

Government Policies and On-Farm Wheat Allocation in Rural China

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Research Discussion Paper No. 45

September 2000

The authors wish to thank Scott Rozelle for making the survey data available and Scott Rozelle, Dan Sumner, and other participants in the UC Davis Development workshop for their insights and thoughtful comments. The Montana Agricultural Experiment Station and the Trade Research Center at Montana State provided research support for this project.

The purpose of research discussion papers is to make research findings available to researchers and the public before they are available in profession journals. Consequently, they are not peer reviewed.

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Abstract

Market-oriented policy reforms have potentially important effects on farm-level grain production and utilization decisions in developing countries. This paper provides an empirical evaluation of the potential effects of market liberalization in China on farm-level wheat consumption, market sales, and on-farm storage. The results indicate that price changes have economically important impacts on utilization decisions by farm families through both income and substitution effects and that off-farm income also appears to be significant. The potential to earn off-farm income is also shown to be an important factor in grain utilization decisions. Storage is affected by government procurement policies as well as by more traditional food and income security considerations. The results indicate that policy makers should account for such changes in farm household behavior in designing and assessing the consequence of market liberalization programs for agricultural sectors in developing countries.

Keywords: China, Wheat, Grain Storage, Procurement Quotas, Household Allocation Decisions

JEL Codes: Q18, O13, P23, D13

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Introduction

In 1993 and 1994, the Chinese government's grain acquisition policies and market controls were subject to extensive reforms. Mandatory farm-level grain delivery quotas were reduced, private grain markets liberalized, and prices paid by government grain buyers for both quota and over-quota purchases tied more closely to private market prices. In addition, government price subsidies for urban consumers were to be substantially reduced and urban market prices to be closely aligned with procurement costs. In fact, in many regions, government procurement agencies continued to offer low prices for over-quota purchases (Park and Rozelle 1998). As a result, relieved of most restrictions on sales to private markets, many farmers increased grain sales to private markets or increased storage in anticipation of future private market sales. Consequently, urban consumers experienced up to sixty percent increases in wheat prices and responded by demanding policy adjustments (Rozelle et al. 2000). Thus, in late 1994 and 1995, the government responded to urban consumer concerns by rolling back many of the grain market reforms introduced in 1993.

This paper utilizes farm level cross-section data from 155 farm households in six villages within two primary wheat producing regions to estimate the effects of changes in government quota and price policies on the allocation of wheat by Chinese farmers. The survey data, collected during the spring of 1995 from Hebei and Liaoning Provinces, provides information on farm household behavior during the period in which China's private grain markets were least regulated. The results of the study, therefore, are of particular interest because parameter estimates of price effects are less likely to be biased downwards because of unobserved government restrictions on private market sales.

The determinants of end-of-year farmer-owned wheat stocks in China are of particular interest as they have been estimated to be quite large, amounting in aggregate to between 85 and 111 percent of production in the early 1990s (Crook 1996; Foreign Agricultural Organization 2000). Crook has suggested that a number of factors are important in determining the levels of stocks held by Chinese farmers. He has argued that Chinese farmers hold large grain stocks partly because they serve as a form of lifetime savings (private land ownership and enrollment in state pension plans by farmers are limited). Crook also proposes that Chinese farmers hold grain stocks because of financial and grain market imperfections, government grain price policy and market restrictions, and historically developed farmer attitudes toward risk of food shortages. The factors identified by Crook are generally consistent with commonly held views that farmers in developing countries hold grain stocks because of convenience yields (Renkow 1990), grain or credit market imperfections, risk aversion (Saha and Stroud 1994; Johnson and Song 1999), as a price hedge (Park 1996), food security concerns (Ke 1996), and—as in developed countries—in anticipation of profits (Gardner 1979).

In this study, we develop an inter-temporal theoretical model of farm household wheat utilization decisions for consumption, market sales, and changes in storage. The model, while in many respects similar to those developed by Saha and Stroud (1994) and also Carter and Zhong (1999), is novel in that it accounts for the effects of China's grain procurement program on farm household wheat allocation between consumption, storage, and market sales. The predictions of the model are tested using cross section survey data through an econometric model of wheat utilization that accounts for household demographic and economic characteristics.

The empirical results reported here are largely consistent with the predictions of the theoretical model and indicate that market prices and government quota policies have economically

important effects on farm consumption, on-farm storage and market sales. The potential for households to earn off-farm income and household wealth are also important determinants of household wheat utilization decisions. The econometric results are also consistent with the implications of Park's dynamic programming model of market grain sales by poor households in China.

