Understanding China's Grain Procurement Policy from a Perspective of Optimization

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Abstract

This paper develops an optimization model to analyze the policy formulation under China's dual-track grain procurement system. By capturing the redistribution objective and the urban food security objective in a political preference function, we provide some rigorous explanations of three important aspects of China's grain policies: the choice of the dual-track procurement system over the lump-sum tax scheme as a means of extracting economic surpluses from the grain sector; the suppression of the procurement price to its minimum until the mid-1990s; and the switch from taxing to subsidizing grain production at end-1996. Our findings underscore the paramount importance of the urban food security objective behind the evolution of China's grain procurement policy, including the liberalization of the system in the 2000s.

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1. Introduction

China established the unified procurement and sales system for grain (hereafter the grain procurement system) in 1953 as part of its ambitious pursuit of industrialization under central planning. The system required farmers to sell to the grain bureaus some specified quota amount of grain at suppressed prices and allowed qualified urban non-agricultural residents under the household registration (*hukou*) system to buy rationed grain from these agents at similarly suppressed sales prices. It therefore extracted economic surpluses from the grain sector for industrial investment by reducing the cost of wage-goods and thereby suppressing wages paid to urban industrial workers. Apparently the first underlying objective of China's grain procurement policy was to tax agriculture and support industry, similar to that of the redistribution policies in many developing countries (Krueger, 1993; Anderson, 2009).

While the unified procurement and sales system covered almost all agricultural products in the central planning period for the purpose of redistribution, it lasted the longest for grain.[1] The reluctance of China's policymakers to relinquish the control over grain marketing as compared to other industrial inputs in the reform period can be attributed to the objective of safeguarding food security for the urban non-agricultural residents. The adherence to this second objective had been central to the evolution of the

[1] China abolished the state procurement of most agricultural products by the first half of the 1990s except for grain and cotton. The cotton distribution was liberalized in 1998 when the government stopped its direct price intervention. Similar liberation in grain distribution took place only in the early 2000s.

state grain procurement system until the second half of the 1990s. It should be noted that China has adopted since the 1950s a set of complementary policies including the restrictions on the use of arable land, the prohibition of rural-to-urban labor movement through the *hukou* system, the tight grip on grain imports, and the state investments in rural infrastructure and technologies to boost grain self-sufficiency and thereby maintain food security for the whole nation. The state-controlled grain procurement system, the most important component of the policy set until its liberalization in the 2000s, served mainly to secure urban food security by targeting only urban non-agricultural households as the qualified consumers of the procured grain.

Until the late 1990s, China's policymakers always faced a dilemma in setting the procurement price and quota under the grain procurement system. While they needed to lower the procurement price to extract economic surpluses from any given quota, the disincentive effect discouraged farmers from delivering the assigned quota, which might jeopardize urban food security. It may be a general perception that under central planning the procurement plan would be enforced by socialist ideological education or punitive measures. However, it has been reported that even in the central planning era farmers expressed their dissatisfaction with the suppressed procurement prices by reducing the amount of grain they delivered, which in turn forced the government to raise the prices (Yuan, 1994). Despite the many failures in plan enforcement observed throughout the history of China's grain procurement system, one could not conclude that the policy was made without regard to farmers' reaction. Rather, it could be due to inaccurate assessment of the situation and the problems with implementation.

The Chinese policymakers' awareness of the need to incorporate farmers' reaction in the policymaking process is reflected in the numerous adjustments in procurement policy in the central planning era that aimed to boost farmers' incentives, including the price premium for above-quota delivery and material rewards tied to grain delivery. In the reform period, economic incentives were further enhanced by not only substantially raising fixed and above-quota procurement prices but also officially sanctioning market sales. With the establishment of the dual-track grain procurement system in 1985, those farmers who fulfilled their delivery quota would be allowed to sell surplus grain on the market. It signifies the increased reliance on the market to provide economic incentives to boost efficiency. It would be illuminating to examine China's grain procurement policy formulation under the dual-track system from an optimization perspective with reference to policymakers' objectives and farmers' reaction.

Theoretical analyses of China's dual-track procurement system are few. Sicular (1988) and Lau et al. (2000) focus on its efficiency and distributional effects. Assuming legal resale of goods between the plan track and the market track, they arrive at the same conclusion that efficient resource allocation can be achieved under the dual-track system. It is important to note that their conclusions regarding the efficiency impact of the dual-track system hinge on the assumption of successful enforcement of the state plan. Yet both studies assume exogenous procurement quota and price without considering the constraints on the setting of state plan to ensure enforcement.

There are some theoretical and empirical studies in the Chinese literature that analyze the case of enforcement failure or endogenous procurement quota and conclude that the procurement price has a positive impact on grain output (Cheng et al., 1993; Lin,

2000; Wang and Huang, 2001). Yet, there is no study that directly addresses the issue as to how the procurement price and quota are set to enforce the state plan. We make use of the endogenous theory of economic policy to fill this gap.

The endogenous theory of economic policy that recognizes policymakers as rational agents maximizing their political preference function subject to political and economic constraints has been widely applied in the study of government intervention in the farm commodity markets (Gardner, 1983, 1987; Oehmke and Yao, 1990; Rausser and Foster, 1990; Bullock, 1994). Based on the interactions between the government and various interest groups whose welfare will be affected by the policy concerned, the political preference function is a useful tool to analyze government policies regarding the pricing and trade of grain in the OECD countries including the US, Japan, and Korea (Oehmke and Yao, 1990; Lee and Kennedy, 2006). Specifying the function to capture the features of China's policy-making process, we will analyze the formulation of China's grain procurement policy.

Using an optimization model, the present paper examines the choice of the procurement price and quota to enforce the state plan, or to induce quota fulfillment. Following the results of Sicular (1988) and Lau et al. (2000), we assume that the dual-track procurement system does not distort resource allocation when the state plan can be enforced. We hypothesize that Chinese policymakers are rational decision makers who formulate grain policies in such a way as to maximize their political preference function subject to certain constraints. While a voluminous literature has been devoted to the study of China's grain sector and its procurement system, this is the first attempt to use an optimization model to explain the choice of the procurement price and quota.

