Grain Policy in Chinese Villages: Yield Response to Pricing, Procurement, and Loan Policies

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This paper assesses the effects of pricing, procurement, and loan policies on China's grain economy. A dynamic control model of the village leader is specified. Parameters of structural and control equations are estimated using time-series cross-section data. Simulation results show that pricing and procurement policies are not effective in raising yields, because of conflicting objectives of local officials. Loan policies can increase yields. The paper concludes that rural policies often have contradictory effects that can arise for a number of reasons. An important reason is the fact that local officials in a reforming economy have greater decision-making discretion than higher-level officials and execute policies to meet their own objectives.

Key words: China, decision-making, grain policy, village leaders.

During the recent drive for development, Chinese leaders decollectivized agriculture, making households the fundamental unit of agricultural production. Financial reforms, allowing local governments more control over their own revenues, were equally important (Wong). After fulfilling obligations to the state, individuals were encouraged to create non-state economic enterprises, while local officials had both the incentive and opportunity to pursue economic gain (Odgaard).

In the early 1980s, productivity response and efficiency gains were unparalleled (McMillan, Whalley, and Zhu; Fan). In contrast, rural economic growth was slower and less balanced in the second half of the decade (State Statistical Bureau 1985–90). Grain output stagnated and yields and real rural incomes grew only marginally. Only rural industry grew, expanding output at an increasing rate (State Statistical Bureau 1980; 1984; 1989).

In spite of early impressive gains from the reforms, leaders have grown increasingly aware of the difficulties in implementing policy reform (Oi 1991b). After being filtered down through China's administrative bureaucracy, policies are often severely distorted by local leaders (Sicular, 1988a) who are promoting their own objectives (Wang). The ineffectiveness of recent policy measures, especially in the grain sector, in part, explains the central leadership's growing suspicion of economic reform, and has led to recent efforts to regain control (Oi 1991a).

This paper assesses the differential effects of changes in the government's pricing, procurement and rural industrial loan policies on the performance of the grain sector and on other important variables—industrial profits, capital assets and nonagricultural employment. We also examine why the newly evolving decision-making framework of village leaders has dampened the effectiveness of rural policies. We demonstrate that centrally developed policies can lead to contradictory results, in part because local officials' multiple objectives affect policy implementation at the local level.

Modeling decisions of local leaders in a mixed economy, such as in rural China, is difficult. In this paper, village leaders are assumed to be economic planners maximizing a multiattribute utility function subject to structural and endowment constraints. Moreover, leaders have only partial control over the behavior of farmers.

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The structural relationships and the objectives of the village leaders are estimated from observations and data collected during 15 months of fieldwork in central China (Rozelle). Time-series data from 40 villages are used to estimate the equations of a dynamic control model describing the behavior of village leaders and the environment within which they operate. The effects of external policy adjustments on industrial output, investment, technology adoption, fertilizer allocation, and the intensity of cash cropping are simulated into the future. The simulations demonstrate that pricing and procurement measures have little or even a negative effect on grain yields; only rural industrial credit policy succeeds (albeit only marginally) at increasing agricultural productivity.

Chinese Rural Policy

Controlling the grain economy is important to China's development strategy. Through the 1960s, the efforts of land reformers and moves toward collectivization were primarily motivated by the desire to consolidate control of the rural sector, especially over grain production and marketing (Perkins and Yusuf). While direct area allocations of grain were used less frequently after the early 1960s, the state still exercized considerable influence over grain production through self-sufficiency campaigns, trade restrictions, and by monopolizing marketed-surplus activities. Directives were enforced through complete control over credit, fertilizer, technology, and longer term investments.

The reforms of the late 1970s, including decollectivization, price increases, the greater availability of inputs, and trade and marketing changes, altered this preoccupation with grain. Post-reform economic policy in the 1980s was to be carried out through indirect mechanisms (e.g., pricing and interest rate measures), providing work incentives, and placing production decisions in local hands (Wiens). Within this plan, instruments of direct control (grain quotas and industrial credit) were also to be retained.

The result of these reforms was a productivity boost in nearly all cropping sectors, which stimulated high growth rates in most rural regions. What proportion of this change can be attributed to what set of factors is still being debated. Several authors show that much of the initial increase in the grain sector came from the expanded efforts of households due to decollectivization (McMillan, Whalley, and Zhu; Fan). In the latter half of the decade, decentralization measures and policies to encourage diversification (Sicular) led to slower growth in the grain sector and less balance across rural economic sectors. A working hypothesis in this paper is that these trends have undermined the ability of policy makers to restore the sector's balance and regain control over China's grain production. Understanding these two factors is crucial for formulating an economic policy model based on the behavior of rural agents.