Chinese Agricultural Policy and Grain Utilization

Despite the abandonment of collective production teams and restrictions on grain production by individual households in 1979, in the 1980s and the 1990s the Chinese government continued to rely on a grain acquisition and distribution system that involved a considerable degree of control by the central and provincial governments (Sicular 1995). Through a government quota procurement system introduced in 1953, grain producers were ordered to deliver specific quantities of grain to government grain bureaus at relatively low fixed prices. These bureaus then distributed grain at subsidized prices to permanent urban residents.

In the 1960s, an over-quota procurement system was implemented under which, after meeting the predetermined quotas, producers could sell grain to the government at a premium over the quota price. Despite some significant changes, the core elements of this quota-based grain procurement program still remain in place. In the 1990s, farmers still had to comply with predetermined delivery quotas to government grain bureaus at prices well below those for over-quota sales either to government grain bureaus or to private buyers.¹

Over the period 1991 to 1993, substantial market-oriented reforms were implemented for grain sales. Under these reforms, as noted above, in some provinces farmers enjoyed reductions in mandatory delivery quotas for wheat and were also allowed to sell over-quota production either to government grain bureaus at premium prices or, perhaps more important, into private markets. In

addition, grain price subsidies to urban consumers were substantially reduced. In May, 1991, for example, retail prices for government procured grain were increased by 67 percent (Findlay and Watson 1999) and in 1992 were further increased to approximately correspond to procurement prices paid for over-quota grain (Lin 1992).

In late 1994 and in 1995, higher grain prices in urban markets created considerable political pressures. In response, the government effectively prohibited many farmers from selling over-quota production into private markets, effectively reestablishing monopsony powers for regional government grain bureaus. The key elements of the current government grain acquisition program, put into effect in 1998 during a period of low world market prices, are as follows (Findlay and Watson 1999). Farmers still have to meet grain delivery quotas and receive lower prices for quota grain. Grain Bureaus have exclusive rights to purchase all farmer-marketed grain, while private merchants may only buy grain from government grain bureaus. Grain bureaus must pay market prices for any over-quota grain farmers want to sell unless prices fell below predetermined minimum levels; that is, farmers are guaranteed a minimum price.

The period of liberalization of grain markets in 1993 and 1994 provided China's farmers with opportunities to respond to higher private market prices by reallocating grain between household consumption, storage and private market sales. Reportedly, although grain and credit markets remained imperfect (Park 1996), farmers responded to partial market liberalization by reallocating grain into private markets (Findlay and Watson 1999; Park and Rozelle 1998). As evidenced by the Chinese government's decision to roll back the market liberalization component of the reforms, the extent to which farmers reallocated grain between market sales and other uses was unanticipated. In the next section we present an inter-temporal theoretical model of the farmer's grain allocation decision that captures the potential effects of the key elements of China's grain policy in the 1990s.

Model

The farmer's post harvest decision for allocating wheat between household consumption, storage, market sales and fulfilling the government delivery quota is modeled as an intertemporal decision. Following Saha and Stroud and also Carter and Zhong, the farm household is assumed to optimize wheat allocation among competing uses in the context of an additively separable (in time) utility maximization model in which input decisions are taken to be exogenous and the allocation decision is subject to wheat quantity and income constraints.²

The farm household maximizes the discounted present value of expected utility in two periods, period 0 and period 1. In period 0, the farm has already harvested its crop, but the crop harvest in period 1 is unknown. Household utility in each period depends on household grain consumption, c , and the consumption of a numeraire good, y . In each period, utility also depends on a vector F of measurable family characteristics. Utility in period 1 is defined through the expected values c_1 and y_1 and by a random vector μ that defines departures from these expected values due to variability in wheat production and prices. The farmer's objective function is:

$$(1) \quad U(c_0, y_0; F_0) + \phi E[U(c_1, y_1; F_1, \mu)]$$

where $U(\cdot)$ is a twice differentiable utility function over wheat consumption and the numeraire good, F_i is a vector of farm family characteristics in year i , ϕ is the discount scalar, and $E[\cdot]$ is the expectation operator defined over random μ .

Household income in period 0 is defined as:

$$(2) \quad y_0 = p_{q0} \bar{q}_0 + p_{f0} \cdot q_{f0} - k(s_0 + \Delta s_0) + NW(r_0, F_0, w_0),$$

where \bar{q}_0 is the government procurement quota, q_{f0} is the quantity of grain sold on the free market, p_{q0} is the price paid for grain under the government quota, p_{f0} is the over-quota market price for wheat, s_0 is the initial level of storage in period 0, and Δs_0 is the net addition to household grain storage. Storage costs in period 0 are $k(\Delta s_0 + s_0)$. Prices are assumed to be known in period 0 but not in period 1. The function $NW(\cdot)$ denotes non-wheat income, which depends on the value of farm produce other than wheat (r_0), the value of off-farm income and family wealth as proxied by the vector of family characteristics (F_0), and the village wage level (w_0).³ The vector of family characteristics includes household non-agricultural wealth and demographic information that reflects potential on- and off-farm labor supply (see de Brauw, Taylor, and Rozelle [2000] and also Giles [2000] for analysis of household labor patterns in rural China).

