	0	2643	541	223	67	6753	6937	6601	44	0	1478	75	1747	15808	22486
Mineral	8043	2975	9867	2021	3997	1194	103786	4160	3139	0	0	-525	4038	9005	15780	115528
Food	155	57	8406	1722	1246	372	60311	49224	59333	4601	0	5013	4940	11157	129327	184698
Textile	1743	645	3729	764	2256	674	116693	32379	25974	1445	0	8225	9910	37978	106000	212783
Non-metal	52698	19491	10053	2059	26041	7779	328671	7615	21675	4710	987	4279	33283	24641	63907	359294
Metal	47906	17719	10779	2208	12842	3836	336045	27652	25265	768	118805	21645	102311	40095	234230	467963
Elect	1623	600	1478	303	2167	647	39040	1126	2627	0	0	-310	300	0	3443	42183
Construction	0	0	0	0	0	0	0	0	0	0	243056	0	0	0	243056	243056
Trade&trans.	10816	4000	6656	1363	11951	3570	133084	27083	24017	11548	7607	6601	266	0	76855	209674
Service	1366	505	22124	4531	13648	4077	88154	27979	37501	109209	215	-1097	0	2694	176500	264654
Intermediate	125214	46312	80404	16468	76150	22746	1423707	334003	261324	132990	380260	53610	165263	147771	1308959	2567403
Factor returns																
Labour	36090	13348	48793	9994	64909	19389										
Capital	16128	5965	44832	9182	62724	18736										
Land																
Total cost	177431	65625	174029	35645	203784	60870										

8

Changes in the Economic Environment and Agricultural Adjustment

The effects of policy can be of two kinds, that which changes the feasible choice set (factor mobility) and that which affects the incentive structure in the economy. A single policy measure may affect both. A monetary expansion may expand farmers' feasible choice set outside agriculture thus increasing the potential mobility of agricultural factors. It may also lead to a change in relative prices, particularly when price controls are present.

The computable general equilibrium (CGE) model is applied here to examine the effects of policy changes on agricultural performance. Following one of the major arguments of this study, price policies, for example state purchase price of grain, are determined endogenously. The exogenous shocks of interests to this study include:

- changes in the world market
- economic reforms such as tariff reduction
- variations in macroeconomic policies
- a rapid expansion of rural industry
- improvement of labour mobility between urban and rural areas.

The exogenous shocks are designed to illustrate how Chinese agriculture reacts, within the economic framework modelled in this study, to various shocks and policy changes.

Before economic reform, the Chinese economy was almost an autarky, and internally, individual sectors were insulated from each other. Not only did changes in the world market have little effect on the domestic economy, but changes in one sector had very limited impact on other sectors. Economic reforms, however, have been raising the degree of economic integration with the economy between the Chinese economy and the

rest of the world. Simulations of changes to the world market and rapid expansion of the rural industry (the 'Dutch Disease') are designed to show interdependence between the agricultural sector and the rest of the economy.

Tariff reform and monetary expansion are also introduced to show economic interdependence. Simulation of a tariff reduction on wool — one key product of interest to this study — has direct and indirect impacts on wool production, textile production and other parts of the economy at the same time. Simulation of monetary expansion exposes an important effect that money may have in a semi-marketized economy. Money may not be neutral in the presence of price distortions. A change in money supply therefore influences the real structure of the economy.

Most indirect effects are created by the increasing degree of economic integration, both externally and internally. Economic reform in China, however, is far from complete. Labour market segmentation between rural and urban areas persists. This is one of the key characteristics of the current Chinese economy limiting the indirect effects of exogenous shocks. The simulation of labour market reform is therefore designed to show the cost incurred by the Chinese economy due to limited labour mobility and the economic potential of further reform.

The key issues of interest are endogenously determined changes in price distortion, changes in agricultural performance including production, consumption and trade of agricultural products, and changes in the macroeconomy, particularly GDP growth, trade balance and the overall price level.

Shocks to the World Markets: Demand Shift and Price Change

International Markets and the Chinese Economy

Two kinds of shocks in the world markets are examined: a rise in demand for Chinese manufactured exports and changes in world agricultural prices.

Examination of the effects of changes in international markets on the domestic economy are commonly undertaken, particularly in the application of economy-wide models (Higgs 1986). The effects tend to be greater as the economy opens. In an autarkic economy, influences are limited.

As the Chinese economy increasingly integrates into the world economy, it will become more dependent on the rest of the world. Any changes in the international market will have greater impacts on its economic structure and agricultural performance.

Since economic reform began, China's exports and imports have risen rapidly. The most significant component of the export increase is of labour-intensive manufactured goods, including textile products. Export of some textile products, however, is still subject to the Multifibre Arrangement (MFA) (Yang 1992). As manufactured exports are likely to continue to increase in the near future, it is of interest to study the impact on agricultural performance of a shock to world demand for Chinese manufactured exports. The shock can be thought of as a significant rise in the reputation of the Chinese goods or removal of the MFA.[1] This change will affect price distortions and agricultural performance.

Following Higgs (1986), the impact of MFA removal can be described with the assistance of Figure 8.1.

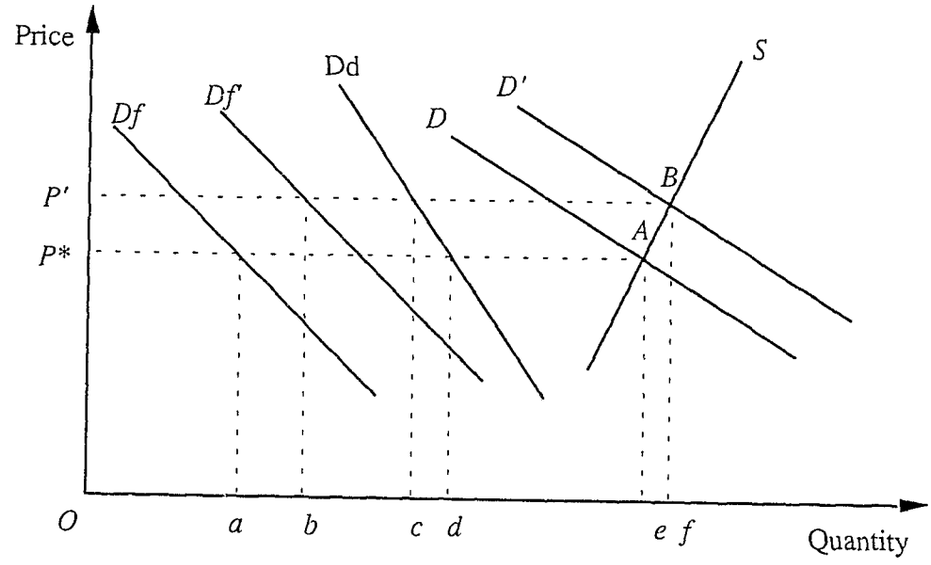
Assume demand for China's textile products (D) consists of two parts, domestic demand (D_d) and foreign demand (D_f). Chinese textile industry supply is represented by the schedule S (products produced by other countries are separated from this market). Equilibrium occurs at the intersection of D and $S(A)$. Total supply is Oe, Oa to the international market and ae to the domestic market.

If the MFA is removed in the process of international trade negotiation, some industrial countries, including the United States, will have to abolish restrictions imposed on

[1] Yang argued that, though China may have benefited from the MFA system in early years when it started to enter the international markets, the MFA system has increasingly become a constraint on the growth of China's exports of textile products. China may enjoy a more rapid increase in its exports if the MFA system is to be removed (Yang 1992).

Chinese textile exports. This suggests that a shift of foreign demand for Chinese textile products, from D_f to D_f, will occur. Accordingly, the total demand curve (D) will shift to the right (D'). The new equilibrium would be at point B. The direct result is that total supply increases and the textile industry expands, and the price of Chinese textile products rises from P^* to P'. Supply to the international market rises from Oa to Ob, while supply to the domestic market drops from ae to bf (or from Od to Oc).

Figure 8.1 Direct effects of a rise in demand for China's exports



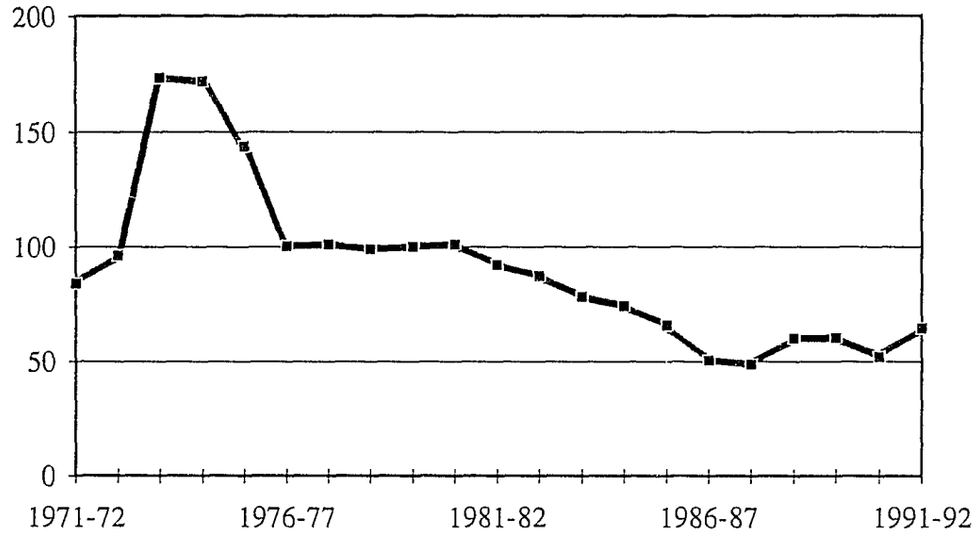
Due to the characteristics of production activity and the nature of demand, fluctuations in agricultural markets are more rapid than in other markets. Domestic policies, such as subsidies to agricultural exports, have resulted in increasing fluctuations in the world markets (Tyers and Anderson 1992).

World grain prices have exhibited a long-run declining trend, particularly wheat prices (Tyers and Anderson 1992). China pursues a grain self-sufficiency policy but in recent years has imported some wheat, 14.9 million tonnes in 1989 and 12.5 million tonnes in 1990,[2] and exported some rice and soybeans. China's response to changes in the international grain markets may be limited because of the grain 'self-sufficiency' policy

[2] State Statistics Bureau, *China Statistical Yearbook 1991*, China Statistics Press, Beijing:626.

