Grain Market Fluctuations and Government Intervention in China*

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1 Introduction

This paper examines the impact of price controls in China's grain market on grain production stability.

After two decades of economic reform, China's manufactures and part of agricultural productions other than grains have mainly become market-oriented. However, the state is still playing an important role in the grain markets. It is believed that, due to the Cobweb Effect, grain market is usually subject to large fluctuations without government intervention. The instability in grain market may lead to either a dearth or a surplus of supply, which may damage consumers and producers seriously. The government is therefore highly involved in the grain market in order to stabilise the grain supply.

Opening to international grain markets might have a positive effect on stabilising the domestic grain production, because a sufficiently large market can smooth the supply and demand shocks. However, because the domestic prices for some major grain products have been significantly higher than international levels, more access to the international market could result in large increases in imports and large drops in farmers' income in the short run.

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Over the long term, an efficient solution should be a further reallocation of resources between the agricultural and non-agricultural sectors. During the reforms of the past 20 years, about 100 million farmers have transferred to the rural industrial sector, and 40-50 million to the urban sectors (Wang, 1999). It will take time for a large part of the remaining (and growing) 330 million farmers to be transferred to non-agricultural sectors. In the short run, however, stabilising the domestic market remains an important issue. This paper therefore focuses on short run stability of the domestic grain market.

The government uses two measures to stabilise the grain market. It purchases a large part of the grain output from farmers at fixed prices via a quota system. It also controls the grain trade and uses imports and exports to adjust the grain supply.

In this paper, I examine the extent to which the goal of grain market stabilisation has been achieved via these measures, particularly the price controls. Whether the government intervention being successful can be indicated by the followings: a) if it can adjust the market to smooth the market price overshooting; and b) if it can reduce the time lag of adjustment or provide information in advance of market changes. In addition, we should ask what is the cost paid to achieve this goal, and whether the benefits exceed the costs?

2 Literature Review

Theoretically, there are a few reasons for grain markets to be subject to the Cobweb Effect (see, e.g., Gravelle and Rees, 1981: 277-287). First, the seasonal nature of grain production results in synchronous supply adjustments with time lags in response to price changes. Second, as a basic necessity, the inelastic demand for grain leads to larger price changes compared with more elastic cases, when there is a supply or demand shock. In the case that grain supply is relatively price elastic compared with demand (because farmers have choices whether to produce grain or other agricultural products according to prices), shocks can be enlarged and price fluctuations can diverge. In this case, an

external shock can easily result in an overshooting in supply adjustment and diverging price fluctuations in the short run, instead of converging to equilibrium.

To investigate grain market stability, three issues are important: a) how farmers respond to changes in market prices and government prices; b) what is the mechanism used to set government prices; and c) what are the interactions between the market prices and government prices. Some studies have investigated the first and second issues, but rarely has the third issue been analysed. Also, some results of earlier studies are doubtful, mainly due to the limitations in data.

Rozelle and Boisvert (1993) estimated the impact of changing price ratio between industrial and agricultural goods (P_{t-1}, i.e., with a time lag) on grain yields (G_t). Other variables included in the grain yield function were proportion of hybrid rice area, which is endogenously determined by P_{t-1}, fertiliser applied, and cash crop area. They found a surprising positive (but insignificant) effect of P_{t-1} on G, suggesting an increase in yield in response to a relative decline of agricultural prices. However, as they correctly indicated, this response might have been a substitution effect resulting from declining cash crop prices, because the agricultural prices included both grain and cash crop prices.
Lin (1996) found that, over the period 1952-89, total government purchases of grain, i.e., the sum of quota and "above-quota" purchases, were endogenously related to grain output through what has been described as the "ratchet principle" (Weitzman, 1980). Lin further indicated that changes in government purchasing prices have an impact on grain production even when government prices are lower than market prices. This finding is different from that of some other authors (e.g., Byrd, 1989; Sicular, 1988), who argued that because the amount of the quota was fixed, changes in the quota prices have no impact on production. However, Lin's finding is consistent with some empirical observations from inside China (i.e., An, 1992), which indicated positive production responses to changes in quota prices.

Huang, Rosegrant and Rozelle (1998) estimated impacts of a number of important variables on grain output. They are:

- Prices for rice and other grains (a mixture of market prices and government prices);
- Prices for cash crops;
- Prices for land (approximated as total revenue per unit of land minus input costs);
- Farmers' wage (approximated as net rural labour income per capita);
- Public investment in irrigation;
- Public agricultural research stock (estimated from national budgetary expenditures on research, see Pardey et al. 1992);
- Institutional innovation (the introduction of the Household Responsibility System, see Lin 1992); and
- Environment variables, i.e., salinisation, erosion, etc.

Provincial data for the period 1978-92 were used.

This model represented a large improvement on the previous studies because of the inclusion of a number of new variables. However, the study was restricted by the unavailability of separate market and government prices, so that their possibly different effects on farmers' supply could not be isolated. The accuracy of this study may be also restricted by the quality of data. For example, the estimated own-price elasticity of grain supply other than rice is surprisingly negative. Moreover, specification of the dynamic equilibrium model has to rely on some assumptions which may not be appropriate.

Some important findings of above studies are confirmed by Wang (1999) via a production function approach, with some new findings added. Using provincial-level data for 1980-96, he found a number of variables made important contribution to growth of grain production in China. They are expansion of irrigated area, state expenditure on agricultural research and development, state investment in agricultural infrastructure, institutional reform (the Household Responsibility System), the ratio of the area sown to grain over the cultivated land area, and TFP growth. Natural disasters and government price subsidies were found to have a negative effect on grain production. Wang also concluded that the government-dominated price changes were likely to be negatively

related to production changes of the preceding year. Therefore, he suggested that the time-lagged adjustment might have resulted in market fluctuations instead of market stabilisation. However, the limitation of data did not allow this study to distinguish the effects of government prices and market prices.

3 Grain Pricing and Trade in China

China has had a government-controlled grain market since the 1950s. The government monopolised grain purchasing and supply during the centrally planned period. In the 1980s, the government partially liberalised the domestic grain trade. However, farmers still need to fulfil the state quota, and state grain companies still play a major role in the market.