The wheat consumption constraint in period 0 is:

$$(3) \quad c_0 = Q_0 - q_{f0} - \bar{q}_0 - \Delta s_0$$

where the farm's wheat output, Q_0 , is known. The income constraint in period 1 will be:

$$(4) \quad y_1 = p_{q1}\bar{q}_1 + p_{f1} \cdot q_{f1} + NW(r_1, F_1, w_1)$$

where the period 1 values of the market price for wheat, the quota price, non-wheat income and wealth, and the quota price and quantity levels are all unknown in period 0.

Given the random harvest level Q_1 , the consumption constraint in period 1 will be:

$$(5) \quad c_1 = Q_1 - q_{f1} - \bar{q}_1 + (s_0 + \Delta s_0)$$

Since we are modeling only two-periods, the household does carry grain stocks beyond period 1.

In this framework, the farm household's wheat allocation problem in period 0 is:

$$(6) \quad \max_{X_0} H = U(c_0, y_0, F_0) + \phi E[U(c_1, y_1, F_1; \mu)]$$

subject to the income and wheat quantity constraints in equations (2), (3), (4) and (5), where $X_0 = \{q_{f0}, \Delta s_0\}$, with market sales and additions to storage defining wheat consumption through the constraint in equation (3).^{4, 5} Assuming that interior solutions exist, the first order conditions for the wheat allocation choice variables yield the following results:

$$(7a) \quad H_{q_{f0}} = -U_{c0} + P_{f0} U_{y0} = 0, \text{ and}$$

$$(7b) \quad H_{\Delta s_0} = -U_{c0} - U_{y0} \cdot \frac{\partial k}{\partial \Delta s_0} + \phi E[U_{c1}] = 0.$$

Equation (7a) implies that the marginal rate of substitution between grain consumption and the composite good equals the ratio of the prices of the two commodities and also defines the opportunity cost of wheat consumption as $P_{f0} U_{y0}$. Equation 7(b) implies that the marginal utility loss from foregone grain consumption plus the marginal utility loss of income due to storage costs equals the discounted expected marginal utility from grain consumption in period 1. Optimal consumption in period 0 is determined simultaneously with both optimal market sales and additions to storage through the constraint in equation (3) and the first order maximization conditions (7a) and (7b). In a reduced form context, these optimal values depend on grain production, quota levels, wheat market prices, sources of farm income other than wheat market sales (including quota revenue and market sales of other farm products), family characteristics, and expectations about grain production and other stochastic variables in period 1.

Some insights about the implications of changes in exogenous variables on the solution to the farmer's maximization problem in period 0 are provided by Figure 1, which abstracts from

changes in stock levels and storage costs. In Figure 1, production of the wheat consumption good (c) and the aggregate good (y) in period 0 occur at point A on the production possibilities frontier (PPF). However, this *ex post* production point does not define the Chinese farmer's relevant market sales and consumption opportunities. Given that stocks remain constant, wheat available for market sales and consumption equals wheat production less the farm's government procurement quota which is subject to a mandatory price discount. The availability of the composite good is increased from its level at point A by the quota revenue ($\bar{q}_0 p_{q0}$). Thus the initial endowment of wheat and the composite good available for allocation between competing uses is defined by point B. At B, market prices determine the consumption budget line that defines the farmer's consumption opportunity set. Given this opportunity set, the farm household can utilize wheat sales in private markets (or to government grain bureaus) to achieve the level of welfare associated with indifference curve U_0 that is tangent to the household's budget constraint at point C. Note that the farm household does not have the option of autarky at a point such as D since the government rigorously enforces the quota.⁶

Provided that wheat is a normal good, the first order conditions (7a) and (7b) imply that wheat market sales will increase with production, decrease with the quota level, and increase with carry-in stocks. Market sales will increase with the price of wheat if the ratio of the marginal utilities ($\frac{U_{c0}}{U_{y0}}$) increases as y_0 increases, but absent this constraint an unambiguous prediction does not follow from the model. Wheat market sales increase with increases in other farm sources of income in

period 0 as the composite good is normal, but may be associated with either reduced wheat consumption, or lower stock levels, or both.

