SIMULATIONS ON THE IMPACTS OF AGRICULTURAL POLICIES ON GRAIN SUPPLY AND DEMAND IN CHINA

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A Dissertation

by

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ABSTRACT

China's economic development entered a new phase. Large scale funding supports are available for agricultural development. Facing the decreasing food production situation, agricultural subsidy policies and grain price support policies have been implemented under the guideline of "offering more, taking less and loosening control" since 2003, aiming to mobilize farmers' enthusiasm for agricultural production, thus enabling grain production to rebound. The total amount of subsidies keep rapid increase annually and the grain minimum purchasing prices rise year by year. Those great support measures may show some influences not only on grain production but also on consumption, imports and exports. However, few studies have examined those impacts both on grain supply and demand. This study, therefore, attempts to evaluate the effects of agricultural policies on grain price, production, consumption, import and export employing a simultaneous equations model.

In the model, grain production is determined by the area and yield response functions. Area is specified as a function of the area and producer price of previous year, subsidies and trend variable. Yield is specified as a function of the yield and producer price of previous year, subsidies and grain planted areas. Grain food and feed consumption are modeled as a function of grain market price, per capita income and meat price. Import is specified as a function of grain market price, production, consumption and the exchange rate of Chinese yuan to US dollar. Export is specified as a function of grain market price, production, consumption and the exchange rate of Chinese yuan to US dollar. For subsidy policy simulation, the producer price is specified as function of production costs, subsidies and a dummy variable. Note that the subsidies show positive influence on grain prices in recent years in China. While for minimum purchasing policy simulations, grain price is

modeled as a function of minimum grain prices because grain prices are strongly influenced by the grain minimum purchasing price policy in China. For market clearance, grain ending stocks are a residual of total supply minus total demand.

The simulation results indicate some key factors. First, agricultural subsidies positively impact grain production, and show a bigger influence on the next year's production than that of current year. Second, subsidies have negative influences on grain consumption but the influences are very tinny. Third, for grain minimum purchasing price policy, increasing grain minimum purchasing price will promote the next year's grain production and can reduce grain consumption in only the current year. Fourth, subsidies can reduce imports and increase exports for rice and wheat, but decrease both imports and exports for corn. Grain minimum purchasing prices can increase grain imports and reduce grain exports. Finally, both policies can result in a rise in grain ending stocks both in the current and the next year.

Generally, the influences from agricultural subsidy policies are rather small, while price support policy shows very significant impacts on grain supply and demand. Thus, continuing efforts should be made to design appropriate minimum purchasing prices for grains.

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CHAPTER 1 INTRODUCTION

1.1 Backgrounds

China is the largest agricultural country with a biggest population in the world. Its agricultural GDP was 4748.6 billion yuan in 2011, accounting for 10% of the total economy. The population of China in 2011 was 13.47 billion, among which 65656 million were agricultural population occupying 48.73% of the total population. Also, China is a big food consumption country, accounts for approximately 30 percent, 17 percent and 21 percent of the rice, wheat and corn demanded in the world market. Thus, food issues appear particularly important to China, and since 2004 the Central No.1 Document, which often pays attention to the most important social issues, has continuously focused on agricultural issues for 10 years.

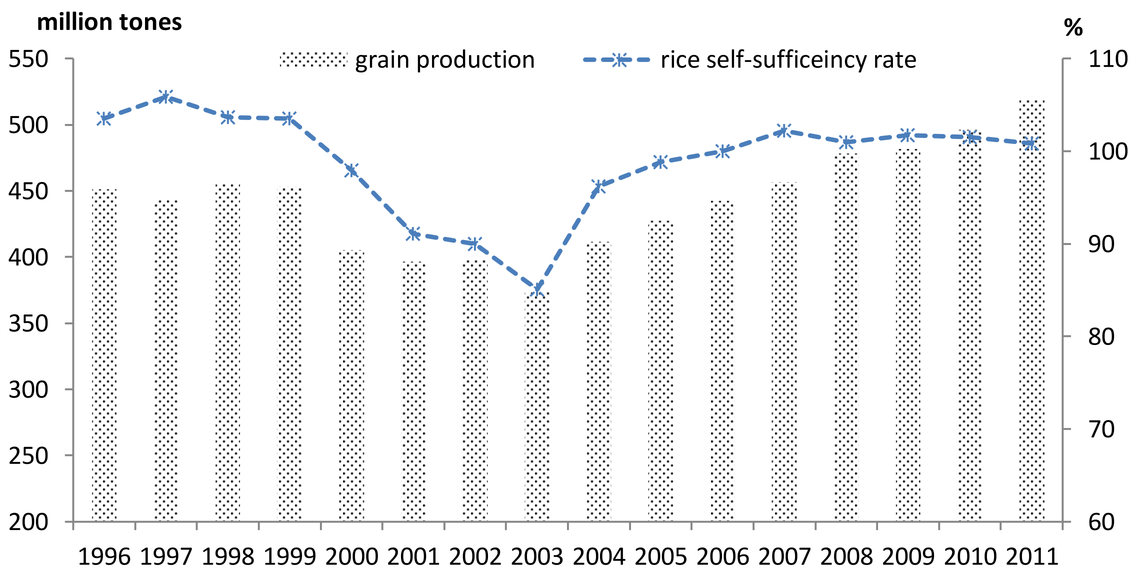

Figure 1.1 Decreasing grain production in China from 1997 to 2003

Source: USDA, PSD Online 2013.

Grain production plays a critical role in maintaining China's food security and social stability. Thus, to increase grain production becomes an important objective of the government. But since 1998, grain production had decreased, and met a historical low level of 374.29 million tons in 2003, and also the grain self-sufficiency rate, rice self-sufficiency rate touched a bottom of 85.1% in the same year.

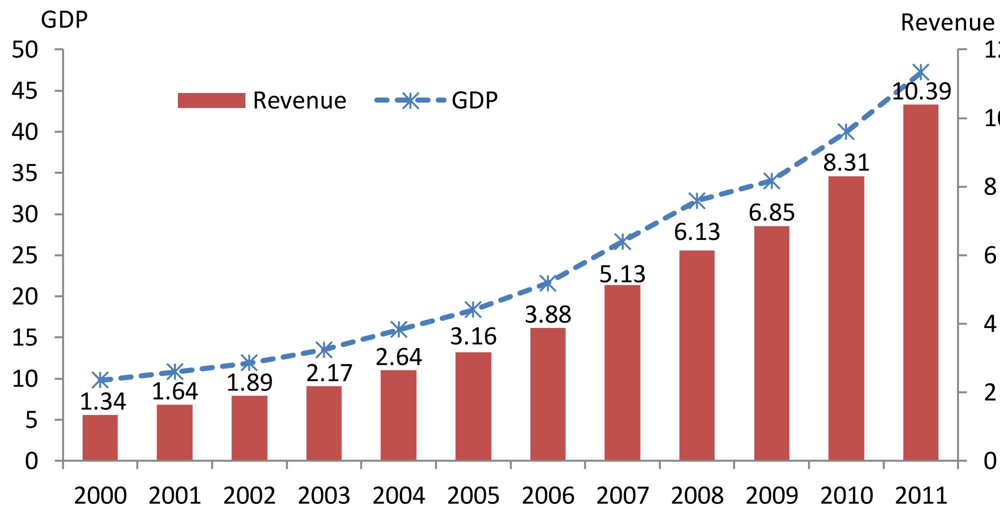

Figure 1.2 Increasing GDP and national revenue in China (trillion yuan)

Source: China Statistical Yearbook 2012.

China's economy has experienced a rapid growth since the late of 1970s and came to a new phase in 2000s. The economy scale of China jumped over 10 trillion yuan in 2001 and increased to nearly 50 trillion yuan in 2011. Also, national revenue has kept rapid growing, it priced 2 trillion yuan in 2003 and increased to more than 10 trillion in 2011, nearly 10 times that in 2000. Now large scale funds are available to support agricultural development.

For a long time, agriculture supports industrial development since the building of new China. Now China's economy development, especially the industrial development, has entered into a new stage, it is high time to implement the industry - nurturing – agriculture policy. Facing these backgrounds, in 2003 the government made a new guideline of "offering more, taking less and loosening control" for agricultural development. It dramatically increased support to agriculture, the rural economy and rural areas, and took practical measures to ensure that priority is given to agriculture, the rural economy and rural areas in its work. Among the policies and measures the agricultural subsidy polices and grain minimum purchasing price policy achieved best results, aiming to mobilize farmers' enthusiasm for agricultural production, thus enabling grain production to rebound. The subsidy policies for grains started from 2003, and the grain minimum purchasing price policy enforced in 2004.

1.2 Objectives

Since the agricultural policies were implemented, a great amount of fund supports have been provided for agricultural development. Much attention has been paid to the effects of these polices. The total amount of subsidies keep rapid increase annually and the grain minimum purchasing prices rise year by year. Those great support measures may show influences not only on grain production but also on consumption, imports, exports and ending stocks. However, few studies have examined the impacts of these support policies both on grain supply and demand. Therefore, this study attempts to evaluate the effects of these two main agricultural policies on grain prices, production, consumption, imports, exports and ending stocks employing a simultaneous equations model. To achieve this final objective, some sub studies need to be done to check the direct effects of these policies. The objectives of this study can be summarized as follows:

1. Describe the current situations of grains supply and demand in China.

2. Introduce the implementation of the main agricultural policies in China, the agricultural subsidy policies and the grain minimum purchasing price policy.

3. Examine the direct effects of agricultural policies, the direct effects mainly focus on grain market prices, planted area and yield.

4. Develop a partial equilibrium model of China grain supply and demand based on the studies of direct effects of these policies.

5. Evaluate the impacts of agricultural policies on grain supply and demand using three scenarios. The supply sectors include grain production, grain imports and ending stocks, the demand sectors are grain consumption, grain exports and the.

6. Finally, present the main conclusions and policies implications according to the previous studies.

1.3 Justifications

Agricultural policies cover an extremely extensive range. The main purpose of our study is to examine the policy effects on grain supply and demand, thus, the agricultural policies involved in two policies, they are agricultural subsidy policy and grain minimum purchasing price policy, both are correlated to grain supply and demand directly.

The support policies are mainly focused on these three grains (rice, wheat and corn) which are the most important food grains in China relating to the country's food security. Therefore, grains in this study only refer to rice, wheat and corn. In this study, they are studied separately in individual models.

1.4 Organization

This study contains 8 chapters. Chapter 1 states the backgrounds and justifications, objectives and organization of this study; in chapter 2, a review of a representative studies on evaluating agricultural supply response, effects of agricultural subsidy policies. Some studies on partial and general equilibrium models for food supply and demand are also reviewed; chapter 3 describes the current situations of grain supply and demand in China, three main grains, rice, wheat and corn, are introduced separately from the production, consumption, imports, exports and ending stocks; in chapter 4, we introduce the implementations of the two main agricultural policies, they are subsidy policies and grain minimum purchasing price policies. The subsidies include fine seed subsidies, grain direct subsidies, farm machinery subsidies, and comprehensive subsidies. For the grain minimum purchasing price policy, it only covers rice and wheat in current stage, corn is not covered by this price support policy; in chapter 5, the effects of these policies are evaluated. We estimate the yield and area response for three grains using Nerlove model in which a subsidy variable is incorporated. The impact of subsidies on grain prices is also examined in this chapter using cointegration analysis, and the effect of minimum purchasing price policy is also assessed using the grey relational analysis; in chapter 6, a simultaneous equations model is built to link agricultural policies and the sectors of grain supply and demand; in chapter 7, the simulation analysis has been conducted to evaluate the impacts of agricultural policies on grain prices, production, consumption, imports, exports and ending stocks; and finally, in chapter 8, we present our conclusions and policy implications.

CHAPTER 2 LITERATURE REVIEW

2.1 Studies on Supply Responses

Nerlove (1958) included expectation theory into the study of agricultural response and developed Nerlove model. The adaptive expectation can be expressed as follows,

$$P_t^* = P_{t-1}^* + \beta(P_{t-1} - P_{t-1}^*),\ 0 < \beta \le 1 \qquad (1)$$

where P_t^* and P_{t-1}^* are expected prices at year t and t-1, respectively, β is the coefficient of expectation, which lies between zero and one. Nerlove (1958) hypothesized farmers react in terms of the expected price. Then the acreage response function can be written as follows:

$$X_t = \alpha_0 + \alpha_1 P_t^* + u_t \qquad (2)$$

where X_t is the acreage in year t, P_t^* is the expected price in year t, α_0 and α_1 are the coefficients to be estimated. P_t^* is unobservable, so it cannot be estimated. In particular, last year's expected price, P_{t-1}^*, can be represented by last year' acreage, X_{t-1}. This means that expected price this year is a function of last year's actual price and last year's acreage. We can replace last year's expected price in equation (1) by a linear function of last year's acreage. If we now substitute this new expression for expected price into the acreage response function, equation (2), we obtain a new relation between acreage this year and last year's actual price and last year's acreage. The relationship is expressed as:

$$X_t = \pi_0 + \pi_1 P_{t-1} + \pi_2 X_{t-1} + v_t \qquad (3)$$

where π_0 turns out to be equal to $\alpha_0\beta$, π_1 equals $\alpha_1\beta$, and π_2 equals $1-\beta$. Equation (3) is called Nerlove model, and it has been applied extensively in researches on agricultural supply response. According to the survey of Askari and Cummings (1977), more than 100 empirical studies employed Nerlove's concept. Braulke(1982) made a note on Nerlove model and gave some advices on using this model. Khalid (2003) evaluated the yield response in Pakistan agriculture with cointegration approach. Jeffrey (2009) estimates the supply response of cotton and cereal crops in smallholder production systems in Mali. In China, Wang xiuqing(1998), Si wei(2006), Ma wenjie(2009), Wang Hong(2010) use Nerlove model to estimate the supply response of vegetable, sugar, wheat, and corn of China, respectively. Also some researchers use other methods to estimate the supply response, for example, Ito (1999) employed implicit revenue functions to evaluate rice supply response.

2.2 Studies on Effects of Price Support Policy

The effects of price support policy (Minimum purchasing price policy) have received much attention from academics and policy makers since its implementation, and the studies on this topic are many. Qu (2006) introduced grain minimum purchasing price policy in details, and pointed out the differences between the protective price policy implemented before and minimum purchasing price policy. Yang (2006), Wang (2006), Huang (2006) and Yun (2010) concluded that the minimum purchasing price policy enhance farmers' income and stabilize grain market prices effectively based on studying annual income and price data. Liu (2009) analyzed the policy effects from economic theory, they concluded that in theory the GMPP policy is helpful to protect farmer's interest and to keep grain price and production stable. Wang (2010) found that food price policy is a major factor influencing food market prices, and he summarized the influence of different price policy on food market prices in different periods. Li (2011) pointed out that under the background of agricultural product prices decline 6.2% in the first half year of 2009, the prices of rice and wheat increased by 4.9% and 8.7%, respectively, after the implementation of minimum purchasing price policy for rice and wheat. However, those researches most are based on theoretical or descriptive analyses, up until now, no empirical study on evaluating the effect of MPPP is found due to a short policy implementing period. In order to fill this gap in the literature, we attempt to employ grey relational analysis method which only requires a very limited data sample to empirically examine how significant this policy factor is among the determinates of grain market prices, and seek to provide more convincing information for policy making. This part will be discussed in chapter 5.

2.3 Studies on Effect of Subsidies

Wang and Xiao (2006) have employed the Positive Mathematical Programming (PMP) Model to study the effects of agricultural subsidies on grain production and agricultural income based on investigated data of 5 counties in China, and their conclusion is the impact on grain production is not so large but farmers' income has been increased with the implementation of subsidy policy. Mu and Koike (2009) simulated the impacts of agricultural subsidy policy on outputs of agricultural sector and non-agricultural sectors employing the SCGE model, and their results suggest that agricultural subsidies promote the outputs of both agricultural and non-agricultural sectors, but the income levels didn't change so much after the implementation of subsidy policies. Huang et al (2010) simulated the impacts of agricultural subsidies on Chinese food security based on the China agricultural CGE model, and results show that agricultural subsidies play an important role in ensuring the country's food security, and promote the increase in investments, GDP and exports. Huang et al (2011) evaluated the impacts of agricultural subsidies on agricultural production using descriptive and multiple regression analysis based on panel data in 6 provinces, the conclusion is the subsidies in China are actually an income transfer payment, they did not show significant impacts on agricultural production, and did not distort market prices, so the current agricultural subsidy policies do not break the rules of WTO.

2.4 Studies on Modeling Efforts on Grain Supply and Demand

IFPRI developed the International Model for Policy Analysis of Agricultural Commodities and Trade (IMPACT), in which the effects of population, investment, and trade scenarios on food security and nutrition status, especially in developing countries, were analyzed. IMPACT covers 36 countries or country groups and 16 commodities, including all cereals, soybeans, roots and tubers, meats, and dairy products (accounting for virtually all of the world's food and feed production and consumption). The model is specified as a set of country-level demand and supply equations linked to the rest of the world through trade. Food demand is a function of commodity prices, per capita income, and population growth. It includes fresh and processed food. Feed demand is a function of livestock production, feed prices, and feeding efficiency. Crop production is determined by the area and yield response functions. Area is projected as a function of crop price, investment in irrigation, and estimated rates of loss of land to urbanization and land degradation. Crop yield is a function of crop price, input prices, investments in irrigation, and yield growth due to technological change. Growth in productivity due to technological change is in turn estimated by its component sources including advances in management research and, in the case of food crops, plant-breeding research. Other sources of growth considered in the model include private-sector investments in agricultural research and development, agricultural extension and education, markets, infrastructure, and irrigation.

Rosegrant et al (2001) projected world food supply and demand, trade, prices, and food security to the year of 2020 based on an updated version of IMPACT.

The Arkansas Global Rice Model (AGRM) is based on a multi-country econometric framework. The model consists of six sub regions. These regions are the U.S., South Asia, North Asia and the Middle East, the Americas, Africa and Europe. Major components of a sub-model include a supply sector, a demand sector, trade, price linkage equations and market clearance. The supply sector is determined by harvested acreage and yield. The harvested acreage is specified as a function of harvested acreage one year lagged, expected price received by producers and expected input price. Yield is generally specified as a function of expected output, input price and technological change. For demand sector, the per capita rice demand is generally specified as a function of per capita income in real terms, rice retail price and wheat price. The demand for exports is a function of the difference between domestic production and consumption and export price. For price linkages, farm price is generally modeled as a function of retail price, retail price is generally a function of deflated FOB price and a time trend that captures the improvement in marketing efficiency. Export price is generally modeled as a function of Thai price (5% broken). The market clearance, ending stocks are a residual of total supply net of total demand. Production is defined as total harvested area multiplied by yield, total consumption is per capita demand multiplied by population.

Huang and Li (2003) developed a China's agricultural policy simulation and projection model (CAPSiM). CAPSiM is a partial equilibrium model composed of 13 sub-models. It is one of the most comprehensive models for analyzing China's agricultural policy and projection. The model can be used in both short- and long-run projection or policy simulation. Price can be determined either endogenously or exogenously. Most of the elasticity and parameters used in CAPSiM are estimated econometrically with imposition of theoretical constraints. In CAPSiM, acreage is a function of various input and output prices, including crop prices, fertilizer price, labor price and land rent. Yield is defined as a function of crop price, agricultural technology, water stocks, ratio of erosion area to total area and ratio of salinity area to total area. Total production equals acreage times yield. For demand sector consists of food consumption, feed consumption, other consumption (including seed consumption, industry consumption and waste), food per capita consumption is made up of urban food consumption and rural food consumption, urban food per capita consumption is a function of food price and real income, rural food per capita consumption is specified as a function of food price, real income and market development rate. Total food demand equals food per capita consumption times population. Feed consumption and other consumption are an equation of last year amount times annual growth rate. Total demand sums food consumption, feed consumption and other consumption. Ending stocks are expressed as follows:

$$B_t^G = B_{t-1}^{stock}(1+\psi D_t^G / D_{t-1}^G) - \psi B_{t-1}^{stock} + lp_t^D$$

Where B^G is ending stocks, D^G is demand, l is the marginal changes due to commodity prices, p^D is commodity prices. If ψ =0, for long-run analysis; if ψ =1, for short-run analysis. For trade sector, the equations are as follows:

$$X_t^{import} = \sigma(P_t - P_t^{import}) + Q_t$$

$$X_t^{export} = -\sigma(P_t - P_t^{export}) - Q_t$$

where σ is an import or export elasticity with respect to domestic demand obtained from FAO with a value of 2.2. P is the domestic commodity price, P^{import} is the import price and

P^{export} is the export price, Q indicates domestic demand. The market clearance equation is as follows:

$$X_t^{import} - X_t^{export} + S_t = D_t + B_t - B_{t-1}$$

where X^{import}, imports; X^{export},exports; S, total production; D, demand; B, ending stocks, B_{-1} , beginning stocks.

Chen and Liu (2008) developed a partial equilibrium model to simulate China's coarse grain supply and demand. Due to some data is not available, they assumed the ending stocks of the coarse grains remain unchanged and used coarse grain producer prices to instead of consumer prices. The model consists of 7 structural equations: production equation, price equation, export equation, import equation, price linkages and market clearance equation. Production is a function of production one year lagged, last year's coarse grain price, corn price, agricultural input price index and disaster rate. Coarse grain price is specified as a function of per capita coarse grain demand, ratio of GDP to last year GDP, corn price and a dummy variable. Export equation is a function of export one year lagged, export price, and exchange rate between Chinese yuan and U.S. dollar. Import equation is a function of coarse grain price, and last year's coarse grain production. For prices linkages, export price is defined as a function of domestic price and exchange rate; corn price is modeled as a function of corn price one year lagged and domestic coarse grain price. the market clearance is total demand (per capita demand times population) equals production plus import, and minus export. In their model, per capita GDP, population, disaster rate, exchange rate, input price index are exogenous variables, the others are endogenous variables.

CHAPTER 3 SITUATIONS OF GRAIN SUPPLY AND DEMAND IN CHINA

3.1 Grain Production

From 1990 to 1995 China's grain production remained stable, in 1996, it began to increase and touched a historical high level of a value of 512.30 million tons in 1998, after that the production began to decrease. The production declined from 508.39 million tons in 1999 to 462.18 million tons in 2000, decreased by 46.21million tons or 9.1% in one year.

In 2003, the production touched a historical low level, the planted area in 2003 was 99.41 million hectares, which was 4.48 million hectares less than in 2002, and the grain production was 430.70 million tons, down 5.8% from 2002, which was the biggest drop in three years. Summer grain production dropped by 2.7% to 29.48 million tons, and autumn grain production was down by 7% to 304.83 million tons. Except for the provinces of Shandong, Guizhou, Yunnan, Jinlin, Shanxi, Hainan and Gansu and the municipality of Chongqing, all other producing areas reported a contraction in grain production, of which 13 major producers reported an 88.6% decline, or 23.35 million tons. The main reason resulting in the big decline in grain production was a low grain price. Figure 3.1 shows the movements of grain price and grain production. Generally, the current year's production is determined by the last year's price. The real grain prices were relatively low in 2000- 2003. But it rebounded in 2003 as a result of the balance in supply and demand following a drop in the output of grains and the support policies for agricultural development. Under the new guideline of "offering more, taking less and loosening control", more policy supports and money are provided to grain production. Farmers' enthusiasm for grain production was greatly stimulated, and grain production had begun to rise year by year.

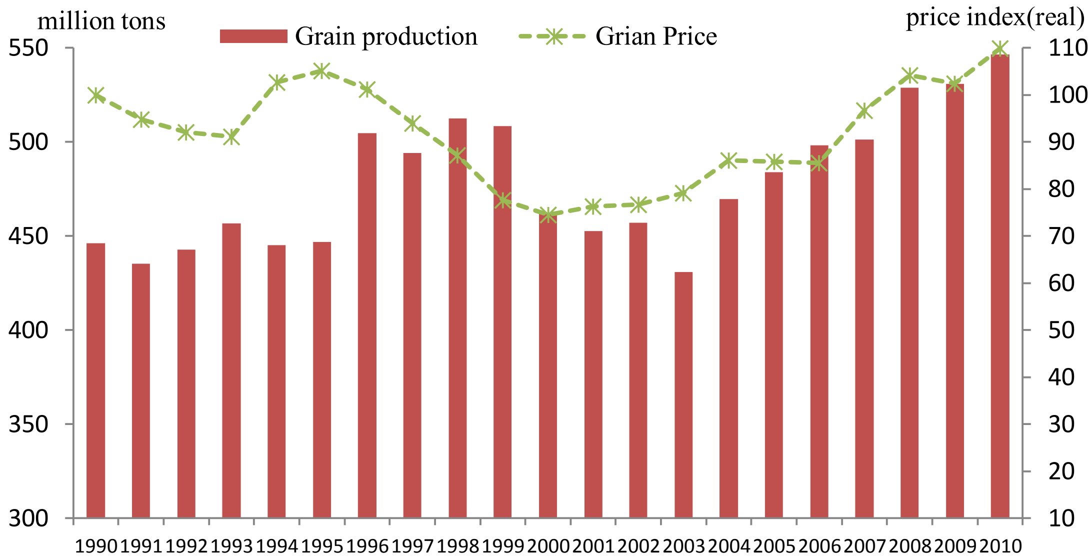

Figure 3.1 Total grain production and price in 1990-2010

Source: China Agricultural Development Report 2011.

Grain production witnessed a significantly favorable turn for the better in 2004 due to favorable policies, higher prices and good weather conditions, reversing five consecutive years of decline in the areas planted to grains and realizing a historic recovery of grain production. Grain acreage increased to 101.61 million hectares, 2.2 million hectares more than the previous year, reversing five consecutive years of slide. Total grain production reached 469.47 million tons, increasing by 38.77 million tons or 9% over the level in 2003, the biggest increase in the past 60years. With the yield reaching a record high of 308kg/mu, an increase of 19.2 kg over last year. Rice production was 125.4 million tons, up 12.9 million tons or 11.5% from 2003, and wheat production was 92.0 million tons, an increase of 5.5 million tons or 6.4%, bringing to an end of four successive years of fall in its production. Corn production was 130.3 million tons, grew 14.5 million tons or 12.5% over that of 2003. All provinces except Tibet, Hainan, Guangdong and Guangxi, which reported a slight decline in the production, recorded increases in grain production, with 13 major producing areas increasing by 35.37 million tons, or 11.6%, making up 91.2% of the total increase.

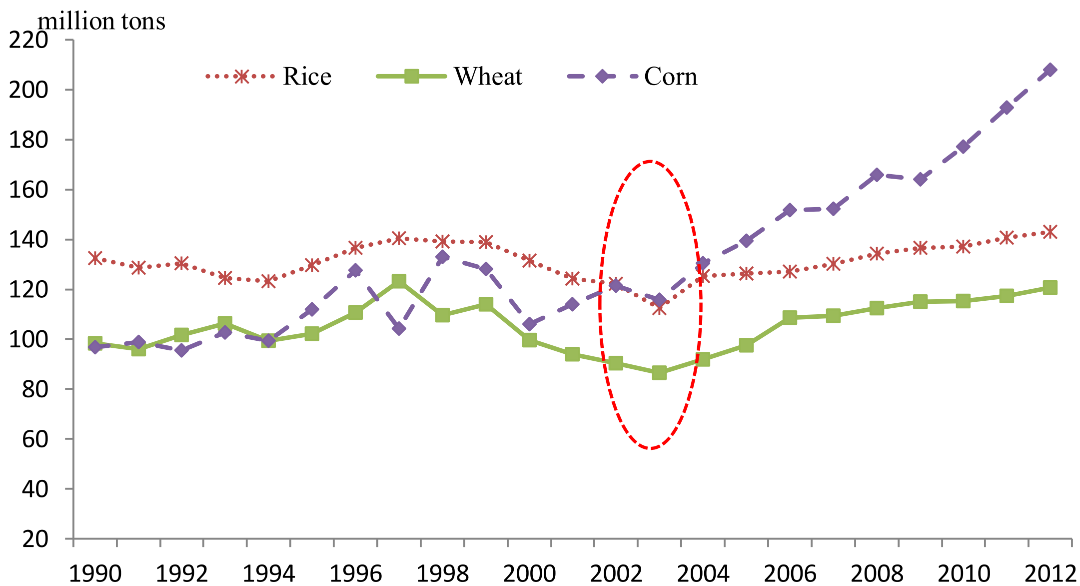

Figure 3.2 Changes in production of rice, wheat and corn

Source: USDA, PSD Online 2013.