There are normally three different prices in China's grain market: the state quota price, the "negotiate price" or "above-quota price", and the free market price. Data are now available to allow identification of the separate three prices during the period 1985-98. These three prices for rice, wheat and corn at the national level are shown in Table 1. Note that the annual market prices were calculated as averages of the monthly survey data at 30 local grain markets located in different provinces.

The following are explanations of the three prices for grain:

1. The state quota price. Grain producers are obliged to sell a pre-determined quantity of grain products to the state at prices fixed by the central government. Most of the time quota prices were lower than market prices, but exceeded market prices since 1997. The state purchases at the quota prices is normally around 50 million metric tons per year (see Ministry of Commerce (MOC), various years; and Ministry of Domestic Trade (MODT), various years). This volume accounts for about 10 percent of current total production, but may reach up to 30 percent of the total domestic market supply, because the major part of grain output is consumed by farmers without entering the

market. Changes in quota prices were usually made in spring of each year, and the prices basically remain at the same level for the remaining period of the year.

2. The "above-quota prices" or "negotiate prices". The state also purchases grain from farmers above the state quota. The prices for above-quota purchases were also fixed in the 1960s to1980s, but were usually higher than the quota price by 20-50 percent. They are called "negotiated prices" because in the beginning the above-quota purchases were based on farmers' voluntary. However, when these prices were exceeded by market prices and the government could not purchase sufficient quantities, the above-quota purchases became compulsory. However, the mechanism for setting the above-quota prices was changed in the 1990s, when local branches of the state grain bureau were allowed to make their own decisions on the above-quota prices. This made the above-quota prices close to, but may still lower than, market prices. Usually, the annual state purchases at the above-quota prices were 40-50 million metric tons, similar to the quota purchases (see MOC and MODT, various years). In the late 1990s, the central government decided to purchase all the market grain by offering farmers a "protection price", which was to be set above the market price level (although this goal was never fully achieved and has been partially given up recently, it might have increased the above-quota purchases to 70-100 million tons).[1]
3. Market prices. These prices fluctuate when demand and supply changes. There are no statistical data for the volume of market grain each year. A rough calculation by the author suggests approximately 50 million tons per year in the late 1990s.[2]

[1] The government abandoned price protection on low quality rice and wheat in 2000.
[2] This was calculated as the residue of total domestic supply (420 million tons as the 1999-2000 average, paddy weight has been converted into rice weight, other grains are unprocessed) subtracting non-commercial grains (estimated as 250 million tons) and the state purchasing (estimated as 120 million tons).

Table 1 Quota, above-quota, and market prices of rice, wheat and corn (yuan/kg)

YEAR	Paddy (quota)	Paddy (abv.quo)	Rice (market)	Wheat (quota)	Wheat (abv.quo)	Wheat (market)	Corn (quota)	Corn (abv.quo)	Corn (market)
1985	0.35	0.36	0.629	0.43	0.43	0.496	0.31	0.33	0.366
1986	0.36	0.44	0.768	0.44	0.51	0.590	0.31	0.40	0.442
1987	0.38	0.51	0.891	0.44	0.55	0.637	0.33	0.44	0.487
1988	0.40	0.61	1.145	0.47	0.63	0.782	0.34	0.47	0.548
1989	0.48	0.87	1.691	0.51	0.89	1.180	0.37	0.64	0.782
1990	0.51	0.82	1.337	0.51	0.85	1.049	0.38	0.63	0.729
1991	0.51	0.73	1.137	0.51	0.77	0.859	0.38	0.55	0.618
1992	0.55	0.65	1.100	0.59	0.73	0.880	0.42	0.55	0.665
1993	0.62	0.74	1.251	0.66	0.75	0.865	0.46	0.64	0.752
1994	0.89	1.14	2.078	0.89	1.04	1.152	0.69	0.90	1.056
1995	1.09	1.72	3.005	1.08	1.53	1.744	0.86	1.38	1.612
1996	1.33	1.71	3.016	1.31	1.65	1.756	1.06	1.39	1.491
1997	1.48	1.45	2.364	1.46	1.43	1.441	1.23	1.1	1.490
1998	1.46	1.34	2.175	1.44	1.3	1.298	1.23	1.17	1.579

Sources: Ministry of Agriculture (1999), and Centre for Rural Economic Research of the Ministry of Agriculture, 1999. Market prices for 1985, 1986 and 1998 were estimated from the available information.

In attempting to stabilise the grain markets, another measure used besides the price controls is the government control over grain imports and exports. Most grain imports and exports are carried out by state trading companies, mainly the Grain and Edible Oil Import and Export Corporation. Import and export decisions are made mainly according to domestic needs.

All changes in prices, imports, exports, and production are likely to be interrelated, e.g., farmers make production decisions in reaction to price changes, while government decisions on pricing, import and export are likely to depend on the information about production and demand changes.

From 1985 to 1991, the quota prices changed smoothly, with only small nominal increases in most years, which only partially offset the inflation. An only large increase in nominal quota price (13.2 percent) was in 1989, as a reaction to the output decline of the preceding year, although this was still too low to offset the 19 percent high inflation in that year. Meanwhile, both above-quota prices and market prices increased by over 40 percent. Output remained at the level around 400 million tons in 1985-89, then increased to 446 million tons in 1990 (likely to be a result of the increase in the above-quota prices and market prices in 1989), and again stagnated in 1991-93. This situation was changed since 1992 when the nominal quota price increased by 11 percent (or 6.1 percent in real terms), which was a reaction to the fall in grain output (by –2.5 percent) in 1991. Output grew slowly in 1993, and then declined in 1994. In 1994, the nominal quota price increased by 42.9 percent, or 15.2 percent in real terms. The real prices were further increased by 4.4 percent, 13.2 percent, and 9.8 percent in 1995, 1996 and 1997, respectively. These price increases resulted in a 4.8 percent output growth in 1995 and a further 8.1 percent increase in 1996, which lifted total output (unprocessed) above 500 million tons. Due to the surplus in supply, both the market and above-quota prices fell heavily in 1997-98, while the quota price increased in 1997 and only slightly decreased in 1998. This made the quota prices exceeded market prices in 1997-98. In 1999, all three prices were reduced. Output remained at the level of above 500 million tons until 1999, then fell heavily (–9 percent) in 2000 (see Table 2).