The specification of the political preference function captures the two objectives of China's grain procurement policy mentioned earlier, namely, sectoral income redistribution and urban food security. Together with the constraint on plan enforcement derived from farmers' reaction, our model addresses the problem of policymaking regarding the procurement price and quota. Our results shed light on the following questions: 1) Would grain farmers be paid more than the minimum price necessary to induce quota delivery? 2) Why have China's policymakers not adopted lump-sum tax to redistribute economic surplus from the grain sector to the industrial sector? 3) What happened around 1996 that apparently changed China's policy stance from taxing to subsidizing grain production?

We will show that the answers to the above questions hinge on the importance of urban food security perceived by China's policymakers. As long as they stress urban food security and adhere to the state control of grain distribution, they will set the procurement price only at the minimum level necessary to induce quota fulfillment and prefer the quota procurement system to lump-sum tax as a means of redistribution. While many will attribute the apparent change in policy stance at end-1996 to the change in policymakers' preference in favor of grain farmers' welfare, our analysis shows that the switch from taxing to subsidizing farmers was largely a result of urban food security no longer being the guiding objective.

The rest of the paper proceeds as follows. The next section derives the constraint on the choice of the procurement price and quota with reference to grain farmers' behavior under the dual-track system. Section 3 specifies the political preference function to capture the Chinese features and uses the optimization model to analyze some major

policy choices that characterize the evolution of the system. Section 4 concludes the paper.

2. The Minimum Procurement Price for Plan Enforcement

China's grain procurement system has gone through numerous modifications since the 1950s. It is beyond the scope of this paper to do a comprehensive analysis. Instead, we will focus on the dual-track procurement system implemented between 1985 and the early 2000s. In essence, the dual-track system was installed to overcome the adverse effect on farmers' production incentive of the suppressed procurement prices for quota grain with a view to improving quota delivery and allocative efficiency (see Cheng (1996) and Wu and McErlean (2003) for some concise overviews).

Under the dual-track system, farmers who have fulfilled their quota can sell surplus grain at market-determined prices through two channels. The first one is voluntary above-quota deliveries to the grain bureaus at negotiated prices. These prices were not controlled by central directives but to be mutually agreed in response to market forces based on regional, seasonal, and quality factors (Sicular, 1993; Ke, 1995).[2] The second channel is the free market including, for example, the periodic rural market fairs and grain wholesale markets that emerged in the 1990s. Before the implementation of price protection policy at end-1996, the prices of surplus grain sold through these two channels moved in tandem with the free market prices being slightly higher (PYC, 1997).

[2] Prior to the dual-track system, the grain bureaus also procured above-quota grain from farmers at higher prices. However, such procurement might not be voluntary and the prices were set by the government but not determined by market forces (Ke, 1995; Cheng, 1996).

The revival of rural markets for agricultural commodities began in China as early as in 1978 and restrictions on private trade were lifted in subsequent years for most farm products (Sicular, 1993; Huang and Rozelle, 2006). While maintaining mandatory procurement of grain, the grain bureaus participated in market transactions through negotiated procurement. The government enforced quota delivery by making it the condition for negotiated transactions and closing the free market until the procurement quota had been fulfilled (Ke, 1995; Wu and McErlean, 2003). Within the share of market transactions in grain procurement that increased from 9 percent in 1978 to over 65 percent in 1998, negotiated transactions accounted for at least two-thirds of them until 1992 and about one half between 1993 and 1998 (Huang, 2001). Therefore the state agents could to a considerable extent monitor the quota fulfillment of those farmers who wished to sell surplus grain at market prices.

Abstracting from the crucial features of the dual-track procurement system, we specify the assumptions and construct the optimization model. First of all, we define the quantity of grain supplied by farmers as commercial grain that is net of their own consumption.[3] We assume that farmers will fulfill their delivery quota only in response to sufficient incentives. In reality, the incentives would include both economic and political rewards, or punishments. For simplicity, we will only consider economic incentives in terms of farmers' earnings.[4]

[3] Despite the cases of excessive procurement that jeopardized farmers' livelihood in the central planning era, we argue that rational policymakers would not expect the procurement policy to be feasible without allowing for farmers' subsistence.

[4] This assumption will not alter the nature of the optimization problem. For example, if the grain bureaus exert political or economic threat to coerce farmers into fulfilling their quotas, there will still be a minimum procurement price required for plan enforcement, albeit lower than the minimum level derived later in this section.

To derive the constraint on the choice of the procurement price and quota with reference to farmers' reaction, consider a dual-track system with the following assumptions. Farmers are required to deliver a quota amount of grain to the government at a fixed procurement price. Upon fulfillment of the quota, they can sell any amount of surplus grain on the market.[5] The procurement price and quota are set by the government. When the procurement price is set below the market price, farmers are induced to fulfill the quota only by the privilege to sell surplus grain on the market. If the procurement price is set above the market price, the procurement quota will transfer income to farmers. We assume the free market price and the negotiated price are the same in our model.[6] We further assume that all grain procured at market price will be sold to consumers at market price.[7]

Farmers are profit maximizers with identical marginal cost curves. They have the option whether or not to deliver the quota. The only penalty on farmers for not fulfilling the quota is denying them access to the free market for surplus grain. Yet the government will buy at the procurement price whatever amount farmers supply within the quota. The procured grain will be sold to eligible buyers at or below the procurement price. Given the bureaucratic authoritarian government of China, the cost of operating the sizable grain bureaus had not been the major concern in policymaking until the late 1990s. We will leave out the details of the implementation issues and assume that the grain bureaus

[5] In the actual implementation, farmers might choose to sell higher-value cash crops on the market after fulfilling their grain quotas. Nevertheless, this alternative action to take advantage of the market track would not alter the basic conclusion of our analysis.

[6] This simplifying assumption, which is justified by the observation that the two market-determined prices moved closely together until 1996, will not alter the nature of the optimization problem.