In 2008 grain production made a historic breakthrough, reached a historical high and realized an increase for the fifth consecutive year, for the first time in the past 40 years. In addition, grain yield had set a record for the fifth successive year, for the first time since 1950s. In 2008 grain production realized increase and set record in both total output and yield. Grain production made another breakthrough on the basis of increases in the previous four consecutive years. Total grain production and yield both achieved growth for the fifth successive year and reached a historical high. The year also marked the first time in eight years that grain supply and demand stuck a rough balance, thus effectively relieving the pressure of supply vs demand. Planted area of grains totaled 106.79 million hectares in 2008, 1.15 million hectares more than in the previous year. They produced a total amount of 528.71 million tons, up 27.11 million tons of 5.4% from the previous year, and an increase of 3.2% over 1998, when the previous production record was set. Grain yield reached 4951.5kg/hectare, 201kg or 4.2% more than the record in 2007. Higher yield made a contribution of over 80% to the increase in total production, the biggest in the past five years. In 2008, rice production was 134.3 million tons, up 4.1 million tons or 3.1% from 2007, wheat production was 112.5 million tons, an increase of 3.2 million tons or 2.9%, compared with the 2007's, and corn production was 165.9 million tons, went up 13.6 million tons or 8.9% over that of 2007. The growth trend kept continued after 2008. In 2012 the total grain production stood at a new historical high, realized an increase for the ninth consecutive year, reached 589.6 million tons, up 158.9 million tons or 36.9% over that of 2003, the lowest level since 1990s. The production of rice, wheat and corn reached 143.0 million tons, 120.6 million tons and 208.0 million tons, an increase of 30.5 million tons, 34.1 million tons and 92.2 million tons or 27.1%, 39.4% and 79.6% over that of 2003 for rice, wheat and corn, respectively.

3.2 Grain Consumption

China accounts for approximately 30 percent, 17 percent and 21 percent of the rice, wheat and corn supplied and demanded in the world market, indicating even a small change in grain production and consumption patterns in China could have a big influence on world food supply and demand.

Rice total consumption had kept continuous growth with the developing of economy since 1980s, and in 2001 touched its summit of 136.5 million tons, and then changed to decline, but in 2006 the decrease stopped at a level of 127.2 million tons, which was down 6.8% from the historical high in 2001. From 2007 rice consumption began to increase again, which seems to be unnormal. Wheat consumption showed the same situation with rice, it had experienced a stable growth since 1990s and reached a record high of 110.3 million tons in 2000. Then stated to decline, in 2006 it was down to a low level of 102.0 million tons, and had rebounded since 2007, in 2011 a new record was set at a value of 120.0 million tons.

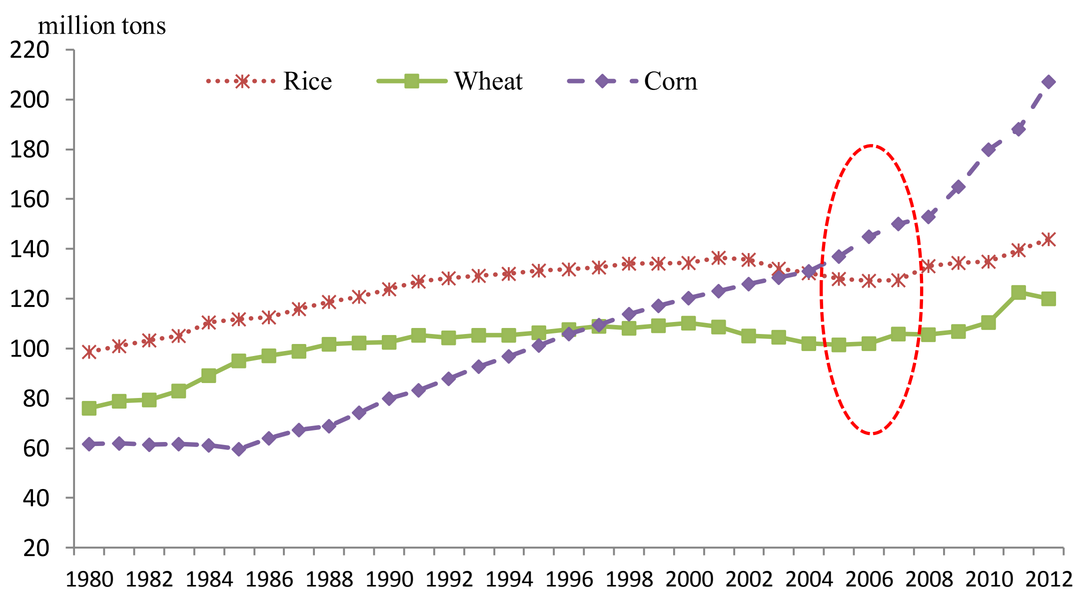

Figure 3.3 Changes in China's grain consumption

Source: USDA, PSD Online 2013.

From 1980s to 2000s, the income level of Chinese was still low, with consumers becoming rich due to the economic development, they will increase grain consumption to improve their living quality, at this stage grains are normal food for them; when income level rises to a certain extent, other high quality foods such as meat, dairy, are available for them, they change to consume more meat and dairy and reduce food consumption, at this stage the grains are inferior food. China's economy still kept rapid growth after the middle 2000s, but the consumption in rice and wheat during this period rebounded, rather than decline or stayed at a low level. Generally, the consumption structure has changed with the economic development and earning increase. But the new increase trend is really out of our expectations.

Corn is not a staple food and most is used for feed. Corn consumption had experienced a long and stable growth; it increased from 59.7 million tons in 1985 to 137 million tons in 2005, up more than two times at an annual average rate of 4.2%. But in 2006 the increase started to become faster than before, went up 8 million tons or 5.8% over the last year, and increased by 7.8% in 2009, 9.1% in 2010 and 10.1% in 2011. These increases were attributed to rapid economic growth in China's economy expanding caused high demand in corn for industrial use and feed use.

Generally, in recent years, new trends in grain consumption are observed in China. The consumption of rice and wheat showed a downward trend in early 2000s but it starts to rise since mid-2000s (Figure 3.3). The consumption of corn grew steadily until mid-2000s but shows a sharp increase now. These new trends in grain consumption in China attract extensive concerns from academics. The high meat prices mainly contribute to these new changes in grain consumption, high meat prices lead to grain consumption substitutes meat consumption for rice and wheat, and call for high feed demand to produce more meat for wheat and corn, the details will be discussed in chapter 6.

3.3 Grain Trade

China exported 1.35 million tons of grains in 2012, down from 1.51 million tons in 2011, a drop of 11.9%, while importing 9.10 million tons of grains, a cut of 8.5% from 9.95 million tons in 2011. Thus, net grain export came to -7.75 million tons, China has become a grain net importer for four years. The import amount increased from 1.39 million tons in 2009 to 7.75 million tons in 2012, more than 5 times the amount in 2009.

Rice

From 1992 to 2003, normally, rice import was sustained at a level of less than 0.3 million tons per year, but except the period of 1993-1995 and 2003, during which rice import fluctuated drastically. China imported 0.97 million tons of rice in 1993, a jump of 3.6 times from the previous year. It increased to 2 million tons in 1994, up 106.2% over 1993, and went down by 57.5% from 2 million tons in 1994 to 0.85 million tons in 1995. These dramatic fluctuations in 1993-1995 are attributed to reductions in rice production. In 1993 China produced 124.39 million tons rice, decreased 5.96 million tons or 4.6% from 1992. In 1994 rice production came to a minimum of 123.15 million tons, down 1.24 million tons from the previous year, while rice import reached a maximum of 2 million tons in 1994. Also, in 2003 rice production dropped by 8.0% over the last year, and rice import increased by 330% from 0.26 million tons in 2002 to 1.12 million tons in 2003. After 2003 China increased rice imports from international market, in 2004-2010, the average was 0.47 million tons per year, in 2012 the import was 2.90 million tons, which was much larger than less than 0.3 million tons per year the average level before 2003 (Figure 3.4).

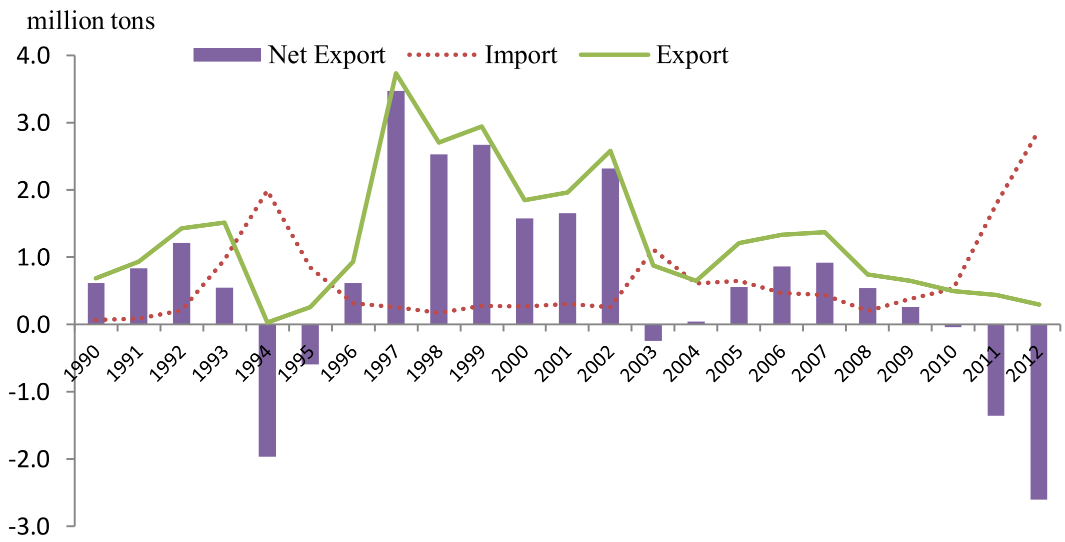

Figure 3.4 Import and export of rice in China during 1990-2012

Source: USDA, PSD Online 2013.

Rice export is also affected by production. In 1994 China's rice export shrank from 1.52 million tons in 1993 to 30 thousand tons in 1994 due to the reduction in rice production. In 1997 with rice production went to a maximum of 140.49 million tons, a 8.3% increase from 1995, the exports also went up to its maximum of 3.73 million tons, 4 times larger than the last year. From 1997 to 2002, the export had sustained at a relatively high level with an average of 2.63 million tons per year until meeting a sharp decline in rice production in 2003. In 2003, the export was 0.88 million tons, down 65.9% from 2.58 million tons in 2002. It was reduced to 0.66 million tons in 2004. In 2005 -2007, it recovered moderately to above 1 million tons per year. Note that with domestic demand increasing, export was decreasing, it was reduced from 1.37 million tons in 2007 to 0.3 million tons in 2012 (See Figure 3.4).

For 1990 to 2009, Except for those years in which rice production decreased dramatically, for example 1993, 1994 and 2003, China was a net rice exporting country, and the export quantities were much higher than that of imports. But in recent years, due to the increasing domestic demand, rice import showed an increasing trend while exports are in decline. Note that in 2010, China's rice imports were 0.54 tons, up from 0.39 million tons in the previous year, an increase of 38.5%. Rice exports were 0.50 million tons, down from 0.65 million tons in 2009, a cut of 23.1. As a result, there was a net rice import of 40 thousand tons, which was the first time since 2004 and under a background of a bumper harvest. In 2012 the amount of rice net import increased to 2.6 million tons (See Figure 3.4).

Wheat

China was a net wheat import country since 1990s. From 1990 to 1995 the imports were much higher, especially in 1991, 1994 and 1995. In 1991 China imported 15.86 million tons from foreign countries, a jump of 68.5% from 9.41 million tons in 1990, which touched a summit of wheat imports. In 1994 and 1995, wheat imports had witnessed sharp increases, they were 10.26 million tons in 1994, up 5.94 million tons or 137.5% from the previous year, and further increased from 10.26 million tons in 1994 to 12.53 million tons in 1995, went up 2.2%, meeting a maximum again in such a short time (Figure 3.5). As the same with rice, the production played an important role in these big fluctuations. Generally grain production may show negative impacts on grain imports, as wheat production came to a low level of 96 million tons in 1991, Chinese government had to increase wheat supply by importing more wheat from international markets to ensure the food security, resulting in the jump in wheat import in 1991. Likewise, in 1994 the production was 99.30 million tons, went down 7.09 million tons from the last year and met a minimum value, in 1995 it had a moderate recover, up to 102.22 million tons, while wheat imports went down to a peak in the same years. Similar situation was also witnessed in 2004. From 1996 to 2002 the imports had stayed at a low level, but wheat production was at a high level in this period. And also, after 2004 the imports returned to low levels with an average of 0.73 million tons per year, but wheat production was increasing annually from 97.4 million tons in 2005 to 120.4 million tons in 2012 (See Figure 3.5). Obviously, wheat production and import had shown simultaneous and opposite movements, suggesting that wheat production may shows negative influences on wheat import.

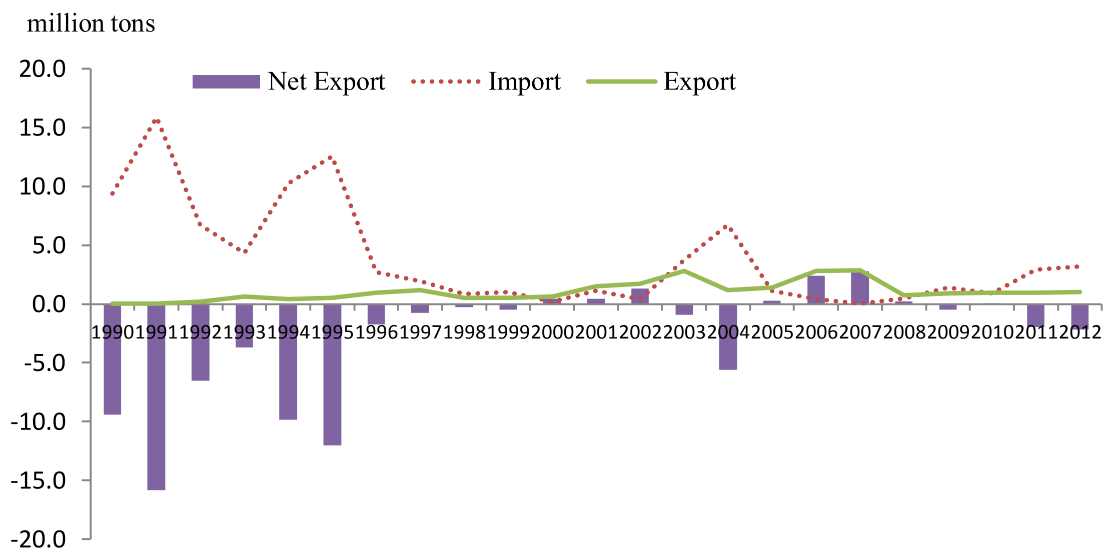

Figure 3.5 Import and export of wheat in China during 1990-2012

Source: USDA, PSD Online 2013.

China's wheat exports were very small, from 1990 to 2000, the average was 0.51 million tons per year. From 2001 to 2007, exports had become relatively large, the average amount was increased to 2.03 million tons during this period. Big increase was observed in 2003 with an amount of 2.82 million tons, and in 2006, 2007 the wheat export was 2.78 million tons and 2.84 million tons, respectively. After 2007 with domestic consumption increasing, more wheat was transferred to domestic use, and export started to decrease, in

2008 it's dropped 74.6% from the peak in 2007 to 0.72 million tons in 2008. In 2008-2012, wheat exports sustained at low levels with an average of 0.91 million tons per year due to the great increasing domestic demand in China. For most years from 1990 to 2012, China was a net wheat importing country, especially in the earlier 1990s, now China tends to import more wheat from international market (See Figure 3.5).

Corn

China imported small amount of corn from international market for most years. The record high during 1990-2008 was in 1994 with a value of 4.29 million tons, this was mainly due to the high corn prices, in 1994 corn prices jumped 60% from 30.17 yuan/50kg in 1993 to 48.22 yuan/50kg in 1994, high corn prices forced corn industries to change to international market so as to reduce their production cost. In 1995 corn import decreased to 1.48 million tons, went down by 65.6%. From 1996 to 2008, the corn imports went back to low levels with an average of 80 thousand tons per year. But as domestic consumption increase, China had to import more corn from foreign countries. Corn import jumped from 0.05 million tons in 2008 to 1.30 million tons in 2009, an increase of 1.25 million tons. In 2011 it increased to 5.23 million tons, more than 5 times larger than that of 2010 (See Figure 3.6).

In 1990- 1993, the corn export was increased from 6.88 million tons in 1990 to 11.59 million tons in 1993 or by 68.5%. But in 1994 it sharply decreased to 1.33 million tons, down 10.26 million tons or 88.5% over the last year. The key reason causing this sharp reduction was corn prices in domestic market, which jumped 60% from 30.17 yuan/50kg in 1993 to 48.22 yuan/50kg in 1994. Facing high corn prices in China domestic market, producers or sellers tended to sell their products in domestic market rather than international market, so corn for exports were reduced. When corn price touched a summit of 67 yuan/50kg in 1995, corn exports also moved to a minimum of 0.16 million tons, went down by 88% over the previous year. In 1996 corn prices began to decline, and corn exports had rebounded and stood at a historical high of 15.24 million tons in 2002. Corn exports are also impacted by domestic consumption, the decline since 2003 might be attributed to the rapid increasing domestic demand in China, in particular for industrial use and feed use. Corn consumption had increased from 128.4 million tons in 2003 to 207.0 million tons in 2012, an increase of 61.2%, and corn export had shrank from 7.55 million tons in 2003 to 0.05 million tons in 2012, went down 7.5 million tons or 99.3% (See Figure 3.6).

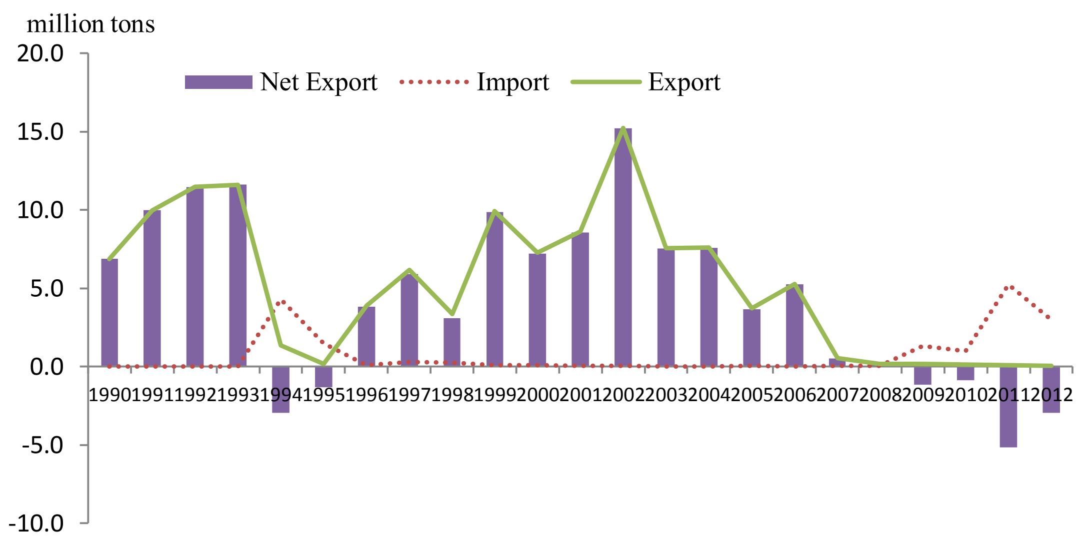

Figure 3.6 Import and export of corn in China during 1990-2012

Source: USDA, PSD Online 2013.

In 2009 corn production was 163.97 million tons, but the consumption increased to 165 million tons, 1.03 million tons larger than production, in 2010 the gap extended to 2.75

million tons. This also changed the structure of corn imports and exports. In 2009, corn imports were 1.30 million tons, up 1.25 million tons from 0.05 million tons in the previous year, an increase of 96.2%, while corn exports decreased to 0.15 million tons. As a result, there was a net corn import of 1.15 million tons, in 2011 the corn net import was extended to 5.14 million tons, in 2012 the amount was 2.95 million tons. (See Figure 3.6).

3.4 Ending Stocks

Grain ending stocks are increasing in recent years, in 2012 the ending stocks of rice, wheat and corn were 46.62 million tons, 58.75 million tons and 63.29 million tons, respectively, increased 1.85 million tons, 0.76 million tons and 4.29 million tons or by 4.1%, 1.3% and 7.3% over that of 2011, respectively. As it is shown in movements of grain ending stocks, they were highly correlated to each other and moved simultaneously. From 1990 to 2012, the movements of grain ending stocks can be divided into 4 periods.

The first period is from 1990 to 1999, in this period the ending stocks had experienced rapid growth, and set high records for each grain in 1999, rice ending stocks increased by 3.6% from 94.00 million tons in 1990 to 97.35 million tons in 1999, wheat ending stocks increased from 49.94 million tons in 1990 to 102.94 million tons in 1999 by 106.1%, corn ending stocks were 123.80 million tons in 1999, an increase of 40.98 million tons or 49.5% over the level in 1990, we believe the high grain production contributes to these increases, the grain production in this period reached historical high in this period, the records were 140.5 million tons in 1997, 123.3 million tons in1997 and 133.0 million tons in 1998 for rice, wheat and corn, respectively; the second period is from 1999 to 2003, in which the ending stocks had exhibited dramatic and continuous declines, the ending stocks of rice decreased by 54.9% from 97.35 million tons in 1999 to 43.92 million tons in 2003, wheat ending stocks were reduced from 102.94 million tons in 1999 to 43.29 million tons in 2003, a decrease of 57.9%, corn ending stocks were 44.85 million tons in 2003, a reduction of 78.95 million tons or 63.8% from that of 1999, these big decreases in grain ending stocks were mainly attributed to reductions in grain production. The production of rice, wheat and corn were 112.5 million tons, 86.5 million tons and 115.8 million tons, down 20.0%, 29.8% and 12.9% from their high records in 1997 or 1998 (See Figure 3.7).

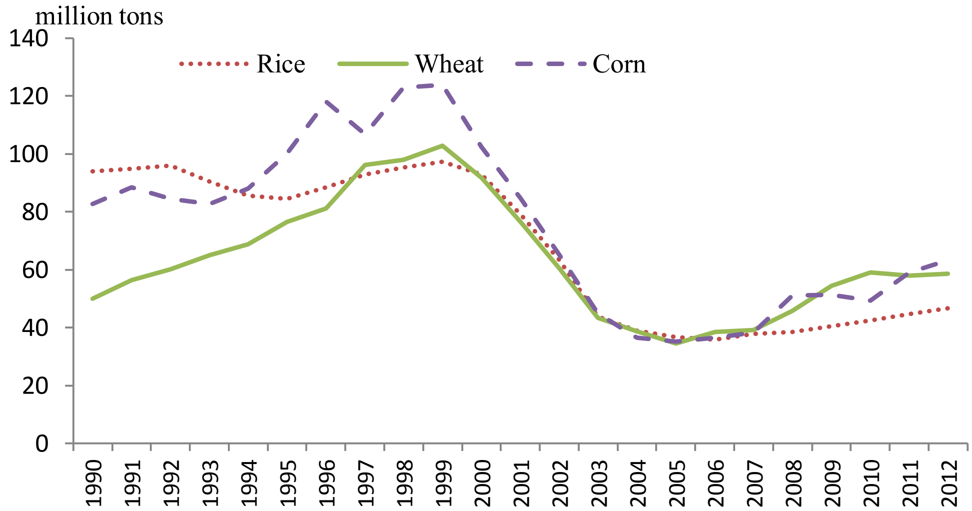

Figure 3.7 Ending stocks of grains in China during 1990-2012

Source: USDA, PSD Online 2013.

The third period is from 2003 to 2007, when grain ending stocks remained at low levels, the averages were 38.66 million tons, 38.85 million tons and 38.33 million tons in this period for rice, wheat and corn, respectively; the fourth period is from 2007 to 2012, in which the grain ending stocks had experienced growth again, the ending stocks of rice, wheat and corn in 2012 were increased 8.86 million tons, 19.67 million tons and 24.89 million tons over the levels in 2007, up 23.5%, 50.3% and 64.8%, respectively, as we know, grain production had showed significant increases in this period, this may promote grain ending stocks to increase (See Figure 3.7).

CHAPTER 4 MAJOR AGRICULTURAL POLICIES IN CHINA

Since middle 1990s, the grain prices have been on a sustained decline, resulting in a continuous drop in grain production, and a slowdown in the growth of farmers' earnings for years and a widening of the gap between urban and rural residents in their incomes. This situation has an impact on the supply of farm produce and the country's food security, thus affecting the development of the entire national economy and social stability. Therefore, the central government has persisted in the principle of "offering more, taking less and loosening control". It dramatically increased support to agriculture, the rural economy and rural areas. Among the policies and measures, agricultural subsidy policies and grain minimum purchasing price policies are mainly for grain production, aiming to mobilize farmers' enthusiasm for agricultural production, thus enabling grain production to rebound and enhancing farmers' incomes.

4.1 Agricultural Subsidy Policies

Since China's development entered a new phase, large scale fund supports are available for agricultural development. Since 2003 a series of agricultural subsidy policies has been paid to farmers under the guideline of "offering more, taking less and loosening control". The subsidies include fine seed subsidies, grain direct subsidies, farm machinery subsidies, and comprehensive subsidies. To further consolidate the foundation of agriculture and increase the income of farmers, the central government decided in January 2005 to increase the effort to carry out the subsidy policy. In Opinions on a Number of Policies for Strengthening Rural Work and Raising the Overall Production Capacity of Agriculture, the CPC Central Committee and the State Council pointed out that these effective policies should remain unchanged; the benefits given to farmers should not be reduced; and the support offered to agriculture should be continuously increased.

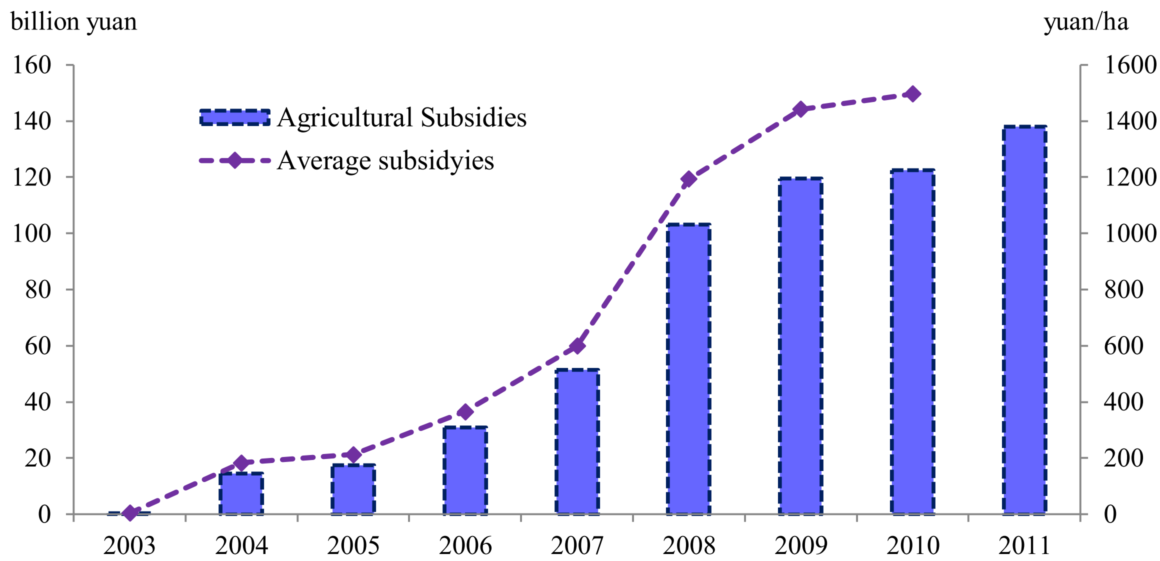

Figure 4.1 Changes in agricultural subsidy scales in China

Source: China Agricultural Development Report 2004- 2012.

