Property rights formation and the organization of exchange and production in rural China

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July 3, 1998

Abstract

Most exchange of farm land in rural China is conducted by local governments rather than by decentralized land markets. We investigate the forces determining the reallocation behavior of village governments, and hence the formation of the right "security of tenure". We also examine the relationship between administrative reallocations and market reallocation. This amounts to an examination of the choice between centralized and decentralized organization of agricultural production.

Key Words: Property rights, Collective choice, Chinese Agriculture

1. Introduction

The arrangement of property rights is widely recognized as having an important impact on investment and production decisions (De Allessi 1980)[1]. Property rights, including the degree of "tenure security"—the freedom from expropriation—are determinants of investment behavior (Besley 1995, Bottomley 1963, Agnello and Donnelly 1975) and hence productivity growth. The choice between centrally planned economic activity and decentralized economic activity organized by markets also is important. Indeed, Olson (1996) argues that differences in the way that economic activity is organized explains much of the gap between rich countries and poor. In China's current policy debates, it is unsurprising that the nature of property rights in agricultural land and the extent to which markets should supplant administrative authority are important topics.

Since the introduction of the Household Responsibility System (HRS) in the early 1980's, local officials have redivided more than half of the farm land in rural China among villagers through periodic administrative reallocations. These reallocations grant a villager secure tenure only until the next reallocation. We investigate the forces determining the reallocation behavior of village governments, and hence the formation of the right "security of tenure". Given the recent growth in land rental and the hiring of agricultural labor, we also examine the relationship between administrative and market factor allocations. This analysis amounts to an examination of the choice between centralized and decentralized organization of agricultural production.

We analyze survey data collected by the authors and their colleagues in China in 1996 and 1997. These data describe the land reallocations in 215 villages during the period 1980-96, along with their economic and political environments. Cross-sectional variation in these data allow us to identify the effects of changes in economic and demographic variables and changes in the political and institutional environment (e.g. the size of village bureaucracy, the frequency of elections, or the size of particular interest groups), on the behavior of local governments. While the political economy of property rights formation is not a new topic, our data are unique: Most analyses

of the political economy of property right formation are case studies[2].

We consider four hypotheses about villages' reallocation behavior: (1) realloca-
tions are conducted according to simple demographic rules; (2) reallocations are used
to dispossess villagers who do not fulfill certain tax obligations; (3) reallocations re-
distribute land rents in favor of particular interest groups or politicians; and (4) in
the absence of markets for agricultural land and labor, reallocations move land to
higher valued uses. The data suggest that these hypotheses are important in reverse
of the order listed. Many of the patterns observed in our data are explained by the
hypothesis that administrative reallocations move land to higher valued uses; the
other three hypotheses have less explanatory power.

We also find that administrative reallocation decreases as market exchange in-
creases. Together with our finding that reallocations move land to higher valued
uses, this suggests that village governments and markets are substitute providers of
"land reallocation" services. Thus, we find that administrative reallocations increase
and security of tenure decreases as the opportunities to move land to higher valued
uses increase and as market activity decreases[3].This intriguing finding suggests that
tenure is insecure because administrative reallocations are substituting for poorly
functioning land rental markets.

Finally, we consider alternative explanations for the poor functioning of agricul-
tural factor markets.

2. Background

In the late 1970s and early 1980s, China's reforms dismantled agricultural collec-
tives and allocated farm land to households as part of the Household Responsibility

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[2]Libecap and Wiggins (1984) examine the politics that determine property rights in oil fields for
three states: Texas, Oklahoma, and Wyoming. Ostrom (1990) examines the nature and evolution of
rights to various common property resources in about 20 case studies. Boycko, Shleifer and Vishny
(1995) describe how the national government encouraged the evolution of private property rights in
Russian firms. Pashigan (1976) examines the choice between state, municipal, and private ownership
of public transit systems, and makes use of a sample of 58 cities instead of case studies.

[3]One occasionally reads the statement that security of tenure is a neccesary condition for the
establishment of markets. That this statement is false is demonstrated in Malik and Schwab (1991),
and Jimenez (1984). If this were true then we would have the direction of causation backwards:
Insecure tenure would cause market failure.

4

Table 2.1:

Village Reallocation Behavior

% Of villages that have reallocated	71.6
Mean number of reallocations (all villages)	1.7
	(1.8)
Mean number of reallocations (given reallocate at least once)	2.4
	(1.7)
% of land reallocated since HRS	48.5
	(43.4)
Size of most recent reallocation:	
% of land	57.6
	(41.3)
% of households	72.6
	(31.2)

Note: Standard deviations are reported in parentheses.