If wheat is a normal good, wheat consumption in period 0 increases with production, decreases with an increase in the quota (because of a downward shift in the budget constraint), increases with carry-in stocks, and increases with other farm sources of income (besides wheat market sales). Increases in the price of wheat increase potential farm income and therefore could lead to either increases or decreases in consumption if wheat is a normal good because of offsetting farm income and substitution effects (see also Carter and Zhong 1999). Only if wheat is an inferior good will consumption definitely decline as the price of wheat increases.

If wheat is a normal good, additions to wheat stocks will increase with production, decrease with increases in the quantity of the quota, and decrease with increases in other farm sources of revenue under decreasing absolute risk aversion. Additions to wheat stocks will decrease with carry-in stocks if storage costs increase with the stock level.

Increases in the current market price for wheat increases the opportunity cost of holding stocks, but also increase the farm household's income available for current and future consumption. These offsetting price and income effects preclude any definite predictions of the effects of increases in the current market price on wheat storage.

The above two-period model can also be used to obtain insights about the effects of changes in expected production, quota level, other farm sources of revenue, the wheat market price in period 1, and other variables of interest. However, these effects clearly also depend on the nature of the farm households' risk attitudes. The survey used in the empirical analysis presented below provides only cross-section data for period 0. The lack of time-series data therefore precludes any hypothesis tests about the effects of risk or changes in exogenous variables in period 1 on wheat consumption, storage, and market sales in period 0.

The predicted effects on wheat allocation decisions of changes in the values of key exogenous variables in period 0 are summarized in Table 1. These predictions are based on the assumption that both wheat and the composite commodity are normal goods. As noted above, the absence of unambiguous predictions about the effects on market sales, consumption, and storage of market price increases is consistent with Carter and Zhong's argument regarding these offsetting income and substitution effects for consumption.

Data

Cross-section household survey data were collected under the direction of researchers at the University of California at Davis in the spring of 1995, the last crop year in the period during which government policy was most liberal in terms of farm access to grain markets. More than 200 households were surveyed across 6 villages in two wheat producing provinces in Northeast China, of which 155 provided sufficiently complete responses to be utilized in the econometric analysis

presented below. Data were obtained on production, family size, consumption, storage, prices of crops and borrowing. Descriptive statistics for variables included in the estimated econometric models discussed below are presented in Table 2.

Households were included in the analysis if they had “farm resident status” (lived on the farm) and also had to fulfill a wheat delivery quota. The households included in the sample obtained substantial income from farming, but some also had considerable off-farm income and family members may even have lived off the farm for some period of time during the crop year. After meeting their mandatory delivery quotas, farmers with permanent farm resident status generally had considerable quantities of wheat available for household consumption or market sales. Among the farms included in the sample, average total harvested wheat production amounted to over 1,800 kilograms (kgs) and ranged from about 350 to 7,000 kgs per household. On average, 19 percent of the current year’s wheat harvest was utilized to meet quota requirements, 40 percent was consumed by the household, 17 percent was sold into private markets, 1 percent was sold to government grain buyers through negotiated sales, 7 percent was added to storage. The use of the residual 8 percent was not identified but, presumably, was used either for livestock feed, or lost in storage, or processed at home. The average amount of over-quota wheat available per farm included in the sample was 1,229 kilograms (approximately 45 bushels), ranging from a minimum of a 62 kilogram deficit (approximately 2.3 bushels) to a maximum of 4,035 kilograms (approximately 148 bushels). Government procurement quotas varied substantially among farms, ranging from a minimum of 16 kgs to a maximum of 2,974 kilograms.

Exogenous factors influencing the post harvest wheat allocation decision include crop yield in the current period (which is known prior to the allocation decision), carry-in wheat stocks, the government delivery quota, predetermined quota revenue, the wheat market price, the village wage,

family characteristics, and a measure of non-agricultural household wealth (value of consumer durables plus the value of the family's house). The separation of household income into revenue from wheat marketings, quota revenue, and income from other sources permitted the explicit empirical evaluation of the effects of exogenous (non-wheat) sources of income on wheat consumption, sales, and storage. In this regard, the empirical analysis presented below differs from those of Carter and Zhong and Saha and Stroud.

The quantity of wheat available to farmers in period 0 after satisfying the quota requirements is defined as “disposable wheat” (the difference between harvested wheat and the sum of the farm's delivery quota, seed use, and wheat swaps).⁷ Wheat carry-in stocks are included as a separate explanatory variable to delineate between the effects of new production and carry-in stocks on current period wheat allocation decisions.