(Chapter 5). But substitution exists between domestic and imported grains. This study investigates the impact of a decline of world wheat price on Chinese agriculture.

Figure 8.2 Real prices of Australian wheat exports, 1971-92 (1979-80=100)



Note: Wheat prices are export price quotations for Australian standard white (eastern states) and expport prices are deflated by the Australian producer price index.
Source: ABARE (1992), *Commodity Statistical Bulletin 1992*. Australian Bureau of Agricultural and Resource Economics, Canberra.

Experiment: Rise in Demand for China's Textile Exports

Changes to the Chinese economy and the agricultural sector following a 10 per cent increase in world demand for China's textile exports are presented in Tables 8.1, 8.2 and 8.3.

The textile industry is a major industrial and exporting sector. In the current Chinese economy, a 10 per cent increase in world demand for China's textile exports would have a significant macroeconomic effect. Real GDP would rise by 0.18 per cent, equivalent to 4.15 billion RMB yuan in 1987 prices (Table 8.1). The impact on foreign trade is significant. Export volumes would increase by 0.46 per cent and import volumes rise by 0.14 per cent. As a result of these changes, the balance of trade would improve by 1.32 per cent.

Table 8.1 Macroeconomic impact of a change in foreign demand

	10% increase in demand for China's textile exports
Real Gross Domestic Product	0.18
Balance of trade	1.32
Export volume	0.46
Import volume	0.14
Real rural wage	0.65
Real urban wage	0.46
Employment in rural industry	2.34
Employment in agriculture	-0.78

Note: All numbers in the table are percentage changes.
Source: Simulation results.

Another interesting result is the effect on wages and employment. Increases in textile exports would result in real wage rises of 0.65 and 0.46 per cent in the rural and urban areas, respectively. Labour relocation would occur, rural industrial employment rises by 2.34 per cent and agricultural employment drops by 0.78 per cent. On the basis of current employment levels, this implies a labour flow of 2.4 million persons from agriculture to rural industry.

Endogenous price distortions are also affected by this exogenous shock. Two of the major outcomes in this simulation directly influence the levels of state prices for grain and fibre. One is changes in market prices and the GDP deflator, and the other is changes in the share of agriculture in the whole economy. As the first factor has a positive effect while the second factor has a negative influence on the levels of the state prices, state prices for grain and fibre all rise in this simulation, although the changes are not significant in magnitude (Table 8.2). The results show, however, that relaxation of restrictions on labour flow would lead to larger adjustment in state prices.

Table 8.2 Impact on price distortion of a change in foreign demand

	10% increase in demand for China's textile exports
State price of rice	0.007
State price of wheat	0.007
State price of other grain	0.007
Purchase price of cotton	0.010
Purchase price of wool	0.010

Note: All numbers in the table are percentage changes.
Source: Simulation results.

This shock only has indirect effects on the agricultural sector. The changes in Chinese agriculture following this shock, however, are not insignificant (Table 8.3).

Table 8.3 Impact on the agricultural sector following a change in foreign demand

	10% increase in demand for China's textile exports
Agricultural outputs	
Rice	-0.02
Wheat	-0.04
Other grain	-0.03
Cotton	-0.09
Other crops	0.03
Wool	-0.11
Other livestock	0.00
Forestry products	-0.01
Fishery products	-0.01
Agricultural trade	
Export of rice	-0.57
Export of other grain	-0.16
Import of wheat	0.83
Import of wool	7.80
Agricultural market prices	
Rice	0.35
Wheat	0.97
Other grain	0.12
Other crops	1.34
Other livestock	0.53
Farmer's real income	0.48
Agriculture's share in economy	-0.78

Note: All numbers in the table are percentage changes.
Source: Simulation results.

Market prices for all agricultural products would rise, from between 0.12 to 1.34 per cent. This is because the rise in export demand stimulates development of the textile industry. Textile output increases by 1.4 per cent equivalent to 1.90 billion RMB yuan, and actual textile exports rise by 9.3 per cent. The booming textile sector competes for more resources, such as labour. Non-tradable sectors are stimulated due to higher income. Other tradable sectors, including some tradable agricultural products, are hit by these changes. Economic structural change would be accelerated, the share of the agricultural sector in the whole economy would drop by 0.78 per cent, from 20.26 per cent to 20.10 per cent. This overall decline is reflected in the fall in most agricultural outputs. Grain output falls by 0.02-0.04 per cent and cotton and wool output drop 0.09

and 0.11 per cent, respectively. The only exceptions are output of other crops which rises by 0.03 per cent and output of other livestock which is unchanged.

To understand why a rise in price combines with a drop in output, it is important to follow the mechanism for output determination in the CGE framework. Although agricultural prices increase unevenly, activity levels decline because they are dependent on demands for intermediate inputs as well as primary factors including labour. After the shock, the factor demand declines as a consequence of the growth in the textile and other sectors. Individual agricultural output thus decreases. This provides an added reason for the rise in the domestic market prices for most agricultural products (also taking the rise of total income into account).

Of particular note are changes in cotton and wool output. In a CGE model of a market economy, a shock to the demand for textile exports would obviously stimulate domestic production of cotton and wool as these products are principal raw materials for the textile industry. Yet, both outputs of wool and cotton decline in the case of China because producer prices for wool and cotton are controlled by the government, determined by a farmer-state bargaining process. State prices of cotton and wool respond to this shock but at much smaller magnitudes than the market prices for cotton and wool would. As a result, domestic supplies of wool and cotton do not increase; instead, they fall.

Farmers' income is influenced by two factors. First, farmers' real income from agriculture may drop due to the contraction of the agricultural sector. On the other hand their labour income, particularly from the industrial sector, rises. A combination of these two factors results in an increase of 0.5 per cent in farmers' real income.

Experiment: Increase in the World Price of Wheat

Changes in world market prices may be driven by various factors including technological innovation in supplier countries and shifts in taste affecting demand. These changes will have a significant impact on economies involved in these markets.

In a market economy importing wheat, a rise in the world wheat price would raise domestic wheat production and affect production activities competing for resources with wheat production. In an economy where the state determined wheat price is exogenously set, a rise in world wheat price would reduce wheat imports but would not directly affect domestic wheat production, as the state price for wheat would not change unless the government adjusted it.

Both of these responses occur in the Chinese economy (see Table 8.4).

Table 8.4 Simulation results of changes in world wheat price

	10% increase in wheat price in the world market
Macroeconomic impacts	
Real GDP	-0.003
Balance of trade	0.001
Export volumes	-0.011
Import volumes	-0.010
Employment in rural industry	-0.416
Employment in agriculture	0.104
Price distortions	
State price of rice	-0.003
State price of wheat	1.249
State price of other grain	-0.001
Purchase price of cotton	-0.031
Purchase price of wool	-0.031
Agricultural outputs	
Rice	-0.002
Wheat	1.132
Other grain	-0.591
Cotton	-0.004
Other crops	-0.000
Wool	-0.010
Other livestock	-0.789
Agricultural trade	
Exports of rice	-0.003
Exports of other grain	-0.398
Imports of wheat	-5.439
Imports of wool	-0.412
Textile industry	
Output of textile products	-0.113
Export of textile products	-0.551
Farmer's real income	-0.103
Agriculture's share in economy	0.018

Note: All numbers in the table are percentage changes.
Source: Simulation results.

A 10 per cent rise in the world wheat price leads to a 5.4 per cent in imports of wheat, from 13.2 million tonnes to 12.5 million tonnes (Table 8.4). State price for wheat rises,

while all other state prices fall. All agricultural outputs drop, except wheat and other crops. Domestic wheat output rises by 1.1 per cent, up from 87.8 million tonnes to 88.7 million tonnes.

More importantly, this change leads to labour relocation (about 0.3 million persons) from rural industry to agriculture. Farmers' income is affected both by the supply of agricultural output and their wage income from the rural industry. The combination of these two effects reduces farmers real income by about 0.1 per cent. The share of agriculture in the whole economy increases.

Trade Policy Reform and a Reduction in Tariff on Wool Imports

Trade reforms of the transition period have been an important driving engine for the rapid growth of the Chinese economy. Trade reform measures can be classified into two general groups: institutional reform and correction of incentive distortions.

Institutional reforms mainly include decentralization of importing and exporting activities and implementation of the enterprise responsibility system. Correction of incentive distortions includes the gradual liberalization of exchange controls and reduction of import tariffs.

As the Chinese government has decided to seek membership of GATT, it has committed to further and more complete trade reforms, particularly the removal of quantitative restrictions and import tariffs. This study places special emphasis on tariff reduction on wool imports for two reasons. First, China benefits greatly from the realization of its comparative advantage, namely the rapid development of labour-intensive manufacturing. One important sector in this respect is textile and clothing. Wool is one of the important material inputs into this sector. China has dramatically reduced its tariff on wool imports in the past ten years or so. It can be expected that a further reduction may facilitate more rapid growth of textile production and exports. Second, Australia recently proposed establishment of free trade between Australia and China in textiles. This proposal received positive response in China during a visit by the Australian Prime

Minister in 1993. Further tariff reductions are a step towards free trade. The simulation of reduced wool tariff is therefore designed to examine the detailed impacts on the Chinese economy of such a policy.

The mechanism of economic adjustment to a tariff reduction is similar to that for a change in world market prices except that this reform involves re-allocation of tariff revenue.

Experiment: Abolition of the Tariff on Wool Imports

The tariff rate for wool (greasy and scoured) was 22.3 per cent in 1986 on average (Yang 1992). This was reduced to 15 per cent in 1988 (Morris et al. 1993). Again, in December 1992, the government adjusted the tariff rates on raw materials for the textile industry, including wool, downward by 9.6 per cent (Fang Xing and Meng Ming 1993). The current tariff rate on wool is about 13 per cent. The simulation was carried out by removing this tariff on wool imports (Table 8.5).

The removal of the tariff on wool imports would push the domestic price down by 4.3 per cent. The change in the state price is influenced by agriculture's share in the economy (it drops 0.034 per cent) as well as the import price (exclusive of the import tariff).

Wool imports increase by 6.4 per cent (9.7 thousand tonnes) but output decreases by 3.5 per cent (7.3 thousand tonnes). This change in wool production and imports is transmitted to other agricultural commodities and the rest of the economy. Changes in output of other agricultural products are minor with the exception of cotton output which decreases by 1.2 per cent. This reduction is presumably a result of an inward shift of the cotton demand curve due to fibre substitution effects generated by lower wool prices. The textile industry is also affected directly. Output of textiles and clothing (including footwear) increases by 3.2 per cent and exports increase by 1 per cent.