System(HRS). This reform effectively made households residual claimants to farm output. The HRS also gave village leaders authority over the allocation of land to households, as well as discretion over the assignment of other use rights, e.g., freedom of crop choice and the right to rent.

Village leadership consists of the Party Secretary (*shuji*) and the Village Head (*cunzhang*). The Party Secretary is selected by higher-level party organizations, while the village head is either appointed by township officials or is selected by villagers or a representative assembly in elections that may or may not be legitimate. In rare cases, a single individual holds both positions. The division of responsibility between the party secretary and the village head is not always clearly defined, but both are evaluated on the basis of their success in meeting targets set by higher levels of government for family planning, quota fulfillment, and tax collection. Performance contracts tie wages explicitly to meeting these targets, as well as other economic and social concerns like village economic growth and equity (Ho (1994), O'Brien (1997), Rozelle (1994)). Promotion decisions are based on similar criteria. On the other hand, village leaders are subject to lobbying by the villagers, and they are occasionally subject to some sort of election, or to pressure from above in response

Table 2.2:

Agricultural factor markets

	1988	1995
Number of households renting-in	2.1	8.9
	(5.7)	(14.1)
% of land rented-in	0.6	2.9
	(1.8)	(5.8)
Number of farm laborers hired	9.1	24.4
	(27.1)	(49.8)
Number of individuals working off-farm	107.4	210.1
	137.0	(186.5)

Note: Standard deviations are reported in parentheses.

to villager lobbying. Finally, leaders are occasionally subject to violence at the hands
of the villagers.

Across rural China, we observe enormous heterogeneity in the extent to which
households enjoy secure tenure and exercise a right to rent land. Although national
pronouncements have repeatedly called for secure tenure for a period of fifteen years,
this has not happened. Tenure security is largely determined by the frequency and
magnitude of village-wide land reallocations. In these reallocations, all or part of
the land is taken back from the households and re-divided among existing and new
households. Reallocations typically occur in the off-season, are overseen by the village
leaders, and involve several months of administrative work. Much of this work revolves
around (1) gathering and updating information on household demographics and labor
supply; (2) talking and arguing with villagers about the nature of the prospective
reallocation; and (3) redefining plot boundaries and reallocating land.

Table 2.1 reports the frequency of village-wide reallocations. In more than two-
thirds of all villages, land has been reallocated at least once. Conditional on realloca-
tion, the average number of reallocations is 2.3. Table 2.1 also reports the percentage
of land that has been reallocated since the introduction of HRS and the percentage of
land that was reallocated in the most recent reallocation. On average, slightly more
than half of all farm land (including villages that have not reallocated) has changed
hands since HRS was introduced, with a typical reallocation involving two-thirds of

6

a village's land.[4]

Although seventy percent of surveyed villages report that households enjoy un-encumbered rights to rent land in 1995, the land rental market appears to be very thin. Table 2.2 offers estimates of the percentage of land rented out in 1988 and 1995. While the amount of land rented increases from 1988 to 1995, in 1995 less than three percent of all land was rented out. The market for agricultural labor is equally thin. Only half of all villages report the use of hired labor in 1995, up from one quarter in 1988, and less than 1 percent of agricultural labor is procured through the market[5].

While the markets for land rental and farm labor are poorly developed, the market for non-agricultural labor has boomed. Our data detail several categories of this labor including employment in village-run enterprises, family businesses, and long-term employment outside the village. Between 1988 and 1995, the number of individuals employed off-farm doubled while the labor force grew only modestly. By 1995, nearly forty percent of the local labor force was employed outside of agriculture either full or part-time, a level consistent with those reported at the national level (ZGTNJ, 1996).

In return for use-rights to the land, in much of China households are allocated quotas. Quotas are a vestige of the pre-reform period, and entail the delivery of grain, cotton, and/or oil crops to the state at predetermined prices that can be as low as 50 percent of free-market prices (Sicular, 1995). With HRS, responsibility for quota delivery shifted to households, although upper level officials hold village leaders responsible for quota fulfillment. Villages typically allocate quotas to household on the basis of family size, allocated land, or some combination of the two. In absolute terms, village quotas have remained fairly constant since the early 1980s. On average, quotas run slightly less than 10 percent of village gross agricultural output, or 15 percent of village net output. Quotas are usually fulfilled in-kind, however, a growing number of villages are allowing quotas to be met in cash[6]. In 1995, 58.7 (44.1) percent

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[4]Our estimates for the percentage of land reallocated since the HRS are truncated at 100. A village that reallocated all of its land twice would only report a reallocation of 100 percent.