A wheat price variable is constructed to measure the relevant prices faced by farmers. Many farms in the survey had no wheat sales. In addition, reported farm level sales prices reflect seasonality, quality differences, differences in each farmer's negotiating ability, and differences in market opportunities across villages. In terms of the opportunity costs of consuming and storing grain, seasonal variations should not be included in price measures, while quality differences, differences in negotiating ability, and village differences should be included. Therefore, prices received by each farmer reporting market or negotiated grain sales are detrended using a linear time trend.⁸ Thus, these detrended prices still reflect quality premiums, gains associated with negotiating ability, and village market opportunities. Village averages of detrended prices are used as proxies for market prices faced by farmers who have no reported grain sales. Among the 155 households included in the econometric analysis, 58 reported market sales of wheat to private buyers, 15

reported negotiated sales of wheat to government grain buyers (of these 15, three also had sales to private buyers), and 82 had no market sales.⁹

Other sources of farm income are defined to include quota revenues from government purchases of both wheat and corn (the two major grains in this survey area) and the quantity of the farm's disposable corn.¹⁰ The disposable quantity of corn indicates both the income potential from corn sales or livestock feeding and potential effects on wheat storage costs (because corn stocks compete with wheat stocks for storage space).¹¹ Off-farm earnings are also important sources of income for many of the households in the sample and on average are almost four times higher than revenues from corn and wheat sales. However, some farm households report no off-farm earnings. We therefore use instruments to account for each household's potential for off-farm earnings to avoid a potential errors-in-variables problem associated with using off-farm earnings as an explanatory variable. Four demographic variables are related to the potential for off-farm earnings, farm labor, and consumption: (1) the number of family members of working age (between 13 and 60) living on the farm, (2) the average wage level within the village, calculated as the mean wage for survey respondents working within a village, (3) the number of family members of working age living off the farm (not more than 9 months) who can provide income remittances to the farm, and (4) the household head's average educational level.¹² Another variable, the number of family members of non-working age (under 13 or over 60) living on the farm, primarily relates to wheat consumption.

Household wealth is also a potentially important determinant of farm household decisions (e.g., de Brauw, Taylor, and Rozelle 2000). Chinese farmers cannot currently own land and financial markets are underdeveloped, so consumer durables and housing may provide relevant measures for

wealth other than agricultural commodities.¹³ Here, we combine reported values of each farm family's consumer durables and housing to obtain a proxy for non-agricultural wealth.

Disposable wheat (harvested wheat less wheat used for quota deliveries, seed, and swaps) represents the post-harvest quantity of wheat available for consumption, storage, and market sales allocations. On some farms, reported harvested wheat production was insufficient to cover quota, seed and swaps and thus the quantity of disposable wheat was negative. In these circumstances, farms met their quota obligations and consumption needs by drawing down their stocks and/or through market purchases. Carry-in stocks were reported to be quite large—on average one-fifth of the current year's harvest.

Estimation Issues and Results.

Separate regression equations were estimated for additions to grain storage, on-farm consumption, and market sales for the 1994 crop year (period 0 in the model presented above). Although contemporaneous correlation between errors across equations was expected, a seemingly unrelated regression system of equations was not used because each equation had the same explanatory variables (Judge et al. 1988). Over half of the farm households had no market or negotiated sales and therefore a Tobit regression model was used for market sales. Village dummy variables are not included in the regressions because they would be perfectly collinear with the village average wage variable. To avoid potential heteroscedastic error problems related to land area, all dependent and independent variables were normalized by dividing them by a measure of land area that accounts for differences in land quality. Farmers reported land holdings in four subjective land quality categories (good, average, poor, very poor). Village average yields for each land quality category were used to construct a single normalized measure land holdings adjusted for yield variations across the four land categories.¹⁴

Coefficient estimates for the models of additions to storage, home consumption, and market sales are presented in Table 3. Explanatory variables with statistically significant coefficients include disposable wheat, carry-in stocks, the detrended wheat market price, measures of other potential farm and non-farm sources of family income, family demographics, and non-agricultural household wealth.¹⁵ Each estimated equation is discussed in turn.

Additions to Storage

The following variables are estimated to have statistically significant effects on the allocation of harvested wheat into on-farm stocks: the quantity of disposable wheat, the level of carry in stocks, the market price of wheat, the quantity of disposable corn, the number of family members living off the farm, the number family members of non-working age living on the farm, and the village wage level.

In the stocks equation, the coefficients for disposable wheat (positive) and carry-in stocks (negative) have the expected signs, indicating that additions to stocks increase with larger harvests, decrease with larger quotas, and decrease when carry-in stocks are already large. Higher wheat market prices reduce the quantity of wheat allocated to storage, indicating that increases in the opportunity costs of storage reduce stock holding. As the quantity of disposable corn increases, additions to wheat stocks decline, reflecting either reduced risk effects under decreasing absolute risk aversion, or increasing costs to storage, or both.