[7] Sometimes when the quota grain was not sufficient to meet the demand of qualified consumers for rationed grain, the grain bureaus would sell some of the grain procured at negotiated prices at the lower procurement prices incurring operating losses (Ke, 1995). We do not model this case as it is beyond the scope of this paper.

handle all transactions at zero cost. To rule out the possibility of allocative inefficiency that may result from having the rationed grain supplied to those low-marginal value urban users, we assume that the marginal benefit of these consumers is at least as high as the market price.[8]

[Insert Fig. 1.]

In Fig. 1, *D(P)* and *S(P)* respectively depict the market demand and supply curves under the free market system. *S(P)* is the horizontal sum of the identical marginal cost curves of individual farmers. Without government intervention in grain distribution, the equilibrium market price and quantity would be P^* and Q^*.

The present paper does not address the efficiency issue as the grain procurement system per se need not distort resource allocation as long as the state plan is enforced (Sicular, 1988; Lau et al., 2000). Hence we assume that the enforcement of procurement plan will achieve the same resource allocation as in the free market producing the same quantity of grain as given by the intersection of the demand and supply curves in Fig. 1. Our model focuses only on the choice of optimal procurement price and quota to ensure plan enforcement. We assume that both the policymakers and the grain farmers know the shapes of the market demand and supply curves.[9]

[8] The presence of black markets for rationed grain coupons until the early 1990s, which transferred the rights to purchasing rationed grain from low-marginal value consumers to higher-marginal value consumers, helps justify this assumption.

[9] This restrictive assumption can be replaced by the assumption of legal resale of goods between the plan track and the market track such that the procurement price becomes infra-marginal and does not affect the market equilibrium (see Lau et al., 1997 & 2000).

Let $\overline{P}$ and $\overline{Q}$ be the procurement price and quota set by the policymakers. Suppose the $\overline{P}$, $\overline{Q}$ combination is set below the supply curve as depicted by, for example, point *U* in Fig. 1. Farmers have two options. First, they can fulfill the quota and then sell surplus grain on the market. Second, they can deliver a smaller amount of grain to the state, forsaking the privilege to access the free market. They will choose the option that brings a larger producer surplus.

In Fig. 1, if farmers fulfill the quota, the amount of grain they deliver to the state, that is $\overline{Q}$, will bring a producer surplus of *area b–d*. Upon quota fulfillment, farmers have the privilege to sell surplus grain on the market. To maximize profit, they will sell $Q^* - \overline{Q}$ of grain on the market at price P^*, deriving a producer surplus of *area e*. The total producer surplus will be *b–d+e*. If farmers choose not to fulfill the quota, the profit-maximizing output will be $\hat{Q} = S(\overline{P})$ and the producer surplus will be given by *area b* in Fig. 1. Whether farmers fulfill the quota $\overline{Q}$ or just deliver an amount of $\hat{Q}$ to the government depends on the relative size of *d* and *e*. There are two possible cases assuming identical procurement and sales prices.

Case 1: *Area d* ≤ *Area e*

In this case, $b - d + e \geq b$. The procurement plan can be enforced as farmers will fulfill the quota. They will produce Q^* and sell the surplus grain at P^* after delivering $\overline{Q}$ to the government at the procurement price $\overline{P}$. The grain bureaus will then sell the quota amount at $\overline{P}$ to eligible consumers. The producer surplus will be given by *b–d+e* whereas the consumer surplus by the sum of area *BJUK* and area *EJW* in Fig. 1. The equilibrium output will be the same as that under a free market. Social surplus will be

maximized as represented by area *ABE*. Compared with a free market, the procurement system will transfer an amount equal to $(P^* - \overline{P})\ \overline{Q}$ from farmers to the industrial sector without changing the resource allocation.

Case 2: *Area d > Area e*

In this case, $b - d + e < b$. Farmers will produce and deliver only $\hat{Q}$ to the state, forsaking the privilege to sell surplus grain on the market. The procurement plan cannot be enforced. Compared with a free market situation, there is a deadweight loss equal to area *EFH* in Fig. 1.

The analysis of the two cases shows that farmers' behavior under the procurement system imposes a constraint on the choice of the procurement price and quota. If the $\overline{P}$, $\overline{Q}$ combination is chosen appropriately, the procurement plan can be enforced enabling the government to redistribute income without compromising allocative efficiency. This result is consistent with those in Sicular (1988) and Lau et al. (2000). In particular, the system redistributes income from the grain sector to the industrial sector when the procurement price is set below the equilibrium market price.

The state plan will be successfully enforced if the procurement price and quota are set at the levels that make farmers willing to comply. For any given quota, there is a minimum procurement price (MPP) that induces compliance. The minimum *MPP* curve, as depicted by *OMNE* in Fig. 2, gives the minimum procurement prices associated with different quotas. It divides all combinations of procurement price and quota in Fig. 2 into two regions. The one on or above the curve comprises all those combinations that induce quota fulfillment without distorting resource allocation. The combinations below the

curve entail enforcement failure making the total quantity supplied of commercial grain less than the free market equilibrium level.

[Insert Fig. 2.]

There are three segments to the *MPP* curve as depicted by *OM*, *MN*, and *NE* in Fig. 2. Segment *NE* corresponds to the case where the minimum procurement price exceeds b_0 in Fig. 1. It traces out all the $\overline{P}$, $\overline{Q}$ combinations for which the procurement price is above b_0 and *area e* = *area d* in Fig. 1. NE is upward sloping because any increase in the procurement quota will reduce the amount farmers sell to the free market and the associated producer surplus (i.e. *area e* in Fig. 1). To induce farmers to fulfill a larger quota, a higher procurement price must be offered. Note that any increase in the procurement price will increase producer surplus, as measured by *area b* along *NE*.[10] Therefore, movements along the *MPP* curve from point *N* to point *E* entail rising producer surplus. In particular, producer surplus equals zero at point *N*. When the $\overline{P}$, $\overline{Q}$ combination is set at point *E*, quota fulfillment under the procurement system will bring to farmers the same amount of producer surplus as under a free market.