According to the above description, we may assume that the government pricing behaviour follows one of two path: in normal cases it makes only minor adjustment to either fully or partially offset inflation, possibly with consideration of expected changes in domestic demand; whereas in special cases, e.g., where there are significant shortages or threats of shortages in grain supply, it makes large changes (or even continued changes) in quota prices, in order to encourage farmers' production, and vice versa.

As shown in Table 2, grain exports and imports were not well managed by the state trade companies. Because of the time lag in reaction to production changes, imports are often increased when grain output increases (e.g., in 1987, 1989, 1995 and 1996), and imports

are reduced or exports increased when output decreases (e.g., in 1991, 1994 and 1999). Such action can only serve to fluctuations.

Table 2 Grain output growth and changes in prices and net import in China

YEAR	Grain output (mil.tons)	Output growth %	P^q change %	P^a change %	P^m change %	RCPI %	IM/OUT %
1986	392	3.3	1.8	20.8	20.8	6.1	-0.43
1987	405	3.4	4.2	11.7	11.8	6.2	2.20
1988	394	**-2.6**	5.1	14.3	22.0	17.5	2.07
1989	408	3.4	**13.2**	40.3	47.2	19.3	2.46
1990	446	9.5	3.3	-4.1	-13.7	4.5	1.77
1991	435	**-2.5**	0.0	-11.0	-16.0	2.3	0.59
1992	443	1.7	**11.0**	-5.9	1.7	4.7	-0.43
1993	456	3.1	11.5	11.3	8.9	13.7	-1.72
1994	445	**-2.5**	**42.9**	45.4	48.5	23.4	-0.96
1995	467	4.8	**22.8**	50.5	49.0	17.5	4.00
1996	505	8.1	**22.2**	2.3	-1.9	7.9	2.03
1997	494	-2.1	12.8	-16.3	-14.0	2.5	-0.30
1998	512	3.7	-1.0	-3.9	-4.4	-1.0	-0.39
1999	508	-0.8	**-4.0***	-4.0*	-4.0*	-1.5	-0.71
2000	462	**-9.0**					

Note: Pq, Pa and Pm are quota price, above-quota price, and market price, respectively. IM/OUT is net import as a ratio over total output of grain. RCPI is the rural inflation rate of consumer prices.
* Data are estimated by the author.
Sources: calculated from Table 1 and the National Bureau of Statistics (2000).

4 Modelling Interactions of Grain Production, Pricing and Trade

In the following, a simultaneous equation system is specified and panel data at the provincial level is used to analyse the short run relationship between changes in (government and market) prices and grain production, and the interaction between grain trade changes and production.

Output data and separate data for quota, above-quota, and market prices are now available either for total grains or for rice, wheat and corn, for the periods 1985-97(98). These three crops are the most important food and feed grains in China, accounting for about 85 percent of total grain output. Most of the data are available for the 30 provinces (quota prices were nation-widely unified, and above-quota prices were available also at the national level). Market prices were collected continuously from one rural grain terminal market in each province by CRER of MOA. Other data are from NBS (various years), MOA (1997-99), MOC (1988-93), and MDT (1995-98).

Short Run Grain Supply Function.

Growth of domestic grain supply in the short run is hypothesised to depend mainly on the following factors:

1. Changes in state quota prices (current year prices or prices lagged one year, depending on the timing of price changes, i.e., if the price change in a particular year was announced in advance of the sowing season, there would be no time lag, otherwise there would be a one-year lag). A positive relationship is expected. Because most changes in quota prices were made early in each year, at least before harvests, we can reasonably assume a uni-direction impact from changes in quota price of either year *t* or *t*-1 (i.e., P^q_t or P^q_{t-1}) on grain output growth of year *t* (G_t), and there is no feedback from G_t to P^q_t or P^q_{t-1}.
2. Changes in above-quota prices with or without time lag. A similar assumption about the causal relationship may apply, but will be tested.
3. Changes in market prices with or without time lag (P^m_{t-1} or P^m_t). A positive impact on G_t is expected. A bi-direction relationship between P^m_t and G_t is possible, but only a uni-directional impact from P^m_{t-1} on G_t can exist.
4. The inflation rate, P^f_t or P^f_{t-1}, which may reduce the price effect on output.
5. Price index of agricultural inputs (P^i_t or P^i_{t-1}), mainly fertilisers, insecticides, farming machinery and tools, and fuels, etc. This price index is assumed to be an exogenous variable and may have a negative effect on G_t.
6. Price index of cash crops (P^c_t or P^c_{t-1}). This variable is assumed to be exogenously determined and may have a negative impact on G_t, because of the substitution effect.

7. Natural disasters, It is an exogenous variable.
8. Changes in net grain imports as a proportion of total production (M_t or M_{t-1}). A uni-directional impact from M_t or M_{t-1} to G_t is assumed.
9. Other possibly influential variables are changes in state expenditure on agricultural R&D, in state investment in agricultural infrastructure, and adoption of Household Responsibility System (see Lin 1992, Huang, Rosegrant and Rozelle 1998, and Wang 1999).
10. A time trend. It represents the impact of other unidentified factors on grain supply over time.

Quota Price Function.

It is hypothesised that the government decides to change quota prices for grains according to the following information:

1. Growth of grain output in the preceding year. There is possibly a negative but inelastic relationship between G_{t-1} and P^q_t, meaning that the government prices may respond to output changes but may be normally rigidity. Due to the reason mentioned before, no impact is assumed from G_t on P^q_t.
2. Domestic inflation rate in rural areas (P^f_t or P^f_{t-1}). The government may increase nominal purchase prices of grain to compensate farmers when there is high inflation.
3. Changes in grain demand, which can be indicated by a group of variables: population growth, per capita income growth, and changes in people's consumption structure.
4. Previous net imports of grain, M_{t-1}. A large M_{t-1} may mean an abundant supply of grain, which may lead to a government decision to decrease or not increase purchase prices, and vice versa.
5. Whether the government uses previous changes in grain market prices as a reference in making pricing decisions will be tested.
6. A time trend to represent the impact of other unidentified factors on quota pricing over time. This also applies to the following equations.