Policies after 1984 provided incentives for farmers to diversify out of agriculture in general, and grain production in particular. Prices have increased more rapidly for cash crops than for grains. Limited progress in freeing markets for land, labor, and capital provided few opportunities for the utilization of labor in agricultural activities in most of China's densely populated farming regions. Controls were lifted on locally produced industrial products but retained for key agricultural goods, leaving the cropping sector less responsive to economic forces. Fiscal reforms left increasing proportions of rural industrial profits under local control (Oi 1991b).

Decentralization is also closely associated with the fiscal reforms which set limits on the amount of revenues extracted from and subsidies injected into localities by higher levels of government (Oi 1991a). Local leaders concerned with administrative duties and developing their local economies were forced to expand industrial production in order to increase local revenue bases. Expenditures and investment became inextricably tied to these revenues. The rules also allowed local officials to increase their own incomes if the locality's economic product grew at a faster rate.

Local Policy Implementation

To analyze the effects of reform policies on the grain sector, one must understand how township officials, village leaders and farmers make decisions. A full discussion of such decision making is beyond the scope of this paper. We focus here on the "economic problem" of village leaders.[1] Although this discussion is stylized on the basis of observations, interviews, and analysis

[1] See Rozelle for discussions of township officials, village leaders, and farm households. Farmer behavior is treated elsewhere as well (e.g., Lin).

from study sites in northern Jiangsu during 15 months of fieldwork, Sicular (1991) provides evidence that village leaders are active participants in local economies in much of China. Hence, the results of this study have relevance for China's rural areas as a whole.

Village leaders are the lowest level of administrators responsible for implementing rural policy; as members of the village-community, their own interests are also closely identified with those of farm households. As managers of agriculture and industry, they must balance interests of higher levels of government with those of local constituents (Oi 1989).

Based on extensive field interviews, six goals were identified as important to village leaders: promotion, status, job security, independence from officials at higher levels, personal profits, and a commitment to the village (Rozelle). Industrial activities are equated with the independence and profit goals. Agricultural accomplishments, such as producing high grain yields and adopting new agricultural technology, are associated with promotion and job security objectives. Providing farmers with cash cropping activities and off-farm employment opportunities increases leader satisfaction and status by increasing the welfare of their villages. Local leaders pursue some goals more vigorously than others; the economic reform environment has also made progress toward certain goals easier and more beneficial. The following discussion provides insights as to why local actors frequently take actions favoring industrialization at the expense of grain policies.

In agriculture, local leaders have control over the village's land and capital equipment. Control over land includes short-term planting and long-term allocation among farm households. Although farmers do allocate their own labor and current inputs, these decisions are influenced through production contracts linking farm output to be delivered to the state marketing unit to the provision of low-priced, high-quality inputs (e.g. fertilizer, diesel fuel, and credit). Despite these efforts, expansion of agricultural activities by increasing a village's endowment of land, labor or capital is difficult, given limited factor markets (Perkins) and the central government's efforts to recentralize control over farm inputs such as fertilizer (Stone).

The situation is different for rural industry. Village leaders directly control their enterprises. They make labor decisions, and they select short-term capital utilization levels and long-run investment rates. Leaders are often able to determine wage rates and procure village-produced raw materials at favorable prices. Most importantly, after satisfying tax obligations, they retain control over earned revenues and can seize many opportunities to expand the economic output of the village economy.

Given these differences between agriculture and rural industry, it is easy to see why targeting grain production with agricultural policies may be difficult. Why do village leaders care anything about grain yields? First, high grain quotas still exist in most rural areas and there are prohibitions against relying on outside sources of grain. Second, high yields may enhance the status of village leaders or lead to a promotion. Finally, by increasing yields, more grain land can be diverted to other crops, many of which are used by local rural industries as raw materials.

In summary, agricultural authorities in charge of increasing productivity, especially in the grain sector, operate in an environment imposing constraints on the expansion of the sector. They face increasingly independent local leaders with little incentive to pursue grain activities; yet, pressures to fulfill agricultural targets and the interdependence of farm and non-farm activities make it impossible to ignore this sector. On the positive side of the ledger, they do have several policy instruments at their control. The question remains: what mix of policies will induce village leaders to take actions leading to optimal increases in grain productivity? This paper takes a step toward answering this question.