Under this government's guideline, the subsidy amount keeps increasing year by year, in 2003 it was 0.3 billion, only provided for wheat fine seed subsidies, in 2004 the fine seed subsidies were expanded to rice and corn, and grain direct subsidies and farm machinery subsidies came into enforce, the total subsidy amount jumped to 14.52 billion yuan; in 2005 the amount increased to 17.37 billion yuan, an increase of 2.85 billion yuan or 19.6% from that in 2004; in 2006 the comprehensive subsidies were started to be implemented with a value of 12 billion yuan, the total subsidies were increased to 30.95 billion, up 78.2% over the total amount in 2005; in 2008, the prices of agricultural inputs, such as fertilizer, diesel, were very high, increasing agricultural production costs for farmers, in order to make farmer still can gain from grain production, the central government decided to enhance the amount of comprehensive subsidy, the comprehensive subsidy was increased from 27.6 billion yuan in 2007 to 71.6 billion yuan in 2008, went up 159.4%. As a result, the total subsidies increased to 103.04 billion yuan in 2008, a big increase of 51.68 billion or 100.6% from that in 2007. In 2011 the total subsidy amount was 138.1 billion yuan, a historical high level, compared with 2008 and 2004, up 34% and 851.1%, respectively. Table 4.1 shows the rapid increases in total agricultural subsidies.

4.1.1 Fine Seed Subsidy

Fine seed subsidy for grains went into force in 2003. It is a direct payment to farmers and aims to encourage them to adopt fine seeds to enhance grain yields and qualities. For main grains, subsidies for fine seeds were first enforced in 2003 for wheat implemented in provinces of Hebei, Henan, Shandong, Jiangsu, and Anhui. In 2004 the scope and scale of experiments on subsidies for fine seeds were expanded to rice in the main producers of Hunan, Hubei, Jiangxi, Anhui, Liaoning, Jilin, Heilongjiang and corn in Neimeng, Liaoning, Jilin, Heilongjiang, Hebei, Henan, Shandong, Sichuan. In 2005, the covered areas for wheat were expanded to 11 main producing areas, 6 new provinces were included, they were Shanxi, Hubei, Sichuan, Shaanxi, Gansu, and Xinjiang provinces. In 2008 the covered areas were expanded to 13 provinces, Neimeng and Ningxia were newly included. In 2009 all 31 provinces and areas were covered by wheat fine seed subsidies. The subsidy rate was 10 yuan per mu for each province.

For rice, the coverage of fine seed subsidies was expand to 10 provinces in 2007, three new areas were referred to Sichuan, Guangxi, and Chongqing and reached to all rice producers in 2008. The subsidy rate was 15yuan per mu for rice in Heilongjiang, Jilin, and Liaoning provinces; in Hunan, Hubei, Jiangxi and Anhui provinces, they were 10 yuan per mu for early season rice and 15 yuan per mu for middle grain rice and mid-season long grain rice while those for late long grain rice were yet to be announced in 2004. The coverage of corn fine seed subsidies was increased to 13 provinces in 2008 from 8 provinces in 2004-2007, the newly implemented areas were Shanxi, Anhui, Guizhou, Yunnan, Shaanxi. Finally, all corn producing areas were subsidized in 2009. The subsidies were 10yuan per mu for corn in all implemented areas and remained unchanged since this policy went in enforce in 2004.

Table 4.1 Evolution of fine seed subsidies for rice, wheat and corn in China

Grain	Period	Province covered	Rate Yuan/mu
Wheat	2003-2004	Hebei, Henan, Shandong, Jiangsu,Anhui	10
	2005-2007	Hebei,Henan,Shandong,Jiangsu,Anhui, Shanxi,Hubei,Sichuan,Shaanxi,Gansu,Xinjiang	10
	2008	Hebei,Henan,Shandong,Jiangsu,Anhui,shanxi,Hubei, Sichuan,Shaanxi,Gansu,Xinjiang,Neimeng, Ningxia	10
	2009-	All 31 Provinces	10
Rice	2004-2006	Hunan,Hubei,Jiangxi,Anhui,Liaoning,Jilin,Heilongjiang	7[a] 10[b], 15[c]
	2007	Hunan,Hubei,Jiangxi,Anhui,Liaoning,Jilin,Heilongjiang, Sichuan,Guangxi,Chongqing	7[a] 10[b], 15[c]
	2008-	All 31 Provinces	10[d],15[e]
Corn	2004-2007	Neimeng,Liaoning,Jilin,Heilongjiang,Hebei,Henan,Shandong,Sichuan	10
	2008	Neimeng,Liaoning,Jilin,Heilongjiang,Hebei,Henan,Shandong,Sichuan,Shanxi,Anhui,Guizhou,Yunnan,Shaanxi	10
	2009-	All 31 Provinces	10

Source: China Agricultural Yearbook 2010. Note: a, b, c indicate subsidy rate for late season rice, early season rice and middle and medium grain rice before 2008, respectively; d and e indicate subsidy rate for early season rice and late, middle and medium grain rice after 2008, respectively.

Fine seed subsidies of wheat was first provided for farmers in 2003 at an amount of 0.1 billion yuan. In 2004, the central government also arranged 0.1 billion for fine subsidies of wheat. But in 2005 the subsidies began to show increases over the previous year, its amount jumped to 1 billion yuan, 10 times larger than that of the previous years. In 2008 the subsidy scale was expanded further, the amount increased to 2billion yuan, 2times larger than that in 2005-2007. Finally the subsidies reached to 4.18 billion yuan when all wheat producing areas were covered in 2009. Rice is extensively planted in China and was subsidized in 2004 with an amount of 2.55 billion yuan. And the subsidies had saw increases for each year. In 2007 the subsidies were 3.76 billion yuan, up 47.5% over 2004, in 2008 it jumped to 6.56 billion yuan when all producing area were subsidized, went up 4.01 billion yuan from the beginning of 2.55 billion yuan, increased by 157% over 2004; in 2004 the central government also allotted 0.1 billion yuan for fine seed subsidies of corn on 10 million mu of planted areas, in 2006 the subsidies increased to 0.3 billion yuan, and jumped to 2 billion yuan in 2008. In 2009, when all corn planted areas were covered by this policy, the total amount reached to 5.9 billion yuan.

Table 4.2 Fine seed subsidies for rice, wheat and corn in China (billion yuan)

Year	Rice	Wheat	Corn
2003	--	0.10	--
2004	2.55	0.10	0.10
2005	2.67	1.00	0.10
2006	2.75	1.00	0.30
2007	3.76	1.00	0.30
2008	6.56	2.00	2.00
2009	6.57	4.18	5.90
2010	6.57	4.18	5.90

Source: China Agricultural Development Report 2004-2011.

Fine seed subsidies are also provided for soybeans, cotton, role, peanut, but those subsidies are very small in the total fine seed subsidies. Figure 4.2 shows the increasing movements of total fine seed subsidies including other corps in China. The amount in 2003 was only 0.3 billion yuan; in 2004 the scope and scale of experiments on subsidies for fine seeds were expanded to rice and corn, the total amount had increased to 2.85 billion yuan. The subsidies increased from 2004 to 2008 with an annual growth rate of 44.3% and reached 12.34 billion yuan in 2008. Finally all the planted areas for rice, wheat and corn were covered by the subsidy in 2009, the subsidy scale met a record high of 19.85 billion yuan, a jump of 7.51 billion yuan, up 60.9% over that in 2008. In 2010 the amount was 20.4 billion, in 2011 it increased to 22 billion yuan.

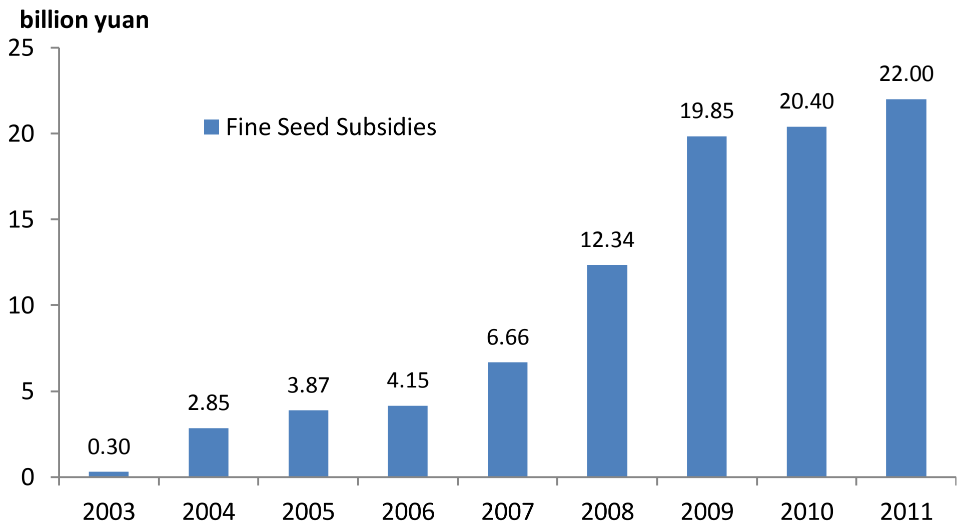

Figure 4.2 Total fine seed subsidies in 2003-2011

Source: China Agricultural Development Report 2004-2012.

4.1.2 Grain Direct Subsidies

In the past, the Chinese government support agricultural development and protect farmer's interests by providing subsidies to circulation, but farmers only can benefit from these subsidy policies indirectly, the effectiveness of subsidizing circulation was just 25%, that's to say, provide 4yuan, farmers only can receive 1yuan. This type of support policy was ineffective, and new improvements need to be explored. The prevailing measure many developed countries adopt to protect agriculture is to provide direct subsidies to farmers, this subsidies method is more effective and will not cause marketing distortion. Early in 2000, the Ministry of Finance of China began to search reformation methods. In March 2001, Ministry of Finance submit a draft for implementing grain direct subsidy policy to the State Council, and State Council approved this draft, and decided to enforce it in several counties in Anhui, Jilin, Hunan, Hubei, etc. for experiments in the year of 2002. The experiments achieved remarkable results, from the investigation to 1809 farmers, 99% of the interviewees said that the grain direct subsidies mobilized farmers' enthusiasm for agricultural production greatly. Therefore, in October 2003, the State Council decided to adopt a more direct more energetic and more straightforward approach in an effort to mobilize farmers' enthusiasm in national wide from 2004.

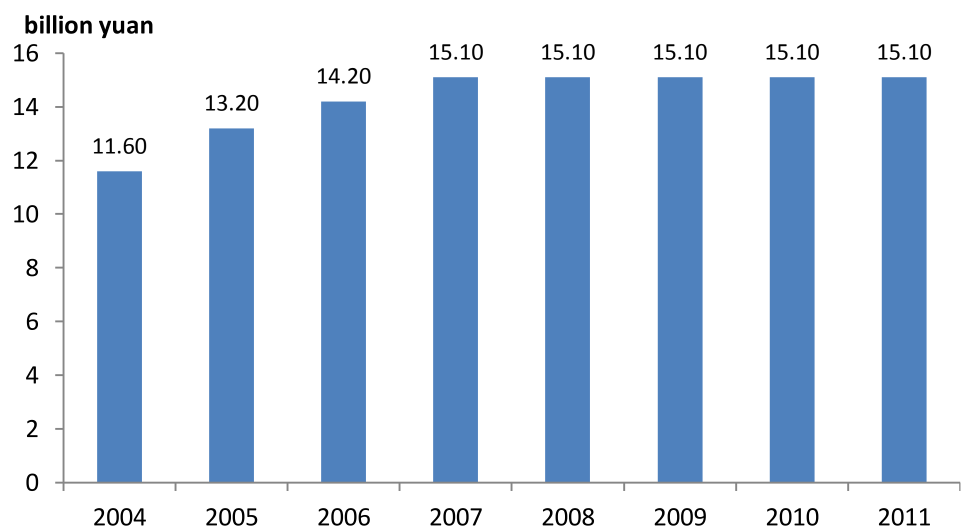

Figure 4.3 Grain direct subsidies in 2004-2011

Source: China Agricultural Development Report 2005-2012.

In March 2004, the central government allocated 11.6 billion yuan from the grain risk fund and used them as grain direct subsidies to farmers in main grain producing areas. Direct grain subsidy is paid for farmers who plant main grains such as rice, wheat and corn, the staple food, if farmers abandon their land or use farm land for industrial purposes, then they will not get any subsidy. In 2005 the subsidies increased to 13.2 billion yuan, a rise of 1.6 billion yuan, up 13.8% over the amount in 2004; in 2006 the amount was increased to 14.2 billion, an increase of 1 billion or 7.8% from that of 2005; in 2007 the direct subsidies were 15.1, up 6.3% compared with the previous year. Since 2007 the amount has remained at a level of 15.1 billion yuan until 2011.

4.1.3 Farm Machinery Subsidies

To raise the level of mechanization in agriculture, certain amounts of subsidies were provided to individual farmers, farm workers, farmer households running farm machinery businesses and farm machinery service organizations for purchasing or updating large farm machines and tools. In2004, 70 million yuan were paid for the purchase 100 thousand pieces of farm machines and tools. In 2005, the experiments on subsidies for the purchase of farm machines and tools extending to land reclamation areas directly under the jurisdiction of the central government and 566 counties across the country, and the amount of farm machinery subsidies increased to 0.3 billion yuan, a rise of 0.23 billion yuan from the previous year and four times the amount provided in 2004. In 2006 the amount was 0.6 billion yuan, two times that in 2005, and the number of farm machines and tools were increased to 300 thousand, 3 times that in 2004. The subsidy amount continued to grow, it increased to 4 billion in 2008, doubling those in the previous year and nearly 7 times that of 2006.

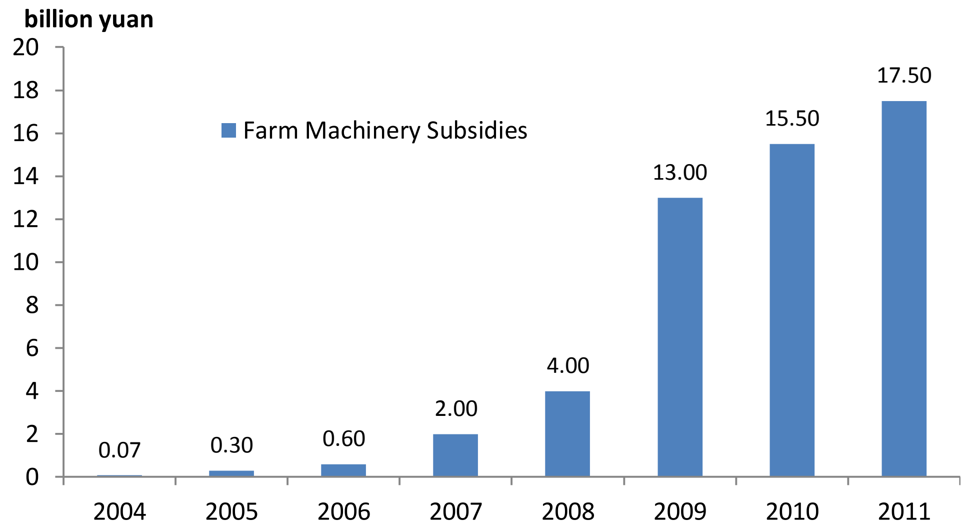

Figure 4.4 Total Farm Machinery Subsidies in 2004-2011

Source: China Agricultural Development Report 2005-2012.

In 2009 the scope and size of farm machinery subsidies were greatly expanded, subsidies jumped to 13 billion, more than 3 times of the amount in 2008. In 2010 the amount was 15.5 billion yuan, an increase of 2.5 billion yuan over the level in 2009. In 2011, 2 billion was added to the amount of 2010 and reached a historical high level of 17.5 billion yuan. Until 2011 total more than 4 million pieces of farm machines or tools were subsidized, and the level of mechanization in agriculture was strongly raised due to the subsidy policy.

4.1.4 Comprehensive Subsidies

Over the past years, the prices of agricultural input have remained high, especially in 2006, the grain production costs rose by a big margin as the prices of petroleum went up and the state adjusted the prices of diesel for agricultural use. This would have certain adverse effects on the earnings of grain farmers. In order to strengthen the support of central finances to agricultural development and offset farmers' burden in their extra payments for the purchase of diesel, fertilizer and other goods due to the increasing prices of these materials, since 2006 a new comprehensive direct subsidy has been set up for the purchase of goods for use in agricultural production and innovating a mechanism for providing subsidies to grain production.

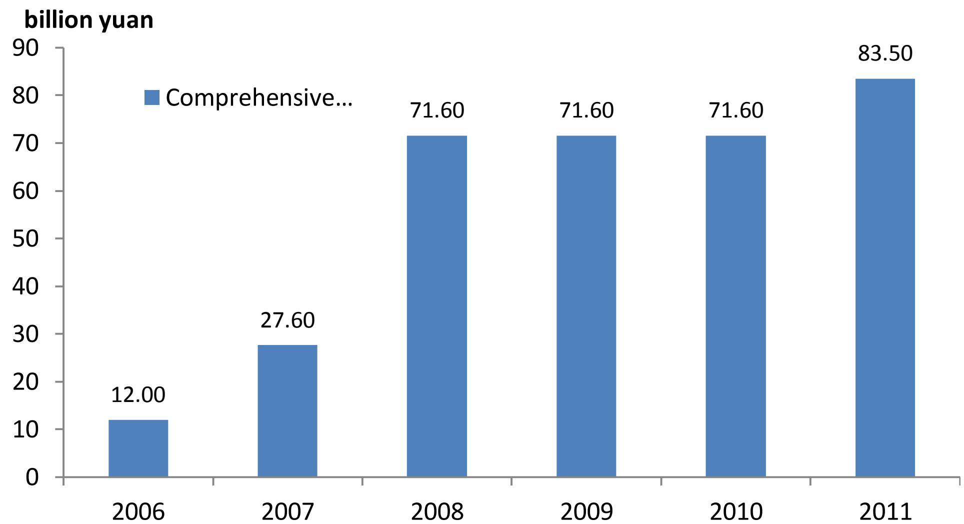

Figure 4.5 Total comprehensive subsidies in 2006-2011

Source: China Agricultural Development Report 2007-2012.

In 2006, 12 billion yuan were paid by the central government as grain comprehensive direct subsidies. In 2007 it was increased to 27.9 billion, 15.6 billion yuan more than the previous year or went up 130% over 2006. In 2008 the comprehensive subsidies scope and size were greatly expanded. In view of the drastic rises in the prices of goods for use in agricultural production in 2008, the central finances took powerful measures to minimize the adverse effect of the price rises on agricultural production and farmers' income by rising comprehensive subsidies to 71.6 billion. This was a big margin, 44 billion yuan more than the previous year, almost 5 times the amount in the beginning year of the subsidy. From 2008 to 2010, the amount remained unchanged for 3 year. But in

2011 it continued to grow, increased to 83.5 billion yuan, a jump of 11.9 billion yuan or 16.6% over the levels during 2008-2010.

4.2 Grain Minimum Purchasing Price Policy

4.2.1 Price Protections

Since the 1990s, China has implemented protective price policies to ensure its food supply and to support farmers (Figure 4.6). Each year, the Chinese government has set a protective price for each grain, and purchased the product at the fixed price. The protective prices were set based on grain production costs to ensure non-negative profits for farmers. According to the food-market situation, the government has modified the degree of protection. In the early 1990's, facing a declining food supply, the policy gave complete protection to all grains for all planting areas. Its effect appeared soon, resulting in continual oversupply in the food market. In 1998, the policy changed to partial protection and some grains dropped from the protection list. In 2001, the protection was further weakened and only the grains in major planting areas were under the price protection (Sun 2002). In 2004, the grain minimum purchasing price policy started to control the food supply. The policy is to set a minimum purchasing price each year for each grain and if the price in the food market is below the minimum price, the government purchases grains until the market price reaches the minimum price. The average minimum purchasing prices for rice and wheat were set at 73.2 yuan/50kg in 2004 and at 70 yuan/50kg in 2006, respectively, while Corn has not been covered by this policy up until now. The minimum prices began to rise since 2008 and in 2009 they rose to 93.5 yuan/50kg and 84 yuan/50kg for rice and wheat, respectively.

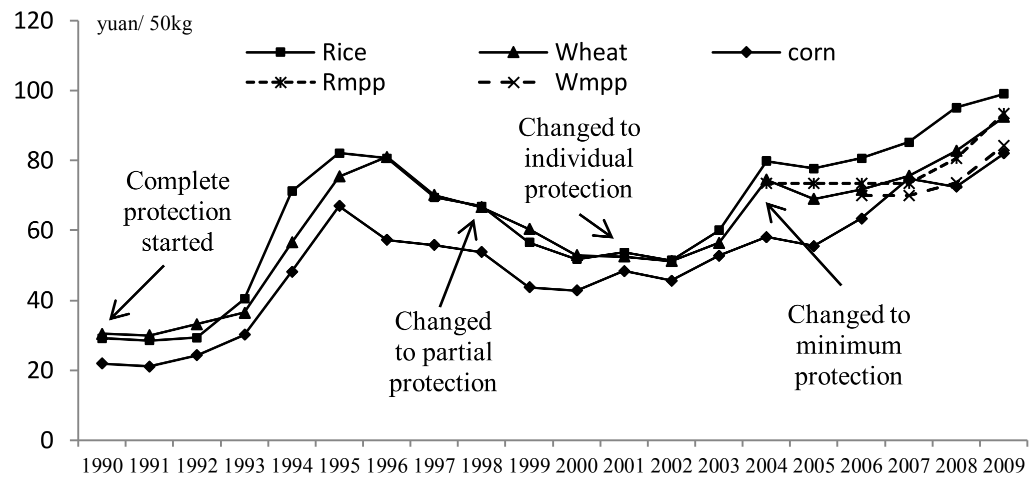

Figure 4.6 Producer prices under protective price policy in China

Source: Yearbook of Agricultural Return and Cost in China.
Note: Rmpp and Wmpp denote rice and wheat minimum purchasing price, respectively.

4.2.2 Evolution of Grain Minimum Purchasing Price Policy

Supporting grain prices not only can protect the farmers from price fluctuations but also encourages growth in the grain supply. Therefore price support policy is often regarded as an ideal policy tool for government intervention in the grain market. Since 2004, the Chinese government has been employing MPPP in main grain producing areas to regulate grain market prices. This policy is to set a minimum purchasing price each year for each grain in the implemented areas and if the grain market prices are below the minimum purchasing price, the grain enterprises delegated by the government will start to purchase grains from market at the minimum purchasing prices until the grain prices are above the minimum price. In 2004, rice became the first crop covered by this policy. In the policy, rice is divided into two categories, the early season rice including early season long grain rice and the mid-late season rice including middle season long grain rice, late season long grain rice and medium grain rice. For rice, the implementing areas were expanded in 2008. The implemented areas of early season rice were expanded from 4 provinces to 5 provinces, all of which are located in southern China, the early season rice share in national production rose from 59% to 75%; the implemented areas of Mid-late season rice increased from 7 provinces with a production of 91.2 million tons in 2009 to 11 provinces producing 124.7 million tons of mid-late season rice in 2009, the mid-late season rice share in national production rose from 57% to 78%. For wheat, the minimum purchasing price policy was enforced in 5 main producing provinces and the number of provinces covered has stayed unchanged since the implementation year of 2006. Those provinces are Hebei, Jiangsu, Anhui, Shandong, Henan, and Hubei, in which the total wheat production was 88.5 million tons in 2009, accounting for 77% of the total wheat production in China (See Table 4.3).

Table 4.3 Changes in main producing areas covered by GMPP policy (million tons)

Grain	Period	Province covered	Production	Share (%)
Early season rice	2004-2007	Anhui, Jiangxi, Hubei, Hunan	19.62	59
	2008-	Anhui, Jiangxi, Hubei, Hunan, Guangxi	25.16	75
Mid-late season rice	2004-2007	Jilin, Heilongjiang, Anhui, Jiangxi, Hubei, Hunan, Sichuan	91.19	57
	2008-	Jilin, Heilongjiang, Anhui, Jiangxi, Hubei, Hunan, Sichuan, Liaoning, Jiangsu, Henan, Guangxi	124.71	78
Wheat	2006-	Hebei, Jiangsu, Anhui, Shandong, Henan, Hubei	88.46	77

Source: China Agricultural Yearbook 2010. Note: the production was the total production of the covered provinces in 2009; the percent indicates the production share of the covered areas in the national production.

Due to the different harvest times, the policy implementing periods are different for grains. Basically, the implemented period for rice is from sep.16 to Dec.31, but because Jilin, Heilongjiang and Liaoning are located in northern China, the harvest season for rice often comes later, the implemented period in these areas is from the last year's Nov.16 to the next year's Mar.31. For wheat the implementing period is from each year's May.21 to Sep.30. The announced time of a policy is also important as it may influence the effect of a policy. For early season rice, the minimum purchasing prices are often announced in each July, about two months before the implemented time. For middle and late season rice, the announced time is in September of each year, only a few days before the implemented time in the southern producing areas, but two months before the implemented period in the northern areas. In the case of wheat, the minimum purchasing prices are often announced in each May, also several days before the period of implementation (See Table 4.4).

Table 4.4 The implemented periods and announced time of GMPP policy

Grain	Province covered	Implemented period	Announced time
Early harvested rice	Anhui, Jiangxi, Hubei, Hunan, Guangxi	Sep.16-Dec.31	July
Mid-late harvested rice	Sichuan, Jiangsu, Henan, Guangxi, Anhui, Jiangxi, Hubei, Hunan	Sep.16-Dec.31	September
	Jilin, Heilongjiang, Liaoning	Nov.16- Mar.31	September
Wheat	Hebei, Jiangsu, Anhui, Shandong, Henan, Hubei	May.21- Sep.30	May

Note: The implemented period for Liaoning and Heilongjiang before 2008 was from previous Nov. 10 to Feb. 28. The implemented period for wheat before 2008 was from Jun. 1 to Sep. 30.

Table 4.5 reports the annual minimum purchasing prices for each grain. Rice minimum purchasing price policy provides three minimum price levels for four types of rice (early season long grain rice, middle season long grain rice, late season long grain rice, and medium grain rice). The minimum prices for early season long grain rice are relatively lower than the other three types of rice. In 2004 it was set at 70 yuan/50kg, and increased to 102 yuan/50kg in 2011, up 45.7%. Middle and late long grain rice always share the same minimum price each year; the minimum prices for these two grains increased from 72 yuan/50kg in 2004 to 107 yuan/50kg in 2011, an increase of 48.6%. In medium grain rice's case, its minimum prices are higher than other rice. The minimum price was set at a level of

75 yuan/50kg in 2004, and in 2011 it went up to 128 yuan/50kg, increasing by 70.6%, which was the biggest increase among the different rice varieties. (See Table 4.5).

Table 4.5 Changes in grain minimum purchasing prices (yuan/50kg)

Year	Rice				Wheat		
	Ear- LG	Mid- LG	Late- LG	MG	White	Red	Mixed
2004	70	72	72	75	--	--	--
2005	70	72	72	75	--	--	--
2006	70	72	72	75	72	69	69
2007	70	72	72	75	72	69	69
2008	77	79	79	82	77	72	72
2009	90	92	92	95	87	83	83
2010	93	97	97	105	90	86	86
2011	102	107	107	128	95	93	93

Source: Annual governmental documents.