As the number of family members working off the farm increases, additions to wheat stocks decline, possibly reflecting reductions in income risk because of increases in potential off-farm remittances. These risk mitigation effects are consistent with evidence based on the analysis of time-series/panel data reported by Giles. As the number of family members of non-working age living on the farm increases, measured wheat stocks decline, probably because of increased wheat

consumption requirements.¹⁶ Off-farm family members consume on-farm wheat because the survey utilized here included off-farm members only if they lived on the farm for at least three months of the year. The absolute size of the coefficient for these off-farm family members, however, is larger than the coefficient for other farm members, suggesting that their impacts on stock-holding decisions include risk mitigation effects.

Wheat Consumption

The following variables are estimated to have statistically significant effects on the allocation of harvested wheat into consumption: the quantity of disposable wheat, the market price of wheat, the number of family members of working and non-working age living on the farm, the village wage level, and the level of non-agricultural wealth. Increases in disposable wheat have a significant positive effect on wheat consumption but increases in the level of carry-in stocks do not. Among farmers in this sample, home wheat consumption is not significantly influenced by carry-in stocks. In addition, as the number of family members living on the farm increases, home wheat consumption increases.

Higher wheat prices have a positive and statistically significant effect for on-farm wheat consumption. This result is potentially consistent with two competing hypotheses. First, wheat may be a normal good for which positive farm income effects associated with wheat price increases offset pure substitution effects. Alternatively, as was noted above with respect to the definition of the wheat market price variable, higher market prices could be associated with higher wheat quality and farm families increase wheat consumption when wheat is of higher quality and thus more suitable for human consumption.¹⁷ The latter hypothesis is consistent with the additional finding reported in Table 3 that higher levels of non-agricultural wealth lead to significantly lower levels of wheat consumption while the former hypothesis is not.¹⁸

Wheat Market Sales

The following variables are estimated to have statistically significant effects on the allocation of harvested wheat into consumption: the quantity of available wheat, carry-in stocks, the quantity of disposable corn, and the number of family members living on the farm. The market price of wheat had no statistically significant effect on market sales, suggesting an inelastic short term supply response.

Market sales increase as the quantity of available wheat increases (either because of increased production or decreased quota deliveries). Market sales also increase with carry-in stocks and with increases in disposable corn. The theoretical model offers no unambiguous prediction about the sign of the effects of wheat prices on market sales (because of offsetting substitution and farm income effects) and so the empirical finding that the price of wheat has no significant effect on market sales is not surprising. Furthermore, market sales decrease significantly with the number of family members living on the farm.

Elasticities and Policy Implications

The above statistical results provide useful insights about several important economic issues. To assess the policy implications and quantitative importance of the statistical results, elasticities for selected policy and market-related explanatory variables were calculated at the sample means of the dependent and explanatory variables. These estimates are presented in Table 4 which also identifies those estimates derived from statistically significant coefficients.

The elasticity estimates indicate that increases in wheat available (primarily wheat production less delivery quota obligations) have relatively large positive effects on market sales and stocks, but only proportionally small effects on consumption. In particular, a one percent increase in disposable wheat increases household consumption by only 0.1 percent, but increase additions to stocks by

about 0.6 percent and market sales by 2.5 percent, a substantially larger effect. A one percent increase in carry-in stocks only reduces additions to stocks by about 0.1 percent but increases market sales by about 0.7 percent.

Additions to wheat stocks, consumption, and wheat market sales are relatively unresponsive to market prices. This finding is consistent with offsetting price and farm income effects for wheat allocation, as noted by Carter and Zhong for wheat consumption.

Wheat stocks and market sales are relatively responsive to the quantity of disposable corn available to the farm household. A one percent increase in disposable corn reduces wheat stocks by about 0.3 percent and increases wheat market sales by 2.24 percent. These adjustments may reflect both the fact that an increase in the amount of disposable corn reduces income risks and at the margin results in increased storage costs.

Quota revenues are predetermined and therefore exogenous to the household's wheat allocation decision. Wheat stocks, consumption, and market sales are unresponsive to these revenues in both statistical and in percentage terms. Historically, quota revenues have often been slow in reaching farmers, with the IOU's frequently issued by government grain agents frequently remaining unpaid for months (see Findlay and Watson 1999).

Consumer durables and the value of the family's house measure long-term household wealth. Non-agricultural wealth has only a small proportional effect on wheat consumption, and wheat consumption declines slightly as household wealth increases.