Modeling the Economy in Chinese Villages

To analyze the effects of policies on the village grain sector of the economy, village leaders are modeled as local economic planners operating in a mixed economy. They pursue multiple goals by allocating resources under their control (i.e., control variables), subject to the factors which determine the village's major economic processes (as described in a set of state equations). Such a problem suggests that a dynamic optimal control model would be an appropriate analytical framework. Since there is no well-defined theoretical framework from which to specify the structural and behavioral "models" for decision makers in a mixed economy, the final specification is based on observations made during the extensive interviews conducted during the 15 months of fieldwork in central China. The empirical work itself will provide new information on the important relationships in these economies.

The Model

Village leaders are assumed to maximize a multiple attribute utility function subject to a series of state equations. In matrix notation the model is

$$(1) \qquad \max V = E\left\{\sum_{t=1}^{\infty} \beta_t(\boldsymbol{\omega}_t'\mathbf{X}_t + \mathbf{X}_t'\boldsymbol{\Omega}\mathbf{X}_t)\right\}$$

subject to

$$(2) \qquad \mathbf{X}_t = \mathbf{A}\mathbf{X}_{t-1} + \mathbf{C}\mathbf{U}_t + \mathbf{b} + \boldsymbol{\epsilon}_t$$

where $\boldsymbol{\Omega}$ and $\boldsymbol{\omega}_t$ = matrices of weights; $\mathbf{X}_t$ = a vector of state variables; $\mathbf{U}_t$ = a vector of control variables whose levels are set by local leaders; $\boldsymbol{\epsilon}_t$ = a vector of error terms; and $\mathbf{A}$, $\mathbf{C}$, and $\mathbf{b}$ are matrices of structural parameters.

By assuming a quadratic-linear functional form,[2] optimal levels of the control variables are linear functions of lagged state variables:

$$(3) \qquad \mathbf{U}_t^{*} = \mathbf{G}\mathbf{X}_{t-1} + \mathbf{g}$$

where $\mathbf{G}$ and $\mathbf{g}$, the behavioral coefficients, depend on parameters in (1) and (2).

Empirical Specification, Data, and Estimation

The empirical specification of equations (1) and (2) consists of an objective function containing five arguments: profits, grain yields, capital, off-farm labor, and hybrid rice area; and structural equations for industrial profits, grain yields, capital, investment, non-agricultural labor, hybrid rice area, prices, the grain obligation, and loans made to rural industry. A detailed justification for the arguments in the objective function and the specification of each structural equation (table 1) is in Rozelle and Boisvert and Rozelle.

Data for 1983 through 1988 from a village survey conducted during 15 months of field work in central China were used in the estimation. The data include information on production, investment, nonfarm activities, credit, prices, and technology adoption and come primarily from records kept by the accountant in each village and from account books and records kept by the treasurer of each village-run factory. Data were from 40 villages chosen randomly from more than 100 villages in three townships of Jiangsu province, a densely populated region in the Yangtze River Valley.

Although well over 80% of sown area in the sample areas was dedicated to grain in the prereform years, area devoted to cash crops followed the national trends and expanded to a little more than 30% by 1988 (versus 29% nationwide—State Statistical Bureau 1989). Simultaneously, rural industrial output of the village economy expanded rapidly, growing by over 15% per year from 1983 to 1988. By the final year of the study, the proportion of the sample area's gross value of industrial and agricultural output (GVIAO) had risen from less than 40% to nearly 60%. These rapid growth rates are by no means atypical. Nationwide, during this period the proportion of rural industrial output in the GVIAO of the rural economy rose from nearly 20% to about 50% (State Statistical Bureau 1984, 1989). The study sites are representative of rural areas in China which have well developed agricultural infrastructure and a rapidly developing industrial base.