Above-quota Price Function

Changes in above-quota prices, P^a_t, may relate to either quota prices or market prices, as well as to G_t or G_{t-1}. Therefore both the two prices and G, with and without time lag, are included in the equation to test different hypotheses. Net imports are included due to the same reasons for being included in the quota and market price functions.

Market Price Function

Factors that may have an impact on the market price include:

1. Grain output growth of the preceding year. This captures the effects of shifting supply curve on the demand side. A higher output should result in a lower market price, and vice versa.
2. Growth of per capita income of the current year or the preceding year. It is treated as an exogenous variable. Income effect on market prices can be either positive or negative, depending on whether the staple grains become inferior goods as income increases.
3. Changes in food consumption expenditure as a proportion of total consumption expenditure per capita. This relationship should be positive.
4. Population growth. This relationship should be positive.
5. (Urban) inflation rate, which is a deduction of consumers' real income, therefore should have an impact opposite to the income effect. Because grain consumption is small in total urban consumption, this variable is assumed to be exogenous.
6. Empirical observations suggest that changes in the quota prices in the current year or the preceding year may have a large impact on market prices. This will be tested.
7. Net imports M_t or M_{t-1} are expected to have a negative impact on market prices.

There are a few missing variables due to data unavailability: industrial and business consumption demand for grains, changes in grain stocks, and the volume of inter-province grain trade. Therefore estimates of this function would be only proximate.

Grain Import Function

Grain imports and exports are mainly controlled by state trading companies. We can assume that the state uses the same information to make decisions for both grain trade and quota pricing. Because the times of the import decisions made in each year are unknown, all the variables are included both with and without time lag. Note, considering that the government decisions may not be fully executed, to make further decisions on grain trade may need to look at the actual net imports of the preceding year (M_{t-1}).

The Model

$$G_t=a_1+a_2P^q_t+a_3P^q_tD94+a_4P^q_{t-1}+a_5P^a_t+a_6P^a_{t-1}+a_7P^m_t+a_8P^m_{t-1}+a_9P^f_t+a_{10}P^f_{t-1}+a_{11}P^i_t+ a_{12}P^i_{t-1}+a_{13}P^c_t+a_{14}P^c_{t-1}+a_{15}RD_{t-1}+a_{16}RD_{t-2}+a_{17}IF_{t-1}+a_{18}IF_{t-2}+a_{19}HR_t+a_{20}HR_{t-1} +a_{21}DS_t+a_{22}M_t+a_{23}M_{t-1}+T \quad (1)$$

$$P^q_t=b_1+b_2G_{t-1}+b_3G_tD94+b_4P^m_{t-1}+b_5P^f_{t-1}+b_6Y_{t-1}+b_7F_{t-1}+b_8PO_{t-1}+b_9M_{t-1}+T \quad (2)$$

$$P^a_t=c_1+c_2G_{t-1}+c_3P^q_t+c_4P^q_{t-1}+c_5P^m_t+c_6P^m_{t-1}+c_7M_{t-1}+T \quad (3)$$

$$P^m_t=d_1+d_2G_{t-1}+d_3Y_t+d_4Y_{t-1}+d_5F_t+d_6PO_t+d_7P^{uf}_t+d_8P^q_t+d_9P^q_{t-1}+d_{10}M_t+d_{11}M_{t-1}+T \quad (4)$$

$$M_t=e_1+e_2G_t+e_3G_{t-1}+e_4P^m_t+e_5P^m_{t-1}+e_6P^f_t+e_7P^f_{t-1}+e_8Y_t+e_9Y_{t-1}+e_{10}F_t+e_{11}F_{t-1}+ e_{12}PO+e_{13}PO_{t-1}+e_{14}M_{t-1}+T \quad (5)$$

where

G is growth rate of grain output at provincial level.

P^q, P^a and P^m are percentage changes of the state quota, above-quota, and market prices of grain. P^q was held equal by the central government for all provinces until recently.

P^c, P^i, P^f, and P^{uf} are percentage changes of cash crop prices, farming input prices, and the rural and urban inflation rates (rural CPI and urban CPI).

RD is the state expenditure on agricultural research and technological development at the economy level; it is assumed to have an equal spillover effect on grain production in all provinces.

IF is the state investment in agricultural infrastructure at the economy level. Data at the provincial level are not available for most of the years. With consideration of its spillover effects, e.g., large investment projects can affect many provinces, IF is also assumed to have an equal effect on grain production in all provinces.

HR is the change in the number of villages/production teams from the collective production system to the Household Responsibility System as a percentage of the number of total villages/teams.

DS is the change in the areas affected by natural disasters as a proportion of total sown area. The area affected by natural disasters is defined as where output dropped by 30% or more from the preceding year.

M is the change of net imports as a proportion of total production.

Y is the growth rate of household income per capita.

F is the change in food consumption as a percentage of per capita household expenditure.

PO is the growth rate of population.

D94 is a dummy variable (D94=1 for year 1994 and =0 otherwise). It is applied to P^q_t in Equation (1) and to G_t in Equation (2) because when there was a predicted output decline in 1994, P^q_t increased dramatically after the sown season, therefore supply did not respond to the changes in quota prices in the same year.

T is a time trend. T=0, 1, …12 for year 1986, 87, …98.