[Insert Fig. 3.]

Segment *MN* corresponds to the case where the minimum procurement price is positive but below b_0. This case is illustrated in Fig. 3. Suppose the $\overline{P}$, $\overline{Q}$ combination is

[10] In Fig. 1, total producer surplus is given by $b - d + e$ and $d = e$ along *NE*.

given by point *U*. Without fulfilling the procurement quota, farmers cannot sell any grain on the market. Unable to cover the marginal cost of any amount of grain delivered to the government at such a low price, their optimal supply of grain will be zero, and so will be the producer surplus. To induce farmers to fulfill the quota, the $\overline{P}$, $\overline{Q}$ combination must enable them to derive enough producer surplus from market sales, as indicated by area *e*, to compensate their loss in quota delivery, which is given by area *d*. The equality between area *d* and area *e* determines the minimum $\overline{P}$ that is required for quota fulfillment. Note that in this case quota fulfillment only entails zero producer surplus. *MN* is upward sloping because an increase in procurement quota will reduce the gain from market sales, which must be balanced by an equal reduction in the loss incurred in quota delivery through upward adjustment in the procurement price. Along the whole MN segment, producer surplus is zero.

OM in Fig. 2 depicts the non-negative constraint on the minimum procurement price. Along *OM*, the procurement price is at its lowest possible value of zero requiring farmers to deliver grain to the government without receiving any payment. This quota delivery is virtually a tax in kind. Farmers are willing to deliver the free grain only because the subsequent access to the market enables them to derive sufficient producer surplus to compensate for the loss incurred in the quota delivery. When we move from the origin to point *M*, the procurement price remains zero while the quota increases, causing producer surplus to fall as an increasing amount of surplus is extracted from farmers. At the origin, producer surplus is the same as that under free market and it falls to zero at point *M*.

Let us take a closer look at some interesting $\overline{P}$, $\overline{Q}$ combinations on the *MPP* curve. One extreme case corresponds to the segment *MN* in Fig. 2. With these combinations, the government extracts the entire producer surplus. This is the extreme version of the case alleged by Gardner (1983) that the production-control approach in the form of Stalinist delivery quotas at state-set prices could be used to redistribute all producer surplus to consumers with relatively small deadweight loss. Another set of interesting $\overline{P}$, $\overline{Q}$ combinations is given by segment *OM* in Fig. 2. Any such combination is virtually a "grain tax" on farmers that is similar to a lump-sum tax. Thus the dual-track procurement system embraces the lump-sum tax scheme.[11] As the result is important for later analysis, it is stated in the following lemma.

Lemma 1: The dual-track procurement system embraces the lump-sum tax scheme.

3. The Optimal Choice of Procurement Price and Quota

To analyze the optimal choice of the $\overline{P},\overline{Q}$ combination in China's grain procurement system, we hypothesize that the policymaking process is not fundamentally different from that of other non-socialist countries. Chinese policymakers are assumed to be rational decision makers who seek to maximize their political preference function (PPF). However, as opposed to the standard PPF methodology that incorporates only the interest groups' welfare (Bullock, 1994), our model specifies the function differently to characterize China's political system. The decision-making of the Chinese leaders would

[11] As a matter of fact, the procurement quota assigned to farmers was a combination of the fixed procurement quota and a grain tax imposed on each piece of cultivated land according to its normal or expected grain output (Carter and Zhong, 1988). For simplicity, we only consider either pure quota procurement or pure lump-sum tax in the optimization model.

closely resemble that of an authoritarian leader identified by Baldwin (1996), whose decisions are heavily influenced by the ideologies that shape his economic and social views. Instead of being subject to direct political pressures from domestic interest groups, economic policies are made within the government bureaucracy where provincial governments and ministries organized by function negotiate for budget allocations or policies that would benefit their localities or sectors. We specify the PPF to capture the two major objectives of China's grain procurement policy, both of which stemmed from the heavy industry-oriented development ideology adopted in the central planning period. The first one was to redistribute economic surpluses from the grain sector to the industrial sector and the second one was to safeguard food security for the urban non-agricultural population. The PPF also includes the welfare of grain farmers and urban consumers to completely capture the consideration of sectoral income distribution in the formulation of China's grain procurement policy.

The policymakers pursue the redistribution objective by suppressing grain prices in order to keep urban wages and industrial costs low. We hypothesize that any saving in grain procurement costs would be translated into an equal amount of saving in industrial costs. The amount of the transfer, denoted by G, equals the reduction in procurement cost under the quota procurement system as compared to a free market system. It can be expressed as follows.

$$G = [P^* - \overline{P}\,]\;\overline{Q} > 0$$

The urban food security objective is captured by the size of the procurement quota $\overline{Q}$ in the PPF. The larger is the quota, the more cheap grain the government can make available to urban workers. When the policymakers are apprehensive about urban food

security, they will perceive the command of a larger procurement quota as better safeguard against insufficient urban food supply.

Our model adopts a partial equilibrium analysis, which is quite common among the analyses using PPF (Oehmke and Yao, 1990; Lee and Kennedy, 2006). Taking other complementary grain policies as given, which would determine the market equilibrium illustrated in Fig. 1 largely through their influence on the supply curve of commercial grain, the model provides rigorous answers to the three questions identified in Section 1 regarding the redistributive nature of China's grain procurement system. Consider the following political preference function.

$$PPF = U(T, \ \overline{Q}, CS, PS) \qquad U_i > 0, \ U_{ii} < 0 \ \forall i$$

where *CS* and *PS* denote consumer surplus of urban consumers and producer surplus of grain farmers respectively. *T* denotes the net transfer of economic surplus from the grain sector to the industrial sector, which is the gross transfer *G* introduced earlier net of any fiscal outlay incurred in grain marketing, which will be explained below.