Data were also collected on three policy variables—prices, grain quotas, and loans received by village enterprises. Industrial prices used in the analysis are village specific. Agricultural prices were collected at the township level and assumed to be identical for villages within each township, but these prices do vary over time and across township. Commodity prices for grain and cash crops were aggregated into a single index. Multicollinearity between the cash crop price index and the grain price index precluded an econometric specification with both variables. The fact that cash crop prices closely track grain prices may be a result of the institutional structure of the procurement system in rural China. When grain officials intervene and change prices, officials with responsibility for procuring cash crops apparently also respond by increasing the prices of their commodities. Thus, grain price policy is tied to the price policy of cash crops, and this paper's focus on the agricultural price index could be viewed as looking at grain price policy. Prices were deflated by an index constructed from county-level producer data. The quotas, or procurement obligation, include "required" sales of grain by farmers to the state grain bureau. Sales are classified as either basic

[2] The quadratic-linear optimal control model is analytically tractable (Futon and Carp). It allows for diminishing marginal utilities of the individual goals. This specification can also be thought of as first-order Taylor series approximation of the true relationships.

Table 1. Empirical Specification of the Village Leader Model

$$
\begin{aligned}
&\max E(V) = E\Bigg\{\sum_{t=1}^{\infty} \beta^t + (\omega_1\pi_t + \omega_2\pi_t^2 + \omega_3 G_t + \omega_4 G_t^2 \\
&r_t, i_t, h_t, \qquad + \omega_5 K_t + \omega_6 K_t^2 + \omega_7 L_t + \omega_8 L_t^2 \\
&f_t, w_t, c_t \qquad + \omega_9 h_t + \omega_{10} h_t^2 + \text{interactive terms})\Bigg\}
\end{aligned}
$$

subject to

$$
\begin{aligned}
\pi_t &= \alpha_0 + \alpha_1 r_t + \alpha_2 i_t + \alpha_3 w_t + \alpha_4 K_{t-1} + \alpha_5 P_{t-1} + \epsilon_{1t} \\
G_t &= \beta_0 + \beta_1 h_t + \beta_2 f_t + \beta_3 c_t + \beta_4 P_{t-1} + \epsilon_{2t} \\
K_t &= K_{t-1} + i_t \\
i_t &= \partial_0 + \partial_1 w_t + \partial_2 \pi_{t-1} + \partial_3 L_{t-1} + \partial_4 P_{t-1} + \partial_5 B_{t-1} + \epsilon_{3t} \\
L_t &= \tau_0 + \tau_1 r_t + \tau_2 i_t + \tau_3 h_t + \tau_4 w_t + \tau_5 P_{t-1} + \tau_6 O_{t-1} + \epsilon_{4t} \\
h_t &= \rho_0 + \rho_1 L_{t-1} + \rho_2 G_{t-1} + \rho_3 c_t + \rho_4 P_{t-1} + \rho_5 O_{t-1} + \epsilon_{5t} \\
P_t &= \lambda_0 + \lambda_1 P_{t-1} + \epsilon_{6t} \\
O_t &= \mu_0 + \mu_1 O_{t-1} + \epsilon_{7t} \\
B_t &= \phi_0 + \phi_1 B_{t-1} + \phi_{8t}
\end{aligned}
$$

State variables:		Control variables:	
π_t	= profits, village industries	r_t	= output (revenue), village industries
G_t	= grain yields	i_t	= investment in capital plant
K_t	= capital in rural industries	h_t	= proportion hybrid rice area
L_t	= off-farm employment	f_t	= fertilizer supplied
h_t	= proportion hybrid rice area	w_t	= village industry wage
P_t	= industrial-ag price ratio	c_t	= cash crop area
O_t	= marketed surplus obligation		
B_t	= loans to village industries		

or bonus quotas. Amounts sold under either of these categories are viewed as obligatory, not voluntary. "Loan activity" measures lending transactions between the village enterprises and state run banks, rural credit cooperatives, and departments within the Township and Village Industry Bureau.

Following Chow and Fulton and Karp, a two-step approach was used to estimate the parameters of (1) through (3). The first step is to estimate the parameters of (2) and (3) directly using fixed effect methods (i.e., OLS with a dummy variable for each village). Because $\mathbf{\Omega}$ and $\boldsymbol{\omega}$ from (1) are implicit functions of **A**, **C**, **b**, **G**, and **g**, it is possible in a second step to recover the set of objective function coefficients consistent with those revealed through the behavior of village leaders. See Rozelle for details.