This shock also affects labour allocation between agriculture and rural industry. About 12 thousand persons move out of agriculture. The balance of trade worsens a little. This is because the wool textile industry, encouraged by the reduction of import tariffs, is

largely domestic-market oriented compared with the cotton textile industry. Real GDP, however, increases by 0.01 per cent (about 230 million yuan). Farmer's real income rises marginally, although the agricultural sector contracts (by 0.034 per cent).

Table 8.5 Simulation results of changes in tariff on wool imports

	Abolition of tariff on wool imports
Macroeconomic impacts	
Real GDP	0.010
Balance of trade	0.003
Export volumes	0.004
Import volumes	0.003
Employment in rural industry	0.011
Employment in agriculture	-0.004
Price distortions	
State price of rice	0.001
State price of wheat	0.001
State price of other grain	0.001
Purchase price of cotton	-0.024
Purchase price of wool	-4.280
Agricultural outputs	
Rice	-0.011
Wheat	0.024
Other grain	0.013
Cotton	-1.230
Other crops	0.003
Wool	-3.508
Other livestock	0.002
Agricultural trade	
Exports of rice	0.002
Exports of other grain	0.000
Imports of wheat	-0.001
Imports of wool	6.401
Textile industry	
Output of textile products	3.179
Export of textile products	1.046
Farmer's real income	0.001
Agriculture's share in economy	-0.034

Note: All numbers in the table are percentage changes.
Source: Simulation results.

Macroeconomic Policies: Changes in Money Supply

Linkages Between Money and Agriculture in China

In earlier policy analysis in China, agricultural performance was only related to changes in agricultural policies. But the linkage between sectoral performance and

macroeconomic policies is an important issue in economic study (Brown 1978, Krueger, Schiff and Valdes 1988, Mundlak, Cavallo and Domemech 1989).

Analysis of agricultural performance in China in the second half of the 1980s shows that variations in farmers' feasible choice set is the main cause of agricultural stagnation (Chapter 3). Farmers' feasible choice set was affected by economy-wide policies as well as sector-specific policies. The monetary expansion in the mid-1980s stimulated the development of the rural industry. Farmers' employment and investment opportunities outside agriculture widened dramatically.

Money supply policy is chosen here as an exogenous shock for simulation. The model constructed in the previous chapter assumes only two kinds of effects of monetary policy in the short-run. First, a change in the money supply will change the overall price level in the economy. The price structure will change since controlled prices may respond to the monetary change differently from market prices. Second, in the Chinese economy, monetary expansion usually targets growth of particular industries, such as the rural industry in the mid-1980s. Monetary expansion therefore will not only widen farmers' feasible choice set, but may also affect the endogenously determined price distortions.

Identification of linkages between monetary policy and the agricultural sector is a difficult and interesting issue. A complete theory of the interaction between macro variables and micro analysis has not yet been developed in the literature. In macroeconomics, however, the neutrality property of money in a real economy has been a controversial topic (Morgan 1978; Gale 1982). The interest of macro economists lies in relating money to fluctuations in aggregate output levels (Keynes 1935, Patinkin 1965, and Reinhart and Reinhart 1991). No light was cast on structural aspects of the economy because, in a macroeconomic world, commodities and agents are assumed homogeneous and thus highly aggregated.

Some recent studies suggest that changes in the money supply are likely to affect sectors differently depending on economic structure. Analysts found that inflation, which can be solely caused by an increase in money supply, is seldom fully anticipated. Even when it is

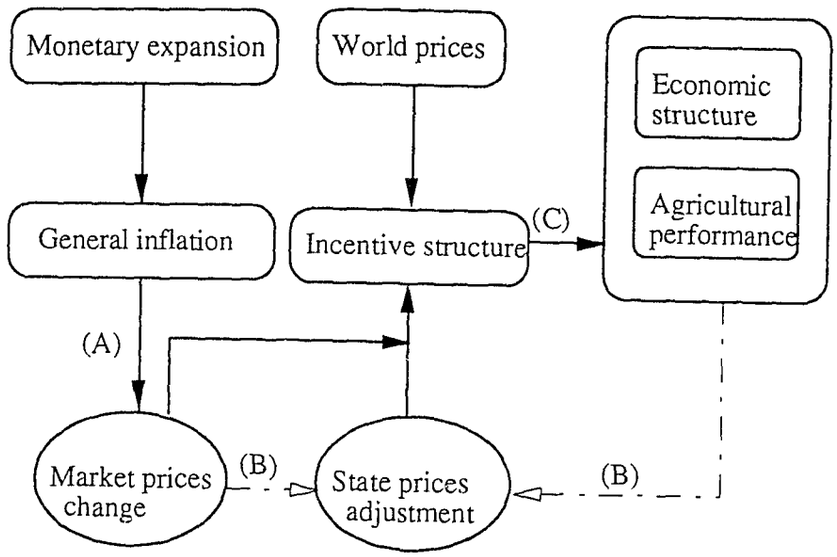
fully anticipated, there are often institutional and other constraints preventing economic agents from making the adjustments necessary to preserve their real incomes. A rise in the general rate of inflation is therefore associated with different relative price movements, depending on the adjustment process in different factor and product markets. Inflation may favour one sector or one group of individuals over another (Blanchard 1990). The relationship between money and the relative price of agricultural output has been increasingly studied and empirical work has been undertaken by some economists. Bordo (1980) and Frankel (1986) argue that agricultural commodity prices are more responsive than manufactured goods prices to an increase in the money supply. Tweeten (1980) suggested the opposite. In a recent study of the Canadian case, Taylor and Spriggs (1989) supported the Bordo-Frankel hypothesis. Whether or not agricultural prices are more responsive, the important impression is of differential change among sectoral prices. If relative prices do change as confirmed by Bordo (1980), Frankel (1986) and Tweeten (1980) (though in different directions), then sectoral output levels will change differently. Therefore, money supply policy will definitely have structural effects on the economy.

The model applied in this study is not able to capture the full impact of money supply change on agricultural performance for two reasons. First, the differential mechanism of individual sectoral prices responding to money supply shock, as studied by Frankel (1986), Bordo (1980) and others, is not incorporated into the model structure. Second, some of the possible effects on the real variables are long-term phenomena, while the model developed in this study is short-run in nature.

The effects that this model can capture directly relate to price distortion policies. A monetary expansion would cause general inflation in the economy. All market prices would float up, when state prices are controlled by the government. Economic structure is expected to change. This is a simple interpretation of the monetary effects. But the story described in this study does not stop there. State prices are not completely exogenous, they also respond to changes in market prices and other changes in the economy. The adjustment of state prices, following the monetary expansion and general

inflation, would bring further real effects to the economy. This mechanism can be illustrated using Figure 8.3.

Figure 8.3 The mechanism of monetary effects in a short-run China model



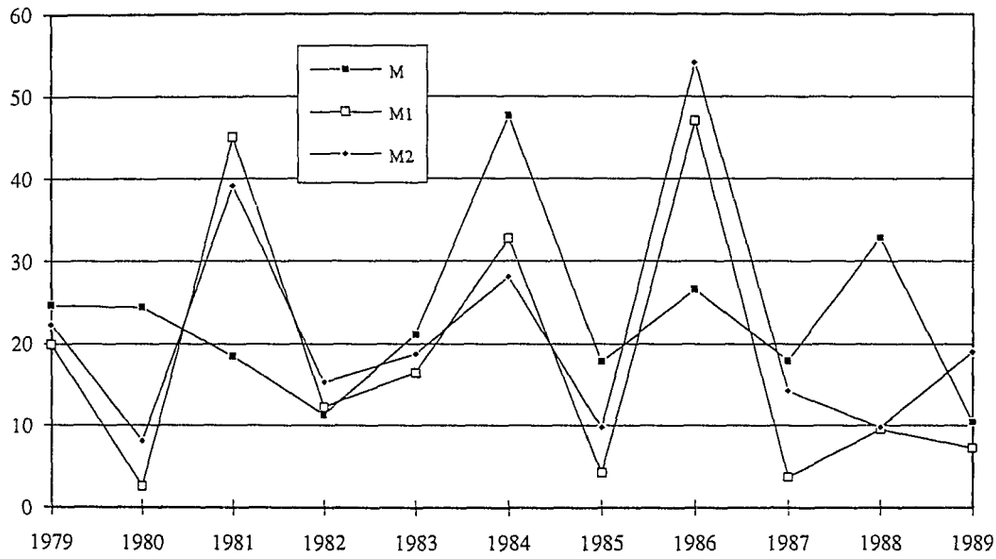
There are three effects following a change in money supply which should be emphasized in looking at the simulation results: how market prices change; how changes in market prices and economic structure affect distorted prices; and what the equilibrium economic structure is after the shock.

One important issue in modelling trade and monetary relationships is the treatment of the exchange regime. In pre-reform China, only one official exchange rate existed. This has changed during the reform period. Martin (1990) discussed the dual-tier exchange and foreign exchange-retention system and introduced it into a CGE framework. For simplicity in this study, however, only a market exchange rate is introduced. Recent developments in China have brought a large number of foreign exchange markets into existence. Individuals and firms can exchange on those markets. Following the marginal condition in economic decisions, the market exchange regime modelled in this study could be thought of as an approximation to reality.

Money supply is examined carefully in this study because it has been an important policy instrument over the past decade. Real money supply has varied dramatically under

different macroeconomic environments since 1979 (Figure 8.4). When the government attempted to stimulate economic growth, money supply was expansionary, such as between 1984 and 1987. When inflation became a serious problem, the government tended to contract the money supply, as in 1988 and 1989. These dramatic monetary changes have had a significant impact on the economy and the agricultural sector.

Figure 8.4 Growth rates of real money, 1979-89 (per cent)



Note: M refers to currency, M1 equals M plus firm deposits, and M2 equals M1 plus household deposits (Huang 1988). All the money variables are deflated by the inflation rate of the same year.
Sources: State Statistics Bureau, *China Statistics Yearbook*, various issues, China Statistics Press, Beijing; Huang (1988).

Experiment: A Monetary Expansion

The major effects that this model captures relate to the asymmetry generated by price controls, since in the absence of controls money would be neutral. The essence of the monetary simulation is to study the impact of price distortion policies in the economy when there is an exogenous shock.