The policymakers choose the optimal $\overline{P}, \overline{Q}$ combination that maximizes their PPF subject to the constraint governing plan enforcement as depicted by the area above and along the *MPP* curve. Let $g(\overline{Q})$ be the *MPP* curve that gives the minimum procurement price for quota $\overline{Q}$. The actual procurement price is $\overline{P} = g(\overline{Q}) + s_p$. Given that $g(\overline{Q})$ is already the minimum price to induce quota fulfillment, $s_p \geq 0$. A positive s_p indicates that the procurement price is above the minimum level, i.e. in the area above the MPP curve. And the grain bureaus sell the procured grain to eligible buyers at or below the procurement price. Let $g(\overline{Q}) + s_c$ denote the sales price. s_c ($\leq s_p$) and can be positive

or negative. When $s_c < s_p$, the government finances the price difference with fiscal outlay, which is given by $F = (s_p - s_c)\ \overline{Q}$.[12]

The net transfer, denoted by T in the following expression, is positive indicating the amount of surpluses extracted from the grain sector and made available for industrial investment.

$$T = G - F = [P^* - g(\overline{Q}) - s_p]\ \overline{Q} - (s_p - s_c)\ \overline{Q} = [P^* - g(\overline{Q}) - 2s_p + s_c]\ \overline{Q} \qquad (1)$$

To solve for the optimal $\overline{P}, \overline{Q}$ combination, we need to derive the corresponding producer surplus and consumer surplus. The producer surplus is composed of two parts, one associated with the minimum procurement price and the other with s_p.

$$PS = h(\overline{Q}) + s_p\ \overline{Q} \qquad (2)$$

where $h(\overline{Q})$ is the producer surplus associated with quota fulfillment at the minimum price. As shown in the previous section, $h'(\overline{Q}) < 0$ along OM of the MPP curve in Fig. 2; $h'(\overline{Q}) = 0$ along MN; and $h'(\overline{Q}) > 0$ along NE. As all the $\overline{P}, \overline{Q}$ combinations associated with plan enforcement result in the same resource allocation as under the free market, where the social surplus is denoted by W^*, the sum of consumer surplus, producer surplus, and net transfer to industry under quota fulfillment will also be W^*. Therefore consumer surplus is given by

$$CS = W^* - PS - T = W^* - PS - G + F.$$

Using equations (1) and (2), we can rewrite the last equation as

$$CS = W^* - h(\overline{Q}) - [P^* - g(\overline{Q})]\ \overline{Q} + (s_p - s_c)\ \overline{Q}\ .$$

[12] Sometimes the sales prices were increased together with the procurement prices. Then the fiscal outlay would be made in the form of allowances to urban workers if the government found it necessary to compensate them for the higher cost of living.

The following optimization problem represents policymakers' choice of $\overline{Q}$, s_p and s_c to maximize their $PPF = U(T, \overline{Q}, CS, PS)$.

$$\underset{\overline{Q}, Sp, Sc}{Max}\ PPF=U[(P^* - g - 2s_p + s_c)\ \overline{Q},\ \overline{Q},\ W^* - h - (P^* - g)\ \overline{Q} + (s_p - s_c)\ \overline{Q},\ h + s_p\ \overline{Q}\ ]$$

subject to $s_p \geq 0,\ s_c \leq s_p$

The following first order conditions must be satisfied for interior solution where $s_c < s_p$.

$$\frac{\partial U}{\partial \overline{Q}} = U_1(P^* - g - 2s_p + s_c - \overline{Q}\ g') + U_2 + U_3[-h' - (P^* - g) + s_p - s_c + \overline{Q}\ g'] + U_4(h' + s_p) = 0 \qquad (3)$$

$$\frac{\partial U}{\partial s_p} = -2U_1\overline{Q} + U_3\overline{Q} + U_4\overline{Q} \begin{matrix} < \\ = \end{matrix} 0 \qquad \text{for } s_p \begin{matrix} = \\ > \end{matrix} 0 \qquad (4)$$

$$\frac{\partial U}{\partial s_c} = U_1\overline{Q} - U_3\overline{Q} = 0 \qquad (5)$$

Equation (5) implies that $U_3 = U_1$. Substituting this equality into equation (4), we have $U_4 = U_1$ for interior solution that $s_p > 0$. Substituting these equalities into equation (3) we have

$$\frac{\partial U}{\partial \overline{Q}} = U_2 = 0, \qquad (6)$$

which contradicts the assumption that $U_2 > 0$. It implies that we cannot have interior solution for s_p.

For corner solution where $s_c = s_p$ and hence $F = (s_p - s_c)\ \overline{Q} = 0$, the PPF becomes

$U[(P^* - g - s_p)\ \overline{Q},\ \overline{Q},\ W^* - h - (P^* - g)\ \overline{Q},\ h + s_p\ \overline{Q}\ ]$.

The following first order conditions must be satisfied.

$$\frac{\partial U}{\partial \overline{Q}} = U_1(P^* - g - s_p - \overline{Q}\ g') + U_2 + U_3[-h' - (P^* - g) + \overline{Q}\ g'] + U_4(h' + s_p) = 0 \qquad (7)$$

$$\frac{\partial U}{\partial s_p} = -U_1 \overline{Q} + U_4 \overline{Q} \begin{matrix} < \\ = \end{matrix} 0 \quad \text{for } s_p \begin{matrix} = \\ > \end{matrix} 0 \tag{8}$$

To have interior solution where $s_p > 0$, equation (8) implies that $U_4 = U_1$. Substituting this equality into equation (7), we have

$$\frac{\partial U}{\partial \overline{Q}} = (U_1 - U_3)\,[h' + (P^* - g) - \overline{Q}\, g'] + U_2 = 0. \tag{9}$$

Note that when $s_c = s_p$, the sum of producer surplus and transfer to industry under procurement plan enforcement is equal to the producer surplus under a free market.[13] Therefore the following value remains the same for all $\overline{Q}$ under quota fulfillment.

$$PS + T = h(\overline{Q}) + [P^* - g(\overline{Q})]\,\overline{Q}\,.$$

It follows that

$$\frac{\partial (PS + T)}{\partial \overline{Q}} = h' + (P^* - g) - \overline{Q}\, g' = 0.$$

Substituting this equality into equation (9), we have

$$\frac{\partial U}{\partial \overline{Q}} = U_2 = 0, \tag{10}$$

which contradicts the assumption that $U_2 > 0$. Therefore equation (10) also implies that we cannot have interior solution for s_p and its optimal value must be zero. Equations (4) and (5) in the case where $s_c < s_p$ and equation (8) in the case where $s_c = s_p$ both imply that

$$U_1 > U_4.$$

[13] The equality can be verified with the help of Fig.1. When the procurement plan is enforced, $PS = b - d + e$ whereas $T = a + c + d$. $PS + T = a + b + c + e$, which is the producer surplus achieved under a free market.