5 The Estimation Results

A Three-Stage-Least-Square estimation was carried out to estimate the five equations simultaneously, using a fixed-effect model. Those variables that had insignificant estimates in earlier estimations, and were thought not to be essential, were omitted. The end results are as follows (for details see Table A1 in Appendix).

$$G_t=6.884+0.231P^q_t-0.091P^q_tD94+0.220P^a_t+0.064P^m_{t-1}-0.766P^f_t-0.626DS_t-1.409M_t-0.642T \quad (1)$$

$$P^q_t=-3.196-0.029G_{t-1}-0.897G_tD94+0.858P^f_{t-1}+0.390Y_{t-1}+0.947F_{t-1}+0.027PO_{t-1}-0.538M_{t-1}+0.753T \quad (2)$$

$$P^a_t=-2.885-0.001G_{t-1}+0.872P^m_{t-1}-1.012M_{t-1}-0.007T \quad (3)$$

$$P^m_t=2.795-0.278G_{t-1}-0.737Y_t+0.855P^{uf}_t+1.143P^q_t+0.525P^q_{t-1}-2.386M_{t-1}-2.496T \quad (4)$$

$$M_t=-0.248-0.041G_{t-1}+0.023P^m_{t-1}+0.104P^f_{t-1}+0.096Y_{t-1}+0.107F_{t-1}-$$

$$0.421Mt_{-1}-0.248T \quad (5)$$

Findings from the estimation are explained as follows:

Results of the Short Run Grain Supply Function

a. Farmers' production G_t responds positively to changes in the quota price and above-quota price without time lag (significant at close to 5%, and 5%, level). G_t also responds to market prices significantly (at 0.1% level), with time lag. This lag can be explained as the market price changes all the time and therefore being unpredictable before harvest. Farmers therefore have to make their production decision according to the preceding year's market prices. They can respond to the current changes in quota prices because these prices are mainly pre-fixed before production. However, this does not necessarily mean that quota prices are better than market prices in stabilising grain market, depending on how they are determined and how they respond to supply changes (see result of the quota price function). The relatively lower market price elasticity may indicate that farmers are restricted to selling their products in the market before they fulfil the state quotas. Therefore the role of market is restricted.
b. According to the estimated own price elasticities, if all the quota, above quota, and market prices increase by 10 percent, total grain output, as the direct responses, will increase by 5.2 percent over two years.
c. The cross price effect between grains and cash crops was insignificant (z=-0.33), therefore P^c was omitted. This may be due to the state quota controls on both grain and some important cash crops (mainly cotton and oil-bearing crops).
d. Agricultural input price index P^i and rural consumer price index P^f are found highly correlated (corr=0.936). To avoid the multicolinearity problem, P^i is dropped, and P^f represents both effects. It is significant at 0.1% level.
e. Normally, changes in net imports would affect domestic supply via changes in equilibrium prices. However, the net imports are found to have a direct negative impact on domestic supply (z=-2.88), besides the price effect. This may be due to the rigidity of state purchase prices. Because of this, local branches of the state grain bureau may use other measures to adjust their grain purchases. For instance, assume

grain supply is abundant due to a large import, whereas the grain bureau branches are not allowed to reduce the purchase prices, they may lower the grades of grains they purchased, or simply refuse to buy. These result in a negative impact on grain production without changing government prices.

f. Natural disasters (DS) are found to have significantly negative effects on output growth. The Household Responsibility System, public investment in R&D, and that in infrastructure are insignificant, likely because these variables work most effectively in the early 1980s, whereas the growth data currently used are only from 1986. Another reason may be that the later two variables are not provincially specified.

Results of the Quota Price Function

a. There is possibly negative response of the quota price (P^q_t) to changes in output of the preceding year (G_{t-1}), but is insignificant. However, in a single equation analysis using separate data for lagged output of rice, wheat and corn to replace G_{t-1}, significant negative response are found for rice (t=-3.797). That for wheat is also negative and close to 10% significance level (t=-1.514). (See Equation 2 in Table A2 of the Appendix.) These results suggest that the government mainly uses the previous year's changes in rice and wheat outputs as the point reference in making decisions about price changes, but the adjustment may be rigid. The lagged adjustment indicates that the government pricing have no significant advantages over market pricing in order to reduce the Cobweb effect, whereas the rigidity in adjustment may make things worse.

b. The highly significant coefficients of P^f_{t-1}, Y_{t-1}, F_{t-1}, and PO_{t-1} indicate that the government adjusts the quota prices mainly considering the previous inflation rate and demand changes, whereas the later suppose to be positively related to changes in people's income, consumption pattern, and population growth.

c. No positive relationship was found between P^m_{t-1} and P^q_t. This indicates that the quota prices do not follow the market prices. P^m_{t-1} was therefore omitted.

d. There is a negative relationship between M_{t-1} and P^q_t (z=-2.88), which suggests that the government makes price decisions with consideration of previous year's imports.

Results of the Above Quota-Price Function

a. No significant relationship is found either between G_t and P^a_t, or between G_{t-1} and P^a_t. Both P^q_t and P^q_{t-1} are also insignificant with very low z ratios. The results suggest that adjustment in above-quota prices does not respond to output changes. It does not follow the quota price changes either.

b. Instead, changes in market prices of the current year and the preceding year, P^m_t and P^m_{t-1}, are both highly significant (c_5=0.872, z=34.97; and c_6=0.208, z=9.42). This suggests an adoptive relationship between market prices and above-quota prices. The later closely follow the former, with time lag to some extent.

c. M_{t-1} is also significant and has a relatively large impact on P^a_t.

Results of the Market Price Function

In this function, the following variables are highly significant (all at the 0.1% level): G_{t-1}, Y_t, P^{uf}_t, P^q_t, P^q_{t-1}, and M_{t-1}. Other variables are insignificant and were therefore omitted.

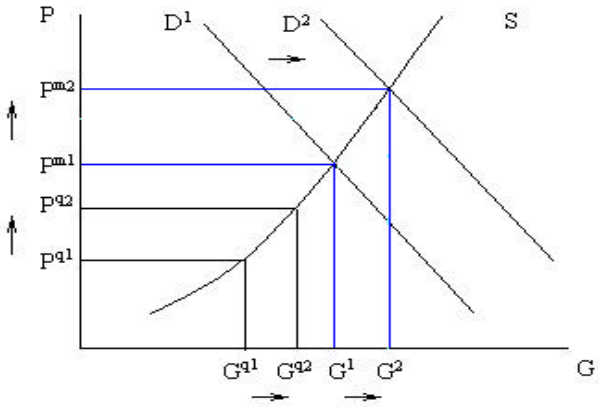
The results clearly indicate the followings:

a. Changes in market prices are closely related to output changes in the preceding year. That is, they change after one harvest (in late of each year) till another.

b. At the same time, market prices respond significantly to both P^q_t and P^q_{t-1}. This indicates that changes in quota prices have a large impact on market price, even if the former is lower than the later. This is explained in Figure 1.

c. Other variables that have significant impacts on market prices are changing income levels and net imports. Contrary to government expectations, the income effect on market prices is negative, indicating that staple grains have become inferior goods (this can be verified by the household survey on food grain consumption, NBS 2000). Net imports have a negative effect because it increases total grain supplies.