Simulating the Impact of Changes in Pricing, Procurement, and Loan Policy

The estimated structural and control equations are shown in tables 2 and 3. The adjusted R-square statistics for the structural equations range between 0.46 and 0.80; those for the control equations are all above 0.60, except for the wage equation (0.25). Signs on the coefficients of the independent variables in both sets of equations are consistent with prior expectations; many of the estimated standard errors are relatively small compared to their magnitudes.[3]

Estimates of the weights on the five variables in the village leader's objective function, $\boldsymbol{\omega}$ and $\mathbf{\Omega}$, from equation (1) provide additional evidence of the model's performance. The elasticities of utility derived from the estimated coefficients for the two variables associated with rural industrialization, capital assets and factory profits, are 0.84 [0.014] and 0.39 [0.048], respectively.[4] These are much higher and have relatively lower standard errors than the variables associated with either agricultural (grain yields—0.0038 [0.019]—and hybrid rice adoption—0.00000019 [0.00021]) or the welfare of farm

[3] The model generated fairly accurate within-sample predictions. Theil coefficients are between 0 and 1 except for the industrial profits equation and the wage rate equation.

[4] The numbers in brackets, [ ], are the asymptotic errors of elasticities. See Rozelle for procedures used to estimate them and a full discussion of these results.

Table 2. Structural Equations Describing the Village Environment, Fixed Effects Independent Variables

Equations	Industry output (r_t)	Capital invest. (i_t)	Hybrid area (h_t)	Fert. supply (f_t)	Indust. wage (w_t)	Cash Crop area (c_t)	Lagged endogenous variables (π_{t-1})	(G_{t-1})	(K_{t-1})	(L_{t-1})	Lagged exogenous variables (P_{t-1})	(O_{t-1})	(B_{t-1})
Indust. Profit (π_t)	0.011 (2.84)	0.39 (2.44)			−0.15 (0.54)				0.29 (2.09)		17.40 (1.43)		
Grain Yield (G_t)			76.00 (2.00)	15.48 (3.04)		−0.11 (1.44)					0.03 (1.00)		
Indust. Capital (K_t)					−0.032 (0.22)		−0.071 (1.48)		1.00*	10.97 (0.40)	−5.26 (0.84)		1.38 (9.48)
Nonfarm Labor (L_t)	0.000019 (4.23)	−0.00015 (0.90)	−64.89 (3.68)		−0.00028 (0.75)						0.0018 (0.12)	0.00025 (0.09)	
Hybrid Rice (h_t)						−0.00028 (1.95)		0.00024 (1.55)		−0.0012 (4.52)	0.00012 (1.96)	0.000025 (1.58)	
Indust. Ag. Price (P_t)											−2.64 (2.61)		
Marketed Obligation (O_t)												0.045 (0.60)	
Loan (B_t)													−2.28 (2.97)

Note: Estimated as a village fixed-effects model, but the coefficients of the dummies are not reported (Rozelle, 1991). The t-ratios are in parentheses. *Restriction placed on model.

households in the village (nonfarm employment—0.022 [0.011]). These results are consistent with the expectation that leaders are preoccupied with rural industrialization to further personal gain and independence from higher authorities. They remain concerned about maintaining agricultural productivity and overall village welfare.

Because the simulation focuses on grain yields, the second equation of table 2 is of primary importance. Village leaders can raise yields by requiring farmers to plant a larger proportion of hybrid rice or by increasing fertilizer supply. The negative sign on the coefficient of the cash crop variable shows that village leaders can also increase yields by regulating the amount of land planted to cash crops. This relationship was not evident *ex ante*. Since cash crops are relatively more profitable than grain, one might expect grain yields to fall if leaders allowed more area to be planted to cash crops and farmers allocate more time and current inputs to them. The impact on yields appears to be small (note the low t-ratio) most likely because farmers are tacitly allowed to cultivate additional cash crop area only if grain productivity does not suffer. The only policy variable that enters the grain yield equation directly is a measure of the relative prices. The positive sign on the coefficient for the ratios of industrial to agricultural prices indicates that, when facing declining relative agricultural prices (or increasing industrial prices), village grain yields rise. Part of the explanation for this result may be due to the inclusion of both grain and cash crop prices in a single index. This result may also show that village leaders use administrative means (e.g. restricting cash crop area) or other actions to encourage farmers to sustain agricultural yields even in the face of falling agricultural prices.