Wheat has been divided into three categories (white wheat, red wheat, and mixed wheat) in the wheat minimum purchasing price policy system according to the properties of the wheat. The minimum price for white wheat is higher than that of red wheat and mixed wheat. It was set at 72 yuan/50kg in 2006 and increased to 95 yuan/50kg in 2011, up 31.9%. Red wheat and mixed wheat share the same rate of minimum price, their minimum prices were 69 yuan/50kg in 2006, and increased to 93 yuan/50kg in 2011, increased by 34.8%. Generally, after 2008 grain minimum prices started to increase annually. This indicates that the Chinese government is making a major effort to tilt policy support towards agricultural development.

CHAPTER 5 EFFECTS OF AGRICULTURAL POLICIES

5.1 Total Subsidies and Agricultural Supply Responses

Agricultural subsidies policies aim to promote agriculture production to recover via influencing grain yields and grain planted acreages. In the following sections we will the estimate agricultural supply responses for rice, wheat and corn. In the supply response model, we incorporate the subsidy variable in agricultural supply response models so as to evaluate effects of total subsidies on grain yields and planted areas.

5.1.1 Yield Responses in China

Grain yield is critical for food supply particularly in land scarce countries. In many Asian and African countries, the grain yields are still at a very low level. However, in China the grain yield has experienced a rapid growth over the past five decades. The figures below show how grain yields in China have changed over the past five decades. In the early 1960's, the grain yields in China were at a very low level, but then started to increase at a higher rate than the world average, and after half century's growth, the yields of rice and wheat are more than 1.5 times higher than the world average level. Corn also shows the same tendency. As we know, multiple factors have affected the grain yield, but among those factors, polices often play an important role. Hence, in this paper we aim to evaluate the contribution of current agricultural policies implemented in China, such as the price policy and the subsidy policies, in particular seed and machinery subsidy, to the increase in grain yields.

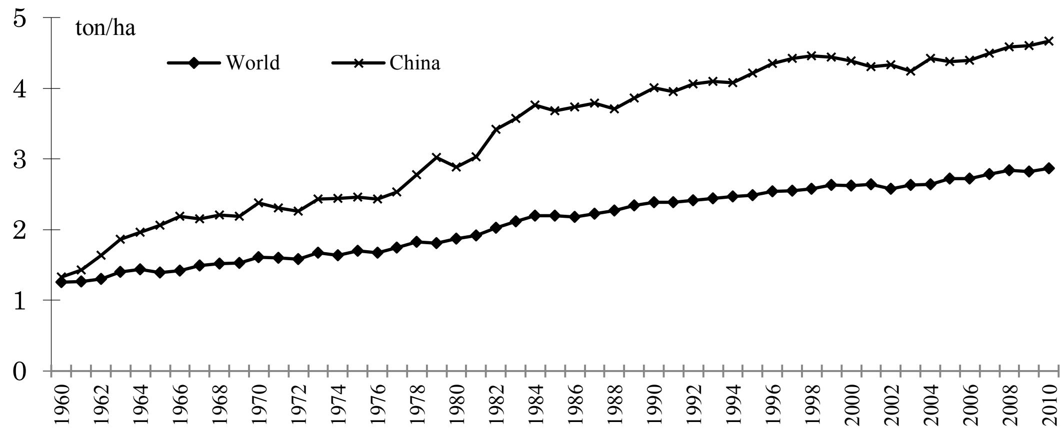

Figure 5.1 Rice yields in China and world since 1960

Source: USDA, PSD Online 2013.

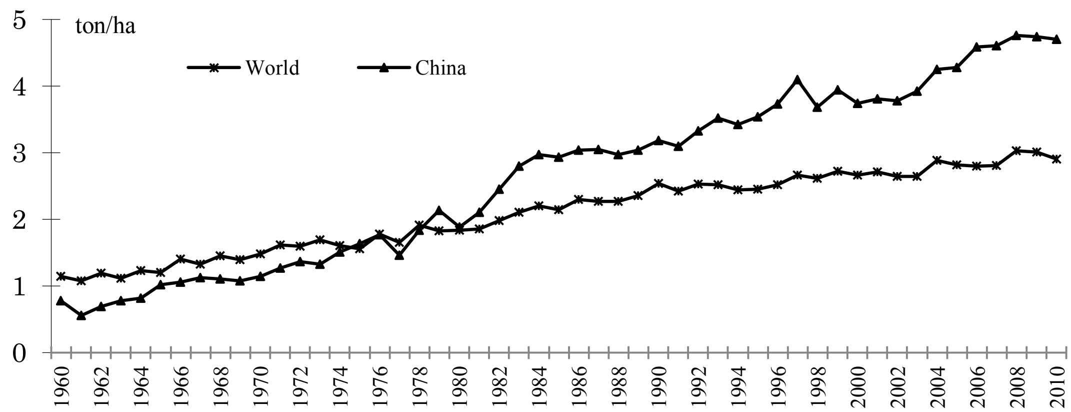

Figure 5.2 Wheat yields in China and world since 1960

Source: USDA, PSD Online 2013.

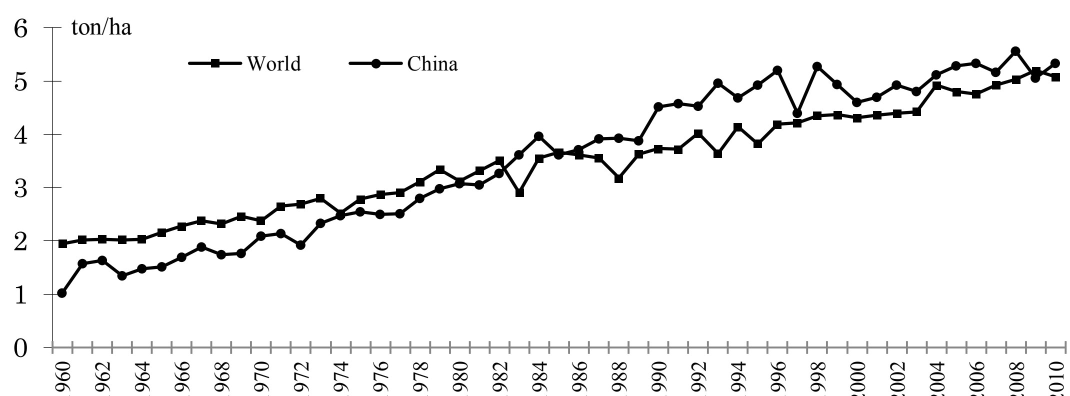

Figure 5.3 Corn yields in China and world since 1960

Source: USDA, PSD Online, May 2012.

Yield Response Model and Data

Since 2003, the Chinese government has paid more attention to agricultural development and provided fine seed subsidies for crops. The fine seed subsidy is a direct payment to farmers and aims to encourage them to adopt fine seeds to enhance grain yields. Wheat has been subsidized since 2003, while rice and corn have been subsidized since 2004. The subsidy rate for wheat and corn remains unchanged at 150 yuan/ ha each year, but for rice the average rate for three types of rice, i.e. early harvested, middle harvested and late harvested, is 160 yuan/ha before 2008, and 200 yuan/ha since then. The amount of subsidy each farmer receives has almost not changed, but the targeted subsidized areas have been extended annually and finally all the planted areas were covered by the subsidy in 2008 for rice and in 2009 for wheat and corn. Reflecting this, the total amount of subsidies increased to 17.63 billion yuan for all three grains in 2009, from 0.1 billion yuan for wheat in 2003, and from 2.55 and 0.1 billion yuan in 2004 for rice and corn, respectively. Additionally, other subsidies like machinery subsidy also can promote grain yields to increase.

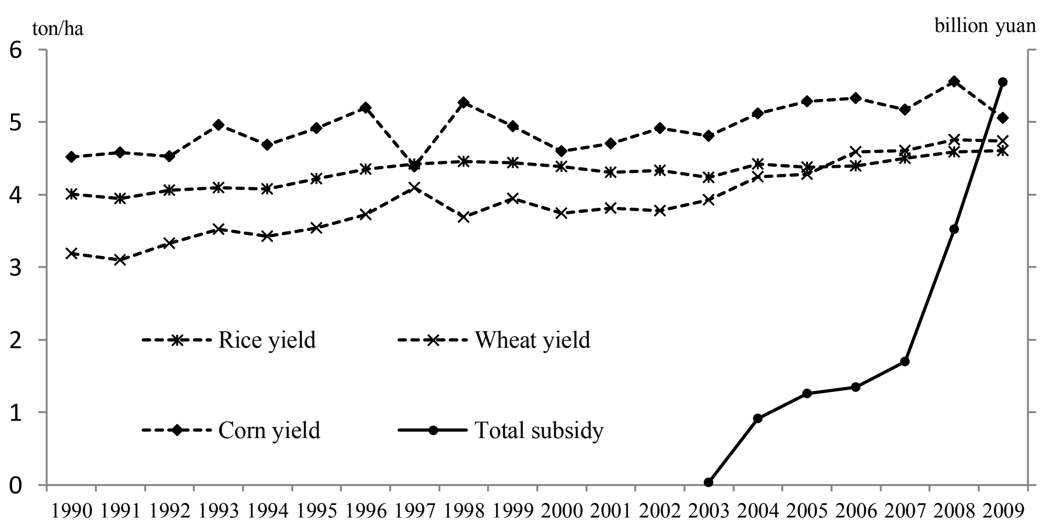

Figure 5.4 Grain yields and fine seed subsidies for principal grains in China

Source: China Agricultural Development Report 2004-2010.

Agricultural supply response is to evaluate the response of supply variables (production, area, or yield) to price and other factors. It is considered to be a dynamic process, affected by factors in previous years as well as by those in the current year (Nerlove, 1956, 1960). Assuming adaptive expectation, the Nerlove model links the farmers' behaviors, such as areas planted and yields, to their expected price. The Nerlove model has been widely applied to estimate this dynamic process (Askari and Cummings 1977). For example, Wang (1998), Si (2006), Ma (2009), and Wang (2010) estimated the supply response of vegetables, sugar, wheat, and corn in China, respectively. However, few studies have so far examined the yield response to the recent agricultural subsidy policy in China. The following extended Nerlove model is employed in this study to assess the impacts of subsidy policy on grain yields. Other input factors such as time trend reflecting technological change and climate change may reflect grain yield, but they were not statistically significant and were dropped from our extended model.

$$\ln Y_{it} = \alpha + \beta_1 \ln Y_{it-1} + \beta_2 \ln P_{it-1} + \beta_3 \ln S_t + \beta_4 \ln A_{it} + V_{it}$$

where Y_{it} represents yield of grain i at year t; i represents rice, wheat, and corn and t is from 1990 to 2011. $P_{it\text{-}1}$ represents real producer price of grain i at t-1 deflated by consumer price index (1990=100). S_t is the total amount of subsidies at t. A_{it} represents planted areas grain i at t; V_t is the random error term. Producer prices are included and β_1 is expected to take a positive sign. Agricultural subsidies should show positive impact on grain yields. Hence, β_2 is expected to take a positive sign. Finally, farmers tend to abandon the inferior lands, so when they expand grain planted areas, the overall qualities of the farmer land will fall, and this may lead to grain yields to decrease. Therefore β_4 is expected to be negative.

The yield data is a three-year moving average for 1990-2011 from the China Agricultural Development Report. The annual producer prices were obtained from the Yearbook of Cost and Return of Agricultural Commodities in China deflated by consumer price index with 1990 as a base year. Data on subsidies is from the China Agricultural Development Report.

Empirical Results

In the rice and the corn model, because the area variables were not significant, we dropped them from the model. In the wheat and the corn model, we use AR (1) to account for autocorrelation in residuals.

Table 5.1 Estimated results of yield response model

Variable	Rice	Wheat	Corn
C	0.155**	2.235***	0.907***
	(0.057)	(0.392)	(0.169)
$\ln Y_{t-1}$	0.808***	0.642***	0.332**
	(0.037)	(0.045)	(0.133)
$\ln P_{t-1}$	0.038***	0.119***	0.054**
	(0.007)	(0.025)	(0.023)
$\ln S_t$	0.001*	0.007***	0.011***
	(0.001)	(0.002)	(0.002)
$\ln A_t$	--	-0.210***	--
	--	(0.041)	--
$AR(1)$	--	-0.438*	-0.401
	--	(0.235)	(0.243)
R^2	0.98	0.99	0.95
LM(1)	0.84	0.70	0.39

Note: ***, **,* indicate 1%, 5%, and 10% significant level, respectively; C, the constant; values in parentheses are standard errors; LM (1) is the significant probability of Lagrange Multiplier Test, 1 indicates the lagged order.

The estimated results are shown in Table 5.1. High R-squared indicates that the models fit the samples well and most variables are significant at the 1% or 5% level. The

LM(1) test significances of rice, wheat, and corn are 0.84, 0.70, and 0.39, respectively, not rejecting the null hypothesis of serial non-correlation at the 5% significance level, implying no first-order autocorrelation exists in regressions.

From the results, parameters on the previous yield are positive and significant, implying grain yields partially depend on the own yield in the previous year. The price in the previous year was significant and also influenced the yield. If the price of rice, wheat and corn increased by 1%, yields increased by 0.038%, 0.119 and 0.054%, respectively. Finally, parameters on the subsidy are positive and significant at 1% or 10% level. Although elasticities of yields with respect to the amount of the subsidy are not so large, they are respectively 0.001, 0.007 and 0.011 for rice, wheat and corn, its impact is not small when considering an increase in its amount from 0.3 to 138.1 billion yuan.

Conclusions

China experienced remarkable growth in yields of principal cereal grains. In this section, we evaluated the yield responses to grain prices and the subsidies by employing the Nerlove model. We find that grain yields are closely related to yields in the previous year. Yield elasticities with respect to price in the previous year are 0.038, 0.119 and 0.054, for rice, wheat and corn, respectively. Yield elasticities with respect to the amount of total subsidies are 0.001, 0.007, and 0.011, respectively for rice, wheat and corn. Yields respond more sensitively to price than to subsidies. Because prices positively influence grain yields, price policies, which helped stabilize prices at high levels, led to a steady increase in grain yields in China. Given the dramatic increase in the amount, we find that the subsidies also significantly contribute to a rise in grain yield.

5.1.2 Acreage Responses in China

Planted Areas and Total Agricultural Subsidies

Since 1990 rice and wheat planted areas were in decrease. The rice planted area constructed from 33064 thousand hectares in 1990 to a minimum of 26508 thousand hectares, a reduction of 6556 thousand hectares or 19.8%. Wheat planted areas were decreased to a historical low level of 21626 thousand tons in 2004, down 9127 thousand tons or 29.7%, compared with that in 1990. For corn, the planted areas experienced increase from 21402 thousand tons in 1990 to 24498 thousand tons in 1996, up 14.0%, during 1996-2003 it remained stable at an average of 24432 thousand tons per year.

But since the subsidy policies were implemented, grain planted areas have started to recover for rice and wheat, corn planted areas had experienced a new round growth. In 2004 rice planted areas stopped the five-year continuous decline, and increased to 28379 thousand hectares, up 7.1% over that in previous year. Corn planted areas rose to 25446 thousand hectares, went up 5.7% over the level in 2003. The recovery in wheat planted areas started in 2005, wheat planted areas were increased from 21626 thousand hectares in 2004 to 22793 thousand hectares in 2005 by 5.4%. In 2011 the planted areas recovered to 30057 thousand hectares, 24270 thousand hectares and 33540 thousand hectares for rice, wheat and corn, up 13.4%, 12.2% and 39.4 compared with the lowest levels, respectively.

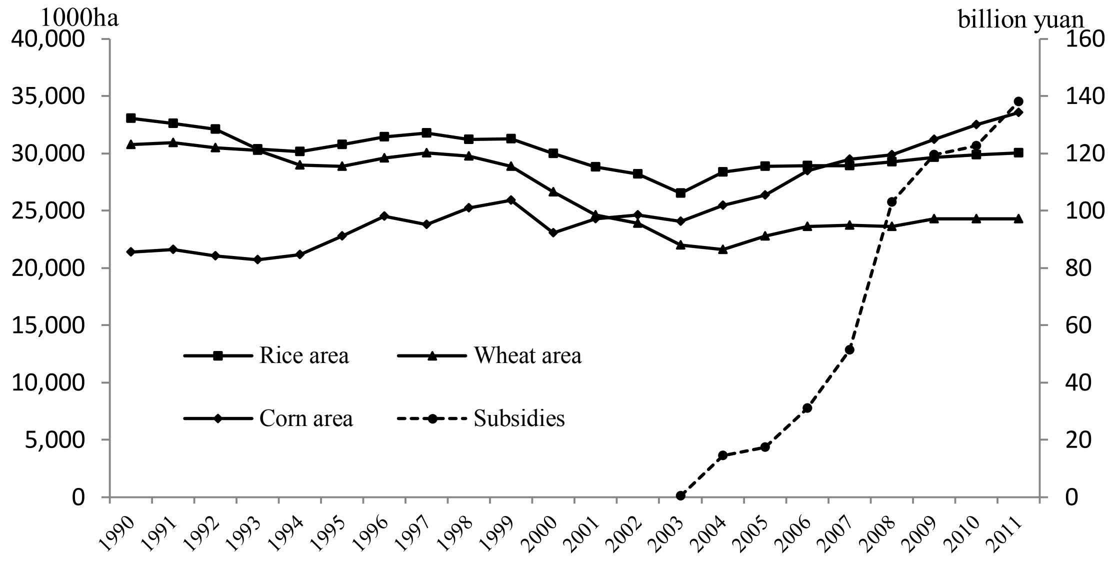

Figure 5.5 Grain planted areas and agricultural subsidies in China

Source: China Agricultural Development Report 2003-2012.

Area Response Model and Data

Assuming adaptive expectation, the Nerlove model links the farmers' behaviors, such as areas planted and yields, to their expected price. The following extended Nerlove model is employed to assess the policy impacts on grain planted areas. Other input factors may affect grain planted areas, but they were not statistically significant and were dropped from our extended model.

$$\ln A_{it} = \alpha + \beta_1 \ln A_{it-1} + \beta_2 \ln P_{it-1} + \beta_3 \ln S_t + \beta_4 \ln T + U_{it}$$

where A_{it} represents planted area of grain *i* at year *t*; *i* represents rice, wheat, and corn and *t* is from 1990 to 2011. P_{it-1} represents real producer price of grain *i* at *t-1* deflated by consumer price index (1990=100). S_t is the total amount of agricultural subsidies at *t*. *T* is a time trend with 1990 = 1; *U* is the random error term. The coefficient of prices β_2 is expected to take a positive sign. The subsidy induces farmers in subsidized areas to increase grain planted areas, overall planted area should rise accordingly with an increase in total subsidies. Hence, β_3 is expected to be positive. Finally, a trend variable is expected to reflect the shift in supply curve due to factors such as technological change and climate change.

The planted area data is a three-year moving average for 1990-2011 from the China Agricultural Development Report. The annual producer prices are obtained from the Yearbook of Cost and Return of Agricultural Commodities in China deflated by consumer price index with 1990 as a base year. Data on the total subsidies are from the China Agricultural Development Report.

Empirical Results

The estimated results using OLS are shown in Table 5.2. High R-squared indicates that the models fit the samples quite well and all variables are significant at the 1% or 5% level. The LM(1) test significances of rice, wheat, and corn are 0.89, 0.96, and 0.81, respectively, not rejecting the null hypothesis of serial non-correlation at the 5% significant level, implying no first-order autocorrelation exists in regressions.

From the results, parameters on the previous area are positive and significant, implying grain planted areas partially depend on the own area in the previous year. The price in the previous year also showed influences on the planted area. If the price of rice and wheat increased by 1%, planted areas increased by 0.070%, 0.128% and 0.093% for rice, wheat and corn, respectively. This implies that the prices have been effective to raise grain planted areas. Finally, parameters on the subsidies are positive and significant at 5% level for rice and 1% level for wheat and corn. Although elasticities of grain planted areas with respect to the amount of the subsidies are not so large, they are respectively 0.004, 0.012 and 0.008 for rice, wheat and corn, its impact is not small when considering an increase in its amount from 0.3 yuan in 2003 to 138.1 billion yuan in 2011.

Table 5.2 Estimated results of acreage response model

Variable	Rice	Wheat	Corn
C	2.131***	1.286**	1.351**
	(0.626)	(0.463)	(0.481)
$\ln A_{t-1}$	0.772***	0.838***	0.839***
	(0.061)	(0.048)	(0.049)
$\ln P_{t-1}$	0.070***	0.128***	0.093***
	(0.011)	(0.020)	(0.022)
$\ln S_t$	0.004**	0.012***	0.008***
	(0.002)	(0.002)	(0.002)
T	-0.003***	-0.007***	--
	(0.001)	(0.001)	--
R^2	0.97	0.99	0.95
LM(1)	0.89	0.96	0.39

Note: ***, **,* indicate 1%, 5%, and 10% significant level, respectively; C, the constant; values in parentheses are standard errors; LM (1) is the significant probability of Lagrange Multiplier Test, 1 indicates the lagged order.

Conclusions

China's grain planted areas had witnessed decreases since the middle 1990s. Since 2003 the Chinese government has employed agricultural subsidy policies to encourage farmers to enlarge grain planted areas. After the implementation of these policies, the decrease trend has stopped, and grain planted areas have appeared modest growth. In this section, we evaluated the impacts of the prices and the agricultural subsidies on grain planted areas employing the Nerlove model. We find that grain planted areas are closely related to areas in the previous year. Areas elasticities with respect to price in the previous year are 0.070, 0.128 and 0.093 for rice, wheat and corn. Areas elasticities with respect to the amount of agricultural subsidies are 0.004, 0.012, and 0.008, respectively for rice, wheat and corn. Planted areas respond more sensitively to price than to subsidies. Because prices positively influence grain planted areas, price policies, which helped stabilize prices at high levels, led to a steady increase in grain planted areas in China. Given the dramatic increase in the amount of agricultural subsidies, we find that the subsidies also significantly contribute to a rise in grain planted areas.

5.2 Total Subsidies and Grain Prices

Since China's development entered a new phase, large scale fund supports are available for agricultural development. Facing the decreasing food production situation, a series of agricultural subsidies have been paid to farmers under the guideline of "offering more, taking less and loosening control" since 2003, aiming to mobilize farmers' enthusiasm for agricultural production, thus enabling grain production to rebound. These subsidies include the direct grain subsidies which provide direct payments to farmers who plant specific grains, the fine seeds subsidies which provide direct payments to farmers to use fine seeds in grain production, the comprehensive subsidies provided to grain farmers for their extra payments for the purchase of diesel, fertilizer and other goods for use in grain production due to the increasing prices of those input factors, and the farm machinery subsidies which aim to raise the level of mechanization in agriculture. The grain subsidy, seed subsidy and comprehensive subsidy are provided as income subsidies in terms of farmers' grain planted areas, while the machinery subsidy is a price subsidy. Since those subsidies were implemented, the effects of subsidy policies have attracted much attention from academic researchers and policy makers and the impacts of subsidies on agricultural development in the country have been extensively investigated. For example, Wang and Xiao (2006) have employed the Positive Mathematical Programming (PMP) Model to study the effects of agricultural subsidies on grain production and agricultural income based on investigated data of 5 counties in China, and their conclusion is the impact on grain production is not so large but farmers' income has been increased with the implementation of subsidy policy; Mu and Koike (2009) simulated the impacts of agricultural subsidy policy on outputs of agricultural sector and non-agricultural sectors employing the SCGE model, and their results suggest that agricultural subsidies promote the outputs of both agricultural and non-agricultural sectors, but the income levels didn't change so much after the implementation of subsidy policies; Huang et al (2010) simulated the impacts of agricultural subsidies on Chinese food security based on the China agricultural CGE model, and results show that agricultural subsidies play an important role in ensuring the country's food security, and promote the increase in investments, GDP and exports. However, previous studies mainly focus on the impacts on agricultural outputs and farmers' income levels, and few studies have examined the impulse of agricultural subsidies to grain prices. Li (2011) just points out agricultural subsidies as an important factor driving agricultural commodity prices to increase without convincing evidence. In this section we attempt to explore the impact of agricultural subsidies on grain prices (Taking rice as a case) using cointegration techniques and error correction model.

5.2.1 Agricultural Subsidies, Production costs and Rice Prices

The scale of agricultural subsidies exhibits substantial growth since 2003 (Table 5.3). These subsidies may have influenced grain market prices. According to the basic theory of supply and demand, providing subsidies to the agricultural sector will increase production and make prices go down, but this mechanism works based on several presuppositions: first, the increase caused by subsidies should be large enough so as to influence grain prices; second, there is no government intervention in the grain market; third, production is a reason leading to price changes. In China the realities are: (1) the increase in grain production due to the subsidies is not so large (Wang and Xiao, 2006); (2)

the Chinese government extensively intervenes in the grain market because of the importance of grains as a staple food to the Chinese; (3) the results of causality test (Granger, 1988; Sims, 1972; Robert and Daniel, 2010) in Table 5.4 reveals that in China grain price causes grain production to change, rather than that production is a reason causing price changes. Consequently, the negative influence of subsidies on grain prices may not be expected for the case of China in recent years.

Table 5.3 Changes in agricultural subsidy scales in China

Year	Total Subsidies (billion yuan)		Average Subsidies (yuan/ha)	
	Nominal	Real (190=100)	nominal	Real (1990=100)
2003	0.3	0.2	3.9	1.9
2004	14.5	6.9	182.7	86.8
2005	17.4	8.1	212.5	99.1
2006	31.0	14.2	365.0	167.7
2007	51.4	22.5	599.2	262.7
2008	103.0	42.7	1194.2	494.4
2009	127.5	53.1	1442.3	601.4
2010	134.5	54.3	1496.9	604.3

Source: China Agricultural Development Report 2004-2011; Authors' calculation.

Table 5.4 Granger causality test for rice price and production

Null	Lag=2, N=19(1992-2010)		Lag=4, N=17(1994-2010)	
	F(2,12)	Prob.	F(4,8)	Prob.
H1:Price $\nRightarrow$ Production	10.33	0.002	5.46	0.020
H2:Production $\nRightarrow$ Price	0.63	0.547	1.02	0.455

Source: Authors' estimation.

These subsidies may promote agricultural production and the increase in grain production might reduce grain prices in the market. But since 2004, In order to protect farmers from the price variety and boost grain production, Chinese government has employed grain minimum purchasing price policy to support the grain prices. As illustrated in Figure 5.6, with incentive of subsidies, the supply curve will shift from *S* to S_1, but due to the price support policy, the rice price will still stand above the minimum purchasing price P_0, cannot decrease to P_1. Consequently, the negative influence of subsidies on grain prices may not be expected under the background of the implementation of price support policy in recent years in China.

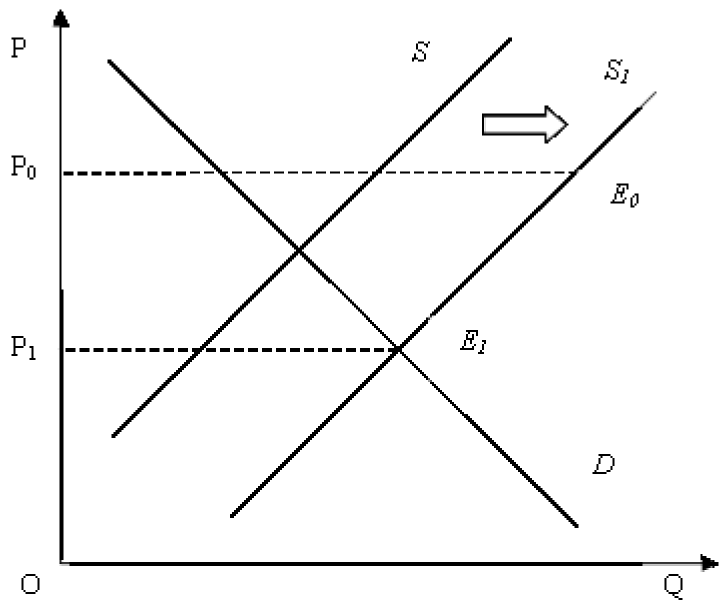

Figure 5.6 Agricultural subsidies and grain prices under the price support policy

We find that Agricultural subsidies largely stimulate the demand in production input factors to increase after the implementation of subsidy policies. The average use increased 19.9%, 17.6% and 22.8% for pesticide, fertilizer, and diesel, respectively, indicating significant growth in demand for input factors after the implementation of subsidy policies (Table 5.5). The subsidies may stimulate input demand in 3 main ways: firstly, providing subsidies for the purchase of goods used in grain production, such as seeds, fertilizers and oils, directly enhances the demand of input factors; secondly, providing subsidies for grain planting will mobilize farmers' enthusiasm for grain production, and production scale, especially the area planted, will be expanded; the expanded production scale requires more basic inputs; thirdly, subsidies as transfer payments will increase farmers' income, and with the subsidies increasing, farmers, especially the poor ones, will have more money to buy more goods for grain production, hence subsidies can stimulate input demand via the income effect of subsidy policies.