Changes in real variables are the result of differential adjustments following the monetary shock. Given a 10 per cent increase in money supply, all nominal variables would float up by around 10 per cent. State prices of grain, wool and cotton, however, respond in a

different way although they are not strictly controlled by the government. These prices move with changes in general inflation, world market prices and economic structure. Whilst the GDP deflator rises 9.9 per cent, state prices increase by smaller margins, 5.63 per cent for cotton and 7.63 per cent for wool (Table 8.6).

Table 8.6 Simulation results of a monetary expansion

	10% increase in money supply
Macroeconomic impacts	
Real GDP	0.05
GDP deflator	9.98
Real wage in urban areas	-0.03
Real wage in rural areas	0.01
Employment in rural industry	0.28
Employment in agriculture	-0.09
Price distortions	
State price of rice	7.83
State price of wheat	8.84
State price of other grain	8.35
Purchase price of cotton	5.63
Purchase price of wool	7.63
Agricultural outputs	
Rice	-0.01
Wheat	-0.02
Other grain	-0.01
Cotton	-4.28
Other crops	-0.01
Wool	-3.35
Other livestock	0.00
Textile industry	
Output of textile products	0.98
Farmer's real income	0.01
Agriculture's share in economy	-0.02

Note: All numbers in the table are percentage changes.
Source: Simulation results.

These differential price responses cause changes to relative prices in the economy. Relative prices of wool and cotton decrease. A lower aggregate agricultural price results in relocation of labour. Industrial sectors tend to demand more labour due to rises in the relative prices of their products.

Labour relocation generates higher activity levels for industry and lower levels for agriculture. Industrial output therefore increases, for example by 0.98 per cent for textile products, and agricultural output decreases. In particular, output of cotton and wool drops by 4.28 and 3.35 per cent, respectively. Outputs of rice, wheat and other grain do

not fall significantly because free markets exist for these commodities alongside the plan system.

These structural changes impact on real GDP because the productivity of labour in industry and agriculture are different. The marginal productivity of labour in industry is more than double that in agriculture (see Chapter 4). The 276,000 farmers relocated in the industrial sector now produce more real product than they did in the agricultural sector. The increased industrial output, less the product decline in agriculture, causes real GDP to rise by 0.05 per cent. The share of agriculture in the economy decreases 0.02 per cent.

The real wage in the urban sector falls, while that in the rural sector rises. Given normal production technology and other fixed factor inputs, the marginal productivity of labour decreases as the amount of labour input rises changing marginal productivities and narrowing the gap between real wages in the two sectors.

The impact of this monetary expansion on farmers' real income depends on several factors. First, agriculture declines in the Chinese economy after the shock. Second, farmers who still work in the agricultural sector now receive higher real wages. Third, a number of farmers move to the industrial sector and receive industrial real wages. The combination of these factors causes farmers' real income to rise by 0.01 per cent.

The results support the argument of previous chapters that changes in monetary policy were one important cause of the expansion and contraction of Chinese agriculture in the second half of the 1980s.

The Dutch Disease: Rapid Growth of Rural Industry

Interaction of Rural Industry with Agriculture

As a result of the rural liberalization policy and the maintenance of restrictions on factor movements between rural and urban areas, rural industry has developed rapidly in the past decade. This rural industry is of particular importance to Chinese farmers. Their resource allocation decisions are usually made between agriculture and rural industry.

Rural industry is created by the farming community. Looking at Chinese farmers as a whole, rural industry is their second most important economic opportunity apart from the agriculture. Resistance to resource relocation between agriculture and rural industries is much smaller than between rural and urban areas. Not only has a large amount of labour and capital moved from agriculture to the rural industry in the past decade, but industrial profits are sometimes returned to agriculture to build agricultural infrastructure. Some rural enterprises directly use agricultural products as raw materials. These firms provide a secure market for local agricultural production. They also constitute a competing force to urban enterprises in both raw material and output markets.

Rural industry has become an important economic sector in China, particularly in contrast with the relatively declining agricultural sector and the slowly growing state industry. In 1990, employment in rural industry accounted for 16.3 per cent of the total labour force and 22.1 per cent of the rural labour force (*China Statistical Yearbook 1991*). At the same time, output from rural industry accounted for 22.3 per cent of national output and 50.9 per cent of rural output. The importance of this sector is likely to increase.

The rapid development of rural industry has had very significant effects on agriculture and farmers in China. This industry will continue to play an important role in competing for resources with agriculture in infrastructure construction and in processing agricultural products. The linkages between rural industry and agriculture will not only affect the development of the rural area, but may impact on the whole economy.

The Dutch Disease originally referred to the effects of a sudden expansion of mineral and energy sectors. In this study, the term is borrowed to describe the effects of an expansion of the rural industry (Findlay, Martin and Watson 1992).

Findlay, Martin and Watson (1992) introduced such a shock by extending a model previously developed by Martin. The efficiency of textiles, clothing and miscellaneous manufacturing industries was increased. They found that absorption increased by 2.5 per cent and that the price level fell by the same amount. Exports and real wages rose. More importantly, the effects on agricultural output were uneven. The output of crops declined because resources were bid away to booming sectors and to the expanding non-tradables sector.

This study replicates this shock. Rural industry is probably the most important non-agricultural sector to agriculture and farmers in China. In the framework of the CGE model, it is of interest to see what the effects are of sudden growth in the rural industry, in comparison with the results by Findlay et al. (1992). Furthermore, this study is able to reveal the influences of such a shock on agricultural price distortion policies and their feedback to the agricultural sector and the economy.

Experiment: A Sudden Expansion of the Rural Industry

One distinct feature of this study is that rural and urban industries are explicitly separated in the model. Therefore we can directly introduce changes in rural industries and examine their effects on agriculture and the economy as a whole. The shock is designed as a 10 per cent rise in the efficiency with which all inputs in all rural industries are used. The rationale for this design is that rural industry, particularly in the coastal provinces, is experiencing a transformation from an industry using traditional and out-of-date technology to a modern one. This transformation is raising productivity rapidly. By designing a uniform improvement in all rural enterprises, the aim is to expose the likely impacts of a dramatic expansion of rural industry on agricultural performance.

In 1987, rural industry accounted for about 20 per cent of GDP in China. If a 10 per cent increase in the productivity of rural industry is transformed into an extra 10 per cent output, its direct contribution should raise GDP by about 2 per cent. The actual effect on GDP, however, is real growth of 3.56 per cent (Table 8.7). This suggests that efficiency improvement in the rural industry has a multiplier effect of about 1.8. The extra 1.56 percentage points of growth can be thought of as the gain from resource re-allocation, and the growth impact transmitted from the rural industry to other parts of the economy.

This shock has very significant consequences for China's trade: export and import volumes increase by 9.36 and 7.33 per cent, respectively. The balance of trade improves.

Table 8.7 Macroeconomic impact of the Dutch Disease

	10% rise in the efficiency of input use by rural industry
Real GDP	3.56
Export volumes	9.36
Import volumes	7.33
Real wage in urban area	0.38
Real wage in rural area	3.39
Employment in rural industry	7.91
Employment in agriculture	-2.67

Note: All numbers in the table are percentage changes.
Source: Simulation results.

Due to the efficiency improvement and rapid expansion of rural industry, rural real wages increase by 3.39 per cent. As labour is not mobile between rural and urban areas by assumption, urban real wages only increase by 0.38 per cent as a direct effect of the rural industry expansion. The gap between rural and urban wages would narrow. About 8.1 million farmers, 2.67 per cent of the agricultural labour force or 7.91 per cent of the rural industry labour force, move to industrial production as a result of this shock.

There are similar effects on state prices. As the industrial sector expands rapidly, the agricultural sector contracts. This leads to a rise in all endogenously determined state prices (Table 8.8).

Table 8.8 Impact on price distortions of the Dutch Disease

	10% rise in the efficiency of input use by rural industry
State price of rice	1.03
State price of wheat	2.02
State price of other grain	0.59
Purchase price of cotton	3.56
Purchase price of wool	2.78

Note: All numbers in the table are percentage changes.
Source: Simulation results.

As expected, most agricultural outputs decrease, 0.12 per cent for rice, 0.56 for wheat, 0.08 per cent for other grain and 1.33 for other crops. Supplies of cotton, wool and other livestock rise by 0.53, 0.79 and 0.1 per cent, respectively. Agricultural trade also changes greatly. Rice exports fall because of the decline in domestic production and the rise in income. The reduction in other grain exports is likely to be related to the need for development of husbandry industry due to higher income, apart from reduced supplies. Imports of wool increase significantly (Table 8.9).

Table 8.9 Impact on agricultural performance of the Dutch Disease

	10% rise in the efficiency of input use by rural industry
Agricultural output	
Rice	-0.12
Wheat	-0.56
Other grain	-0.08
Cotton	0.53
Other crops	-1.33
Wool	0.79
Other livestock	0.10
Agricultural trade	
Exports of rice	-1.21
Exports of other grain	-3.55
Imports of wheat	4.89
Imports of wool	3.91
Farmer's real income	2.04
Agriculture's share in economy	-1.13

Note: All numbers in the table are percentage changes.
Source: Simulation results.

These results reinforce the arguments and findings presented in Chapter 4. An expansion of rural industry apparently results in contraction of agriculture. From the point of view

of agriculture or grain fundamentalists, this might be a serious economic problem as wheat self-sufficiency falls by 1 percentage point (from 87 to 86 per cent).

The contraction or stagnation of the agricultural sector, however, does not necessarily imply a failure in economic development if a wider perspective is applied. As the simulation results show, a decline in the share of agriculture by 1.13 per cent is accompanied by a 2.04 per cent increase in farmers' real income and a rise of 3.56 per cent in real GDP.