Figure 1. How does a change in quota price affects market price?



Note: G is grain output and P is grain price. P^q and P^m are quota price and market price, respectively. D and S are grain demand and supply curves. If the state quota is set as G^{q2} at price P^{q1}, it can be hardly fulfilled because the price does not cover farmers' cost (which might have increased due to inflation). Only the part G^{q1} may be achieved. To ensure the quota G^{q2} being fulfilled, the state may have to increase the quota price from P^{q1} to P^{q2} (but the state still need to stop farmers from selling products in market before fulfilling the quota). This squeezes the market grain supply from G^1-G^{q1} to G^1-G^{q2} (because in the short run, the quota grains may not enter the market, they may only increase the state grain stock), therefore pushes the total demand curve shifting from D^1 to D^2 when market demand does not change (G^2-G^{q2}=G^1-G^{q1}). The market price therefore increases from P^{m1} to P^{m2}.

Result of the Net Import Function

a. Most variables significant in the quota price function are found also significant in the net import function, including P^f_{t-1}, Y_{t-1}, and F_{t-1}. This implies that both quota prices and net imports are tools of the state used to adjust the grain market, and both adjustments rely on the same information.

b. The coefficients of G_t and G_{t-1} are both negative, although, only that of G_{t-1} is significant. This indicates that change in net import relating to output is an *ex post* adjustment. This can rarely help to reduce market fluctuations.

c. Response of net imports to market prices is significantly, but with time lag too.

d. Net imports respond negatively to previous net imports, which may mean overshooting in import adjustment in earlier years.

The Degree of Endogeneity of the Model

After the omission of the insignificant variables, most equations have only exogenous variables and lagged endogenous variables on the right hand side. The latter can also be treated as exogenous variables since they have only uni-directional relationship with the dependent variables (this also applies to P^q_t and P^a_t relating to G_t). In this case, single equation analyses also make sense. Such estimation gives similar result to above analysis (see Table A2 in Appendix).

6 Simulation and Implications

In order to find whether the market is stabilised, we can use the information obtained from above modelling to simulate how the system adjusts in response to an external shock. The estimated parameters in the five equations are used. Endogenous variables are grain outputs, quota prices, above-quota prices, market prices, and net imports. We begin from an assumed desired output level of 480 million metric tons in year –1 and 0. The initial quota, above quota, and market prices are all assumed to be 1300 yuan/ton, and the net import is 3 million tons, just like that in late 1990s. For simplicity, no inflation and demand changes are assumed during the period.

Assume that there is a serious natural disaster in year 1, which affects 25 percent cultivated areas, whereas usually only around 10 percent is affected. This reduced output by nearly 10 percent.

Two scenarios are considered. In scenario 1, the government follows its usual way in price adjustment, i.e., only making miner adjustment in quota prices in response to output changes (the elasticity is –0.029, see estimation result of Equation 2). In this system, outputs cannot converge to a stable level. There is only a partial output recovery in years 3 and 4, followed by a continued slow decline. The output level drops to below 450 million tons in 20 years. In addition, the controlled net import does not respond correctly

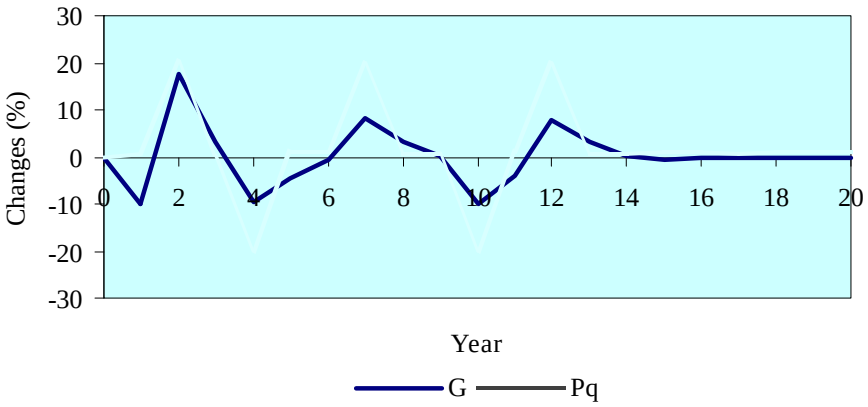
to output changes. Due to insufficient response and lags in adjustment, net import reduces when output is dropping, and increases when output increases (see Table A3 in Appendix).

As we can observe from Table 1 and 2, although the government quota price normally has no significant feedback to small fluctuations in output, it has large, and usually lagged feedback to significant decreases or continued slow growth of output. This happened in 1989, 1992, and 1994-96.

In scenario 2, the government in usual cases follows the same behaviour pattern as described in scenario 1, but it makes dramatic (and lagged) changes in quota prices when there is serious shortage or surplus in supply. Assume that, without demand changes, if an annual output growth or decline exceeds 8 percent of the desired 480 million ton output level, or continued exceeds 4 percent of that level in two years, the government would decrease or increase the quota prices by 20 percent (with lag). This is similar with what has happened in 1994 and after.

In such a system, as the government feedback to the serious shortage in grain supply in year 1, quota price increases dramatically in year 2, and leads to an even larger adjustment in the market and above-quota prices. As an aggregate effect, there is a continued rapid output growth in years 2 and 3, achieves 525 million tons in year 3. Because this exceeds the desired level too much, the government decides to decrease the quota prices by 20 percent in year 4. Output therefore reduces to 475 million tons in the same year, but does not stop at this point. Instead, it further declines in year 5 and 6 to 450 million tons. Again, due to the serious shortage, the government has to increase the quota prices largely in year 7. It also has to decrease and then increase prices in year 10 and 12. It takes more than 12 years before output is basically stabilised (but still decreasing) (see Figure 2, and Table A4 in Appendix). Clearly, in this system, the quota price system does not reduce, but enlarged production fluctuations.