Table 5.5 Changes in average usage of main agricultural inputs (million tons/year)

Factor	Average(97-03)	Average(03-09)	Change (%)
Pesticide	1.3	1.5	19.9
Fertilizer	41.9	49.3	17.6
Diesel	13.0	16.0	22.8

Source: China Agricultural Development Report 2010, China Statistical Yearbook 2011.

The big increases in input factor demand have caused factor prices to go up. Table 5.6 reports the changes in factor prices and rice price. From 2000 to 2002 the oil price did not show big changes. But since 2003 big increases have been witnessed in prices of fertilizer and oil which are two most important factors in grain production and occupy the biggest share in the total production costs. From 2003 to 2010, the prices of fertilizer and oil had increased by approximately 20% and 69%, respectively. The prices of pesticide and machinery remain stable even after the subsidy policies because of the small share in total production costs. Note that except for the increasing factor demand caused by agricultural subsidies, agricultural input sellers' speculation is also a reason causing increasing factor prices, as farmers are provided with subsidies, speculators may take advantage of this occasion to force up the prices of agricultural production materials artificially (Li and Tan et al, 2006).

Farmers are competitors in production factor markets. As rational deciders, they will arrange their production in terms of profit maximization criterion of $MP \times P = W$, where MP is marginal product, P indicates product price, and W is input factor price, if we divide both sides of this equation by MP, we obtain the expression of price $P = W/MP$. As already analyzed, agricultural subsidies lead to an increase in the input factor price (W), while the marginal product (MP) always declines, thus when input factor price (W) increases, in order to achieve profit maximization, the product price (P) will increase. As a result, with the input price increases, the product price also will increase. In 2003 the rice price had started to increase in response to the increasing factor price, from 51.39yuan/50kg in 2002 to 60.06yuan/50kg in 2003, up 16.9%. In 2004 with the rice minimum purchasing price policy implemented, the price increased to 79.82yuan/50kg, 32.9% higher than that in 2003. After 2004 under the mixed influences of subsidies policy and minimum price policy, rice price has maintained continuous growth at an annual rate of 6.7% (Table 5.6).

Table 5.6 Changes in factor prices and rice prices

Year	Machinery (Index)	Pesticide (Index)	Fertilizer (Index)	Oil (Index)	Prod.Costs (¥/50kg)	Rice (¥/50kg)
2000	125.6	97.9	139.2	170.7	40.3	51.7
2001	122.0	95.1	136.3	170.7	39.3	53.7
2002	118.2	93.2	139.6	168.8	40.8	51.4
2003	116.4	93.1	141.8	181.9	42.1	60.1
2004	119.0	95.9	159.9	197.3	42.9	79.8
2005	121.7	99.9	180.3	219.1	48.3	77.7
2006	123.6	101.5	180.5	248.5	49.4	80.6
2007	125.6	102.9	186.6	261.7	51.1	85.2
2008	137.0	111.0	245.8	296.0	58.7	95.1
2009	138.1	111.2	230.4	279.3	59.5	99.1
2010	140.1	111.7	227.0	308.0	68.5	118.0

Source: China Statistical Yearbook 2011; China Agricultural Development Report 2004- 2011.

From the analysis above, we know agricultural subsidies activate production costs, so that the increasing production costs cause increases in grain prices. Briefly, agricultural subsidies trigger the rice price to go up via influencing rice production costs.

5.2.2 Empirical Analysis: A Case of Rice

We employ cointegration techniques to examine the relationship between rice price and agricultural subsidies. As discussed above, three variables (grain price, subsidy and production costs) are involved. *P* indicates rice producer price, *S* represents agricultural subsidies, and *C* stands for production costs, ln indicates natural logarithm form. The subsidies data come from China Agricultural Development Report, the annual rice prices and rice production costs data are obtained from the Yearbook of Cost and Return of Agricultural Commodities in China. All the data were deflated by consumer price index with 1990 as a base year and the sample period is from 2003 to 2011.

Table 5.7 Unit root testing for *LNP*, *LNC* and *LNS*

Variable	Type (C T K)	ADF Statistic	5% Critical Value	Conclusion
lnP	(C,T,0)	-2.42	-4.25	nonstationary
lnC	(C,T,0)	-1.61	-4.25	nonstationary
lnS	(C,0,1)	-2.60	-3.40	nonstationary
Δ*lnP*	(C,T,0)	-8.92	-4.45	stationary
Δ*lnC*	(C,0,0)	-3.50	-3.40	stationary
Δ*lnS*	(C,T,0)	-17.83	-4.45	stationary

Note: Δ indicates fist order difference. C, T and K indicate intercept, trend and lag length, respectively.

As a first step for cointegrating analysis, we compute Augmented Dickey-Fuller unit root test statistics for each series. According to the test results, the ADF values of *lnP*, *lnS* and *lnC* are -2.42, -1.61 and -2.60 respectively, larger than the critical values of 5% significant level, fail to reject the null hypotheses of series has one unit root, showing the original series are not stationary. While the ADF values of the first order differenced variables (Δ*lnP*, Δ*lnS*, and Δ*lnS*) are smaller than the critical values at 5% significant level, rejecting the null hypotheses of the test, indicating that the series of *lnP*, *lnS* and *lnC* are all I(1) process, and cointegration analysis can be conducted to find out if there is a relationship exists among *lnP* , *lnS* and *lnC* or not (Table 5.7).

The analysis follows the two-step Engle and Granger procedure (Engle and Granger, 1987), and the cointegration model is specified as a function of rice price, rice production costs, subsidies, and a dummy variable DM, which is 1 for 2004 when the rice minimum purchasing price policy was implemented, is added to compensate for the sharp increase in rice price of the year. The estimated results are shown as below with the t-values in parentheses,

$$\ln P = 0.136 + 1.090 \ln C + 0.025 \ln S + 0.167 DM$$

$$\quad (0.515) \qquad (12.678) \qquad (4.708) \qquad (6.967)$$

$$R^2 = 0.98 \quad DW = 2.12 \quad Obs. = 9$$

The subsidy variable is significant at 1% level with a coefficient of 0.025, indicating subsidies show positive impact on rice price, which coincides with our expectation as analyzed earlier. LM (1) represents the probability of Lagrange Multiplier Test for first-order autocorrelation, accepting the null hypothesis of the test and implying no serial correlation exists in the residuals. Hence, the lagged variables are not necessary to be incorporated in the model.

In terms of the results of Unit Root Test for residual in Table 5.8, ADF value is -2.87, smaller than the critical value of -1.99 at the 5% level, which means the residual is a stationary series, providing strong evidence that the cointergrating regression above is not spurious and there exists a cointegrating relationship among rice price, agricultural subsidies, and rice production costs.

Table 5.8 Unit root testing for residual

Variable	Type (C T K)	ADF Statistic	5% Critical Value	Conclusion
e	(0,0,0)	-2.87	-1.99	stationary

Note: C, T and K indicate intercept, trend, and lagged length, respectively.

Cointegration analysis implies the existence of causality, however, it does not show the direction of the causality. Therefore, a Granger Causality test is employed to confirm the direction of the causality. According to the test results, the null hypothesis that subsidies do not granger cause rice price to change is strongly rejected at 1% significance level. For small samples, for example less than 20, if Granger Causality test makes a judgment that there exists causality between two variables, then the judgment is correct with a probability of more than 90% (Zhou and Li, 2004), so we can accept this test result, indicating that subsidies is a factor contributing to changes in rice prices. This supports our argument of agricultural subsidies trigger grain prices in section 2 and also is consistent with the realities in recent years in China.

Table 5.9 Granger causality test for rice price production costs and subsidies

Null	Lag	F-Statistic	Prob.
S does not Granger Cause P	2	186.82	0.005
P does not Granger Cause S	2	0.59	0.626

Note: P and S indicate subsidies and rice prices, respectively.

The analyses above tell us agricultural subsidies positively influence rice price and the elasticity of rice price to subsidies in the long run is 0.025. But for the short run, an error correction model needs to be built, including an error term one lagged to modify the cointegrating model so as to measure the impact of subsidies on rice price. The error correction model is expressed as below,

$$\Delta \ln P_t = 0.660 \Delta \ln C_t + 0.058 \Delta \ln S_t - 0.831 e_{t-1}$$

$$\qquad (2.554) \qquad\qquad (4.753) \qquad\qquad (-2.237)$$

$R^2 = 0.80$ $\qquad\qquad$ $Q(1) = 0.17$

T-value in the parentheses implies the coefficient of *lnS* is significantly different from zero, suggesting that the subsidy adjustments have significant impacts on rice prices. The magnitude of the coefficient of *lnS* indicates that a 10% increase in agricultural subsidies leads to a 0.58% increase in rice prices, namely, the elasticity of rice price to subsidies in the short run is 0.058. The sign of error correction term is negative as expected of reverse adjustment and is statistically significant, its coefficient represents the speed of adjustment toward the long-run equilibrium, and is estimated as a value of -0.831, implying that price adjustment towards the long run equilibrium levels is at a relatively fast rate, with about 83.1% of the adjustment occurring within the first year.

5.2.3 Conclusions

In this section, we discussed the relationship between agricultural subsidies and grain prices and examined the impacts of the agricultural subsidies on rice price using cointegration techniques and error correction model. A relationship between rice price and agricultural subsidies has been detected. From the results, the parameter of subsidy variable is positive and statistically significant, implying that agricultural subsidies contribute to the increase in rice price in recent years in China. Statistically, in long run, if the agricultural subsidies increase by 10%, rice prices increase by 0.25%. In short run, a 10% increase in agricultural subsidies results in a 0.58% increase in rice prices. The rice price adjusts towards to the long run equilibrium levels at a rapid speed.

Those subsidies show positive impact, rather than negative impact on grain market prices in recent years on rice price, although the impact is relatively small with respect to the sharp increase in the amount of subsidies.

5.3 Minimum Purchasing Prices and Grain Prices

Since 2003, food production in China has been steadily increasing. Grain production increased from 374.3 million tons in 2003 to 496.4 million tons in 2010, growing by 32.6%. Facing the increasing production, grain prices are forced to decline. In order to avoid decreasing prices which will hurt grain supply, in 2004 the Chinese government started to employ grain minimum purchasing price policy (MPPP) to maintain the stability of grain market prices, which aims to stabilize grain production and protect the income of farmers.

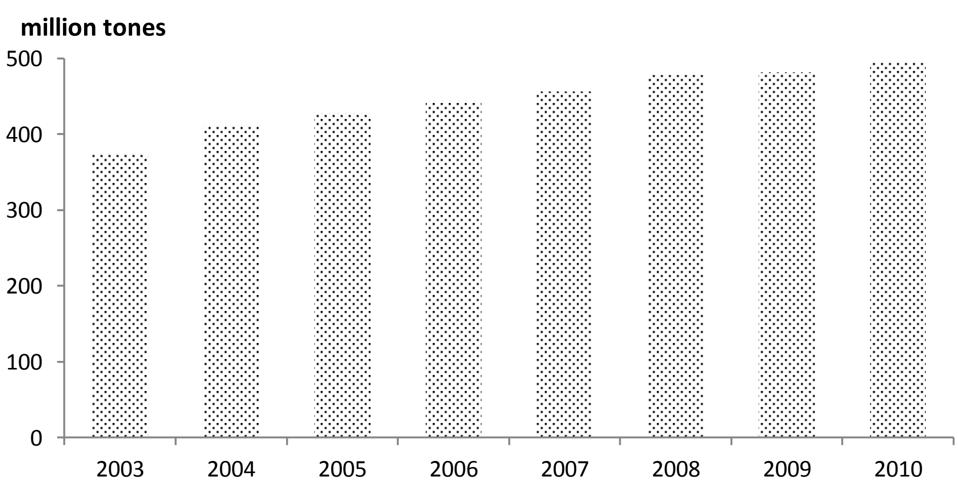

Figure 5.7 Total grain production in China from 2003 to 2010

Source: China Agricultural Development Report 2011.

5.3.1 Grain Minimum Purchasing Prices and Market Prices

Table 5.10 reports changes in minimum purchasing prices, grain prices and the difference between these two prices. The smaller difference indicates the more similar movements the two prices have. The annual minimum purchasing prices are averaged to represent the overall level of rice prices. In the implementation year of 2004, under the support of minimum prices, all grain market prices saw big jumps. The early season rice price increased 24.5 yuan/50kg from 51.6 yuan/50kg in 2003 to 76.1 yuan/50kg in 2004, and the increases in prices of middle season rice, late season rice and medium grain rice were 19.9yuan/50kg, 18.2 yuan/50kg and 17.3 yuan/50kg, respectively.

Table 5.10 Grain market prices and minimum prices in China (yuan/50kg)

Year	Ear-			Mid			Late		
	Price	MP	ΔP	Price	MP	ΔP	Price	MP	ΔP
2003	51.6	--	--	55.5	--	--	63.7	--	--
2004	76.1	70.0	6.1	75.4	72.0	3.4	81.9	72.0	9.9
2005	72.7	70.0	2.7	71.3	72.0	-0.7	76.9	72.0	4.9
2006	75.2	70.0	5.2	73.9	72.0	1.9	81.6	72.0	9.6
2007	80.9	70.0	10.9	82.5	72.0	10.5	90.3	72.0	18.3
2008	96.6	77.0	19.6	92.5	79.0	13.5	99.1	79.0	20.1
2009	96.0	90.0	6.0	94.4	92.0	2.4	99.2	92.0	7.2
2010	102.4	93.0	9.4	109.2	97.0	12.2	120.0	97.0	23.0

Source: Cost and Return of Agricultural Commodities Yearbook in China. Note: MP indicates minimum purchasing price, ΔP is the difference between grain price and minimum purchasing price.

The average price of all rice increased from 60.1yuan/50kg to 79.8yuan/50kg, an increase of 19.7yuan/50kg. Note that in the case of medium grain rice, the differences are quite stable from 2004 to 2009, the market prices always stay an average of 12 yuan/50kg higher than the minimum purchasing prices, reflecting very similar movements between the two prices of medium grain rice. Generally, market prices moved above the minimum purchasing prices and the differences between these two prices are small, exhibiting similarities in the annual movements between minimum prices and market prices.

Table 5.10 Continued

Year	MG			Rice			Wheat		
	Price	MP	ΔP	Price	MP	ΔP	Price	MP	ΔP
2003	68.2	--	--	60.1	--	--	56.4	--	--
2004	85.5	75.0	10.5	79.8	73.2	6.7	74.5	--	--
2005	88.4	75.0	13.4	77.7	73.2	4.5	69.0	--	--
2006	89.8	75.0	14.8	80.6	73.2	7.5	71.6	70.0	1.6
2007	87.1	75.0	12.1	85.2	73.2	12.0	75.6	70.0	5.6
2008	93.4	82.0	11.4	95.1	80.2	14.9	82.8	73.7	9.1
2009	105.8	95.0	10.8	99.1	93.2	5.9	92.4	84.3	8.1
2010	136.9	105.0	31.9	118.0	100.3	17.7	99.0	87.3	11.7

Source: Cost and Return of Agricultural Commodities Yearbook in China. Note: MP indicates minimum purchasing price, ΔP is the difference between grain price and minimum purchasing price.

According to the evolution of this price support policy, we divide the implementation into three periods: 2003-2004 (for wheat is 2005-2006), which is the starting period of implementation; 2004-2007 (for wheat is 2006-2007), in which the minimum prices remained unchanged; 2007-2010, which is the period that grain minimum prices started to increase annually.

Table 5.11 reports changes in increase rate of minimum purchasing prices and market prices for each grain in different periods. In the first period, we witness a big jump in all grain market prices in 2004, the price of early long grain rice went up 47.6%, which was the biggest increase, other rice prices rose by 35.9%, 28.7% and 25.3%, respectively, and the average rice price increased by 32.9%. Note that wheat price also increased in 2004 due to the high correlation with rice price, it increased by 32.0%. These big increases in grain market prices reflect that the price support policy has an obvious impact on grain market prices in the starting year of the policy implementation. In the second period, where the minimum prices stayed unchanged, grain prices had experienced small increases without increasing supports from policies. Most of the grains increased by less than 10% from 2004 to 2007, but the price of medium grain rice only increased by 1.9% in this period compared to big jumps in the first period. In the third period, when the Chinese government raised the minimum purchasing prices drastically, with the minimum prices rising, dramatic increases in grain market prices followed. The average minimum price of rice increased by 37.1%, the average rice price increased by 38.5%, and for wheat the two prices had increased by 24.8% and 31.0%, respectively.

Table 5.11 Increase rates of minimum prices and market prices for each grain (%)

Period	Price type	ELG	MLG	LLG	MG	Rice	Wheat
2003-04	Market price	47.6	35.9	28.7	25.3	32.9	32.0
2004-07	Minimum price	--	--	--	--	--	--
	Market price	6.3	9.5	10.2	1.9	6.8	5.5
2007-10	Minimum price	32.9	34.7	34.7	40.0	37.1	24.8
	Market price	26.6	32.3	32.9	57.2	38.5	31.0

Source: Authors' calculation.

Comparing the increases in the three periods, we find that grain market prices increased dramatically when the price support policy was implemented in 2004; when the minimum prices remained unchanged, grain market prices were more stable; as minimum prices started to increase, grain market prices also witnessed big increases. The movements of the minimum prices and the market prices remain highly simultaneous, indicating MPPP shows significant influences on grain market prices.

The descriptive analysis shows that the policy may effectively affect the grain market prices, but how significant the influence of this price support policy is and if this policy is a main factor determining the movements of grain market prices will be examined in the next part of this paper by employing a grey relational analysis.

5.3.2 Methodology and Data

The grey relational analysis is a branch of grey system theory developed by Dr. Deng (1982, 1989), which is often applied to search for primary relationships among the factors and to determine the significant factors influencing a specific objective. Since its emergence, the grey relational analysis method has been widely applied in many fields. For example, it has been applied in the finance field (Kung and Yu, 2008; Wu, Lin, and Tasi, 2010; Zhang, 2012), in the industry field (Hsu and Wang, 2009), in the energy field (Lin, Lu and Lewis, 2007; Lu, Lin and Lewis, 2008), in the agricultural field (Yun, 2010; Zhao, Mu and Ito, 2012), and so on. As different from the regression analysis, grey relational analysis only requires small size data sets, and also does not require data subject to a normal distribution. In grey relational analysis, a concept of grey relational grade is known as the measure of relevancy between two factors, describing the trend relationship between an objective sequence and a reference sequence in a system from the point of view of geometrical mathematics. The more both trends tend towards concordance, the larger the grey relational grade is, or otherwise the smaller. Grey relational analysis first calls for the normalization of raw data to remove anomalies so that the data in different units can be comparable to each other. Two types of normalizing processing, initial-value processing and average-value processing, are often used to transform the raw data into dimensionless form. The former divides the elements in each sequence by the first component, which is generally applied to data series without an apparent increasing or decreasing trend. The latter uses the average value of the sequence as the divisor, which is more appropriate for the data series with increasing or decreasing trend. Via dealing with the finite raw data using grey processing, the regularity between objective sequence and reference sequence can be found out using the grey relational analysis method.

Assuming there is an objective sequence $Y_0 = \{y_0(1), y_0(2),..., y_0(n)\}$, and a reference sequence $Y_i = \{y_i(1), y_i(2),..., y_i(n)\}$, the normalized data are $X_0 = \{x_0(1), x_0(2),..., x_0(n)\}$ and $X_i = \{x_i(1), x_i(2),..., x_i(n)\}$, $i = 1,2,...,m$, n denoting the sample size of objective sequences and reference sequences, m being the number of reference sequences. The grey relational coefficient between $x_0(k)$ and $x_i(k)$ can then be defined as

$$r_{0i}(k) = \frac{\min_i \min_k |x_0(k) - x_i(k)| + \theta \max_i \max_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \theta \max_i \max_k |x_0(k) - x_i(k)|}$$

where $k = 1,2,...,n$, θ is the distinguishing coefficient in the range between 0 and 1, and often with a value of 0.5. The grey relational grade between the objective sequence and the reference sequence is known as

$$r_{0i} = \frac{1}{n} \sum \rho_{0i}(k)$$

It numerically measures the influence degree of factors to the objective variable, and the numerical values are bounded by 0 and 1. Generally, r > 0.9 indicates a marked influence, r > 0.8 a relatively marked influence, r > 0.7 a noticeable influence, r < 0.6 a negligible influence (Fu and Zheng, 2001). Assessing the effect of a policy is based on the basic assumption that the higher the grey relational grade, the more effective the policy is.

The policy aims to affect grain market prices, thus the annual grain prices are selected as the objective sequence (X_0) and the minimum purchasing prices are selected as a reference sequence (X_1). In order to determine how significant the minimum purchasing price is among the factors influencing grain prices, we introduce three other main drivers, production cost (X_2), international grain price (X_3) and grain production (X_4), as objects for making comparisons with the policy factor.

Table 5.12 Raw data of rice and wheat

Variable	2004	2005	2006	2007	2008	2009	2010	Mean
				rice				
X_0	79.82	76.29	78.04	78.69	82.94	87.01	100.31	83.30
X_1	73.17	71.87	70.81	67.57	69.91	81.82	85.30	74.35
X_2	49.06	54.85	56.12	55.70	61.24	63.61	71.44	58.86
X_3	245.78	282.72	293.75	306.96	610.59	517.58	442.54	376.23
X_4	125.36	126.41	127.20	130.22	134.33	136.57	139.30	131.34
				wheat				
X_0	--	--	69.30	69.80	72.17	81.15	84.17	73.11
X_1	--	--	67.75	64.64	64.24	74.06	74.24	67.67
X_2	--	--	53.69	54.29	54.27	64.13	69.35	59.15
X_3	--	--	185.55	235.67	284.23	196.21	190.15	225.41
X_4	--	--	108.47	109.30	112.46	115.12	114.50	111.97

Source: Authors' calculation.

Grain price data are collected from *China Agricultural Development Report 2011*; the minimum purchasing price data (X_1) are collected from annual government document; the international price data come from *China Agricultural Development Report 2011*. Production cost data are from *Cost and Return of Agricultural Commodities Yearbook in China 2011*. The study periods are from 2004 to 2010 for rice and from 2006 to 2010 for wheat. Price data and cost data are all deflated by China's consumer price index with a base year of 2004. The original data for rice and wheat are shown in Table 5.12 and the mean value of each sequence is also reported in the table so as to normalize the raw data.

5.3.3 Empirical Results

As a first step for grey relational analysis, we must transform the raw data into dimensionless forms by average-value processing due to the increasing trend nature of the data. Table 5.13 reports the processed data of rice average and wheat.

Table 5.13 Average-value processing for raw data

Variable	2004	2005	2006	2007	2008	2009	2010
				rice			
X_0	0.96	0.92	0.94	0.94	1.00	1.04	1.20
X_1	0.98	0.97	0.95	0.91	0.94	1.10	1.15
X_2	0.83	0.93	0.95	0.95	1.04	1.08	1.21
X_3	0.90	1.05	0.93	0.76	1.10	1.27	1.19
X_4	0.92	0.94	0.95	1.00	1.06	1.05	1.08
				wheat			
X_0	--	--	0.95	0.95	0.99	1.11	1.15
X_1	--	--	1.00	0.96	0.95	1.09	1.10
X_2	--	--	0.91	0.92	0.92	1.08	1.17
X_3	--	--	1.07	1.06	1.00	0.88	0.73
X_4	--	--	0.93	0.97	1.03	1.02	1.05

Source: Authors' calculation.

We calculate the grey relational grades with the processed data. The results are listed in Table 5.14. For the average level of rice, the relational grade of rice minimum purchasing price to rice price is 0.881 which is the largest value among the selected factors, indicating a noticeable influence of MPPP on rice prices and the influence from the policy factor is the most significant compared with other factors; then followed by rice production cost and international rice price, and rice production, the grey relational grades are 0.854, 0.618 and 0.553 for rice production cost, international rice price and rice production, respectively. For the four types of rice, the relational grades of minimum purchasing prices are also large, particularly, for medium grain rice, it reached 0.895, which is the largest among grains, indicating strong influences of MPPP on rice market prices. In the case of wheat, the grades of minimum purchasing price, production cost, international price and wheat production are 0.841, 0.807, 0.455 and 0.774, respectively. The minimum price relational grade is also the largest coinciding with rice cases.

Table 5.14 Grey relational grades between crop price and its influencing factors

Factors	ELG	MLG	LLG	MG	Rice	Wheat
Minimum price	0.883	0.852	0.850	0.895	0.881	0.841
Production cost	0.850	0.855	0.872	0.875	0.854	0.807
International price	0.620	0.621	0.623	0.610	0.618	0.455
Production	0.557	0.562	0.560	0.552	0.553	0.774

Note: ELG, early long grain rice; MLG, middle long grain rice; LLG, late long grain rice; MG, medium grain rice. Rice indicates the average level of rice. Source: Authors' calculation.

Generally, among the main determinants, the MPPP has the largest grey relational grade, showing it has the most important influence on grain market prices and determining the movements of grain prices; production costs is the second most important factor affecting grain prices; while the impulse from international grain prices to China domestic grain prices seems to be small, and only with a grey relational grade of approximately 0.6 for rice and less than 0.5 for wheat, reflecting that the international grain prices have negligible influences on China domestic grain prices. This is because of the government intervenes extensively in the grain markets, resulting in domestic prices diverging from world market prices. Grain production is also not significantly related to changes in grain market prices. Actually, in recent years they exhibit the same rather than reverse movements with grain prices due to a series of agricultural support policies. The main conclusion of this research is that the MPPP effectively impacts grain prices and has the most significant influence on grain market prices relative to other factors selected.

5.3.4 Conclusions

This section introduced the implementation of current grain price support policy in China and measured how significant the policy factor is among the factors influencing grain prices employing the grey relational analysis to calculate the grey relational grades between grain prices and their determinants. The results suggest that the minimum purchasing price policy is a major factor determining grain market prices, and among the determinants of grain market prices selected, the price support policy plays a most significant role, providing convincing evidence that the grain minimum purchasing price policy impacts grain market prices effectively and therefore the expected goals of this policy have been achieved. We conclude that for regulation of grain market prices, the current price support policy is a most efficient tool in aiming to protect farmers from price variability and increase farmers' income and agricultural supply, continuing efforts should be made to design appropriate minimum purchasing prices for grains.

CHAPTER 6 CHINA GRAIN SUPPLY AND DEMAND MODEL

In Chapter 6, a partial equilibrium mode China Grain Supply and Demand Model (CGSDM) is developed to study the policy impacts on China's grain production, consumption, trade, prices. We have evaluated the direct effects of the main agricultural policies on grain yields, planted areas and prices in Chapter 5. These studies constitute foundations of CGSDM which includes 5 sectors, production sector, consumption sector, trade sector, price linkages and market clearance.

6.1 Production Sector

In China grain production accounts for a big share in total grain supply. Grain production is determined by the response models of grain yield and grain planted area.