Substituting the above findings into equations (3) and (7) respectively, we have the same result as follows.

$$h' = \frac{U_2}{U_1 - U_4} > 0$$

The above result answers the first two questions raised in this paper. First, as the optimal value of s_p must be zero, farmers will only be paid the minimum procurement price necessary to induce quota delivery. For any procurement price above the minimum level, there exists another price on the MPP curve that can achieve a larger quota while leaving the incoming distribution unchanged. From the policymakers' perspective, any extra amount paid to farmers above the minimum price would better be spent to enlarge the procurement quota.

The above implication is consistent with what happened under the dual-track grain procurement system until 1993. Following the price liberalization in the mid-1980s of cash crops and agricultural inputs, especially chemical fertilizers, as well as the rapid development of rural industries, the opportunity costs of grain production surged in the second half of the 1980s. To induce quota fulfillment, the policymakers had no choice but to adjust the grain procurement price upward. However, the Chinese government was reluctant to raise the grain sales price for fear of political risk associated with rising food prices. As a result, the procurement price rose above the sales price, i.e. $s_c < s_p$, leading to mounting fiscal deficits. The higher procurement price offered to farmers was only to compensate for their rising costs to induce quota delivery. They still received only the minimum price. Even if fiscal outlay is incurred in the marketing of grain, it is to reduce the sales price to consumers but not to benefit farmers. That is why various Chinese

researchers perceive urban consumers as the only beneficiaries of the price subsidies offered in this period (Ke, 1995; Tuan and Cheng, 1999).[14]

The result of the optimization problem also answers the second question regarding the choice between the quota procurement system and the lump-sum tax scheme. As h' must be positive, the optimal $\overline{P}$, $\overline{Q}$ combination must lie on the upward-sloping segment *NE* but not any other segment of the *MPP* curve in Fig. 2. In particular, it will not lie on the segment *OM* that corresponds to the lump-sum tax scheme. This illuminates the advantage of the dual-track procurement system over the lump-sum tax scheme. The reason is that for any amount of surplus extractable from any quota along *OM* by imposing a lump-sum grain tax, there will be a larger quota along *NE* that can extract the same amount of surplus via the dual-track system.

While it is well established in the literature that lump-sum tax is the most efficient way of transferring income in the absence of administrative cost, it is common among developing countries to adopt distorting price intervention instead. A well-acknowledged explanation is that their underdeveloped fiscal system renders lump-sum tax infeasible (Sah and Stiglitz, 1992). Nevertheless, the way in which China's dual-track procurement system operates would not make its administrative costs lower than that of a lump-sum tax scheme. The urban food security objective appears to be a more convincing explanation for the choice of China's policymakers. This view is substantiated by an incident that occurred in the 1990s.

[14] The price subsidies should be distinguished from another type of government outlay incurred in financing the inefficient operations and the rent-seeking behavior of the grain bureaus. While it reflects a significant issue of the implementation problems, they are beyond the scope of this paper.

Beginning in 1993 with the "unification of procurement and sales prices," grain rations and subsidies to urban consumers were abolished nationwide. It was a measure to reduce budget deficits incurred in grain marketing. In terms of the optimization model, it was a policy to eliminate price subsidies by setting identical procurement price and sales price, i.e. $s_p = s_c$. There was also an attempt to liberalize the grain markets to allow increased participation of private traders. Subsequent to some unexpected price surges, however, the policy was reversed in 1994 to make quota delivery compulsory again whereby the grain bureaus regained control of at least 70 percent of grain marketing (MoA, 1995). A research program jointly conducted by China's Ministry of Agriculture and the World Bank in the early 1990s would shed light on the reason for the policy reversal. One of the studies was to consider an alternative system that imposed a simple grain tax on farmers and purchased from them additional quantity of grain on the free market. It was estimated that even if the alternative system, with a proposed increase in tax rate from 3 percent to 7 percent, could have exactly the same redistribution effect as the quota procurement system, it would not enable the government to secure a sufficient amount of commercial grain (Guo, 1995). This finding illuminates the fact that a simple grain tax is a deficient instrument as far as urban food security is concerned.

Before we analyze the apparent switch in the policy stance from taxing to subsidizing grain production at end-1996, let us summarize the result of the maximization problem in the following proposition.

Proposition 1: Given the specified political preference function with urban food security being one of the arguments, the optimal procurement price is always at the minimum

level necessary to induce quota fulfillment and the quota procurement system is preferred to the lump sum tax scheme.

The role of urban food security in guiding grain procurement policy is pivotal in the explanation of the change in China's policy stance from taxing to subsidizing grain production. Let us examine the case where urban food security is no longer a concern of the policymakers. The corresponding PPF would have the procurement quota removed, i.e. $U_2 = 0$ whereas $U_i > 0$ for i = 1, 3, 4. Note that the derivation of our previous results depends on the assumption that U_2 is not zero (see equations (6) and (10)). Now that $U_2 = 0$, we can solve equations (3), (4) with equality sign, and (5) for the optimal values of $\overline{Q}$, s_p and s_c or solve equations (7) and (8) with equality sign for the optimal values of $\overline{Q}$ and s_p (= s_c). We can have interior solution for s_p meaning that the procurement price can be higher than the minimum level given by the MPP curve. In such a case, the procurement price and sales price are set according to the political weights of the three interest groups, namely, the industrial sector, the urban consumers and the grain farmers in the PPF given by U_1, U_3, and U_4 respectively. Therefore, when urban food security ceases to be a guiding objective, farmers can be paid more than the minimum procurement price if their welfare occupies a significant weight in policymakers' preference.