Figure 2. Simulated market fluctuations under price control



Note: G is the annual growth rate of grain outputs, and Pq is the growth rate of quota prices.

7 Conclusions and Policy Implications

1. The government-controlled grain prices have responded rigidly to changes in the demand and supply. The adjustment has a time lag and is inelastic, and therefore has had no significant impact in terms of smoothing the output and market price fluctuations. With this inelastic adjustment, output cannot converge to the equilibrium level.

2. In this situation, the shortage or surplus in grain supply will accumulate to a significant level over years, and, at a certain stage, will result in a large feedback from the government quota prices. This will further affect market and above-quota prices. However, if the price feedback could correct the supply bias in a short run, it is likely to overshoot in the longer term, and therefore results in fluctuations in production and prices.

3. Because the grain quotas squeeze the market, market prices are highly affected by the quota prices and therefore fluctuate to a larger extent than they otherwise would do.

4. The government above-quota purchases do not stabilise the grain market either, because changes in the above-quota prices were not in advance of, but rather likely to follow, the market prices.

5. The other measures for market adjustment, exports and imports, are not well managed by the state trade companies. Because of the time lag in their feedback to production and market changes, or wrong expectations about market changes, net imports were often increased when grain output increased, and reduced (or exports increased) when output fell. Again, these actions enlarged the market fluctuations.

6. It can be concluded from the above, government control over the grain market is not necessary, costly, and did not provide any advantage over the market. In order to stabilise the grain market, the following actions can be considered:

    a. The market can be further deregulated to enhance the role of market competition in demand and supply adjustment.
    b. In order to reduce market fluctuation, the state may maintain a relatively small grain reserve system to operate in the market. However, the operation of this system must be well managed and flexible reacting to market changes.
    c. To achieve this goal, grain purchases and sales by the state reserve authority should not for profit purpose and should be strictly targeted for reducing market surplus and shortages under certain rules. Since the above-quota prices set by local branches of grain bureau only follows the market prices to make profit, the major part of the bureau system should be marketized and no longer subsidised.
    d. Government adjustment should be in advance and based on better information collection, i.e., scientific supply and demand forecasts than the existing *ex post*, and arbitrary, adjustment.
    e. To replace the mandatory quota system, a well-managed information service system can be established to provide farmers demand and supply information. It will work more efficiently in terms of reducing market fluctuations.

f. The grain market could be gradually opened to international trade. Production structure should be adjusted according to China's comparative advantages. However, due to the huge population size of the rural economy, large shocks should be avoided. Effort should be made to help farmers to transfer from grain to non-grain or non-agricultural production.

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Data Sources:

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MOC (Ministry of Commerce), variable years, *China Commerce Yearbook*, Beijing.

MDT (Ministry of Domestic Trade), variable years, *China Domestic Trade Yearbook*, Beijing.

NBS (National Bureau of Statistics), variable years, *China Statistical Yearbook*, Beijing.

NBS, variable years, *China Rural Statistical Yearbook*, Beijing.

Appendix: Estimation and Simulation Results

Table A1. Three Stage Least Square Estimation (Fixed Effect)

Equations	Obs	R-sq	Chi2	Prob
(1)Grain supply	345	0.629	584.124	0.000
(2)Quota price	345	0.404	226.603	0.000
(3)Abo. quo. P.	345	0.747	1173.330	0.000
(4)Mkt P.	345	0.482	759.143	0.000
(5)Import	345	0.412	298.565	0.000
	Coef.	z	P>z	
(1)Dep.var: G_t				
P^q_t	0.231	1.870	0.062	
$P^q_t D94$	-0.091	-1.272	0.203	
p^a_t	0.220	2.192	0.028	
p^m_{t-1}	0.064	3.465	0.001	
P^f_t	-0.766	-3.034	0.002	
DS_t	-0.626	-20.333	0.000	
M_t	-1.409	-2.879	0.004	
T	-0.642	-2.916	0.004	
C	7.525	2.607	0.009	
(2)Dep.var: P^q_t				
G_{t-1}	-0.029	-0.580	0.562	
$G_t D94$	-0.897	-4.356	0.000	
P^f_{t-1}	0.858	10.607	0.000	
Y_{t-1}	0.390	4.721	0.000	
F_{t-1}	0.947	6.200	0.000	
PO_{t-1}	0.027	2.762	0.006	
M_{t-1}	-0.538	-1.809	0.070	
T	0.753	4.605	0.000	
C	-3.949	-2.907	0.004	
(3) Dep.var: P^a_t				
G_{t-1}	-0.001	-0.021	0.983	
P^m_t	0.872	34.965	0.000	
P^m_{t-1}	0.208	9.419	0.000	
M_{t-1}	-1.012	-2.868	0.004	
T	-0.007	-0.040	0.968	
C	-2.878	-1.836	0.066	
(4) Dep.var: P^m_t				
G_{t-1}	-0.278	-3.191	0.001	
Y_t	-0.737	-7.886	0.000	
P^{uf}_t	0.855	5.792	0.000	
P^q_t	1.143	10.950	0.000	
P^q_{t-1}	0.525	6.456	0.000	
M_{t-1}	-2.386	-4.853	0.000	
T	-2.496	-6.544	0.000	
C	5.291	1.259	0.208	
(5) Dep.var: M_t				
G_{t-1}	-0.041	-4.837	0.000	
Y_{t-1}	0.096	7.847	0.000	
F_{t-1}	0.107	4.818	0.000	
P^m_{t-1}	0.023	4.648	0.000	
P^f_{t-1}	0.104	5.994	0.000	
M_{t-1}	-0.421	-7.702	0.000	
T	-0.248	-9.086	0.000	
C	0.129	0.553	0.580	

Table A2. Single Equation Panel Data Estimations (Fixed Effect)

Equations	Obs	R-sq within	R-sq between	R-sq overall
(1)Grain supply	358	0.594	0.311	0.572
(2a)Quota price	345	0.443	0.004	0.438
(2b)Quota price	324	0.706	0.000	0.696
(3)Abo.quo.P.	357	0.807	0.204	0.797
(4)Market P	345	0.649	0.034	0.634
(5)Import	345	0.435	0.260	0.424