6.1.1 Yield Response Model

Grain yield is generally specified as a function of yield one year lagged, producer pr ice one year lagged, total agricultural subsidies and grain planted area. The estimated result s for yield response models are shown in Chapter 5.

$$Y_{it} = f(Y_{it-1}, P_{it-1}, S_{it}, A_{it})$$

where *Y*: Grain yield;

P: Grain producer price;

S: Amount of total agricultural subsidies;

A: Grain planted area;

i: Rice, wheat and corn, respectively; and

t: year, from 1990 to 2011.

6.1.2 Area Response Model

Grain planted area is generally specified as a function of planted area in the last year, grain producer price in the last year, total agricultural subsidies and a trend variable. The estimated results for area response models are shown in Chapter 5.

$$A_{it} = f(A_{it-1}, P_{it-1}, S_{it}, T_{it})$$

where A: Grain planted area;

P: Grain producer prices;

S: Total amount of agricultural subsidies;

T: A trend variable;

i: Rice, wheat and corn respectively; and

t: Study period from 1990 to 2011.

Grain production is defined as grain yield multiplies grain planted area.

$$QP_{it} = Y_{it} \times A_{it}$$

where QP: Grain production;

Y: Grain yield;

A: Grain planted area;

i: Rice, wheat and corn respectively; and

t: Study period from 1990 to 2011.

6.2 Grain Consumption

6.2.1 Grain Consumption Structures

Grain consumption is made up of food use, feed use, industrial use, seed use and other purpose. Like other Asian countries, rice is the most important stable food in China, more than 80% are consumed as food, and the share of rice food consumption remains quite stable; about 8% are used for feed consumption; others for industrial use, seed use account for nearly 8% of the total consumption. Wheat plays an important role in northern people's daily live and is the second important stable food in China. Food consumption occupies 72% in the total wheat consumption, but it has a decline trend over time, from 2009 to 2012, the share down nearly 6%; while the consumption for feed is experiencing a growth and accounts for approximately 13% in recent 4 years; other uses make up 15% of total wheat consumption. Corn is main consumed for feed, accounting for approximately 60%; food consumption is very small, only has a share of 7.5%; 30% are used for other consumptions (Table 6.1).

Table 6.1 Grain consumption structures in China (%)

Year	Rice consumption			Wheat consumption			Corn consumption		
	Food	Feed	Others	Food	Feed	Others	Food	Feed	Others
2009	85.6	8.2	6.2	75.8	9.4	14.8	7.9	60.3	31.8
2010	83.2	8.5	8.3	73.1	11.7	15.1	7.4	60.2	32.4
2011	83.0	8.6	8.4	69.1	16.0	14.9	7.6	57.2	35.2
2012	83.1	8.5	8.4	70.1	14.6	15.3	7.1	59.4	33.5
Average	83.7	8.4	7.8	72.0	12.9	15.0	7.5	59.3	33.2

Source: China Grain, http:www.cngrain.com. China National Grain and Oils Information Center.
Note: Data in 2012 are projected value.

The total grain disappearance is divided into two categories in terms of the grain consumption structures, one is feed consumption, and the other is food and other consumption making up of food use, industrial use and seed use. Rice and wheat are the most important staple foods in China. Their consumption for food and others accounts for more than 90 percent of the total consumption on average (Table 6.1) but more than 10 percent of the total consumption of wheat is used as feed in recent years. Finally, corn is mainly used as feed and less than 30 percent of the total consumption is used as food and other purposes.

6.2.2 Changes in Grain Consumption

Table 6.2 shows that an increase in the total rice consumption is mainly due to an increase in food consumption, while increases in total wheat and corn consumption are attributed to increases in feed consumption.

Table 6.2 Annual grain consumption in China (Million tons)

Year	Rice consumption			Wheat consumption			Corn consumption		
	Total	Food	Feed	Total	Food	Feed	Total	Others	Feed
2006	179.7	162.9	16.8	102.0	98.0	4.0	145.0	41.0	104.0
2007	183.3	166.7	16.6	106.0	98.0	8.0	150.0	44.0	106.0
2008	184.2	169.2	15.0	105.5	97.5	8.0	153.0	45.0	108.0
2009	188.7	173.2	15.5	107.0	97.0	10.0	165.0	47.0	118.0
2010	194.0	177.7	16.3	110.5	97.5	13.0	180.0	52.0	128.0
2011	198.4	182.2	16.2	120.5	98.5	22.0	188.0	57.0	131.0
Average	188.1	172.0	16.1	108.6	97.8	10.8	163.5	47.7	115.8
	ΔTotal	ΔFood	ΔFeed	ΔTotal	ΔFood	ΔFeed	ΔTotal	ΔOthers	ΔFeed
2006	2.2	1.8	0.4	0.5	0.0	0.5	8.0	5.0	3.0
2007	3.6	3.8	-0.2	4.0	0.0	4.0	5.0	3.0	2.0
2008	0.9	2.5	-1.6	-0.5	-0.5	0.0	3.0	1.0	2.0
2009	4.5	4.0	0.5	1.5	-0.5	2.0	12.0	2.0	10.0
2010	5.3	4.5	0.8	3.5	0.5	3.0	15.0	5.0	10.0
2011	4.4	4.5	-0.1	10.0	1.0	9.0	8.0	5.0	3.0
Average	3.5	3.5	0.0	3.2	0.1	3.1	8.5	3.5	5.0

Source: USDA, PSD Online 2013. Note: Δ indicates change to the previous year.

These trends are likely to reflect high meat prices in China in recent years. Due to a sharp decrease in meat supply caused by disasters and an increase in production costs (Li, 2007; Xu, 2008; Ding, 2008), prices of meat showed a stark increase from 2006 to 2008. Pork price from 10.86 yuan/kg in 2006 rose to 16.77 yuan/kg in 2007, increased by 54.4%, and in 2008, the price touched its peak of 20.51yuan/kg. Meat prices are correlated to each other, with pork price increasing prices of beef and mutton also have increased drastically (Table 6.3). Since 2008, Chinese government has implemented intervention measures in pork market, for example subsidy policy and frozen pork storage policy, which help to stabilize the prices. However, meat prices are still at a historically high level in 2010: price of pork increases by 50 percent and prices of beef and mutton increase by more than 80 percent during this period.

Table 6.3 Recent wholesale prices of meat in China (yuan/kg)

Year	Pork	Beef	Mutton
2006	10.9	16.5	17.7
2007	16.8	19.8	22.3
2008	20.5	28.1	29.3
2009	15.9	29.1	30.0
2010	16.3	29.8	32.3
Growth (%)	49.7	80.8	82.8

Source: China Agricultural Development Report 2004-2011.

High meat prices result in a reduction in meat consumption. Table 6.4 shows changes in overall meat prices and consumptions of meat and grains from 2000 to 2010. Economic development in China had steadily increased its meat consumption from 2000 to 2006. However, a sharp increase in meat prices in 2006 interrupted this trend. Meat consumption does not recover to 20 kg until 2010. By contrast, grain consumption for food in urban areas, which showed a downward trend until 2006, has increased during this period, it indicates that meat and grain, especially rice, are highly substitutable with each other, implying a large derived demand from grain for food consumption. Additionally, high meat prices also stimulate demand in feed consumption. More grains especially for wheat and corn are used as feed to produce more meat and make more money. In the next section, we empirically evaluate to what extent a rise in meat prices contributes to an increase in grain consumption and models of per capita food consumption and consumption for feed purpose are estimated separately.

Table 6.4 Prices of meat and the per capita consumption of meat and grains in China

Year	Meat price (indexed)	Meat consumption (kg per capita)	Urban grain consumption (kg per capita)
2000	89.3	17.4	82.3
2001	91.1	16.9	79.7
2002	92.3	19.1	78.5
2003	94.4	19.4	79.5
2004	106.5	18.9	78.2
2005	107.8	20.5	77.0
2006	103.3	20.4	75.9
2007	129.3	18.5	77.6
2008	148.0	18.3	80.8
2009	136.5	19.8	81.3
2010	136.2	20.2	81.5

Source: China Agricultural Development Report 2004-2011.

6.2.2 Methodology and Data

A double-log model is developed to evaluate the impact of a rise in meat prices and grain prices on grain consumption based on the national time series data and consumptions for food and feed are estimated separately. A similar model is employed in Timmer (1979) and Waterfield (1985), who estimate income and price elasticities of food demand. Income level is an important factor determining consumption. Therefore our model incorporates income level measured by per capita GDP. Price is a critical factor influencing consumption, here we include grain price in the model. And also, meat price is considered to explain changes in grain consumption. Note that the urbanization's role in food consumption is often mentioned (Huang, 1993; Wu, 1997), but the urbanization in China is highly correlated with income level. So urbanization is not included in our model. Formally, the model is expressed as:

$$\ln CS_{it} = \alpha + \beta_1 \ln CP_{it} + \beta_2 \ln IN_t + \beta_3 \ln PM_t + u_{it}$$

where CS_{it} represents per capita consumption of grain i for food or feed (kg) at year t; i represents the type of a grain: rice, wheat, and corn; and t is from 1994 to 2011; CP_{it} represents real consumer price (yuan/50kg) of grain i at t deflated by consumer price index (1990=100); IN_t is the per capita GDP in real terms at t; PM_t is the price index of meat in real terms reflecting the overall price level of meats; and u_{it} is a random error term. Data on per capita consumption are obtained from *USDA and China National Grain and Oils Information Center*; Income and price index of meat are collected from *China Statistical Yearbook*; and grain prices are from *China Agricultural Development Report*. We expect a negative sign on income (β_2) because grains are no longer normal goods: average consumers in China tend to spend more money on meat products than grains (Ito, 1989; Ito, 1991; Peterson, 1991; Huang, 1991). A rise in prices of a grain will reduce its consumption while a rise in prices of meat will increase the consumption of a grain as they are substitutes or derived demand from the livestock production increases, implying $\beta_1 < 0$ and $\beta_2 > 0$.

6.2.3 Empirical Results

We estimate the model using Eviews 6.0 for rice, wheat and corn, respectively. In order to eliminate the autocorrelations in error terms, a Weighted Least Square (WLS) method is used for the estimation. Estimation results are presented in Table 6.5. Consumptions for food and for feed are estimated individually. However, because only approximately 8 percent of the total consumption of corn is consumed as food, which shows very tinny influence on total corn consumption, so we only estimate the impacts of meat prices on the per capita consumption for feed. Moreover, because parameters on income are not significant for any type of grain in estimating the feed consumption model, income is dropped from the model. Also, a parameter on wheat price is insignificant and dropped from food consumption model. Other parameters are significant and take an expected sign. Parameters are significant and take an expected sign. Q-statistic tests failed to reject the null hypothesis of not existing correlations in the error terms, implying the serial correlations have been eliminated.

Table 6.5 Estimated results of consumption models

Variable	Rice		Wheat		Corn	
	Food	Feed	Food	Feed	Food	Feed
C	4.824***	2.527***	4.940***	-4.589***	--	1.124***
	(0.137)	(0.097)	(0.044)	(0.422)	--	(0.180)
ln*P*	-0.042**	-0.472***	--	-1.730***	--	-0.678***
	(0.017)	(0.100)	--	(0.152)	--	(0.093)
ln*IN*	-0.110***	--	-0.131***	--	--	--
	(0.010)	--	(0.004)	--	--	--
ln*PM*	0.175**	0.277***	0.114***	2.610***	--	1.170***
	(0.048)	(0.089)	(0.013)	(0.201)	--	(0.090)
R^2	0.96	0.88	0.99	0.90	--	0.95
Q(1)	17	17	22	12	--	22

Note: ***, **, * indicate 1%, 5% and 10% significant levels, respectively; C, the constant; values in parentheses are standard errors.

According to the estimated results, a 10% increase in prices of rice reduces its consumption for food and for feed by 0.42% and 4.72%, respectively. Similarly, a 10% increase in prices of wheat and corn respectively decreases the consumption of wheat and corn for feed by 17.30% and 6.78%. Next, an increase in income by 1% decreases the per capita consumptions of rice and wheat by 0.11% and 0.13%, respectively. The magnitudes are very close to the recent report on income elasticity of the grain demand: -0.157 in urban China and -0.216 in rural China (Feng, 2011). Finally, meat prices are significant at high levels in each model and with positive coefficients, indicating meat prices contribute to increases in both grain food consumption and feed consumption. Statistically, an increase in prices of meat by 10% increases the consumption of rice and wheat for food by 1.75% and 1.14%, respectively. These results imply that grains and meat are substitutes in China. A one percent increase in prices of meat increases the consumption of rice, wheat and corn for feed as well by 0.28%, 2.61% and 1.17%, respectively. Note that price elasticities of grain consumption for feed are larger than those of grain consumption for food. Thus, an increase in prices of meat induces grain consumption for feed more than proportional to the consumption for food. Especially, prices elasticities are high for wheat and corn; their consumption for feed increases more than rice consumption for feed when meat prices increase. This is consistent what we observe in Table 6.2.

Table 6.6 Contribution of meat prices to grain consumption (2006-2010, Kg per capita)

Grain	Consumption Change (1)	Food change due to high meat price(2)	Feed change due to high meat price (3)	Contribution (%)=(2+3)/1
Rice	3.9	3.2	1.0	108
Wheat	5.1	2.5	2.4	96
Corn	22.3	--	29.2	131

Source: Authors' calculation.

Based on the estimation results, we compute the contribution in percentage of high meat prices to increases in grain per capita consumption using the coefficients of meat prices in each model and the actual changes in grain per capita consumption during the period of 2006-2010 (Table 6.6). From 2006 to 2010, per capita rice consumption has increased by 3.9 kg per capita, 82% (3.2 kg) of which is due to an increase in demand as for food while 26% (1.0kg) of which is explained by an increase in demand for feed. The changes in wheat demand for food and feed are 2.5 kg per capita and 2.4 kg per capita, respectively, which accounts for 96% of the total increase. A rise in meat prices also causes a sharp increase in corn demand for feed (29.2 kg per capita), accounting for 131% of the total increase in corn consumption. As a result, high meat prices contribute to the most to increases in grain consumptions, indicating that the high meat prices are changing China's grain consumption patterns.

6.2.4 Conclusions

In recent years, new trends have been observed in China's grain consumptions. Consumptions of rice and wheat, which had shown a downward trend, increases again; corn consumption grows much faster than before. The increase in the total rice consumption is mainly due to an increase in food consumption while the increase in consumption of wheat and corn is attributed to an increase in consumption for feed. The principal factor causing these changes is high meat prices. High meat prices lead consumers to change to consume more rice and wheat and stimulate the demand for feed use of wheat and corn. Elasticities of food consumption of rice and wheat with respect to meat prices are 0.175 and 0.114, respectively. Elasticities of feed consumption of rice, wheat and corn are respectively 0.277, 2.610 and 1.170. The high meat prices in recent periods contribute to an increase in grain consumption greatly, especially for feed. A policy stabilizing meat prices are highly recommended to reduce the high fluctuations of grain demand in China and consequently in world market.

6.2.5 Consumption Sector

Therefore demand sector in CGSDM is a function of grain market prices, per capita GDP and meat prices.

$$Q_{it} = f(CP_{it}, INC_{it}, PM_{it})$$

where Q: per capita grain consumption for food and others or for feed;

CP: Grain consumer price;

IN: Per capita GDP;

PM: Meat indexed price;

i: Rice, wheat and corn, respectively; and

t: Study period from 1990 to 2011 for wheat and corn, 1995 to 2011 for rice.

The total consumption is defined as population times the sum of per capita consumption for food and others and feed.

$$QS_{it} = POP \times (Qfood_{it} + Qfeed_{it})$$

where *QS*: Total grain consumption;

POP: China population;

Qfood: Per capita consumption for food and others;

Qfeed: Per capita consumption for feed;

i: Rice, wheat and corn, respectively;

t: Study period from 1990 to 2010 for wheat and corn, 1995 to 2010 for rice.

6.3 Trade Sector

Grain trade sector is combined by grain import and export. Considering China's domestic grain supply and demand are insensitive to the international grain prices, here we transfer to use domestic grain prices to explain changes in grain imports and exports. Grain production and consumption in domestic market also are important factors determining grain export and import. So they are also incorporated in the import model and export model.

6.3.1 Grain Imports

Grain import is generally specified as a function of domestic grain consumer prices, grain production, grain consumption, and exchange rate of Chinese yuan to US dollar. With domestic prices increase, China may change to import more grains from the international food market, so the sign of domestic grain prices is expected to be negative; as grain production increases, China needs to import less grain from abroad, therefore, a negative sign is expected for grain production; increases in domestic grain consumption may requires more demand on grain import, then grain consumption variable is expected to be negative; finally, the exchange rate of Chinese yuan to US dollar can reduce grain import and a negative sign is expected in the models. The generally function is expressed as:

$$QI_{it} = f(CP_{it}, QP_{it}, QC_{it}, ER_t)$$

where *QI*: Grain import;

CP: Domestic grain consumer prices;

QP: Grain production in China;

QC: Total grain consumption;

ER: Exchange rate of Chinese yuan to US dollar;

i: Rice, wheat and corn, respectively;

t: Study period from 1990 to 2011 for wheat and corn, 1995 to 2011 for rice.

Table 6.7 Estimated results of grain import models

Variable	Rice	Wheat	Corn
C	13.964	102.000***	-198.148***
	(24.593)	(11.855)	(79.422)
ln*CP*	2.335***	5.072***	1.979
	(0.258)	(0.309)	(1.156)
ln*QP*	-9.035***	-9.176***	--
	(1.108)	(0.854)	--
ln*QC*	7.645***	--	16.330**
	(2.367)	--	(6.558)
ln*ER*	--	-0.950*	--
	--	(0.471)	--
AR(1)	--	--	0.852***
	--	--	(0.067)
R^2	0.88	0.94	0.90
Q(1)	0.42	0.50	0.31

Note: ***, **, * indicate 1%, 5% and 10% significant levels, respectively; C, the constant; values in parentheses are standard errors.

The rice and corn model are estimated using Ordinary Least Squares (OLS), and AR(1) is taken in corn model to eliminate the correlation in error terms. For wheat model, the Weighted Least Squares (WLS) is used to account for autocorrelation in residuals, and lead to better estimated results. Exchange rate variable is dropped from rice model and corn model due to the weak significance, consumption variable is not significant in wheat model and omitted from the model. Also, production variable is insignificant in corn model and moved from the model. The estimated results for import models are presented in Table 6.7, parameters are significant and take an expected sign. High R-squared values indicate models fit the data well. Q-statistic tests failed to reject the null hypothesis of no correlation exists in the residuals, suggesting that the serial correlations have been eliminated.

6.3.2 Grain Exports

Grain export is generally modeled as a function of domestic grain consumer prices, grain production, grain consumption, and exchange rate of Chinese yuan to US dollar. When domestic prices increase, it may reduce grain export because grain companies tend to sell their products in domestic market, so as to gain more money, thus the sign of domestic grain prices in export models is expected to be negative; as grain production increases, more grains are available for export, the export may increase, so production variable is expected to be in positive sign; consumption may restrict grain export, for the consideration of food security, domestic consumption has priority than export, so when domestic consumption increases, grain export will go down. Thus, in the export models, consumption have a negative sign as expected; finally, the exchange rate of Chinese yuan to US dollar can increase grain export, and a positive sign is expected for exchange rate in export models. The generally export model is expressed as:

$$QE_{it} = f(CP_{it}, QP_{it}, QC_{it}, ER_t)$$

where Q*E*: Grain export;

CP: Domestic grain consumer prices;

QP: Grain production in China;

QC: Total grain consumption;

ER: Exchange rate of Chinese yuan to US dollar;

i: Rice, wheat and corn, respectively;

t: Study period from 1990 to 2011 for wheat and corn, 1995 to 2011 for rice.

The rice and corn model are estimated using Ordinary Least Squares (OLS), the Weighted Least Squares (WLS) is employed in wheat model to eliminate correlation in error terms. Consumption variable is not significant in rice model and omitted from the model. Production variable is dropped from corn model due to weak significance. In corn model, a dummy variable *DM* which takes 1 in 2009 is included to modify the abnormal value in error term. The estimated results for import models are presented in Table 6.8, parameters are significant and in expected signs. High R-squared values suggest models fit the data well. Q-statistic tests failed to reject the null hypothesis of no correlation in the residuals, indicating that the serial correlations have been eliminated.

Table 6.8 Estimated results of grain export models

Variable	Rice	Wheat	Corn
C	-83.780***	26.189	55.110***
	(18.330)	(52.638)	(6.074)
ln*CP*	-2.205***	-2.602***	-4.468***
	(0.356)	(0.415)	(0.701)
ln*QP*	6.507***	5.609***	--
	(1.364)	(1.551)	--
ln*QC*	--	-8.815*	-3.622***
	--	(5.186)	(0.525)
ln*ER*	3.331***	4.079***	1.627**
	(0.838)	(0.675)	(0.683)
DM	--	--	-1.411**
	--	--	(0.534)
R^2	0.87	0.78	0.91
Q(1)	0.35	0.49	0.87

Note: ***, **, * indicate 1%, 5% and 10% significant levels, respectively; C, the constant; values in parentheses are standard errors.

6.4 Price Linkages

6.4.1 Price Linkages for Subsidy Policy

As discussed in Chapter 5, Grain producer price is generally specified as a function of grain production costs, grain subsidies and a dummy variable *D*04 with a value of 1 for 2004 is included to compensate for the sharp increases in grain prices of the year due to the implementation of grain minimum purchasing price policy. The function is written as:

$$P_{it} = f(CO_{it}, S_{it}, D04, e_t)$$

where *P*: Grain producer price;

CO: Grain production costs;

S: Total amount of agricultural subsidies;

*D*04: Dummy variable with 1 in 2004;

i: Rice, wheat and corn, respectively;

t: Study period from 1990 to 2010 for wheat and corn, 1995 to 2010 for rice.

We estimated the models using Ordinary Least Squares (OLS), the dummy variable is insignificant in corn model and dropped from the model. The estimated results are shown in Table 6.9. All variables are significant at high levels. R-squared values are all above 0.9, indicate good fitness of the models. Finally, the autocorrelations in the error terms have been eliminated.

Table 6.9 Estimated results of grain producer price models

Variable	Rice	Wheat	Corn
C	0.123	1.508***	0.402
	(0.264)	(0.203)	(0.499)
ln*CO*	1.094***	0.591***	0.997***
	(0.086)	(0.063)	(0.172)
ln*S*	0.025***	0.058***	0.037**
	(0.005)	(0.003)	(0.011)
D04	0.167***	0.146***	--
	(0.024)	(0.020)	--
R^2	0.99	0.98	0.92
Q(1)	0.72	0.71	0.25

Note: ***, **, * indicate 1%, 5% and 10% significant levels, respectively; C, the constant; values in parentheses are standard errors.

6.4.2 Price Linkage for Price Support Policy

For price support policies' simulation, grain producer price is modeled as a function of minimum purchasing price.

$$P_{it} = f(MP_{it}, e)$$

where *P*: Grain producer price;

MP: Grain minimum purchasing price;

i: Rice and wheat, respectively;

t: Study period from 2004 to 2011 for rice, and 2006 to 2011 for wheat.

6.4.3 Consumer Price

Consumer price is generally modeled as a function of producer price.

$$CP_{it} = f(P_{it}, e)$$

where *CP*: Grain consumer price;

P: Grain producer price;

i: Rice, wheat and corn, respectively;

t: Study period from 1990 to 2010 for wheat and corn, 1995 to 2010 for rice.

6.5 Market Clearance

Ending stocks are a residual of total supply minus total demand, we moved grain consumption and grain export to the right side, and the clearance function becomes as follow:

$$QP_{it} + QI_{it} + QS_{it-1} = QC_{it} + QE_{it} + QS_{it}$$

where *QP*: Grain production;

QI: Grain import;

QC: Grain consumption;

QE: Grain export;

QS: Grain ending stocks;

i: Rice, wheat and corn, respectively;

t: Year from 1990 to 2011.

CHAPTER 7 SIMUNATIONS ON CHINA'S GRAIN SUPPLY AND DEMAND

7.1 Scenarios Setting for Policy Simulation

In order to analyze the effects of agricultural policies on grain supply and demand, we define three scenarios for simulations to compare with the baseline scenario. In scenario one, a 10% increase in total subsidies and minimum purchasing prices is assumed to be added in the actual values of 2010, the purpose of this scenario is to analyze the dynamic effects of current year's policy on the grain supply and demand of both the current year and the next year, and moreover, the elasticities can be obtained diving the coefficients by 10.

Table 7.1 Shock scenarios for subsidies and minimum purchasing price policies

Scenario	*2010*	*2011*	*Note*
One	+10%	--	Percentage change
Two	+5%	+10%	Percentage change
Three	+5	+10	Quantity change

Note: Changes are assumed to added to the actual values of subsidy amounts and minimum prices in 2010 and 2011.

In scenario two, we suppose the value of subsidies and minimum purchasing prices increase 5% and 10% in the actual values in 2010 and 2011, respectively, seeking to simulate impacts of the annual increasing subsidy amounts and minimum price on grain market; in scenario three, we assume the values are added 5 unit and 10 unit to the actual values in 2010 and 2011, respectively, which aims to examine how much will a quantity change in policies influence grain prices, production, consumption, import and export. The simulated strategies of quantity change or percentage change in these agricultural policies are shown in Table 7.1.

7.2 Simulations for Agricultural Subsidy Policy

7.2.1 Simulation Results for Rice Supply and Demand

Rice Price

For scenario one which simulates a 10% increase only in the value of total agricultural subsidies in 2010, rice prices in 2010 increase by 0.23%, an increase of 0.11 yuan/50kg to the baseline of 2010, while the price in 2011 does not show changes, indicating subsidy policies only can influence rice prices in the current year; in scenario two, where agricultural subsidies increase 5% in 2010 and increase 10% in 2011, rice price rise 0.06 yuan/50kg, increase by 0.12% over the actual price in 2010, in 2011 rice prices rise by 0.23%, increase 0.12 yuan/50kg; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and 10 billion yuan in 2011, then rice prices would rise by 0.24% in 2010 and 0.43% in 2011, an increase of 0.11 yuan/50kg and 0.22 yuan/50kg in 2010 and 2011, respectively. From the simulations, we know that the subsidies push up rice prices in the current years, but hardly can affect the prices in the next year. The simulation results of these three scenarios are shown in Table 7.2.

Rice Production

The subsidies show impacts on grain production both of the current year and the next year by influencing the planted areas, yield and prices. For scenario one where a 10% increase is assumed to be added in the value of total agricultural subsidies in 2010, rice production in 2010 increases by 0.05%, an increase of 70.7 thousand tons to the baseline of 2010, while production in 2011 rises by 0.07%, an increase of 92.1 thousand tons, suggesting subsidy policies show larger influence on rice production in the next year than that of the current year; in scenario two, where agricultural subsidies increase 5% in 2010 and increase 10% in 2011, rice production rise 36.2 thousand tons, increase by 0.03% over actual production in 2010, in 2011 rice production rise by 0.09%, increase 119.5 thousand tons; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and 10 billion yuan in 2011, then rice production would rise by 0.05% in 2010 and 0.16% in 2011, an increase of 71.4 thousand tons and 224.6 thousand tons in 2010 and 2011, respectively. From the simulation results, we may know that the subsidies can not only promote rice production of the current year but also can push up production in the next year, and the impact on the next year is greater than that on the current year although they are both relatively small. The simulation results of these three scenarios are reported in Table 7.2.

Rice Consumption

The subsidies show negative impacts on grain consumption by influencing grain market prices. In scenario one, a 10% increase in agricultural subsidies in 2010 reduce rice consumption 22.6 thousand tons, a reduction of 0.02% to the baseline of 2010, while consumption in 2011 does not show any change, indicating subsidy policies only can influence rice consumption of the current year and the influence is negative and small; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, rice consumption decreases 11.6 thousand tons, a cut of 0.01% over the baseline of 2010, in 2011 rice consumption is reduced by 22.8 thousand tons, a decline of 0.02% from the baseline of 2011; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then rice consumption would shrink by 22.8 thousand tons in 2010 and 41.5 thousand tons in 2011, down 0.02% and 0.03% from the baseline of 2010 and 2011, respectively. The simulation results suggest that agricultural subsidies show negative impacts on rice consumption in the current year and cannot have dynamic impact the consumption in the next year. Anyway the impact is rather small. The simulation results of these three scenarios are shown in Table 7.2.