Proposition 1 does not apply to the situation in China beginning at end-1996 when consecutive years of bumper harvests in the mid-1990s resulted in substantial declines in market prices of grain. Since then the procurement prices have been higher than the market prices from time to time. This development could be attributed to two major

changes that altered the PPF. The first one affected the urban food security objective. The impressive post-reform growth of almost two decades led to a substantial increase in incomes of the city and township households. The overall share of grain consumption in their household budget dropped from above 22 percent in the 1950s and 1960s to 13 percent in the early 1980s and further to below 7 percent in 1996 (ZJXZ, 1996; NBS, 1997). Food security for China's urban residents would have ceased to be a pressing issue. It would no longer be imperative or even desirable for the state to command a large share of grain distribution. It suggests that $\overline{Q}$ would have ceased to be an argument in the PPF.

The second change was related to the redistribution objective. Since the mid-1990s, China's leaders have become increasingly concerned about farmers' welfare for at least two reasons. First, rural poverty and disparity between urban and rural incomes have been acknowledged as a threat to social and political stability.[15] Second, Brown's (1995) controversial wake-up call of "who will feed China?" alerted the government to the threat of national food security. It prompted the attempt to safeguard farmers' incomes against declining grain prices and thereby maintain their production incentives.

In the context of setting the procurement price, farmers' welfare would be considered as opposed to that of urban consumers and the surplus available for the industrial sector. In particular, the income distribution between grain farmers and consumers would be the major consideration. The increased political stake in the well-being of farmers, especially those engaged in grain production, would have added greatly to the weight of the producer surplus in the PPF relative to that of the consumer surplus.

[15] The ratio of urban to rural per-capita income rose from 1.86 in 1985 to 2.86 in 1994 and reached 3.11 in 2002 and 2003 (MoA, 2004). The link between rural poverty and social unrest in the countryside has been widely reported in the mass media (see, for example, *Jingji Ribao (Economics Daily)*, 9 August 2002; Bodeen, 2005).

It was against this backdrop that China implemented the price protection policy in November 1996. Whenever the free market prices fall below the state-set procurement prices, the grain bureaus will procure above-quota grain at protective prices. In that case, market-determined negotiated prices would be replaced by price floors set by individual local governments. As noted by Lu (1999), the policy signals a historical shift in the role of China's grain pricing policy. Instead of extracting economic surpluses from the grain sector, now the government subsidizes grain production and farmers. Deriving net transfer from the grain sector would have ceased to be a policy objective.

[Insert Fig. 4.]

To analyze the working of China's grain procurement system after 1996, we need to modify the PPF. The net transfer T and the procurement quota $\overline{Q}$ will be removed with only the consumer surplus and the producer surplus remaining, i.e. $U_1=U_2=0$, $U_3>0$ and $U_4>0$. We will not give a complete analysis here as it is obvious that a substantial increase in the political weight of farmers' welfare in the PPF could result in the procurement price rising even above the market price when price subsides are available. This is the case of grain procurement at protective prices that occurred in China between end-1996 and 1999 (Fig. 4).

China's leaders have stated repeatedly their adherence to the grain self-sufficiency policy to maintain national food security (Huang et al., 1999; Huang, 2004). The upward trend of assistance to grain farmers to boost their production incentive would only be contained by two factors, namely, the fiscal outlays that the government can afford and

the constraints imposed by WTO on China's domestic grain marketing and trade policies. While the state-controlled grain procurement system is a possible instrument to help safeguard national food security by channeling transfers to farmers, the changes since the 2000s reveal that it is not perceived by the policymakers as an effective instrument to serve this purpose. Starting from 2002, grain marketing was gradually liberalized decoupling many of the subsidies from state procurement. That is, farmers get those subsidies whether they sell their grain to the state-own grain corporations or private traders. The liberalization of grain marketing is believed to be completed in 2004 reflecting the ultimate relinquishment of the long-held ideology that the state should control grain distribution (Ye, 2004).

4. Conclusion

China adopted the state-controlled grain procurement system in 1953 as an integral part of central planning to achieve the development goal of heavy industrialization. The policymaking process encompasses ideological, political, and economic considerations. Capturing the crucial objectives of sectoral income redistribution and urban food security with the political preference function, the present paper analyzes the choice of the procurement price and quota under the dual-track grain procurement system. Our approach has yielded some fruitful results offering coherent and rigorous explanations of three important aspects of China's grain policies: the choice of the dual-track procurement system over the lump-sum tax scheme as a means of extracting economic surpluses from the grain sector, the suppression of the procurement price to its minimum until the mid-1990s and the switch from taxing to subsidizing grain

production at end-1996. Our findings underscore the paramount importance of the urban food security objective behind the evolution of China's grain procurement policy.

Many factors together determine the intricate developments of China's grain procurement system. This paper attempts to perform a rigorous analysis of the policy formulation and inevitably omits many details regarding the implementation issues. Therefore our results should be read together with those in the literature to command a thorough understanding of the evolution of China's grain policies. By identifying the roles of the grain procurement system as but one component of a whole set of complementary policies, this paper enables us to interpret and evaluate its evolution more accurately. In particular, the pursuit of national food security by means of self-sufficiency will not preclude the dismantling of the state-controlled grain procurement system, which only serves to safeguard food security for the non-agricultural sector.