Liberalization of the Labour Market: Achieving Perfect Labour Mobility

Implications of Labour Market Segmentation

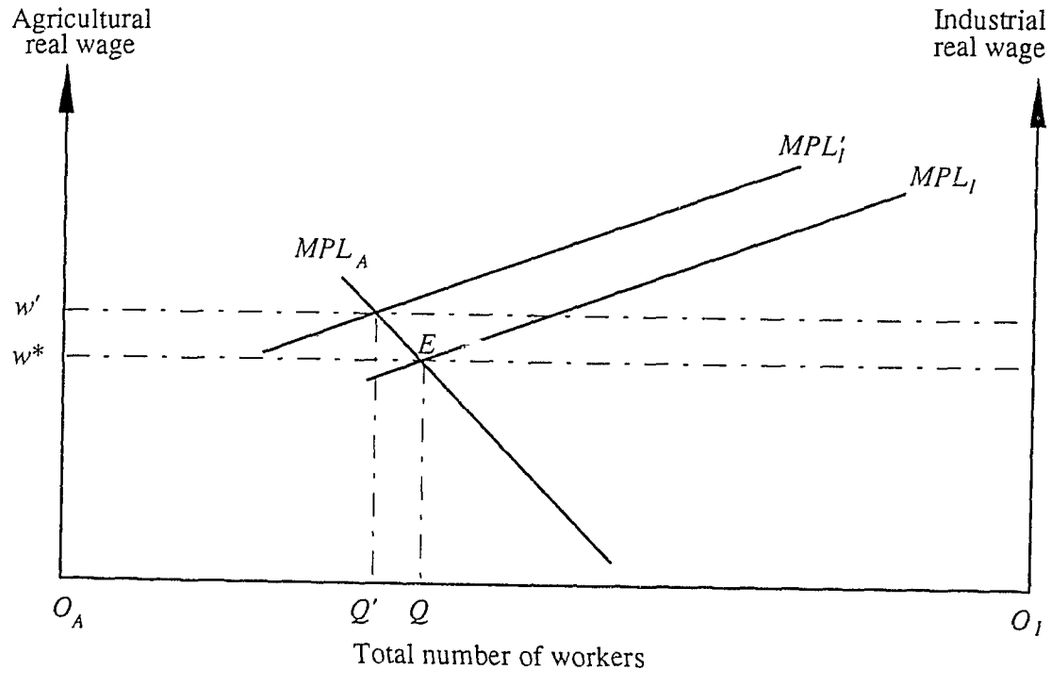
The implications of limited labour mobility for agricultural performance are that an optimal allocation of resources cannot be achieved. Marginal factor productivities are not equalized across sectors, at least between rural and urban areas.

Whether or not the government should lift all controls over factor movement between rural and urban areas has been a controversial question in the study of rural development. China has pursued policies which encourage industrialization of the rural economy. A large number of township, village and private enterprises have been established because the cities are closed to farmers. This method of industrialization protects cities from sudden population expansions (due to the crowding-in of farmers) and social chaos (increasing urban unemployment). The impact on rural areas and the economy has been briefly discussed in earlier chapters.

The story can be illustrated using Figure 8.5. Figure 8.5(a) characterizes the adjustments of the economy with perfect labour mobility. The horizontal axis represents the total number of workers in the economy. The vertical axis on the left represents the agricultural wage and the vertical axis on the right represents the industrial wage. The downward sloping line is the marginal product schedule for agricultural production and the upward sloping lines are marginal product schedules for industrial production. The

number of workers employed in agriculture is measured along the horizontal axis starting from point O_A, while the number of industrial workers is measured from the opposite direction starting from point O_I. With perfect labour mobility, the equilibrium wage rate and labour allocation between agriculture and industry are determined by the intersection of the agricultural and industrial marginal product schedules (E). In this case, agricultural and industrial wages are in fact equalized.

Figure 8.5(a) Labour mobility and economic adjustments: perfect market



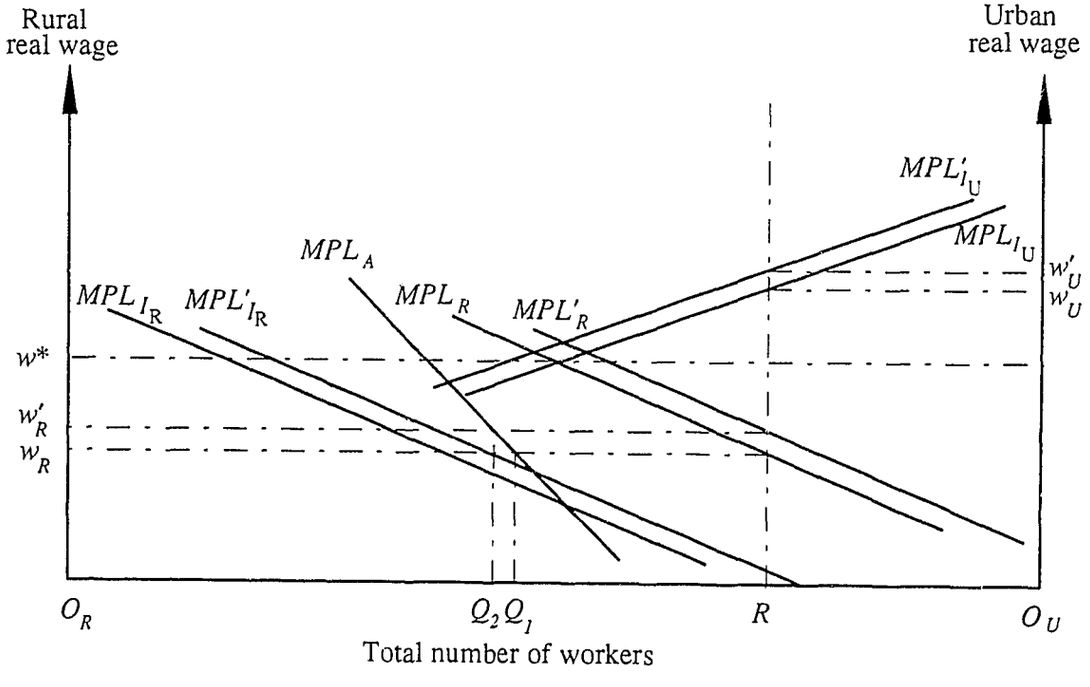
On the other hand, Figure 8.5(b) illustrates the case of labour markets segmented between rural and urban areas. As labour cannot move between the two areas, two wage rates exist in the economy, an urban wage rate for urban industries and a rural wage rate for agriculture and rural industries. Assume that O_RR is the total amount of labour in rural areas and it is allocated between agriculture and rural industries.

Major differences arise in the economy's responses to exogenous changes in the two cases discussed above. Using a rise in industrial marginal product as an example (such as would result from a rise in the world market price), in the case of perfect labour mobility, the industrial marginal product schedule shifts upward from MPL_I to MPL_I'. This causes a change to the aggregate wage rate and a re-allocation of labour. The equilibrium wage

rate would rise from w^* to w' and $Q'Q$ of agricultural labour relocates to industrial production.

In the case of segmented labour markets, the relocation effect is limited because the effects of a rise in urban industry marginal product cannot be transmitted to the agricultural sectors. The marginal product schedules for both industries would shift upward (from MPL_{I_R} to MPL'_{I_R} for rural industry and from MPL_{I_U} to MPL'_{I_U} for urban industry). Both urban and rural wages would rise, probably by different margins. Relocation of agricultural labour to industry (Q_1Q_2) is smaller than in the case of perfect mobility ($Q_1Q_2 < QQ'$).

Figure 8.5(b) Labour mobility and economic adjustments: segmented market



This simplified story suggests that labour market segmentation must distort economic structure. By modelling the removal of this segmentation, this study attempts to illustrate how the Chinese economy can gain from such reforms.

Experiment: Removal of Restrictions on Labour Flows

The simulation is designed to investigate what might happen if labour is perfectly mobile between rural and urban areas. In this case, there will be one unified market wage in the economy. Perfect labour mobility is, of course, only a theoretical case. To achieve this not only requires the abolition of all administrative regulations, but also changes in other aspects of the economy including market information system and transportation and communication facilities.

The removal of restrictions on labour flows is simulated together with the shock of a 10 per cent increase in foreign demand for China's textile exports. The second column in Table 8.10 is reproduced from Table 8.1 and the third column reports the results from the simulation of perfect labour mobility.

Table 8.10 Impact of a 10 per cent increase in foreign demand for textile exports

	Labour market segmentation	Perfect labour mobility
Real GDP	0.18	0.28
Balance of trade	1.32	2.35
Export volumes	0.46	0.98
Import volumes	0.14	0.23
Real urban wage	0.65	0.08[a]
Real rural wage	0.46	0.08[a]
Employment in rural industry	1.03	1.11
Employment in agriculture	-0.78	-1.56

Note: In the case of perfect labour mobility, there is only one wage rate in the economy. All numbers in the table are percentage changes.
Source: Simulation results.

Generally speaking, economic adjustments following a demand shock when perfect labour mobility prevails are much more dramatic. For instance, real GDP would increase by 0.3 per cent (compared to 0.2 per cent) and the balance of trade improves by a larger margin. These results are associated with the re-allocation of labour. If labour is not mobile between rural and urban areas, when there is a shock to export demand, adjustments to urban industry production are limited while rural industry can adjust its output to a larger degree.

This is supported by the results in employment allocation. In the perfect labour mobility case, a 10 per cent export demand shock could cause a 1.6 per cent reduction in agricultural employment (compared to a 0.8 per cent reduction in the earlier simulation). This means that agricultural labour relocates not only to rural industry but also to urban industry.

Some Discussion

Simulations presented in this chapter reveal interesting information about how the whole Chinese economy and the agricultural sector respond to various exogenous shocks, including changes in the world market, an expansion of money supply and rapid growth of rural industry. Government interventions, such as price distortions and restrictions on labour flows, are incorporated into the model and given particular attention.

The results, however, should be interpreted with caution as there are two shortcomings with this China model, apart from the general problems associated with the CGE framework.

One problem relates to the coefficients, particularly the elasticities. Due to the nature of the CGE model, the effects isolated are, in many cases, very sensitive to the adoption of different elasticities. In this study, although appropriate elasticity coefficients for the Chinese economy have been chosen carefully, for example those from the World Bank (1985), Martin (1990) and others, efforts were only made to estimate empirically the supply elasticities of agriculture and elasticities related to endogenous policy determination.

The monetary mechanism is not completely incorporated into the structure. The potential real effects of monetary change on an economy take various forms, particularly in the longer term. This model, however, accepts the neutral treatment of money in principle. Money is only non-neutral and therefore has some real effects because of the existence of incentive distortions. The main purpose of the monetary expansion simulation is to

illustrate the difference that price distortions can make to the real economy, not to show the real effects of monetary change.

9

China's Agriculture in Transition: Some Conclusions

This study has analysed agricultural performance in China during the country's transition from a centrally planned system to an economy increasingly reliant on market mechanisms. The experience of China's agriculture in the second half of the 1980s, and the relationship between the agricultural sector and other sectors of the economy and the outside world, were given particular attention.