Simulation

The policy simulation is started by substituting the values of the observed state variables (except for one of the relevant policy variables) for the last year of the sample into the control equations and generating forecasts of the dependent variables. These predictions and lagged state variables are used to predict a new set of state variables, and the process is repeated for five years. Simulation results are derived for each of the 40 villages (Rozelle). For purposes of discussion, these results are averaged over all villages and are compared to the base scenario. The

Table 3. Control Equations Describing Village Leader Behavior

Equations	Lagged profits (π_{t-1})	Lagged grain yields (G_{t-1})	Lagged capital (K_{t-1})	Lagged nonag. labor (L_{t-1})	Lagged price ratio (P_{t-1})	Lagged obligation (O_{t-1})	Lagged loans (B_{t-1})
Industrial	1.74	184.02	4.04	2543.82	35.22	7.53	11.66
output (r_t)	(0.79)	(0.28)	(1.38)	(1.97)	(0.13)	(0.12)	(2.13)
Industrial	0.011	−7.34	−0.45	85.21	1.39	0.22	0.80
investment (I_t)	(0.24)	(0.56)	(7.77)	(3.34)	(0.25)	(0.18)	(7.48)
Hybrid	0.12×10^{-5}	0.00013	-0.15×10^{-6}	−0.0013	0.00013	0.22×10^{-4}	−0.063
rice area (h_t)	(2.24)	(0.79)	(0.80)	(3.96)	(1.87)	(1.39)	(0.46)
Fertilizer	0.22×10^{-6}	−0.00023	-0.12×10^{-4}	0.0086	−0.00029	−0.00017	-0.4×10^{-5}
supply (f_t)	(0.04)	(1.15)	(1.73)	(2.77)	(0.44)	(1.12)	(0.31)
Village	−0.0051	−7.78	0.010	−13.91	8.76	0.077	−0.010
wage rate (w_t)	(0.17)	(0.84)	(0.26)	(0.77)	(2.27)	(0.09)	(0.14)
Cash crop	0.21×10^{-4}	0.0089	−0.00020	0.33	−0.012	−0.0035	−0.0024
area (c_t)	(0.07)	(0.10)	(0.51)	(1.91)	(0.32)	(0.43)	(3.39)

Note: Estimated as a village fixed-effects model, but the coefficients of the dummies are not reported (Rozelle, 1991). The t-ratios are in parentheses.

base scenario is created by simulating the model for five years beyond 1988 under the assumption that the 1988 agricultural policies remained unchanged. The three policy experiments are: increasing agricultural prices by 20%; increasing procurement quotas by 20%; and reducing lending by financial intermediaries to village factories by 20%. The policy experiments for procurement and lending are accomplished through *ceteris paribus* changes in these variables; changes in agricultural prices are inversely related to the industrial-agricultural price ratio. When changes are made to one target-policy variable, the other exogenous state variables are left at their 1988 levels.

This particular combination of experiments is selected for illustrative purposes, but the trials are consistent with the government's desire to increase grain productivity and slow rural industrial growth. They are extensions of policy changes initiated in 1988. The emphasis on increased grain yields stems primarily from the central government's concern about stagnant food supplies due to mediocre harvests in 1985, 1986, and 1987. There was also concern that an overheated economy, led by the rural industrial sector, was inflationary and was creating serious problems for government firms in the state sector of the economy.

The qualitative effects of simulated policy changes on all state and control variables are in table 4. The top panel shows the direction of response of state variables to the changes in prices, procurement quantities and amount of rural industrial loans; the bottom panel presents the effects on the five control variables. The four panels in figure 1 trace the impacts of policy changes on grain yields, industrial profits, capital assets and non-agricultural employment (and correspond to the first four columns in the top panel of table 4).

Price Policy Change. The effects of an increase in agricultural prices on grain yields are surprising. Yields increase in the initial two years, but by 1991 yields fall continuously. This is also true for the base scenario. The most unexpected result is that grain yields are lower relative to the base scenario after the policy change throughout the simulation period (panel A, figure 1). These results are explained in part because the agricultural price index includes prices for both grains and cash crops. The agricultural price rise creates both an initial increase in the amount of fertilizer supplied by village leaders to farmers and stimulates a positive change in cash crop area (row 1, columns 4 and 5, bottom panel, table 4). With inoperable land markets, expansion of cash crop area can come only at the expense of grain crop area. The reduction in grain yields on a smaller area with more fertilizer available can be explained partially by the fact that the additional fertilizer is being reallocated to cash crops and not grain. Yields also decline because of a decrease in the intensity of hybrid rice cultivation (a higher-yielding rice variety—row 1, column 3, bottom panel, table 4).[5]

[5] Another explanation would be consistent with there being no relationship between agricultural prices and grain yields. If farmers maintain yields primarily to meet quotas and home consumption, the opportunity cost of grain may exceed the value of grain. Thus, even if grain prices rise, there may be no yield response.