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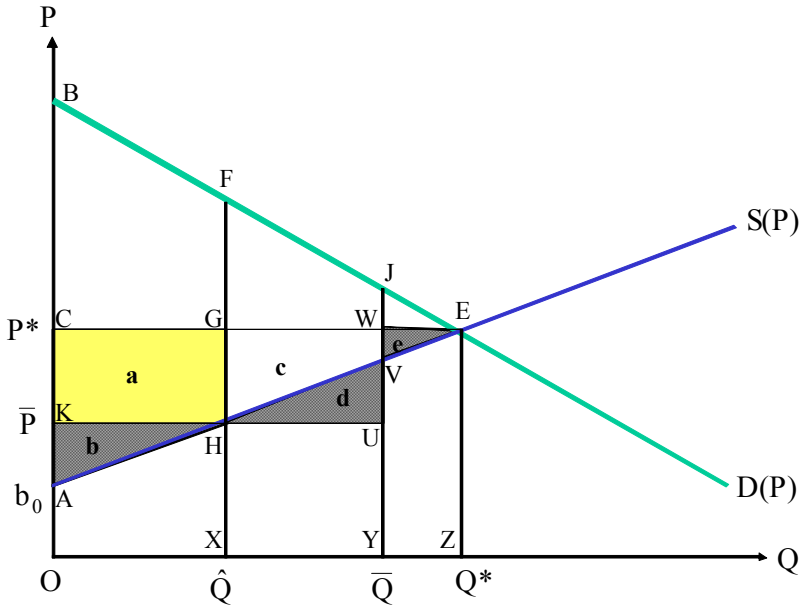

Fig. 1. To deliver quota or not?

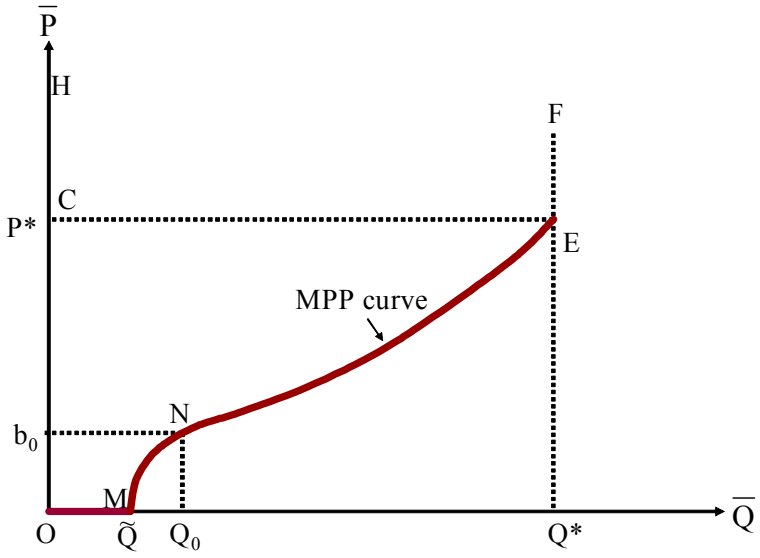

Fig. 2. Minimum procurement price (MPP) curve.

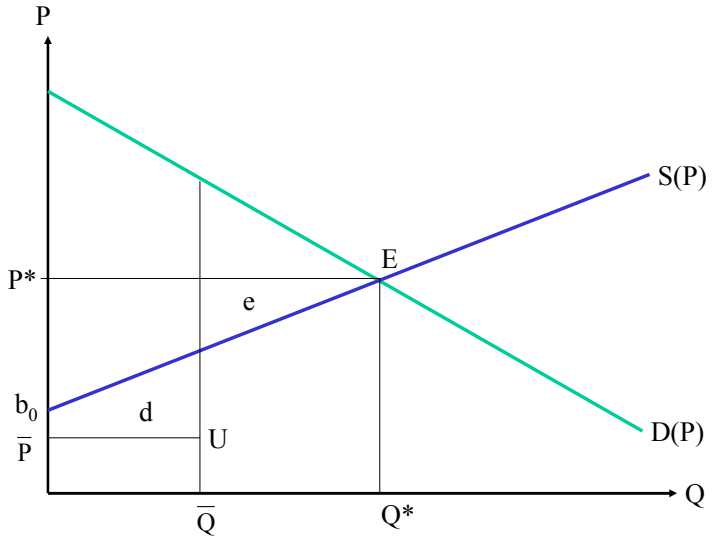

Fig. 3. When the procurement price is below b_0.

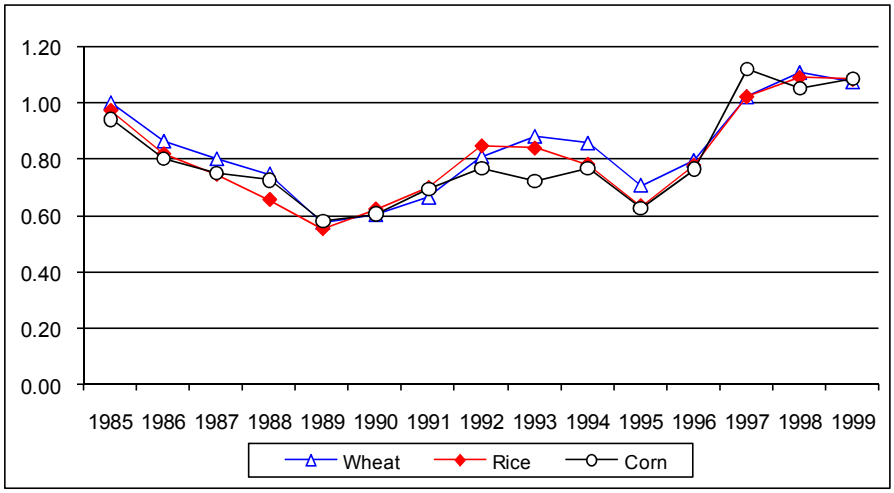

Fig. 4. Ratio of Procurement Price to Market Price of Grain, 1985-1999.[16]

[16] This chart is based on official data published in China's Agricultural Development Report 1996 and 2003. Due to the lack of data, the market prices of grain are approximated by the negotiated prices that always lie between the procurement price and the market price. A ratio of greater (less) than one indicates that the procurement price is higher (lower) than the market price. The series ends at 1999 as no published data on negotiated prices are available after that year.