The most important feature of the study is its economy-wide perspective. New characteristics of Chinese agriculture in the 1980s are identified and factors affecting farmers' decision making and agricultural performance in this new environment are explored. The important findings were incorporated into a computable general equilibrium framework to reflect the reality of Chinese agriculture. The model was then used to quantify adjustments in the agricultural sector and the Chinese economy in response to various exogenous shocks.

A Summary of the Study

The central argument is that the agricultural sector is being increasingly integrated into the rest of the Chinese economy and the world economy through the process of economic reform. Economy-wide policies and changes are as important as sector-specific policies in affecting agricultural performance. At the same time, some restrictions on factor movements and price distortions remain and affect the response of the agricultural sector to exogenous changes.

How Has Chinese Agriculture Changed Since the Reform Started?

The Chinese economy today is neither a perfectly free market nor a stylized central planning system.

The economic system before reform in China was inherited largely from the former Soviet Union. The basic elements of that economic regime included the central planning system, public ownership and a heavy industry-oriented development strategy. Free resource and product flows did not exist since all production and exchange were managed through the planning system. Economic signals like prices and economic policies like fiscal and monetary policy did not have the same functions they have in a market economy.

Take agriculture as an example. Agricultural production and distribution were organized by the production team under the commune system. The central or local government decided what to produce and how to produce it. Farmers and production teams did not have autonomy in decision-making. Agricultural prices did not have the function of guiding resource allocation. Rather, they acted more as accounting measures in the transfer of agricultural products to the government.

Economic reforms in the agricultural sector included three main elements.

- Microeconomic reform focused mainly on the restoration of the household production system replacing the inefficient commune system. Farm households regained their autonomy in decision-making for agricultural production. This change contributed the most important part of agricultural growth in the first half of the 1980s. Rapid growth of township, village and private enterprises in rural China was another positive consequence of this newly established household responsibility system. Although farmers are still restricted from allocating their production resources to urban industries, they are, nevertheless, able to reallocate resources between agriculture and rural industry in the pursuit of maximum income or profit.

- Another dimension of economic reforms was the re-introduction of a free market to the Chinese economy. The marketization process can be divided into two steps, the first step being adjustment of state prices toward market prices and the second step being the opening up of free markets. In the first stage of agricultural reform, the main reforms focused on upward adjustment of the state prices for important

agricultural products including grain and cotton and marketization of less important agricultural products. A more complete marketization scheme was introduced to the rural economy toward the end of 1984. Although some government controls over a number of agricultural products were resumed soon after that, the rural economy as a whole has a higher degree of marketization compared to the urban economy.

- The final dimension was macroeconomic reform. The basic objective of macroeconomic reform is to transform macroeconomic policies from direct resource allocation tools to indirect macroeconomic management measures and to decentralize decision making powers, in line with the effort of introducing market mechanism. Reform of the monetary system, decentralization of fiscal policy management and other related measures introduced in the past ten to fifteen years have facilitated more efficient use of economic resources and higher economic growth.

The essence of economic reform was to reduce direct intervention by the government in the operation of the economy and to allow more decision-making autonomy to economic agents. Economic reform in China can in this way be characterized as economic liberalization. Changes in the economic system call for different approaches to be applied in analysing economic phenomena including agricultural performance. The Chinese economy is not yet a mature market economy. There are two new characteristics requiring particular attention in agricultural policy analysis while admitting the important role played by the market.

The degree of economic integration, both between different parts of the Chinese economy and between the Chinese economy and the rest of the world, has increased significantly in the reform period. Restrictions on resource movements, however, remain in many areas. Resource movements between rural and urban areas, for example, are still restricted. Within the rural economy, farmers' employment and investment opportunities are affected by government policies and regulations. In other words, farmers' feasible choice set is still limited.

Most economic signals including agricultural prices in rural China are determined by the market mechanism, but price distortions remain for some agricultural products such as grain and natural fibre. There was a two-tier price system for grain before 1992. Agricultural production was still subject to state purchase quota of grain. Farmers still had to fulfil this quota regardless of the economic benefits before they could freely decide resource allocation to pursue maximum income.

These two characteristics imply that a conventional profit or income maximization model may not be able to capture Chinese farmers' economic behaviour accurately.

Farmers' Production Decisions

Because the above two characteristics are still playing an important role in economic activity, they have a significant impact on economic equilibrium. This requires theoretical investigation in relation to farmers' production decision-making.

A simple illustrative model is constructed for theoretical analysis. The model consists of two producers, an urban producer and a rural producer, and three production activities, agricultural production, rural and urban industrial production. Both producers are assumed rational, that is, they maximize profits or minimize costs.

As a reference point, economic equilibrium is studied in a competitive case (no restriction on resource movements within the economy and no price distortion). Then the two characteristics identified above are introduced to the model to examine what effects they have.

If the assumption of perfect labour mobility is relaxed and farmers are restricted from moving to urban areas for employment, they can only either be involved in agricultural production or develop their own industries in the rural area. This is the reason for the rapid growth of the township, village and private enterprises in rural China in the reform period. It is also assumed that urban consumers can only be employed in urban industry.

Without any flow of labour between rural and urban areas, there will be naturally a relatively low marginal product of labour in the rural economy and higher marginal product of labour in the urban economy. Without restrictions, labour would flow from rural to urban areas to achieve maximum income (or to equalize marginal products of labour in the two sectors).

Compared with the case in which there are no restrictions on the movement of labour from the rural to the urban sector, the agricultural sector (including grain and natural fibre production, assuming no price distortion) expands relatively, but farmers' wage income is lower than it would be if farmers were able to earn higher wage income in urban industry. There is also a loss to the total output or GDP because of the inefficient use of resources. More importantly, this result implies that abolition of restrictions on labour movement between rural and urban areas would reduce agricultural output.

The impact of price distortions in the grain, cotton and wool markets is clear. Lower state prices for cotton and wool would depress output levels for wool and cotton compared to the case in which there is no price distortion.

The case of a two-tier price system is more complicated. Some economists argue that the state price will not affect production decisions so long as an effective free market exists alongside the state plan (Sicular 1988a; Byrd 1988). This argument is based on the assumption that the state purchase quota is exogenously set. In this case, the state price would not affect the first-order conditions for profit maximization. On the other hand, Lin (1993) argues that the state price will affect farmers' production decisions if the state procurement quota is set endogenously. Which of these arguments is closer to the reality simply depends on whether or not state purchase quotas are set endogenously or exogenously.

Since labour market segmentation between rural and urban areas tends to increase agricultural output while price distortions tend to reduce output levels of grain, cotton and wool, the net effect of these characteristics on agricultural output is ambiguous and depends on the strength of the two effects working in the opposite directions.

To show that the characteristics identified will also affect the way the economy responds to exogenous change, a set of changes in economy-wide policies and in other parts of the economy is introduced in the theoretical model.

One important change introduced is trade liberalization for industrial products, say a reduction of the import tariff. The reduction of tariffs would reduce the domestic price of the imported industrial product. This would further reduce the values of the marginal products of labour in rural and urban industries assuming that the imported product is produced in both industries. As the marginal product of agriculture remains the same (and second round effects are neglected at this stage), there would be a gap between values of marginal products in different sectors. In a market economy, labour would move from agriculture to rural and urban industries until marginal product is equalized. There would be an adverse effect on agricultural production.

But the flow of labour between rural and urban areas is generally prohibited in China. Labour can be reallocated from agriculture to rural industry but not to urban industry. Within the rural economy, equilibrium can be attained, but the difference between rural and urban wages would widen. There would also be an adverse effect on agricultural production. The effect, however, is smaller in magnitude compared with the perfect labour mobility case.

Another important change introduced is monetary expansion. There is much discussion in economic literature of the role of money in the real economy. In classical economics, money is neutral. Changes in money supply only affect the level of prices but leave all real variables unchanged. These assumptions have been questioned in recent literature. This study only attempts to show that, given price distortions, a change in money supply may change real economic structure. An increase in money supply is assumed to raise all market-determined price levels at the same rate, but state prices would respond in a different way, at least in magnitude. Relative price structure would therefore change and relative price change naturally leads to structural change to the economy. Assuming that the state price for cotton always increases at a slower rate than other market prices

following a monetary expansion, the share of cotton output in the economy will be smaller compared to that before monetary change.

Understanding Agricultural Growth in China

This framework is applied to the case of agricultural growth in the second half of 1980s. There are two objectives in this research. First, the case study shows the usefulness of the above framework. Second, existing explanations of agricultural performance in that particular period are not satisfactory.

Agricultural growth in China in the first stage of agricultural reform was remarkable and was viewed as an economic "miracle". The agricultural growth rate jumped from about 3 per cent in 1952-78 to 7 per cent in 1979-84 due to the introduction of reform policies. Economists have successfully explained sources of this dramatic growth. The main causes were the implementation of the household responsibility system, the rises in government purchase prices and increases in agricultural inputs including chemical fertilizers.

Following the introduction of the marketization scheme in the rural economy at the end of 1984, agricultural production and grain production in particular dropped significantly in 1985 and remained at low levels in the following several years until 1989. Explanations offered in the literature for this agricultural stagnation include:

- the completion of the household responsibility system reform in 1983
- worsening of agriculture' terms of trade
- adverse weather conditions
- changes in relative factor endowment.

These hypotheses are examined in this study. It is found that, although some of these factors may have contributed to the pattern of agricultural development in the second half of the 1980s, none of them can be regarded as dominant.

The analytical framework outlined above is then applied to this case. Within the rural economy, it is assumed farmers can freely reallocate resources between agriculture and

rural industry. Rural industry, however, is heavily influenced by government policies and other economic variables. In particular, in the early years of economic reform, farmers were restricted from being involved in rural industrial production. There were also restrictions on resource movements between agriculture and rural industry. As rural industry experienced dramatic expansion and some contraction in the second half of 1980s, farmers' non-agricultural production opportunities changed accordingly.

Because of policy restrictions, the value of marginal products in agriculture and rural industry were not equalized in the 1980s. Marketization reform introduced at the end of 1984 suddenly opened up many rural industrial opportunities for farmers. Assuming that the value of marginal product in rural industry is much higher than that in agriculture, farmers will re-allocate resources from agriculture to rural industry in an effort to achieve maximum income. Alongside the rapid growth of the rural industry, agriculture will contract due to the outflow of resources from agricultural production. This is the story of agricultural stagnation in the years following 1985. At the end of 1980s, because of the contractionary policies particularly targeted at rural industry, farmers' non-agricultural opportunities were affected. Some resources flowed back to agriculture and resulted in agricultural resurgence.