The above elasticity estimates provide useful insights about potential changes in the government of China's current grain procurement policy. The two major elements of this program are farm level delivery quotas and the prices paid by the government for wheat delivered under those quotas. First, we consider a reduction in the delivery quota which simultaneously increases the

quantity of wheat available to the household and reduces farm quota revenues. The elasticity estimates presented in Table 4 show that, accounting for these joint effects, a five percent reduction in the delivery quota, which results in a one percent increase in disposable wheat, will increase additions to stocks by 0.56 percent, consumption by 0.13 percent, and market sales by 2.5 percent.

Second, we consider the effects of a decrease in the quota price that reduces quota revenues. The elasticity estimates presented in Table 4 indicate that a one percent decrease in the quota price will decrease additions to wheat stocks by only about 0.04 percent, and result in very modest increases in wheat consumption (0.03 percent) and market sales (0.065 percent).

These findings indicate that reductions in delivery quota requirements have larger impacts on stock levels, market sales and on-farm consumption than adjustments to quota prices do. Given that current quotas are on average about 20 percent of production, the quota program appears to have important effects on wheat allocation decisions, particularly on market sales.

Conclusion

Grain stocks provide food and income security buffers for Chinese farmers. However, this study provides evidence that these farmers adjust wheat stocks in response to changes in government policy and changes in market prices. The results reported above indicate that increases in potential revenues from other farm enterprises and more extensive potential sources of off-farm income lead farmers to reduce wheat stocks, a result consistent with the hypothesis of decreasing absolute risk aversion. Opportunity costs associated with stock holding also influence farm storage decisions. The results show that farmers respond to increases in market prices by drawing down stocks and by increasing current consumption.

Changes in farm incomes appear to have very small effects on farm household wheat consumption. The effects of several potential sources of farm household income and wealth have

been examined, including the village average off-farm wage, revenues from other agricultural enterprises, and non-agricultural wealth. These variables had mixed and relatively small percentage effects on wheat consumption by farm households. In addition, changes in wheat market prices had only small effects on consumption, possibly because of offsetting income and substitution effects but more probably because higher reported wheat prices reflect higher levels of wheat quality. Wheat consumption does increase with the total amount of wheat available for household allocations after delivery quotas have been fulfilled.

Market sales of wheat were relatively unresponsive to observed changes in reported wheat market prices. It should be noted, however, that the cross section nature of the data utilized only permits an evaluation of short-term price responses. Thus, the one limitation of the study is that it provides no information about the longer run effects of changes in relative prices or other variables on wheat production and allocation decisions.

Finally, the empirical results were utilized to evaluate the effects of changes in key elements of the government's grain acquisition program. A five percent decrease in the delivery quota for wheat, which on average increases the quantity of grain available to farmers by about 1 percent, is predicted to have relatively modest positive effects on wheat stocks and wheat consumption (which increase by 0.56 percent and 0.13 percent respectively). However, the five percent quota reduction would increase market sales quite substantially (by 2.5 percent). If, alternatively, the quota price was increased by five percent, the effects on farmer-held stocks (0.2 percent), wheat consumption (.015) and market sales (.325) would be much smaller. These findings, however, indicate that a move to complete market liberalization through the abandonment of delivery quotas would have substantial impacts on grain allocation decisions at the farm level.

Table 1. Predicted Effects

	Market Sales	Consumption	Additions to Storage
Production increase	↑	↑	↑
Carry-in stocks	↑	↑	↓
Quota increase	↓	↓	↓
Increase in other income	↑	↑	↓
Market price increase	?	?	?

Table 2. Descriptive Statistics

Variable, N=155	Mean	Std. Dev.	Min	Max
Harvested wheat	1813	1119	350	7000
Government wheat quota	356	498	16	2974
Wheat market price	.611	.078	.372	.872
Disposable wheat quantity	1229	721	-62	4035
Wheat stock additions	134	346	-602	1500
Wheat consumption	744	362	0	1800
Wheat market sales	644	1000	0	3500
Carry-in wheat stocks	398	379	0	2000
Village wage	352	67	274	458
Disposable corn quantity	1893	1170	-170	5850
Total quota revenue	210	296	10.8	1736
# On-farm working age	2.33	1.00	0	5.1
# Off-farm working age	.200	.57	0	4.4
# On-farm non-working age	1.39	1.07	0	4
Education years, household heads' average	5.17	2.73	0	12
Non-Agricultural wealth	16,830	13,918	320	69,950