Table 4. Direction of Response of Endogenous State and Control Equations to 20% Change in Exogenous Policy Instruments

	Endogenous state variables				
Policy	Industry profits	Grain yields	Industry assets	Nonfarm employment	Hybrid adoption
Ag-price increase	−	−	+	+	−
Procurement increase	+	−	0	+	+
Loan reduction	−	−[a]	−	−	0

	Control variables[b]				
Policy	Industry output	Industry investment	Hybrid adoption	Fertilizer supply	Cash-crop sown area
Ag-price increase	−[1]	−	−	+	+
Procurement increase	+	+	+	−	−
Loan reduction	−	−	0	+	+

Notes: Direction of response is measured relative to a base scenario where no changes are made to any of the policy variables. All increases and reductions in policy variables are 20 percent of 1988 levels.

[a] Direction of initial response but during the time path, the variables cross.

[b] Village rate held at 1988 rate.

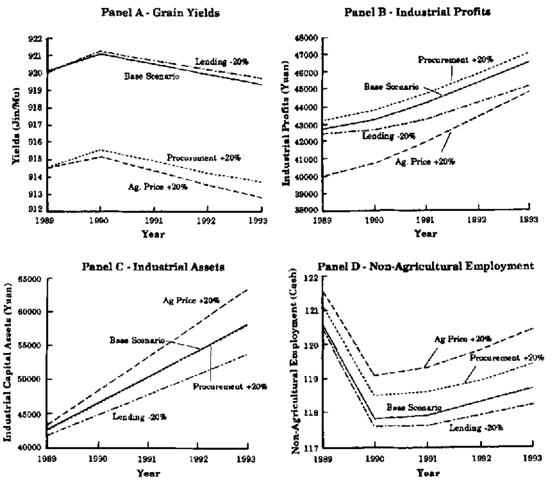

Figure 1. Comparison of important economic variables under alternative simulated policies

With this policy change, industrial prices fall relative to agricultural prices, inducing village leaders to reduce both industrial output and the allocation of financial resources to village factories (row 1, columns 1 and 2, bottom panel, table 4). Thus, profits from industry fall relative to the base scenario throughout the simulation period (panel B, figure 1). Decreases in these variables adversely affect village leader utility since the elasticity of utility with respect to profit is positive. To minimize this welfare loss, village leaders take two actions. First, they decrease the intensity of hybrid rice cultivation (a labor-using agricultural technology). Although this action itself also adversely affects grain yields (and perhaps lessens the likelihood of a leader's promotional opportunities), demand for agricultural labor declines, allowing more labor to move off the farm (panel D, figure 1). Second, leaders apparently redirect factory revenues in order to expand the industrial asset base (panel C, figure 1). Increased off-farm employment opportunities and more capital assets lead to higher village leader utility (since their elasticities of utility with respect to these two arguments are positive) and offset the welfare reduction associated with the decreases in the other state variables.

Procurement policy change. Simulated procurement policy changes force villages to deliver 20% more grain under obligation. This action initially leads to a reduction in the availability of fertilizer to farmers and a smaller cash cropped area relative to the base scenario (row 2, columns 4 and 5, bottom panel Table 4). Industrial output, investment and hybrid adoption are higher for all years compared with the base scenario (row 2, columns 1 to 3, bottom panel, table 4). These effects are responsible for the observed decreases in grain yields relative to the base scenario (panel A, figure 1).

The mechanism underlying the effects of the procurement policy changes is in marked contrast to those for price policy. A fundamental difference between the two policies is that changes in procurement policy force village leaders to increase the area sown to grain. To minimize this additional land requirement, leaders allocate more grain area to higher yielding hybrid rice. Despite adopting new technology, leaders must decrease area sown to cash crops. The new crop mix in the village requires less total fertilizer (partially technologically related since major cash crops such as cotton, mint, and mulberry use much chemical fertilizer). The additional procurement quotas are satisfied by increasing grain area, not yields.[6]

In contrast to grain yields, changes in procurement policy changes lead to increases in nonfarm employment and industrial profits (panels B and D, figure 1). This effect is primarily driven by the increases in industrial output, investment, and hybrid rice adoption relative to the base scenario. The savings from reductions in input intensive cash crops help explain these increases.