From this hypothetical explanation of development in agricultural production in the 1980s, two testable working hypotheses are developed. First, if this argument is valid, the value of marginal product of labour in rural industry should be much higher than that in agriculture at least before 1985. Second, as resources are reallocated from agriculture to rural industry, the gap between the values of marginal product in the two sectors should narrow after 1985.

Proof of this hypothesis was divided into three steps. First, by using a simple theoretical two-sector model, it was shown that an increase in the relative price of agricultural goods and a decline of real production can coexist when farmers' feasible choice set changes dramatically. In other words, as long as the value of marginal product in rural industry is still higher than that in agriculture, farmers would continue to reallocate

resources from agriculture to rural industry although relative agricultural prices might be rising.

Second, empirical evidence is provided. Reforms in agricultural policies, macroeconomic policies and policies toward rural industries in the mid-1980s, in fact, increased farmers' non-agricultural opportunities dramatically. One such example was the monetary expansion which began in 1984. Together with other preferential policies toward rural industry and abolition of policy restrictions on agricultural production, this expansion facilitated the rapid growth of rural industry. Resources moved quickly from agriculture to rural industry in those years.

Third, and more importantly, the hypothesis is proved by statistical estimation of values of marginal products in agriculture and rural industry. Not only was the value of marginal product of labour in agriculture significantly lower than that in rural industry (about 30 per cent in 1985), but the gap between the two sectors also narrowed from 1985 to 1988. This was the main cause of dramatic resource re-allocation.

Dramatic changes in farmers' feasible choice set was the dominant factor behind the extraordinary pattern of agricultural development in the second half of the 1980s. This case underlines the importance of restrictions on factor mobility in Chinese economy. Changes in factor markets may sometimes offset changes in price structure and require particular attention in analysis of the Chinese economy.

Agricultural Price Distortions

The above conclusion does not deny the important role played by price structure in production decisions. Price distortion is also important in agricultural policy analysis. However, in most studies of Chinese agricultural policy, price distortion is usually set as an exogenous variable.

Economic policies including state prices are not determined randomly, according to the theory of political economy. Because most paradigms for endogenous policy developed in the literature do not fit the case of agricultural prices in China, a state-farmer policy

game framework is developed to examine the determination of state prices in relation to farmers' feasible choice set. The state purchase price of grain was taken as a case study.

The game contains only two parties: the state and farmers. Consumers, another important party in the usual framework for agricultural policy, are excluded because state sale policies did not change much from the early 1950s to the beginning of the 1990s. The relationship between farmer and consumers and between the state and consumers are therefore assumed to be stable during that period. Because the state sale prices to urban consumers were consistently lower than market prices, the game is defined to allocate this loss (the gap between the state sale prices and market prices) between the state and farmers.

Both parties in the game attempt to let the other party bear that loss. The state wishes to lower the state purchase prices from farmers while farmers wish to raise state purchase prices. Both parties have destructive powers over the other party in threatening strategies. The state can force farmers to sell grain at low prices by threatening punishment measures like the allocation of education and employment opportunities. Farmers can also refuse to sell if they wish and this would be disastrous for the government. The effectiveness of these threatening powers determines relative strengths in the policy game. The effectiveness of the threatening powers, in turn, depends on other factors and change over time.

In the early stages of economic development under a repressive and vindictive central state system, farmers tend to be weak in the state-farmer policy game. As agriculture is the major industry in the economy and farmers are the dominant group within the population, any small marginal benefit to farmers could entail a very significant loss to the other members of society and a severe burden on the state budget. The state would therefore be willing to give up relatively large amounts of resources to implement its policies. Farmers, on the other hand, are unable to exercise any significant destructive strategy on the government collectively because of the distance of their residence and poor communication and transportation conditions.

As the economy develops, agriculture a becomes smaller part of the economy. The government has less interest than before in agricultural revenue. It is willing to sacrifice less in preventing rises in state purchase prices. Its destructive power over farmers also declines since economic opportunities for farmers increase rapidly. As the number of farmers falls and rural infrastructure improves, it becomes less costly for farmers to organize to lobby for favoured policies. Their destructive power rises accordingly.

The game is characterized as cooperative because both the state and farmers respect the policies (willingly or unwillingly) when they are set.

Given the two-tier price system for grain, one important characteristic of this game is that the government has monopsony power in setting the state grain price. Since it is the only buyer, the more the government buys, the higher the price it has to pay. But in early years, since the government is extremely powerful, the government may be able to depress the state price significantly by other threatening strategies. As farmers become stronger, they are increasingly unwilling to accept any prices lower than market prices. At the other extreme, the state may have to subsidize farmers, as happened in many industrial countries and some East Asian economies as industrialization proceeded.

Based on this framework, a cooperative game-theoretic model is developed and estimated empirically. Bargain strength coefficients are defined as functions of the share of agriculture in the whole economy, the share of agricultural population in total population, income per capita and the market price of grain. It is found that farmers' relative bargaining power is negatively correlated with agriculture's share in the economy and the share of agricultural population, and positively correlated with income per capita and the market price of grain. In general, farmers were still relatively weaker than the state. But it can be expected that farmers' bargaining power will continue to increase as the economy develops.

Effects of Price Distortion in Agricultural Production

The next question of interest is what is the quantitative impact of price distortion on agricultural production. This is answered in two steps. First, agricultural supply elasticities are estimated to provide a partial picture of the effects of a depressed agricultural price on production structure within agriculture. Second, applying these elasticity estimates, policy effects are examined in a more general framework.

There are quite a few models which can be used for estimation of production elasticities. Most of these models are based on stringent assumptions about the operation of market mechanism and farmers' production behaviour. It has to be resolved first whether these models can be applied to the Chinese farmers.

As discovered in this study, farmers' decision-making in China is influenced by a combination of government policy and market conditions (market prices). Farmers have to fulfil policy requirements like state purchase of grain. Having fulfilled state quotas, they then try to utilize remaining resources and market information to maximize income. The assumption proposed in this study is that, in a semi-marketized economy like China, farmers' production activities are guided by the dual system. On one hand, farmers have to fulfil the quantity and price requirements set by the government. On the other hand, they, like any other farmers in the world, respond to changes in marginal prices.

Thus a profit maximization framework can be applied to Chinese farmers so long as data arising from highly distorted activity can be separated from the data set.

The specific model used is the generalized McFadden unit profit function. Two data adjustments are applied in this study to make it possible to use the model. One adjustment is made to price data and the other is made to quantity data.

The model is estimated using time series provincial data for the period 1985-90. Supply elasticities are then derived for rice, wheat, other grain, cotton and other crops.

Compared with the elasticities used in other studies, elasticities derived in this study are somewhat higher. There are several reasons for this general difference. One possible reason is that this study uses more recent data which reflect a higher degree of marketization. Farmers are freer to adjust their production structure now than they were in early years. Another possible reason is that data are adjusted in this study in order to separated activites highly distorted by the government intervention. Generally speaking, state purchase prices and procurement quotas fluctuate less sharply than market-oriented prices and quantities, both in terms of frequency and magnitude. Movements in data would be much smaller without adjustment. Elasticities estimated from other studies tend to under-estimate the actual response of agricultural production to market changes.

From these elasticity estimates, a rough picture of how price distortions have affected agricultural structure is drawn. For example, if the state cotton price is 10 per cent lower than market price, that means cotton output is 0.4 per cent lower than it otherwise would be (own-price elasticity is 0.04) and rice production is 0.4 per cent higher than it otherwise would be (cross-price elasticity is -0.04).

A General Model of the Chinese Agricultural Economy

These numbers provide only an indication of the policy effects because they do not take into account the second round effect of a lower cotton price on rice and cotton production. To capture both the direct and indirect effects, it is necessary to build an economy-wide model.

The model built is a computable general equilibrium (CGE) model of the Johansen type. It follows the spirit of the ORANI model (Dixon et al. 1982) and the Martin model of the Chinese economy (Martin 1990). However, it incorporates some important special features.

The China model reflects the characteristics of labour market segmentation between rural and urban areas. Rural and urban industries are separated in model structure as they are very different in the Chinese economy. Two separate labour markets, one urban and one

rural, are specified. While in the urban labour market, urban residents sell their labour to urban industries, farmers sell their labour to agriculture and rural industry in the rural labour market. Urban and rural wages are therefore determined in separate markets.

Endogenous state price determination is explicitly incorporated in the model. This allows examination of how changes in state prices and how price distortions affect economic structure.

The model contains 22 sectors in total, among which four are agricultural sectors, nine rural non-agricultural sectors and another nine urban sectors. Two of the agricultural sectors, farming and animal husbandry, are multiproduct sectors.

Simulations are designed to illustrate how Chinese agriculture, within the economic framework modelled in this study, would adjust when it encounters various shocks and policy changes. Experiments involve

- changes in world markets
- economic reforms such as tariff reductions
- variations in macroeconomic policies
- a rapid expansion of rural industry
- improvement of labour mobility between urban and rural areas.

A rise in demand for China's textile exports. Of particular interest to this study is a rise in the demand for China's textile exports because it can show how a change in another sector of the economy may affect agriculture. The textile sector has a special connection with the agricultural sector because it uses cotton and wool as its main inputs. A sudden rise in demand for China's textile exports is possible because currently China's exports to many industrial countries, including the United States, is subject to the Multifibre Arrangement (MFA). As efforts have been made to remove this system, it is important to know what the effects on the agricultural sector and the economy as a whole are likely to be.

Results show that benefits from such a change are significant. A 10 per cent increase in demand for China's textile exports would increase China's real GDP by 0.18 per cent. Export volumes would increase by 0.46 per cent and import volumes by 0.14 per cent. Labour re-allocation from agriculture to rural industry would occur as a result of the booming textile industry. Most agricultural outputs would decline while their domestic market prices would increase. As a whole, agriculture's share in the whole economy would decrease by 0.8 per cent, but farmers' real income would rise by 0.5 per cent.

An increase in world price of wheat. China currently imports wheat and exports rice, while it pursues a basic self-sufficiency policy for grain. Changes in the world grain market would affect domestic agricultural production, which would then be transmitted to the other parts of the economy.

A 10 per cent increase in the world wheat price would increase domestic wheat production but reduce all other agricultural outputs. The state price for wheat, affected by this increase in world and domestic markets, is also increased by 1.2 per cent (much smaller than the increase in world price).