Table 7.2 Simulation results of subsidy policies for rice (%)

Scenario	Year	Price	Prod.	Cons.	Imports	Exports	E-Stocks
One	2010	0.23	0.05	-0.02	-0.07	-0.16	0.20
		(0.11)	(70.7)	(-22.6)	(-0.33)	(-0.96)	(93.9)
	2011	0.00	0.07	0.00	-0.59	0.43	0.33
		(0.00)	(92.1)	(0.00)	(-3.13)	(2.07)	(180.8)
Two	2010	0.12	0.03	-0.01	-0.04	-0.08	0.10
		(0.06)	(36.2)	(-11.6)	(-0.17)	(-0.49)	(48.1)
	2011	0.23	0.09	-0.02	-0.37	0.05	0.34
		(0.12)	(119.5)	(-22.8)	(-1.97)	(0.26)	(188.2)
Three	2010	0.24	0.05	-0.02	-0.07	-0.16	0.20
		(0.11)	(71.4)	(-22.8)	(-0.33)	(-0.97)	(94.8)
	2011	0.43	0.16	-0.03	-0.72	0.13	0.65
		(0.22)	(224.6)	(-41.5)	(-3.82)	(0.64)	(356.5)

Source: Authors' simulation. Note: Values in parentheses are quantitative changes with a unit of thousand tons. Scenario 1, subsidies increase 10% in 2010; scenario 2, subsidies increase 5% in 2010 and 10% in 2011; scenario 3, subsidies increase 5 billion yuan in 2010 and 10 billion yuan in 2011.

Rice Imports

The subsidies increase the current year's rice imports but reduce that in the next year through channels of rice production, consumption and prices as well. In scenario one, a 10% increase in agricultural subsidies in 2010 leads to rice imports decrease 0.33

thousand tons in 2010 and decrease 3.13 thousand tons in 2011, down 0.07% and 0.59% over the baseline in 2010 and 2011, respectively; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, rice imports are reduced 0.17 thousand tons in 2010, go down 0.04% over the baseline of 2010, in 2011 rice imports are reduced by 0.37 thousand tons, a decline of 0.37% from the baseline of 2011; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then rice imports would decrease 0.33 thousand tons in 2010, down 0.07%, while this policy assuming will reduce rice imports by 3.82 thousand tons in 2011, a cut of 0.72%. The simulation results indicate that agricultural subsidies show negative impact on rice imports both in the current and the next year, but the influence on the current year's rice imports are relatively small compared to that of the next year. The simulation results of these three scenarios are shown in Table 7.2.

Rice Exports

The subsidies show negative impact on rice exports in the current year but have positive impact on the next year's exports also through channels of rice production, consumption and prices. In scenario one, a 10% increase in agricultural subsidies in 2010 leads to rice exports decrease 0.96 thousand tons, a cut of 0.16% over the baseline of 2010, and increases rice exports by 2.07 thousand tons in 2011, an increase of 0.43% from the baseline in 2011; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, rice exports get down 0.49 thousand tons in 2010 and rise 0.26 thousand tons in 2011, down 0.08% and up 0.05% over the baselines of 2010 and 2011, respectively; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then rice export would decrease

0.97 thousand tons in 2010, down 0.16%, this policy assuming will arise rice exports by 0.64 thousand tons in 2011, up 0.13% over the baseline of 2011. The simulation results indicate that agricultural subsidies show negative impact on rice exports in the current year, while show positive impact on the next year's rice exports. The simulation results of these three scenarios are shown in Table 7.2.

Rice Ending Stocks

Ending stocks are a residual to close the model, they are a residual of grain total supply (production, imports and beginning stocks) net of total demand (total domestic consumption and exports). Generally, the implementation of agricultural subsidy policy leads to an increase in grain ending stocks. In scenario one, a 10% increase in agricultural subsidies in 2010 leads to rice ending stocks increase 93.9 thousand tons and 180.8 thousand tons, increase by 0.20% and 0.33% over the baseline of 2010 and 2011, respectively; in scenario two, where agricultural subsidies are assumed to increase by 5% in 2010 and 10% in 2011, rice ending stocks go up 0.10% and 0.34% in 2010 and 2011, a net of increase of 48.1 thousand tons and 188.2 thousand tons from the baselines of 2010 and 2011, respectively. In scenario three, where 5 billion yuan and 10 billion yuan are added to the amounts of agricultural subsidies in 2010 and 2011, respectively, then rice ending stocks arise 94.8 thousand tons in 2010 and 356.5 thousand tons in 2011, an increase of 0.20% and 0.65%, respectively. The simulation results imply that agricultural subsidies may increase rice ending stocks both in the current and the next year, while the increase due to subsidies is not so large. The simulation results of these three scenarios are shown in Table 7.2.

7.2.2 Simulation Results for Wheat Supply and Demand

Wheat Price

For scenario one which simulates a 10% increase only in the value of total agricultural subsidies in 2010, wheat prices in 2010 would increase by 0.55%, an increase of 0.22 yuan/50kg to the baseline of 2010, while prices in 2011 does not show any change, indicating subsidy policies only can influence rice prices in the current year; in scenario two, where agricultural subsidies increase 5% in 2010 and increase 10% in 2011, wheat price rise 0.11 yuan/50kg, increase by 0.28% over the actual prices in 2010, in 2011 wheat prices rise by 0.55%, increase 0.23 yuan/50kg; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and 10 billion yuan in 2011, then wheat prices would rise by 0.56% in 2010 and 1.01% in 2011, an increase of 0.22 yuan/50kg and 0.41 yuan/50kg in 2010 and 2011, respectively. From the simulations, we find that the subsidies push up wheat prices in the current years, do not show influences on prices in the next year. The simulation results of these three scenarios are shown below (See Table 7.3).

Wheat Production

The subsidies show impacts on wheat production both of the current year and the next year by influencing wheat planted areas, wheat yield and wheat prices. For scenario one where a 10% increase is assumed to be added in the actual value of total agricultural subsidies in 2010, wheat production in 2010 would increase by 0.15%, an increase of 181.6 thousand tons to the baseline of 2010, while production in 2011 would rise by 0.22%, a net increase of 267.0 thousand tons, indicating subsidy policies show larger influence on wheat production of the next year than that of the current year; in scenario two, where agricultural subsidies increase 5% in 2010 and increase 10% in 2011, wheat production would rise 92.9 thousand tons, increase by 0.08% over the actual production in the baseline of 2010, in 2011 wheat production rise by 0.27%, increase 321.7 thousand tons; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and 10 billion yuan in 2011, then wheat production may increase by 0.16% in 2010 and 0.51% in 2011, an increase of 183.3 thousand tons and 606.6 thousand tons over the baseline of 2010 and 2011, respectively. From the simulations, we may know the subsidies can not only promote wheat production of the current year but also can push up the production in the next year, and the impact on the next year is greater than that on the current year although they are both relatively small. The simulation results of these three scenarios are listed in Table 7.3.

Wheat Consumption

The subsidies show negative impacts on grain consumption by influencing wheat market prices. In scenario one, a 10% increase in agricultural subsidies in 2010 would reduce wheat consumption 91.4 thousand tons, a reduction of 0.09% to the baseline of 2010, while consumption in 2011 do not show any change, indicating subsidy policies only show negative influence on wheat consumption of the current year; in scenario two, where agricultural subsidies are added by 5% to the amount in 2010 and 10% to the amount in 2011, wheat consumption would be decreased 46.9 thousand tons, a cut of 0.04% over the baseline of 2010, in 2011 wheat consumption would be reduced by 126.9 thousand tons, a decline of 0.12% from the baseline of 2011; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then wheat consumption may shrink by 92.3 thousand tons in 2010 and 229.5 thousand tons in 2011, down 0.09% and 0.21% from the baseline of 2010 and 2011, respectively. The simulation results suggest that agricultural subsidies show negative impacts on wheat consumption in the current year and cannot show dynamic impact on consumption in the next year. Anyway the impact is also rather small. The simulation results of these three scenarios are shown in Table 7.3.

Table 7.3 Simulation results of subsidy policies for wheat (%)

Scenario	Year	Price	Prod.	Cons.	Imports	Exports	E-Stocks
One	2010	0.55 (0.22)	0.15 (181.6)	-0.09 (-91.4)	1.83 (33.7)	-0.02 (-0.20)	0.46 (306.9)
	2011	0.00 (0.00)	0.22 (267.0)	0.00 (0.00)	-2.03 (-40.8)	1.26 (5.86)	0.67 (527.2)
Two	2010	0.28 (0.11)	0.08 (92.9)	-0.04 (-46.9)	0.93 (17.2)	-0.01 (-0.09)	0.24 (157.1)
	2011	0.55 (0.23)	0.27 (321.7)	-0.12 (-126.9)	0.77 (15.5)	0.88 (4.08)	0.79 (617.2)
Three	2010	0.56 (0.22)	0.16 (183.3)	-0.09 (-92.3)	1.85 (34.0)	-0.03 (-0.20)	0.47 (309.8)
	2011	1.01 (0.41)	0.51 (606.6)	-0.21 (-229.5)	1.24 (25.0)	1.69 (7.88)	1.49 (1163.0)

Source: Authors' simulation. Note: Values in parentheses are quantitative changes with a unit of thousand tons. Scenario 1, subsidies increase 10% in 2010; scenario 2, subsidies increase 5% in 2010 and 10% in 2011; scenario 3, subsidies increase 5 billion yuan in 2010 and 10 billion yuan in 2011.

Wheat Imports

The subsidies increase the current year's wheat imports but reduce that in the next year through influencing channels of wheat production, consumption and prices as well. In scenario one, a 10% increase in agricultural subsidies in 2010 leads to wheat imports increase 33.7 thousand tons in 2010 and decrease 40.8 thousand tons in 2011, up 1.83% and down 2.03 over the baseline of 2010 and 2011, respectively; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, wheat imports would raise 17.2 thousand tons in 2010, go up 0.93% over the baseline of 2010, in 2011 wheat imports are increased by 15.5 thousand tons, an increase of 0.77% from the baseline of 2011; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then wheat imports may increase 34.0 thousand tons in 2010, up 1.85%, while this policy assuming will increase wheat imports by 25.0 thousand tons in 2011, up 1.24%. The simulation results indicate that agricultural subsidies show positive impact on wheat imports in the current year, while have negative impact on the next year's imports. But in the cases of scenario two and three, the reductions due to the previous year's effect have been offset by the current year, and wheat imports still can exhibit increases in these two scenarios. The simulation results of these three scenarios are shown in Table 7.3.

Wheat Exports

The subsidies show negative impacts on wheat exports of the current year but have positive impacts on the next year's exports also through channels of wheat production, consumption and prices. In scenario one, a 10% increase in agricultural subsidies in 2010 results in wheat exports decrease 0.2 thousand tons in 2010, a decline of 0.02% over the baseline of 2010, and wheat exports increase by 1.26% in 2011, an increase of 5.86 thousand tons from the baseline of 2011; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, wheat exports would get down 0.09 thousand tons in 2010 and go up 4.08 thousand tons in 2011, down 0.01% and up 0.88% over the baselines of 2010 and 2011, respectively; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then wheat export may decrease 0.2 thousand tons in 2010, down 0.03%, and this policy assuming would arise wheat exports by 7.88 thousand tons in 2011, go up 1.69% over the baseline of 2011. The simulation results indicate that agricultural subsidies show negative impact on wheat exports in the current year, while show positive impact on the next year's wheat exports. The simulation results of these three scenarios are shown in Table 7.3.

Wheat Ending Stocks

Agricultural subsidies may add wheat ending stocks both in the current and the next year. In scenario one, a 10% increase in agricultural subsidies in 2010 would result in wheat ending stocks increase 306.9 thousand tons and 527.2 thousand tons, up 0.46% and 0.67% over the baseline of 2010 and 2011, respectively; in scenario two, where agricultural subsidies are assumed to increase by 5% in 2010 and 10% in 2011, wheat ending stocks would go up 0.24% and 0.79% in 2010 and 2011, an increase of 157.1 thousand tons and 617.2 thousand tons from the baselines of 2010 and 2011, respectively. In scenario three, where 5 billion yuan and 10 billion yuan are added to the amounts of agricultural subsidies in 2010 and 2011, respectively, then wheat ending stocks would arise 309.8 thousand tons in 2010 and 1163.0 thousand tons in 2011, up 0.47% and 1.49%, respectively. The simulation results of these three scenarios are shown in Table 7.3.

7.2.3 Simulation Results for Corn Supply and Demand

Corn Price

In scenario one which simulates a 10% increase only in the value of total agricultural subsidies in 2010, corn prices in 2010 may increase by 0.36%, an increase of

0.13 yuan/50kg to the baseline of 2010, while prices in 2011 does not show any change, indicating subsidy policies only can influence corn prices in the current year; in scenario two, where the amount of agricultural subsidies increase 5% in 2010 and increase 10% in 2011, corn prices would rise by 0.18%, an increase of 0.07 yuan/50kg over the actual price in 2010, in 2011 corn prices may increase 0.15 yuan/50kg, rise by 0.36%, the same as that in scenario one; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and 10 billion yuan in 2011, then corn prices would rise by 0.36% in 2010 and 0.65% in 2011, an increase of 0.13 yuan/50kg and 0.27 yuan/50kg in 2010 and 2011, respectively. From the simulations, the subsidies push up corn prices in the current years, do not show influence on corn prices of the next year. The simulation results of these three scenarios are shown below (See Table 7.4).

Corn Production

The subsidies show impacts on corn production both of the current year and the next year by influencing corn planted areas, yield and prices. For scenario one where a 10% increase is assumed to be added in the value of total agricultural subsidies in 2010, corn production in 2010 would increase by 0.18%, an increase of 321.7 thousand tons to the baseline of 2010, production in 2011 would rise by 0.15%, an increase of 278.2 thousand tons, indicating subsidies show a little bit larger influence on corn production in the current year than that of the next year, which is different from the cases of rice and wheat; in scenario two, where agricultural subsidies increase 5% in 2010 and increase 10% in 2011, corn production rise 164.6 thousand tons, increasing by 0.09% over the actual production in 2010, in 2011 corn production rises by 0.26%, increasing 480.6 thousand tons; in scenario three, where agricultural subsidies are assumed to be added by 5 billion yuan in 2010 and

10 billion yuan in 2011, then corn production may increase by 0.18% in 2010 and 0.48% in 2011, an increase of 324.8 thousand tons and 896.3 thousand tons over the baseline of 2010 and 2011, respectively. From the simulations, we may know the subsidies can not only promote corn production of the current year but also can push up the production in the next year, and the impact on the current year's production is a little bit larger than that on the next year. The simulation results of these three scenarios are shown below (Table 7.4).

Corn Consumption

The same as rice and wheat, subsidies may show negative impact on corn consumption by increasing corn market prices. In scenario one, a 10% increase in the amount of agricultural subsidies in 2010 would reduce corn consumption by 229.2 thousand tons, a reduction of 0.14% to the baseline of 2010, while consumption in 2011 do not show any change, indicating subsidy policies only show influence on corn consumption of the current year; in scenario two, where agricultural subsidies are supposed to increase by 5% in 2010 and 10% in 2011, corn consumption may decrease 117.4 thousand tons and 258.3 thousand tons, a cut of 0.07% and 0.14% over the baseline of 2010 and 2011, respectively; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of the agricultural subsidies in 2010 and 2011, respectively, then corn consumption may shrink by 231.4 thousand tons in 2010 and 468.9 thousand tons in 2011, down 0.14% and 0.26%, respectively. The simulation results suggest that agricultural subsidies show negative impact on corn consumption in the current year and hardly can show dynamic impact on consumption in the next year. From the simulation results the impact is very small. The simulation results of these three scenarios are shown in Table 7.4.

Table 7.4 Simulation results of subsidy policies for corn (%)

Scenario	Year	Price	Prod.	Cons.	Imports	Exports	E-Stocks
One	2010	0.36 (0.13)	0.18 (321.7)	-0.14 (-229.2)	-1.70 (-8.00)	-0.87 (-3.26)	0.85 (546.2)
	2011	0.00 (0.00)	0.15 (278.2)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	1.11 (824.4)
Two	2010	0.18 (0.07)	0.09 (164.6)	-0.07 (-117.4)	-0.87 (-4.1)	-0.45 (-1.67)	0.43 (279.6)
	2011	0.36 (0.15)	0.26 (480.6)	-0.14 (-258.3)	-1.72 (-49.2)	-0.86 (-1.32)	1.31 (970.6)
Three	2010	0.36 (0.13)	0.18 (324.8)	-0.14 (-231.4)	-1.72 (-8.1)	-0.88 (-3.29)	0.86 (551.5)
	2011	0.65 (0.27)	0.48 (896.3)	-0.26 (-468.9)	-3.10 (-88.7)	-1.57 (-2.39)	2.46 (1830.5)

Source: Authors' simulation. Note: Values in parentheses are quantitative changes with a unit of thousand tons. Scenario 1, subsidies increase 10% in 2010; scenario 2, subsidies increase 5% in 2010 and 10% in 2011; scenario 3, subsidies increase 5 billion yuan in 2010 and 10 billion yuan in 2011.

Corn Imports

The subsidies reduce the current year's corn imports through influencing channels of corn production, consumption and prices as well. But they hardly can influence the corn imports of the next year. In scenario one, a 10% increase in agricultural subsidies in 2010 leads to corn imports decrease 8.0 thousand tons in 2010, down 1.7% over the baseline in 2010; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, corn imports would decrease 4.1 thousand tons in 2010, go down 0.87% over the baseline of 2010, in 2011 corn imports may decrease by 49.2 thousand tons, an decline of 1.72% from the baseline of 2011; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then corn imports would be reduced 8.1 thousand tons and 88.7 thousand tons in 2010 and 2011, down 1.72% and 3.10%, respectively. The simulation results indicate that agricultural subsidies show negative impact on corn imports in the current year. Note that it is different from the cases of rice and wheat, subsidies have no influence on corn imports in the next year. The simulation results of these three scenarios are shown in Table 7.4.

Corn Exports

As the same with corn imports, subsidies also show negative impact on corn exports of the current year through channels of corn production, consumption and prices. In scenario one, a 10% increase in agricultural subsidies in 2010 would result in corn exports decrease 3.26 thousand tons in 2010, a decline of 0.87% over the baseline of 2010; in scenario two, where agricultural subsidies are added by 5% in 2010 and 10% in 2011, corn exports would get down 1.67 thousand tons in 2010 and 1.32 thousand tons in 2011, down 0.45% and 0.86% over the baselines of 2010 and 2011, respectively; in scenario three, where 5 billion yuan and 10 billion yuan are assumed to add to the amounts of agricultural subsidies in 2010 and 2011, respectively, then corn exports may decrease 3.29 thousand tons in 2010, down 0.88% from the baseline of 2010, and this policy assuming would reduce corn exports by 2.39 thousand tons in 2011, down 1.57% over the baseline of 2011. According to the simulation results, agricultural subsidies only can show negative influence on the current year's corn exports, which is different from rice and wheat. The simulation results of these three scenarios are shown in Table 7.4.

Corn Ending Stocks

Agricultural subsidies also can add corn ending stocks both in the current and the next year. In scenario one, a 10% increase in agricultural subsidies in 2010 would result in corn ending stocks increase 546.2 thousand tons in 2010 and 824.4 thousand tons in 2011, up 0.85% and 1.11%, respectively; in scenario two, where agricultural subsidies are assumed to increase by 5% in 2010 and 10% in 2011, corn ending stocks may go up 0.43% and 1.31% in 2010 and 2011, an increase of 279.6 thousand tons and 970.6 thousand tons from the baselines of 2010 and 2011, respectively; in scenario three, where 5 billion yuan and 10 billion yuan are added to the amounts of agricultural subsidies in 2010 and 2011, respectively, then corn ending stocks may arise 551.5 thousand tons in 2010 and 1830.5 thousand tons in 2011, up 0.86% and 2.46% over the baseline of 2010 and 2011, respectively. The impact on the next year's ending stocks is bigger than that of the current year. The simulation results of these three scenarios are shown in Table 7.4.

7.3 Simulations for Grain Minimum Purchasing Price Policies

7.3.1 Simulation Results for Rice Supply and Demand

Rice Price

Rice minimum purchasing prices can sustain rice market prices. For scenario one which simulates a 10% increase only in the value of rice minimum purchasing price in 2010, rice prices in 2010 would increase by 10.4%, an increase of 4.76 yuan/50kg to the baseline of 2010; in scenario two, where rice minimum price increase 5% in 2010 and increase 10% in 2011, rice price would rise 2.38 yuan/50kg, increasing by 5.24% over the actual prices in 2010, and would rise by 10.4%, increasing 5.27 yuan/50kg to the actual prices in 2011; in scenario three, where rice minimum price are assumed to be enhanced by 5 yuan/50kg in 2010 and 10 yuan/50kg in 2011, then rice prices would rise 5.9 yuan/50kg and 11.8 yuan/50kg, an increase of 12.9% and 23.4% over the baseline of 2010 and 2011, respectively. From the simulation results, we know that the rice minimum purchasing price policy can show strong influences on the current year's rice prices. The simulation results of these three scenarios are shown in Table 7.5.

Rice Production

The rice minimum purchasing price may promote rice production in the next year by influencing rice prices. For scenario one where a 10% increase is assumed to enhance in the actual rice minimum price in 2010, leading to rice production in 2011 increase by 1.07%, an increase of 1511.1 thousand tons to the baseline of 2011; in scenario two, the increase is half of scenario one, the increase is 771.5 thousand tons, up 0.55% from the baseline of 2011; in scenario three, where rice minimum price is supposed to increase 5 yuan/50kg in 2010, this may result in rice production increases 1847.8 thousand tons, up 1.31% over the baseline of 2011. The simulations suggest rice minimum purchasing price policy promotes the next year's rice production, but it hardly can show impact on the current year's rice production. The simulation results of these three scenarios are reported in Table 7.5.

Rice Consumption

The rice minimum purchasing price policy may reduce rice consumption in the current year through the channel of rice market prices. In scenario one, a 10% increase in the actual rice minimum price in 2010 would result in rice consumption decreases 949.0 thousand tons in 2010, a reduction of 0.72% over the baseline of 2010, while the consumption in 2011 does not show any change, indicating rice minimum purchasing price policy only can show negative influence on rice consumption of the current year; in scenario two, where rice minimum purchasing prices are assumed to increase by 5% in

2010 and 10% in 2011, rice consumption decreases 488.7 thousand tons, a cut of 0.37% over the baseline of 2010, in 2011 rice consumption would be reduced by 958.6 thousand tons, a decline of 0.72% from the baseline of 2011; in scenario three, where rice minimum purchasing prices are supposed to rise 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, then rice consumption may shrink by 1156.0 thousand tons in 2010 and 2004.6 thousand tons in 2011, down 0.88% and 1.51% from the baseline of 2010 and 2011, respectively. The simulation results suggest that rice minimum purchasing price policy shows negative impact on rice consumption in the current year, but cannot have dynamic impact on consumption in the next year. The simulation results of these three scenarios are reported in Table 7.5.

Table 7.5 Simulation results of rice minimum purchasing price policy (%)

Scenario	Year	Price	Prod.	Cons.	Imports	Exports	E-Stocks
One	2010	10.4 (4.76)	0.00 (0.00)	-0.72 (-949.0)	18.1 (81.3)	-18.9 (-118.7)	2.48 (1148.9)
	2011	0.00 (0.00)	1.07 (1511.1)	0.00 (0.00)	-9.2 (-49.1)	7.2 (35.4)	4.76 (2575.4)
Two	2010	5.2 (2.38)	0.00 (0.00)	-0.37 (-488.7)	8.9 (39.9)	-10.2 (-63.8)	1.28 (592.4)
	2011	10.4 (5.27)	0.55 (771.5)	-0.72 (-958.6)	12.4 (66.4)	-16.0 (-78.7)	4.56 (2467.5)
Three	2010	12.9 (5.9)	0.00 (0.00)	-0.88 (-1156.0)	22.5 (101.3)	-22.6 (-141.7)	3.0 (1399.0)
	2011	23.4 (11.8)	1.31 (1847.8)	-1.51 (-2004.6)	26.7 (142.4)	-30.2 (-148.7)	10.2 (5542.4)

Source: Authors' simulation. Note: Values in parentheses are quantitative changes with a unit of thousand tons. Scenario 1, minimum price increases 10% in 2010; scenario 2, minimum price increases 5% in 2010 and 10% in 2011; scenario 3, minimum price increases 5 yuan/50kg in 2010 and 10 yuan/50kg in 2011.

Rice Imports

The rice minimum purchasing price policy shows positive impact on the current year's rice imports but negative impact on exports in the next year through channels of rice production, consumption and prices as well. In scenario one, a 10% increase in the rice minimum price in 2010 would lead to rice imports increase 81.3 thousand tons in 2010 and decrease 49.1 thousand tons in 2011, up 18.1% and down 9.2% over the baseline of 2010 and 2011, respectively; in scenario two, where rice minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, rice imports would raise 39.9 thousand tons in 2010, go up 8.9% over the baseline of 2010, in 2011 rice imports are increased by 66.4 thousand tons, an increase of 12.4% from the baseline of 2011; in scenario three, where rice minimum purchasing prices are supposed to be enhanced by 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, then rice imports may increase 101.3 thousand tons in 2010, up 22.5%, and may increase 142.4 thousand tons in 2011, up 26.7%. The simulation results indicate that rice minimum purchasing price policy increase rice imports in the current year, but reduce that of the next year. In the cases of scenario two and three, the reductions due to the previous year's effect have been offset by the policy effect from the current year, so rice imports always can exhibit increases in these two scenarios. The simulation results of these three scenarios are listed in Table 7.5.

Rice Exports

The rice minimum purchasing price policy can reduce rice exports of the current year and increase that of the next year also through channels of rice production, rice consumption and rice prices. In scenario one, a 10% increase in the rice minimum price in 2010 would result in rice exports decrease 118.7 thousand tons in 2010, a decline of 18.9% over the baseline of 2010, and increase rice exports by 7.2% in 2011, an increase of 35.4 thousand tons from the baseline in 2011; in scenario two, where rice minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, rice exports get down 63.8 thousand tons in 2010 and 78.7 thousand tons in 2011, down 10.2% and 16.0% over the baseline of 2010 and 2011, respectively; in scenario three, where rice minimum purchasing prices are supposed to be enhanced 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, these policy assuming may reduce rice exports by 141.7 thousand tons in 2010 and 148.7 thousand tons in 2011, down 22.6% and 30.2% from the baseline of 2010 and 2011, respectively. The simulation results indicate that agricultural subsidies show negative impact on rice exports in the current year, but show positive impact on that of the next year. In the cases of scenario two and three, the increases due to the previous year's policy effect have been offset by the next year's effect, therefore rice exports still witness decreases in 2011. The simulation results of these three scenarios are reported in Table 7.5.

Rice Ending Stocks

Like agricultural subsidy policies, rice minimum purchasing price policy may add rice ending stocks as well. In scenario one, a 10% increase in the rice minimum price in 2010 would increase rice ending stocks in 2010 by 2.48%, an increase of 1148.9 thousand tons, and increase rice ending stocks in 2011 by 4.76%, an increase of 2575.4 thousand tons, the impact on the next year's ending stocks is nearly two times that on the current year; in scenario two, where rice minimum purchasing price are assumed to increase by 5% in 2010 and 10% in 2011, rice ending stocks would go up 1.28% and 4.56% in 2010 and 2011, an increase of 592.4 thousand tons and 2467.5 thousand tons from the baseline of 2010 and 2011, respectively; in scenario three, where rice minimum purchasing prices are supposed to rise 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, then rice ending stocks would raise 1399.0 thousand tons in 2010 and 5542.4 thousand tons in 2011, up 3.0% and 10.2% over the baseline of 2010 and 2011, respectively. The simulation results of these three scenarios are shown in Table 7.5.