	Coef.	t	P>t
(1)Dep.var: G_t			
P^q_t	0.046	0.561	0.575
$P^q_t D94$	-0.029	-0.511	0.610
p^a_t	0.307	3.494	0.001
p^m_{t-1}	0.081	4.771	0.000
P^f_t	-0.748	-3.735	0.000
DS_t	-0.609	-18.795	0.000
M_t	-2.108	-4.381	0.000
T	-0.494	-2.838	0.005
C	9.144	4.770	0.000
(2a)Dep.var: P^q_t			
G_{t-1}	-0.046	-0.848	0.397
$G_t D94$	-1.017	-4.469	0.000
P^f_{t-1}	0.844	9.856	0.000
Y_{t-1}	0.402	4.396	0.000
F_{t-1}	0.925	5.712	0.000
PO_{t-1}	0.029	2.694	0.007
M_{t-1}	-0.502	-1.594	0.112
T	0.733	4.189	0.000
C	-3.707	-2.581	0.010
(2b)Dep.var: P^q_t			
R_{t-1}	-0.055	-2.920	0.004
W_{t-1}	-0.026	-1.462	0.145
C_{t-1}	0.001	0.091	0.927
$W_t D94$	-1.395	-15.962	0.000
$C_t D94$	-0.240	-3.016	0.003
P^f_{t-1}	0.649	9.862	0.000
Y_{t-1}	0.315	4.658	0.000
F_{t-1}	0.742	6.064	0.000
PO_{t-1}	0.031	3.998	0.000
T	0.732	5.602	0.000
C	-2.470	-2.255	0.025
(3)Dep.var: P^a_t			
G_{t-1}	-0.079	-1.424	0.155
P^m_t	0.646	31.791	0.000
P^m_{t-1}	0.260	10.011	0.000
M_{t-1}	-1.387	-3.963	0.000
T	-0.277	-1.711	0.088
C	1.522	1.073	0.284
(4)Dep.var: P^m_t			
G_{t-1}	-0.257	-2.748	0.006
Y_t	-0.549	-3.510	0.001
P^{uf}_t	1.632	7.706	0.000
P^q_t	0.631	4.410	0.000
P^q_{t-1}	0.914	7.840	0.000
M_{t-1}	-3.182	-5.890	0.000
T	-2.529	-5.448	0.000
cons	-2.392	-0.635	0.526
(5)Dep.var: M_t			
G_{t-1}	-0.047	-5.070	0.000
Y_{t-1}	0.107	6.855	0.000
F_{t-1}	0.078	2.819	0.005
PO_{t-1}	0.000	-0.198	0.844
P^m_{t-1}	0.013	2.303	0.022
P^f_{t-1}	0.155	7.905	0.000
M_{t-1}	-0.425	-7.206	0.000
T	-0.275	-9.230	0.000
C	-0.099	-0.399	0.690

Table A3. Simulation 1: Government Control and Output Decline

Year	G (mil.ton)	Pq (yuan/kg)	Pa (yuan/kg)	Pm (yuan/kg)	M (mil.ton)	DS (% cult.area)
-1	480	1.3	1.3	1.3	3	0.1
0	480	1.3	1.3	1.3	3	0.1
1	432.9	1.310	1.281	1.279	1.810	0.25
2	472.1	1.325	1.309	1.311	2.768	0.1
3	470.9	1.330	1.262	1.252	-0.322	0.1
4	468.4	1.345	1.265	1.260	-0.628	0.1
5	467.2	1.356	1.260	1.251	-1.495	0.1
6	465.6	1.367	1.254	1.244	-2.317	0.1
7	464.1	1.379	1.248	1.237	-3.124	0.1
8	462.6	1.391	1.243	1.230	-3.932	0.1
9	461.0	1.403	1.238	1.223	-4.738	0.1
10	459.5	1.415	1.232	1.216	-5.540	0.1
11	458.0	1.427	1.227	1.210	-6.340	0.1
12	456.5	1.439	1.222	1.203	-7.138	0.1
13	455.0	1.451	1.217	1.196	-7.932	0.1
14	453.5	1.464	1.211	1.189	-8.725	0.1
15	452.0	1.476	1.206	1.183	-9.514	0.1
16	450.5	1.489	1.201	1.176	-10.301	0.1
17	449.0	1.502	1.196	1.169	-11.086	0.1
18	447.6	1.515	1.191	1.163	-11.867	0.1
19	446.1	1.528	1.186	1.156	-12.647	0.1
20	444.6	1.541	1.180	1.150	-13.423	0.1

Table A4. Simulation 2: Government Control and Large Fluctuations

Year	G (mil.ton)	Pq (yuan/kg)	Pa (yuan/kg)	Pm (yuan/kg)	M (mil.ton)	DS (% cult.area)
-1	480	1.3	1.3	1.3	3	0.1
0	480	1.3	1.3	1.3	3	0.1
1	432.9	1.310	1.281	1.279	1.810	0.25
2	508.9	1.572	1.550	1.587	2.768	0.1
3	525.3	1.574	1.661	1.631	0.189	0.1
4	475.4	1.259	1.317	1.223	-0.354	0.1
5	455.1	1.273	1.148	1.115	-2.207	0.1
6	451.3	1.287	1.146	1.131	-2.723	0.1
7	489.4	1.544	1.365	1.373	-3.322	0.1
8	505.1	1.553	1.506	1.464	-3.547	0.1
9	505.8	1.563	1.499	1.432	-4.597	0.1
10	455.9	1.250	1.174	1.080	-5.689	0.1
11	436.8	1.265	1.031	0.989	-7.136	0.1
12	470.4	1.518	1.222	1.215	-7.732	0.1
13	486.1	1.527	1.354	1.299	-7.639	0.1
14	486.7	1.537	1.345	1.268	-8.780	0.1
15	484.3	1.550	1.334	1.260	-9.801	0.1
16	482.8	1.564	1.330	1.255	-10.549	0.1
17	481.2	1.577	1.324	1.247	-11.413	0.1
18	479.6	1.590	1.319	1.240	-12.248	0.1
19	478.1	1.604	1.313	1.233	-13.083	0.1
20	476.5	1.618	1.307	1.226	-13.916	0.1