From the point of view of the whole economy, this price change has a negative impact. Real GDP would fall by 0.003 per cent. While agriculture's share in the economy would increase by 0.02 per cent, farmers' real income would drop by 0.1 per cent.

A reduction in wool import tariffs. A reduction in the tariff on wool imports may benefit wool exporting countries like Australia, but it would also have welfare effects in China and has interest in the context in China's efforts to join GATT.

The abolition of wool import tariff (about 13 per cent currently) would reduce the domestic wool price by 4.3 per cent. Consumers would benefit from this lower price. Agricultural production would adjust as outputs of wool and cotton would fall. Wool imports would rise dramatically by 6.4 per cent or about 9.7 thousand tonnes. The textile industry is the main sector that benefits from this policy change. Textile industry output

would increase by 3.2 per cent and exports by 1 per cent. There would not be must change to farmers' real income, the real GDP would increase by 0.01 per cent.

Monetary expansion. The mechanism here is simple as previously argued. The experiment is designed to verify the story told for the case of agricultural stagnation in 1985.

A 10 per cent monetary expansion would increase market price levels, in turn, lifting state prices (all less than 10 per cent). Output of wool and cotton, for which prices are strictly controlled by the state, would decrease significantly.

Other simulation results are consistent with experience in the mid-1980s. Labour would be reallocated from agriculture to rural industry. The textile industry would expand by 1 per cent. Agriculture's share in the economy would decline but both farmers' real income and real GDP would increase by 0.01 per cent and 0.05 per cent, respectively.

A sudden expansion of rural industry (the 'Dutch Disease'). The purpose of designing this experiment is the same as that for the monetary expansion. The simulation results are very similar to that experiment.

A 10 per cent improvement in intermediate input use would have a dramatic effect on agriculture. All state prices, particularly those for wool and cotton, would increase sharply. Labour would move from agriculture to rural industry as a result of the boom in rural industry. Agricultural employment would drop by 2.67 per cent. Surprisingly, real GDP would increase by 3.6 per cent. Farmers' real income would rise by 2 per cent while agriculture's share in the economy drops by 1.1 per cent.

Removal of restrictions on labour movement between rural and urban areas. All the above experiments are designed to demonstrate the interdependence of agriculture with rest of the economy. But the other equally important argument advanced is that the integration of different parts of the Chinese economy is still limited. The economy's response to exogenous shocks is therefore also limited compared with the circumstance in which there is a perfect market economy. To illustrate, a 10 per cent increase in

demand for China's textile exports is simulated in two environments: one with, and one without, labour flows between rural and urban areas.

If labour is perfectly mobile within the economy, the effect of a 10 per cent increase in demand for China's textile exports would be much stronger on the economy. For example, real GDP would increase by 0.3 per cent instead of 0.2 per cent. The agricultural workforce would drop by 1.56 per cent instead of 0.8 per cent. The additional fall in the agriculture workforce would be absorbed in booming urban industry.

Main Findings of the Study

The most important finding of this study is that as the Chinese economy is a system in transition, agriculture operates in neither a perfect market nor a stylized central planning system. Economy-wide policies have begun to play important roles in the determination of agricultural performance. The adjustment of the agricultural sector to exogenous changes remains limited because of residual restrictions and distortions. More detailed findings can be outlined as follows.

- There are two important characteristics of Chinese agriculture: the limited factor mobility and price distortion which not only directly affect production decisions but also change the way in which the economy responds to exogenous shocks.

- The dramatic expansion and contraction of farmers' feasible choice sets were the dominant factors determining agricultural growth and contraction in the second half of the 1980s.

- Price policies for grain in China were endogenously determined through bargaining between farmers and the state.

- Farmers' production decisions are guided by a combination of policy regulations and market signals, but their behaviour can be modelled by a profit maximization framework given careful adjustments in the data set.

- The Chinese economy and the agricultural sector adjust to exogenous change but the adjustment is smaller than it would be in the case of perfect factor mobility.

Policy Implications

These findings generate implications for policy making and policy analysis in China.

Policy Makers Should Abandon Agricultural Fundamentalist Perspectives

Economic policies, including agricultural policies, should facilitate the movement towards the comparative advantage of the economy. China had a history of pursuing self-sufficiency for all agricultural products before economic reform. It proved a very costly policy. In the reform period, agricultural (or grain) self-sufficiency continued to retard overall economic development.

Criticisms that the agricultural reform policies of the mid-1980s caused agricultural stagnation are unfounded. Although agricultural production slowed relatively from 1985, farmers' real income rose dramatically. The relative decline of agriculture was not a failure of the policies introduced in 1984, but a natural consequence of marketization reform and farmers' income maximization behaviour. Resources were used more efficiently, as shown by the narrowing gap between the values of the marginal products of labour in agriculture and rural industry.

Policy measures aimed specifically at recovery of agricultural production and the discouragement of rural industry in 1988 and 1989 were misdirected. Chinese agriculture recovered from 1989 but declined again in 1991. This temporary boom in agricultural production cannot be regarded as a result of successful policy change, because production resources were forced to move away from more efficient uses. Although agricultural production increased quite dramatically, farmers real income nearly stood still.

Policy Coordination is Essential in Agricultural Policy-making

Economy-wide and macroeconomic policies were shown to have significant effects on the agricultural sector in the past decade in China. As demonstrated by the experience of the second half of the 1980s, sector-specific factors cannot be regarded as the dominant factors affecting change in agricultural production. Rather, changes in rural industry (or farmers' opportunities in rural industry) proved to be a more fundamental cause of the sudden drop in agricultural production.

But different policy measures are designed for different purposes and often have different influences on agricultural performance. It is therefore critical for agricultural policy-makers to be aware of potential changes in the macroeconomic environment and their impact on the agricultural sector. Otherwise, agricultural policies may not be able to achieve their objective.

Restrictions on Labour Movement Limit Farmers' Adjustment Capacity and Prevent the Economy from Achieving Optimum Efficiency

Economic integration in China is still limited. China is not a mature market economy yet, so care has to be exercised in applying an analytical framework which relies on market assumptions. Prices are important in determining economic structure in China, but other factors also play a large role.

In analysis of a market economy, farmers' feasible production choice set is taken as stable: production decisions only change when the incentive structure changes. But in a reforming economy like China, all institutions and policies are changing dramatically. Farmers' feasible choice set may expand or contract suddenly. When this happens, price changes may become less important in guiding economic decisions. In the mid-1980s when farmers' opportunities in rural industry expanded dramatically farmers moved their resources to rural industry regardless of relative prices in agriculture.

This study has shown that restrictions on labour movement cost the economy significantly in terms of total output losses. Reforms appropriately designed to remove these restrictions smoothly are highly desirable.

Farmers Are Weak in Policy Games with the Government, but Are Becoming Increasingly Powerful: the Danger is Demand for Agricultural Subsidies Will Grow

Agricultural price policy is endogenously determined in a political economy framework. The application of a cooperative game-theoretic model in this study helps better understanding of this mechanism. This is an improvement in agricultural policy analysis in China, as most previous studies treat government policies as exogenous.

But the implications of this model are not limited to theoretical analysis. Although farmers are still very weak in a state-farmer policy game, farmers' bargaining power is increasing with the decline of agriculture's share in the economy and the share of agricultural population in total population, and with the increase in average income per capita and agricultural market prices.

There is a danger that China may follow the path of other East Asian economies where farmers are substantially subsidized by the government, with significant and adverse effects on overall economic development. This will come sooner in China if the government continues to support self-sufficiency for a set of agricultural products. The self-sufficiency objective makes farmers more powerful in bargaining with the government.

The best way to avoid this undesirable outcome is to promote the internationalization of agricultural production.

Self-Sufficiency Policy for Grain will Escalate the Burden on the State Budget, Further Distorting China's Economic Structure

China has declared grain self-sufficiency as one of its national policy objectives, at least for the period 1990-95. Currently, China exports rice in exchange for wheat in the

international market. Further pursuit of grain self-sufficiency will place much greater pressure on domestic grain production. Per capita agricultural resources are very limited in China. This will become an increasingly serious constraint for grain production, not only because of continuous demand increases but because other production activities compete with grain production for land as income rises.

If significant improvements in grain production technology do not occur, the only possible way for China to secure grain self-sufficiency is to distort the domestic grain price. But the cost of price distortion can be extremely high.

Given that the domestic rice price in China is already very close to the international market price, without significant subsidy, it may be very difficult for China to continue to export rice in exchange for wheat. The wheat price in China is already much higher than the world price. Opportunities for increasing output through price adjustments are very limited, unless the government is willing to adopt a policy of substantial grain production subsidization. As pressures on the state budgets have already become a serious problem to the Chinese government, the self-sufficiency policies that subsidize grain producers will be more difficult to implement.

The cost of this, however, goes beyond a burden on the state budget. Rising grain prices would also tend to distort the domestic economic structure. If a subsidy on rice production is adopted in order to maintain grain self-sufficiency, rice production might be encouraged and wheat and other crop production would be discouraged but by much larger margins. Not only is grain self-sufficiency an unachievable goal, but the economy may be forced to import other agricultural crops that it previously exported. If prices of grain products are to be subsidized, output of cotton and other crops will drop sharply. The Chinese economy may also be more dependent on international markets because it has to import more cotton and other agricultural products. The distortion to domestic comparative advantage will result in a reduction of the national welfare.

Directions for Future Research

There are generally three further directions which this study suggests could be fruitful areas of future research.

First, this study has shed some light on the labour market segmentation between rural and urban areas and limited labour mobility between agriculture and rural industry. The real picture is that there is some kind of limited labour flow between rural and urban areas. Theoretical and empirical modelling of this feature is difficult but important.

Second, the game-theoretic policy model applied in this study may be able to capture the essence of policy changes before 1992 in China. Since consumers are excluded from that framework, it is unable to explain how the abolition of the low state sale prices happened in 1992. A framework including farmers, consumers, the government and, sometimes, industrial producers would provide a more satisfactory model of agricultural policies in the future.

Finally, theoretically speaking, the limited economic integration identified in this study is important not only to economies in the process of reform like China, but also to other market economies. Conventional economic theory assumes quick and efficient adjustment by all economic agents. Equilibrium can be achieved at any time. In real life, however, economic adjustments involve both time and cost. A limited response mechanism may better capture the actual story even in developed market economies.

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