7.3.2 Simulation results for wheat supply and demand

Wheat Price

In scenario one which simulates a 10% increase only in wheat minimum price in 2010, rice prices in 2010 would increase by 11.6%, an increase of 4.53 yuan/50kg over the baseline of 2010; in scenario two, where wheat minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, wheat price may rise 2.26 yuan/50kg, increase by 5.8% over the actual price in 2010, in 2011 rice price may rise by 11.6%, an increase of 4.62 yuan/50kg over the baseline of 2011; in scenario three, where wheat minimum purchasing prices are supposed to enhance 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, then wheat prices would rise by 16.5% in 2010 and 32.8% in 2011, an increase of 6.4 yuan/50kg and 13.0 yuan/50kg from the baseline of 2010 and 2011, respectively. From the simulations, we may know that the wheat minimum purchasing price policy pushes up wheat prices in the current years, and cannot show influence on prices in the next year. The simulation results of these three scenarios are shown in Table 7.6.

Wheat Production

The wheat minimum purchasing price may promote wheat production in the next year by influencing wheat prices. For scenario one where a 10% increase is assumed to be enhanced in the actual wheat minimum price in 2010, this may result in wheat production in 2011 increase by 2.45%, an increase of 2925.0 thousand tons to the baseline of 2011; in scenario two, a 5% increase in wheat minimum purchasing price in 2010 may lead to wheat production in 2011 rises 14488.5 thousand tons, up 1.25% over the baseline; in scenario three, where wheat minimum price is supposed to increase 5 yuan/50kg in 2010, this may result in wheat production increases 4089.1 thousand tons, up 3.43% over the baseline of 2011. The simulations suggest wheat minimum purchasing price policy stimulates the next year's wheat production, but not that of the current year. The simulation results of these three scenarios are reported in Table 7.6.

Wheat Consumption

The wheat minimum purchasing price policy can reduce wheat consumption of the current year by affecting wheat market prices. In scenario one, a 10% increase in wheat minimum purchasing price in 2010 would reduce wheat consumption by 1.59%, a reduction of 1671.5 thousand tons to the baseline of 2010; in scenario two, where wheat minimum purchasing prices are supposed to increase 5% in 2010 and 10% in 2011, it may reduce wheat consumption by 0.86% in 2010 and by 2.19% in 2010, a decline of 901.4 thousand tons and 2399.3 thousand tons from the baseline of 2010 and 2011, respectively; in scenario three, where wheat minimum purchasing prices are assumed to raise 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, then wheat consumption would shrink by 2232.0 thousand tons in 2010 and 5263.7 thousand tons in 2011, down 2.1% and 4.8% from the baseline of 2010 and 2011, respectively. The simulation results suggest that wheat minimum purchasing price policy shows negative impacts on wheat consumption in the current year and cannot have dynamic impact on wheat consumption in the next year. The simulation results of these three scenarios are shown in Table 7.6.

Wheat Imports

The wheat minimum purchasing price policy has positive impact on the current year's wheat imports but negative impact on that of the next year through channels of production, consumption and prices of wheat. In scenario one, a 10% increase in wheat minimum purchasing price in 2010 may increase wheat imports 1577.8 thousand tons in 2010 and decrease 351.9 thousand tons in 2011, up 90.4% and down 19.9% over the baseline in 2010 and 2011, respectively; in scenario two, where wheat minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, wheat imports would raise 681.53 thousand tons in 2010, go up 39.17% over the baseline of 2010, wheat imports would be increased by 1234.9 thousand tons in 2011, a jump of 69.9% from the baseline of 2011; in scenario three, where wheat minimum purchasing prices are supposed to rise 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, then this policy assuming would increase wheat imports by 2530.3 thousand tons in 2010 and 5061.7 thousand tons in 2011, up 145.0% and 286.7% from the baseline of 2010 and 2011, respectively. The simulation results indicate that wheat minimum purchasing price policy show positive impact on wheat imports in the current year, but negative impact on imports in the next year. For the cases of scenario two and three, the reduction due to the previous policy effect has been offset by the current year's policy effect, and they still can exhibit increase in 2011. The simulation results of these three scenarios are shown in Table 7.6.

Table 7.6 Simulation results of wheat minimum purchasing price policy (%)

Scenario	Year	Price	Prod.	Cons.	Imports	Exports	E-Stocks
One	2010	11.6	0.00	-1.59	90.4	-17.2	5.14
		(4.53)	(0.00)	(-1671.5)	(1577.8)	(-140.4)	(3389.7)
	2011	0.00	2.45	0.00	-19.9	14.6	7.67
		(0.00)	(2925.0)	(0.00)	(-351.9)	(68.8)	(5894.0)
Two	2010	5.80	0.00	-0.86	39.1	-8.90	2.51
		(2.26)	(0.00)	(-901.4)	(681.5)	(-72.5)	(1655.5)
	2011	11.6	1.25	-2.19	69.9	-6.38	8.86
		(4.62)	(1488.5)	(-2399.3)	(1234.9)	(-30.2)	(6808.4)
Three	2010	16.5	0.00	-2.13	145.0	-23.7	7.5
		(6.4)	(0.0)	(-2232.0)	(2530.3)	(-193.1)	(4955.0)
	2011	32.8	3.43	-4.80	286.7	-20.6	25.3
		(13.0)	(4089.1)	(-5263.7)	(5061.7)	(-97.2)	(19467.0)

Source: Authors' simulation. Note: Values in parentheses are quantitative changes with a unit of thousand tons. Scenario 1, minimum price increases 10% in 2010; scenario 2, minimum price increases 5% in 2010 and 10% in 2011; scenario 3, minimum price increases 5 yuan/50kg in 2010 and 10 yuan/50kg in 2011.

Wheat Exports

The wheat minimum purchasing price policy has negative impact on the current year's wheat exports but positive impact on that of the next year through channels of production, consumption and prices of wheat. In scenario one, a 10% increase in wheat minimum purchasing price in 2010 would lead to wheat exports decrease 140.4 thousand tons in 2010, a decline of 17.2% over the baseline of 2010, and would increase wheat exports by 68.8 thousand tons in 2011, an increase of 14.6% from the baseline in 2011; in scenario two, where wheat minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, wheat exports may get down 72.5 thousand tons in 2010 and 30.2 thousand tons in 2011, down 8.9% and 6.4% over the baseline of 2010 and 2011, respectively; in scenario three, where wheat minimum purchasing prices are supposed to increase 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, then wheat exports would decrease 193.1 thousand tons in 2010, down 23.7%, this policy assuming would reduce wheat exports by 97.2 thousand tons in 2011, down 20.6% over the baseline of 2011. The simulation results indicate that wheat minimum purchasing price policy shows negative impact on wheat exports in the current year, but positive impact on the next year's wheat exports. For the cases of scenario two and three, the increase due to the previous policy effect has been offset by the effect from the current year's policy, and they still can exhibit decline in 2011 in the simulations. The simulation results of these three scenarios are shown in Table 7.6.

Wheat Ending Stocks

Wheat ending stocks are a residual of wheat total supply (production, imports and beginning stocks) net of total demand (total domestic consumption and exports). Generally, the implementation of wheat minimum purchasing price policy leads to an increase in wheat ending stocks both in the current and the next year and the impact on the next year's wheat ending stocks is bigger than that of the current year. In scenario one, a 10% increase in wheat minimum purchasing price in 2010 would increase wheat ending stocks by 3389.7 thousand tons in 2010 and 5894.0 thousand tons in 2011, increasing by 5.1% and 7.7% over the baseline of 2010 and 2011, respectively; in scenario two, where wheat minimum purchasing prices are assumed to increase by 5% in 2010 and 10% in 2011, wheat ending stocks would go up 2.5% in 2010 and 8.9% in 2010, an increase of 1655.5 thousand tons and 6808.4 thousand tons from the baseline of 2010 and 2011, respectively; in scenario three, where wheat minimum purchasing prices are supposed to rise 5 yuan/50kg and 10 yuan/50kg over the actual minimum prices in 2010 and 2011, respectively, this would increase wheat ending stocks in 2010 by 4955.0 thousand tons in 2010 and 19467.0

thousand tons in 2011, an increase of 7.5% and 25.3% from the baseline of 2010 and 2011, respectively. The simulation results of these three scenarios are shown in Table 7.6.

7.4 Elasticities to Agricultural Policies

In scenario one, the other aim of assuming agricultural policies to increase by 10% is to obtain the elasticities of each item of grains with respect to the agricultural policies dividing each change parameter by 10. These elasticities are reported in Table 7.7. Note that we also report the elasticities of grain price with respect to the agricultural policies in the previous year.

Grain prices are only sensitive to the current year's policies, price elasticities with respect to agricultural subsidies are 0.023, 0.055 and 0.036 for rice, wheat and corn, respectively; price elasticities with respect to grain minimum purchasing price policy are 1.040 and 1.160 for rice and wheat, respectively; the elasticities of grain production with respect to the last year's agricultural subsidies are relatively small at 0.007, 0.022 and 0.015 for rice, wheat and corn, respectively, to the current year's subsidies are even smaller at 0.005, 0.015 and 0.018 for rice, wheat and corn, respectively; grain production only responses to the last year's grain minimum purchasing price policy, the elasticities are 0.107 and 0.245 for rice and wheat, respectively; grain consumption only responses to the current year's agricultural subsidies and minimum purchasing prices, the elasticities of grain consumption with respect to current year's subsidies are rather small at -0.002, -0.009 and -0.014 for rice, wheat and corn, respectively, even lower than that of grain production, indicating that subsidies show very limited impacts on grain consumption, the consumption elasticities to minimum purchasing prices are relatively high at -0.072, and -0.159 for rice and wheat, respectively.

Table 7.7 Elasticities to agricultural policies for price, marketing and stocks

Policy	Price	Production	Consumption	Imports	Exports	E-Stocks
			Rice			
SU_{t-1}	0.000	0.007	0.000	-0.059	0.043	0.033
SU_t	0.023	0.005	-0.002	-0.007	-0.016	0.020
MP_{t-1}	0.000	0.107	0.000	-0.920	0.720	0.476
MP_t	1.040	0.000	-0.072	1.810	-1.890	0.248
			Wheat			
SU_{t-1}	0.000	0.022	0.000	-0.203	0.126	0.067
SU_t	0.055	0.015	-0.009	0.183	-0.002	0.046
MP_{t-1}	0.000	0.245	0.000	-1.990	1.460	0.767
MP_t	1.160	0.000	-0.159	9.040	-1.720	0.514
			Corn			
SU_{t-1}	0.000	0.015	0.000	0.000	0.000	0.111
SU_t	0.036	0.018	-0.014	-0.170	-0.087	0.085

Source: Authors' estimation. Note: *SU*, agricultural policies; *MP*, Minimum purchasing price policy; *t*, current year; *t-1*, previous year.

For grain imports, the elasticities to the last year's agricultural policies are negative, but positive to the current year's policies. To the last year's subsidies, the elasticities are -0.059 and -0.203 for rice, wheat, respectively; to the current year's subsidies, they are -0.007, 0.183 and -0.170 for rice, wheat and corn, respectively; to the last year's minimum purchasing prices, the elasticities are -0.920 and -1.990 for rice and wheat, respectively, to the current year's minimum purchasing prices, they are 1.810 and 9.040 for rice and wheat, respectively. From these elasticities, we can know that grain minimum purchasing price policies play more powerful impacts on grain imports than the subsidy policies.

For grain exports, the policies show adverse effects on grain exports. The last year's policies increase grain exports, but the current year's policies reduce grain exports. The export elasticities to the last year's agricultural subsidies are 0.043 and 0.126 for rice and wheat, respectively; to the current year's subsidies, the elasticities are -0.016, -0.002 and -0.087 for rice, wheat and corn, respectively; the export elasticities to the last year's minimum purchasing prices are 0.720 and 1.460 for rice and wheat, respectively; to the current year's minimum purchasing prices, they are more higher at -1.890 and -1720 for rice and wheat, respectively. Grain exports are elastic to grain price support policy, while inelastic to agricultural subsidy policies.

For grain ending stocks, the elasticities with respect to the agricultural policies both in the last and the current years are positive. The elasticities of ending stocks to last year's subsidies are 0.033, 0.067 and 0.111 for rice, wheat and corn, respectively; to the subsidies in the current year, they are 0.020, 0.046 and 0.085 for rice, wheat and corn, respectively; these elasticities are mall, suggesting that grain ending stocks are inelastic to agricultural subsidies. The elasticities of grain ending stocks with respect to grain minimum purchasing prices in the last year are 0.476 and 0.767 for rice and wheat, respectively, and to the current year's minimum purchasing prices, they are 0.248 and 0.514 for rice and wheat, respectively. Grain ending stocks are more sensitive to grain price support policy than subsidy policies, the elasticities to the subsidies are rather small, the elasticities to grain price support policies are also inelastic although they much larger than that of subsidies.

CHAPTER 8 CONCLUSIONS AND POLICY IMPLICATIONS

8.1 Conclusions

In this entire study, grain supply response to agricultural subsidies, the effect of subsidies on grain prices, effect of grain minimum purchasing price policies on grain prices, and new changes in China's grain consumption pattern are discussed. Based on these researches, we constructed a partial equilibrium model of China's grain supply and demand and used this model to simulate the impacts of main agricultural policies on grain prices, production, consumption, import, export and ending stocks. The main findings are summarized in each section below.

8.1.1 Agricultural Supply Response to Agricultural subsidies

Yield Response

China experienced remarkable growth in yields of principal cereal grains. Grain yields are closely related to yields in the previous year. Grain prices in the previous year and agricultural subsidy policy affect grain yields. Yield elasticities with respect to price in the previous year are 0.038, 0.119, and 0.054 for rice, wheat and corn, respectively. Yield elasticities with respect to the amount of agricultural subsidies are 0.001, 0.007, and 0.011, respectively for rice, wheat and corn. Grain prices in the previous year shows positive impact on grain yield, therefore, price support policies can promote grain yield to increase. Yields respond more sensitively to price than to subsidies. Given the dramatic increase in the amount of subsidies, we find that the subsidies also significantly contribute to a rise in grain yield.

Area Response

China's grain planted areas had witnessed decreases since the middle 1990s. Since 2003 the Chinese government has employed agricultural subsidy policies to encourage farmers to enlarge grain planted areas. After the implementation of these policies, the decrease trend has stopped, and grain planted areas have appeared modest growth. Grain planted areas are closely related to areas in the previous year. Grain prices in the previous year and agricultural subsidy policy have positive influences on grain yields. Areas elasticities with respect to price in the previous year are 0.070, 0.128 and 0.093 for rice, wheat and corn. Areas elasticities with respect to the amount of total agricultural subsidies are 0.004, 0.012, and 0.008, respectively for rice, wheat and corn. Considering the dramatic increase in the amount of subsidies, the subsidies also significantly contribute to a rise in grain planted areas although the area elasticities to subsidies are small. Grain planted areas respond more sensitively to price than to subsidies. Grain prices in the previous year contribute to an increase in grain planted areas. Thus, price support policies can promote grain planted areas to increase.

8.1.2 Total Agricultural Subsidies and Grain Prices

In Chapter 5, we discussed the relationship between total agricultural subsidies and grain prices and examined the impact of the subsidies on rice price using cointegration techniques and error correction model. A relationship between rice price and total agricultural subsidies has been observed. From the estimated results, the parameter of subsidy variable is positive and statistically significant, implying that total subsidies contribute to the increase in rice price in recent years in China. The elasticity of rice price to total subsidies in the long is 0.025, in the short run is 0.058. Rice price adjusts towards to the long run equilibrium levels at a rapid speed, with 83.1% of the adjustment occurring within the first year.

The Chinese government provides a large amount of subsidies for agricultural development. Those subsidies show positive impact, rather than negative impact on grain prices in recent years, although the impact is relatively small with respect to the sharp increase in the amount of subsidies.

8.1.3 Effect of Grain Price Support Policy

In chapter 5, we described the implementation of grain minimum purchasing price policy in China and measured how significant this policy factor is among the factors influencing grain prices employing the Grey Relational Analysis. The empirical results suggest that grain minimum purchasing price is a major factor influencing grain market prices, and among the determinants of grain markets prices selected in our study, this price support policy plays a most significant role. This study provides convincing evidence that the grain minimum purchasing price policy impacts grain market prices effectively and the expected goals of this policy have been achieved. Grain production cost also affects grain market prices significantly, and it shows the second significant impacts on grain market prices. But international grain prices can hardly show impact on China's domestic grain prices. This is mainly because of the extensive interventions of the Chinese government in grain markets. Government's interventions lead to domestic prices diverge from world market prices. The grain production also does not show significant influences on grain market prices. Actually, in recent years grain production has exhibited the same rather than the reverse movements with grain prices due to a series of agricultural support policies.

8.1.4 Grain Consumption

In recent years, new trends have been exhibited in China's grain consumptions. Consumptions of rice and wheat, which had shown a downward trend, increase again; corn consumption grows much faster than before. The increase in the total rice consumption is mainly due to an increase in food consumption while the increase in consumption of wheat and corn is attributed to an increase in purpose for feed use. The principal factor causing these changes is high meat prices. High meat prices lead consumers to change to consume more rice and wheat and stimulate the demand for feed use of wheat and corn. Elasticities of food consumption of rice and wheat with respect to meat prices are 0.175 and 0.114, respectively. Elasticities of feed consumption of rice, wheat and corn are respectively 0.277, 2.610 and 1.170. The high meat prices in recent periods contribute to an increase in grain consumption greatly, especially for feed use. Grain prices reduce grain consumption both for food purpose and feed purpose, the price elasticities for food consumption are -0.042 for rice, price elasticities for feed consumption are -0.472, -1.730 and 0.678 for rice, wheat and corn. Income elasticities for food consumption are -0.110 and -0.131 for rice and wheat.

8.1.5 Agricultural Subsidies and Grain Supply and Demand

Agricultural subsidies can show dynamic effects on grain production, they not only can promote grain production of the current year but also can stimulate next year's grain production, and the impacts in the next year are relatively bigger than that of the current year; subsidies have negative influences on current year's grain consumption, but the influences are very tinny; for grain imports, subsidies increase current year's imports and reduce next year's imports for wheat, but in the case of rice the influences on imports are all negative both in the current and the next year; for grain exports, subsidies reduce the current year's exports and increase exports in the next year for rice and wheat. Note that corn is an exception, subsidies show negative influences both on corn imports and exports only in the current year; the subsidies would increase grain ending stocks not only in the current year but also in the next year, and the influence on the next year's ending stocks are higher than that of the current year.

Agricultural subsidy policies have influenced not only grain production, but also influenced grain prices, imports, exports and ending stocks. Note that these influences are rather small, the elasticities are less than 0.1, this indicates subsidies agricultural subsidy policies do not show significant impacts on China's grain supply and demand.

8.1.6 Grain Minimum Purchasing Price Policy and Grain Supply and Demand

Grain minimum purchasing price policy can increase the next year's grain production via influencing grain prices, the elasticities of production with respect to minimum purchasing prices are 0.107 and 0.245 for rice and wheat, respectively. Minimum purchasing price policy can only show negative influences on grain consumption in the current year, the elasticities of consumption to minimum purchasing prices are -0.072 and -0.159 for rice and wheat, respectively. Minimum purchasing price policy can show dynamic effects on grain imports and exports through channels of prices, production and consumption. It increases the current year's grain imports and reduces the next year's imports, and has adverse effects on exports, reducing the current year's exports and increasing that in the next year. The elasticities of imports and exports with respect to the current year's minimum prices are 1.810 and -1.890 for rice and 9.040 and -1.720 for wheat; to the last year's minimum prices are -0.920 and 0.720 for rice and -1.990 and 1.460

for wheat, suggesting that this price support policy shows significant impacts on grain imports and exports. Minimum purchasing price policy would add grain ending stocks both in the current year and the next year, the elasticities of ending stocks to the current year's minimum prices are 0.248 and 0.514 for rice and wheat, respectively, to the last year's minimum prices are 0.476 and 0.767, respectively.

The grain minimum purchasing price policy has influenced not only grain production, but also on grain consumption, imports, exports and ending stocks. These influences are large, especially to grain trade and ending stocks. From the elasticities, wheat seems to be more sensitive to the minimum prices than rice. Grain minimum purchasing price policy shows significant influences on China's grain supply and demand. This price support policy plays an important role in food security of the country.

8.2 Policy Implications

The findings in this research have some important implications for the Chinese government and the rest of the world.

8.2.1 Agricultural Subsidy Policies

Agricultural subsidy policies show tinny influences on grain supply and demand, a great amount of subsidies can promote grain production to increase, this implies that the effectiveness of agricultural subsidies on grain production is low and these subsidies in China do not distort agricultural marketing. Actually, the subsidies are a transfer payment to farmers, and the income effect of these subsidies might be more significant. For sustaining farmers' income level, the subsidies are still very necessary and should be continued. In order to let subsidy policies work more effectively, any improvement in policy design especially payment method of the subsidies is highly recommended.

8.2.2 Grain Minimum Purchasing Price Policy

From the simulation results, grain minimum purchasing price policy show very significant impacts on grain prices and production, and grain trade as well. The minimum purchasing price policy is a powerful policy tool for grain macro-control. Farmers also can greatly benefit from the increasing grain prices and production due to this price support policy, so continuing efforts should be made to design appropriate minimum prices for grains. The government should keep grain minimum prices increasing gradually.

Price support policy leads to sharp increases in grain imports and decreases in grain exports, forcing China to become a net grain importer. Therefore, changes in international markets may have bigger influences on China than before, so China needs to pay much attention to changes in world market. Price support policy also increases grain ending stocks. New consumption for grains should be developed to reduce the stress from balance of grain supply and demand.

8.2.3 Other Implications

(1) For regulation of grain market prices, the Chinese government has employed grain minimum purchasing price policy to sustain grain prices and protect farmers' interests. This price support policy is a most efficient tool in aiming to protect farmers from price variability and increase farmers' income and agricultural supply, continuing efforts should be made to design appropriate minimum purchasing prices for grains.

(2) The high meat prices in recent years greatly contribute to an increase in grain consumption, especially for feed use. Measures stabilizing meat prices are highly recommended to reduce the high fluctuations of grain demand in China and consequently in

the world market. Policy efforts should be made to reduce not only pork production costs but also distribution costs in the pork market; additionally, establishment of a pig futures market may help to discover price and hedge price risk in the pig market, and finally to stabilize the supply and price of pork.

8.3 Suggestions for Further Research

In this study, we evaluate the effects of main agricultural policies on grain supply responses and grain prices, further the influences on grain supply and demand. This main focus on one of the purposes of these support policies, other aspects such as effect on farmers' income and potential influence of price support policy on corn supply and demand need to be studied in the future.

(1) Effect on farmers' income. There are two main purposes of agricultural support policy, one is to promote grain production so as to ensure the food security of the country, and the other is to increase farmers' income as improve their living standard, which is a main objective that the Chinese government struggle for. In current studies, agricultural income is not mentioned, so it is highly necessary to conduct a research to examine effects of these agricultural policies on farmers' income level. Actually, the current direct subsidies are a kind of transfer payment to farmers. The effect on increasing farmers' income is more direct and significant than that on grain production recovery.

(2) Potential impacts of minimum purchasing price policy on corn supply and demand. Since 2012, corn production has historically exceeded rice production and become the first grain in China. Corn production was increased to 208 million tons, while corn consumption also grew rapidly, in 2012 corn total consumption was 207 million. According to the projections of USDA, in 2013 corn consumption will exceed production and imports

will continue to increase. Chinese corn sector is more and more depending on international markets. Thus, to ensure the security of corn sector is on the table for the Chinese government. Up until now corn is still not covered by the grain minimum purchasing price policy, in further research the potential impacts of this price support policy on corn supply and demand will be evaluated, and policy makers may refer to important implications from the further researches.

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APPENDIX

Appendix 1 Rice balance of supply and demand (thousand tons)

Year	Production	Consumption	Imports	Exports	Ending stocks
1990	129097	123853	73	649	90667
1991	130518	126291	124	1018	94000
1992	127804	128101	424	1294	92833
1993	125965	129197	1059	994	89667
1994	125730	130231	1273	605	85833
1995	129790	131103	1057	412	85167
1996	135570	131964	478	1646	87606
1997	138720	132918	254	2460	91201
1998	139509	133667	239	3131	94151
1999	136524	134200	242	2502	94215
2000	131593	135000	284	2254	88838
2001	126007	135500	277	2131	77492
2002	119649	134767	561	1809	61127
2003	120002	132700	663	1373	47719
2004	121413	130133	795	917	38876
2005	126326	128500	578	1071	36210
2006	127946	127550	524	1309	35820
2007	130585	129217	373	1153	36408
2008	133708	131590	345	923	37947
2009	135967	134107	376	632	39551
2010	138090	136107	643	550	41627
2011	139567	138333	847	533	43174

Source: USDA, PSD Online 2013. Note: Data are in three-year moving average.

Appendix 2 Wheat balance of supply and demand (thousand tons)

Year	Production	Consumption	Imports	Exports	Ending stocks
1990	95012	103465	12691	9	49940
1991	98606	104103	10667	67	55043
1992	101327	105018	8970	275	60047
1993	102427	104993	7101	409	64174
1994	102635	105732	9036	513	69599
1995	104028	106490	8497	625	75010
1996	112025	107723	5717	876	84153
1997	114528	108307	1817	891	91300
1998	115632	108882	1252	749	98553
1999	107749	109289	678	569	97121
2000	102464	109453	766	892	90005
2001	94601	108073	568	1284	75817
2002	90218	106147	1753	2018	59622
2003	89577	103900	3638	1904	47033
2004	91962	102667	3875	1797	38407
2005	99288	101833	2755	1784	36832
2006	105070	103167	522	2338	36919
2007	110076	104500	306	2114	40687
2008	112294	106167	641	1483	45972
2009	114255	107667	934	852	52642
2010	115900	112667	1774	944	56705
2011	117527	117667	2142	980	57727

Source: USDA, PSD Online 2013. Note: Data are in three-year moving average.

Appendix 3 Corn balance of supply and demand (thousand tons)

Year	Production	Consumption	Imports	Exports	Ending stocks
1994	104660	97033	2882	4361	86985
1995	112917	101317	1946	1794	98737
1996	114593	105483	613	3407	105052
1997	121578	109723	208	4468	112647
1998	121783	113573	207	6482	114581
1999	122347	117153	141	6850	113065
2000	116058	120213	66	8607	100369
2001	113796	123080	52	10377	80760
2002	117073	125800	23	10469	61587
2003	122473	128433	11	10129	45509
2004	128495	132133	22	6290	35603
2005	140418	137667	27	5528	32853
2006	147755	144000	40	3182	33466
2007	156605	149333	35	1997	38776
2008	160729	156000	461	291	43676
2009	169044	166000	774	145	47349
2010	178000	177667	2425	154	49953
2011	188342	189667	4326	170	52784

Source: USDA, PSD Online 2013. Note: Data are in three-year moving average.

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1. Jiarong Qian, Shoichi Ito, Hiroshi Isoda, Hisamitsu Saito, 2012. Yield Response to Price and High-quality Seed Subsidy Policies in China. Japanese Journal of Farm Management 50(1), 118-123.

2. Jiarong Qian, Shoichi Ito, Yueying Mu, Hiroshi Isoda, Hisamitsu Saito, 2012. Effect of Formula Fertilization Technology Subsidy Policy on Rice Production in China: A Case of Xinyang City. Journal of Rural Problems 186(1), 31-34.

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5. Jiarong Qian, Shoichi Ito, Yueying Mu, Hiroshi Isoda, 2013. Grain Price Support Policy and its Effect on Grain Prices in China: A Grey Relational Analysis. Journal of the Faculty of Agriculture Kyushu University.

6. Jiarong Qian, Shoichi Ito, Yueying Mu, Hiroshi Isoda, 2013. Impacts of Agricultural Subsidy Policies on Grain Prices in China. (Ready to submit)

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