Table 3. Regression Estimates of Post-Harvest Wheat Allocation. N=155‡

Variable	Additions to Storage	Consumption	Market Sales
Constant	25.1 (.966)	-17.9 (-.745)	-147 (-1.35)
Disposable wheat quantity	.336 (4.68)***	.437 (6.61)***	.978 (3.66)***
Carry-in wheat stocks	-1.93 (-3.56)***	-.029 (-.581)	.687 (3.13)***
Wheat market price	-639 (-2.46)**	620 (2.59)**	288 (.356)
Total quota revenue	-.179 (-.731)	.065 (.287)	.198 (.236)
Disposable corn quantity	-.108 (-2.55)**	.012 (.309)	.569 (3.67)***
# On-farm working age	-17.1 (-.715)	39.5 (1.79)*	-370 (-3.50)***
# Off-farm working age	-102 (-2.05)**	54.3 (1.19)	165 (1.06)
# On-farm non-working age	-37.1 (-2.16)**	39.7 (2.50)**	-1420 (-1.95)*
Village wage	.943 (2.52)**	-.55 (-1.59)	-.945 (-.731)
Education years, household heads' average	10.1 (1.39)	1.79 (.268)	-.763 (-.028)
Non-agricultural wealth	.15E-02 (1.08)	-.44E-02 (-3.45)***	-.289 (-.534)
Log-likelihood	176.3	173.4	180.4
Adjusted R-squared	.33	.35	.27

‡ t-values and asymptotic z-states in parenthesis. *** statistical significance at the 1 percent level,

** statistical significance at the 5 percent level, and * statistical significance at the 10 percent level.

Table 4. Selected Elasticity Estimates ‡

Variable	Wheat Stock Additions	Consumption	Market Sales
Disposable wheat quantity	.562 ^{***}	.132 ^{***}	2.51 ^{***}
Carry-in wheat stocks	-.131 ^{***}	.004	.714 ^{***}
Wheat market price	-.076 ^{**}	.122 ^{**}	-.485
Total quota revenue	.0401	.003	.065
Disposable corn quantity	-.276 ^{**}	.006	2.24 ^{***}
Village wage	-.619	.065	-.956
Non-agricultural wealth	.045	-.024 ^{***}	-.135

‡ t-values and asymptotic z-states in parenthesis. *** indicates statistical significance at the 1 percent level,

** statistical significance at the 5 percent level, and * statistical significance at the 10 percent level.

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Endnotes

1. Turner, Brandt, and Rozelle (1999) report that cash settlements of quota became increasingly allowed at the village level in the mid-1990s. Farmers paid the difference between the market price and the quota price for these settlements. However, consistent cash settlement of quota may affect the land allocated to the farmer by the village leader.
2. Input costs are not central to our argument and our data concerning them is limited.
3. See Rozelle et al. (1999) for a thorough discussion and analysis of the role of off-farm earnings in household income in rural China.
4. We consider only the choice variables in period 0 because we only have data from this period.
5. We abstract from borrowing/lending decisions and from off-farm income decisions due to data limitations in these variables and underdeveloped formal credit markets.
6. Point D indicates that consumption of the composite good is higher and wheat consumption is lower under autarky than at Point C. Strictly speaking, this need not be the case given the income reductions from quota sales.
7. Wheat swaps are aggregate non-market gifts and exchanges between family members, neighbors, or other parties with social ties. The exact ties were not included in the survey data. Because variables explaining these swaps were not available, the analysis does not estimate them. We also estimated the model using separate variables for the quota and for available wheat. There were few important differences in the estimates.
8. If farmers have multiple sales during the marketing year, then the value of the price variable is defined as a weighted average by quantity of the detrended prices for these sales.
9. That negotiated sales occur at relatively high detrended prices suggests that government grain buyers appear to compete for grain.
10. We do not include a measure of livestock sales in the measure of other farm income because the survey data on livestock value was limited, and because the quantity of disposable corn should be closely related to livestock feeding. The 15 negotiated sales were spread across most villages, but not occur in every village.
11. There was no statistical gain from using the value of corn rather than corn quantity.
12. We did not have very useful data for the educational level of the off-farm family members.
13. There was no significant statistical gain from separating this household wealth variable into the more liquid consumer durables (e.g., radios, furniture, etc.) and housing.

14. For example, a farm's self reported proportion of good land was scaled up by the ratio of the village average wheat yield for good land over wheat yield for average land.
15. We also considered an alternative formulation for the dependent variable of additions to wheat stocks. Using the ending stock level as the dependent variable gave virtually identical results to those reported in Table 3.
16. Recall that additions to wheat stocks were measured approximately six months after harvest.
17. In alternative estimation models, a different wheat price variable—the simple village average price—was utilized which does not reflect differences in wheat quality across individual farms. The coefficient estimate for this price variable in the wheat consumption equation was statistically insignificant, suggesting that, in fact, the wheat price variable for which results are reported in Table 3 is capturing quality related effects on consumption.
18. The results in Table 3 were qualitatively robust to the omission of non-farm household wealth which is correlated with the village wage (.59) and the education level (.54).