Rural industrial loan policy change. When higher officials reduce loans to village enterprises, there is an immediate reduction in the levels of all of the state variables. Moreover, all variables except grain yields remain at levels below those of the base policy throughout the simulation period (panel B, C and D, figure 1). According to government policy makers who recognize the susceptibility of local industries to lending policies (Wang), reductions in loans were designed to restrain the growth of the rural industrial sector and to halt inflation. Policy makers hoped that these measures would also refocus the attention of leaders on grain production (Oi 1991a).

Curiously, even though increasing grain productivity was only a secondary objective of loan policy in the early 1990s, it is the only measure that has a positive effect on grain yields. Yields under the loan reduction policy rise in the second year to equal the base policy grain yields. After the second year, the new policy gradually leads to relatively higher grain productivity. Hence, the negative impact on the industrial state variables does seem to have succeeded in refocusing the attention of village leaders on the agricultural sector. What mechanisms cause the yield increase and industrial contraction? When the utility of village leaders is reduced through lower profits and capital assets, they can offset part of this loss by increasing grain yields. Decisions to increase fertilizer supplies and raise the area sown to cash crops (column 4 and 5, row 3, bottom panel, table 4) draw labor back into the agricultural sector. After two periods, enough resources have flowed back into grain production that yields surpass those experienced when lending remained at the base-scenario levels.

Meanwhile, village industrial expansion is slowed since loan reductions lead to curtailment of output and investment (column 1 and 2, row 3, panel, table 4). These actions lead to reductions in profits and capital asset growth.

Summary and Conclusions

Research tools to assist policy makers in China's unique reform environment are uncommon. Most existing models of China are based on the assumptions of central planning and contain few behavioral parameters. Transplanted neoclassical models, which rely on classical assumptions and simplified economic structures, also have not performed well (An). This paper develops a more effective analytical tool for use by policy makers in countries making a transition from a state controlled economy to one where market forces guide economic decision making. To illustrate the use of such tools, a dynamic control model of Chinese village leader behavior is estimated and used to assess the effects of changes in government's pricing, procurement and rural industrial loans on the performance of the grain sector.

Based on the general behavioral and structural elements of the Chinese reform economy captured by this paper's simulations, the implications of this analysis for policy are somewhat unexpected. The results suggest that, if officials are interested in setting an agricultural policy to encourage higher grain yields, they can neither rely on increasing agricultural prices nor on increasing a locality's procurement quota. Rather, the only effective means for increasing grain yields is to reduce the number of loans available for rural industrialization. Even when applying

[6] Some of the decrease in yields may be related to factors in addition to ones considered here. Larger quotas could mean reduced effort and lower yields as Putterman demonstrates for the Chinese collective. A similar disincentive can be derived for the individual farmer. Since the increased procurement burden can be looked on as a lump sum tax, there will be no distortion in the marginal price that the farmer faces (Sicular), but there will be a corresponding decrease in income. In a household production framework (Singh, Squire, and Strauss), these negative income effects can imply lower yields through reduced effort, reduced fertilization or for other indirect effects.

strict limits on rural industrial loans, the rise in grain yields is relatively small.

These simulations suggest that these policies either lead to counter-intuitive results or are only marginally effective primarily because complex interactions between the structure of China's rural reform economy and the objectives of village leaders trigger a series of contradictory and offsetting reactions. For example, as was seen in the case of procurement policy, increasing the delivery obligation did induce leaders to expand grain sown area, but other forces caused leaders to reduce the quantity of fertilizer inputs being supplied to the sector. Farmers in turn apparently responded by reducing fertilizer use on grains. The net result was a reduction in grain yields.

If decentralization trends are to continue in the transition of China from a planned economy to one that is more market oriented, it is imperative that policy makers begin to understand the decision making behavior of local leaders so that their policy measures induce actions more compatible with government objectives. Given the importance local leaders attach to rural industrialization, policies might best be designed to tie the timely execution of an important agricultural measure (e.g., the completion of a grain delivery quota, or the maintenance of some minimum level of yields) to the provision of some benefit for a locality's industrial activities.

There are, in fact, signs that central authorities are beginning to understand the dynamics of local decisions. In recent years, authorities have once again begun to encourage the expansion of local industry, but it can proceed without interference only if a certain proportion of industrial profits are reinvested in the agricultural sector (Liu). These new investment funds are to be used to provide certain "socialized services" in the agricultural sector intended to relieve local resource bottlenecks. Such policies appear in part to account for the multiple objectives of village leaders and resolve some of the contradictory effects of local policy execution.

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