[5]Our survey records the number of individuals hired for agricultural labor, not the number of days. Most of the hiring in agriculture is seasonal and amounts to less than ten day per worker. An average village in 1995 had 300 households and a labor force of almost 600, most of whom worked at least part time in farming. In 1988, the number of individuals hired per village was less than ten, and in 1995 was only about 20

[6]The cash obligation associated with a 1 unit output quota is equal to the difference between the

of all villages allowed cash to be used to fulfill grain (cotton) quotas. In these villages, 26.9 (39.8) percent of all households used cash to fulfill their grain (cotton) quota. By comparison, only 30 percent of all villages allowed cash to be used when the HRS was introduced, and only 11.7 percent of all households exercised this option.

3. Explanations for reallocation behavior

We consider four hypotheses about reallocation behavior: The simple demographic rules hypothesis, the tax collector hypothesis, the redistribution hypothesis, and the rational village hypothesis. This section describes each hypothesis and its testable implications.

3.1. Simple demographic rules hypothesis

One possible way of allocating land is to use simple demographic rules that distribute land on the basis of household size, possibly scaling amounts to reflect differences in household demographic composition. Burgess (1997) finds that land allocations in the provinces of Sichuan and Jiangsu are well explained by simple demographic rules of this sort. This behavioral rule is also consistent with Kung (1995), who uses survey data to argue that villagers in rural China prefer egalitarian land allocations. Kung's explanation of his survey data appears to be "non-economic": Individuals' prefer to increase equity. Other explanations are possible: A collective preference for equity is consistent with self-interested behavior in Peltzman's (1980) analysis of voting.

If demographic rules are the only determinant of land allocation, then we expect to find a strong statistical relationship between household demographics and land allocations. To test this hypothesis with our village level data, we test for a positive relationship between total land reallocated and the mean change in a household's demographic characteristics. To proxy for the mean change in household demographic characteristics we use the rate of change of village population[7].

market and quota prices for the unit of output.

[7]We will explain the intuition behind this choice when we describe our data.

8

3.2. Tax collector hypothesis and non-marginal effects

Through agricultural quotas, the state retains a claim to the product of agricultural land. Village leaders serve at the discretion of higher levels of government, and one of their primary responsibilities is to ensure quota fulfillment. Kelliher (1996) provides anecdotal evidence that leaders have a great deal of discretion in the way that they conduct land reallocations, and that they use this discretion to dispossess villagers who do not fulfill quota obligations. We want to know how much of reallocation behavior is accounted for by this punitive dispossession.

Suppose that the leader, with some probability, reallocates land away from any household that fails to fulfill its quota. For low levels of quota the benefit of defaulting on the quota is less than the expected loss associated with dispossession, and we expect to see low levels of reallocation. As the quota rises, the benefit to the household of defaulting rises, while the benefits of retaining the land decline. Thus, we expect that default will be more common as quotas rise, or that a higher proportion of defaults will need to be punished with dispossession. Eventually, if the quota is high enough, some households will want the leader to reallocate their land. Thus, if rent collection for the state is behind land reallocation behavior, reallocations will increase as the quota level rises.

A back of the envelope calculation suggests that the tax collector story may have some explanatory power. Huang (1997) found that in an average village, 90 percent of agricultural quotas were collected. Suppose that the leader immediately marks the 10 percent of the land that is in default for reallocation. Imagine that the incidence of default is random, so that the 90 percent of land that is not marked for reallocation is also random. After six years of this random sampling with replacement, $0.9^6 = .53$ of the land is not marked for reallocation. In other words, a 10 percent annual rate of default which is punished by periodic dispossession, translates into 47 percent of the land changing hands every six years. Since the average time between reallocations is slightly less than 6 years and the average amount of land reallocated is 60 percent, a 10 percent annual non-payment rate could explain much of the observed reallocation.

However other facts weigh against the tax collector story. First, the quota default rate was very high in 1995 because the gap between quota and market prices was unusually large. In other years the rate of default is much lower, probably nearer 1

9

percent[8]. Using this lower rate of default it is difficult to imagine 60 percent of the land being reallocated as a response to non-payment of quotas every six years. Second, the tax collector hypothesis has an important conceptual problem. If reallocation behavior is driven by the need to punish particular acts of default, then we expect to see reallocations occurring fairly continuously and to involve a small number of households. In fact, we observe that reallocations are large and infrequent.

There is another explanation for the role of quotas that makes use of essentially the same logic as the tax collector hypothesis. As the quota obligation increases it becomes increasingly likely that the value of the quota exceeds agricultural rents—agricultural revenues less the opportunity cost of labor. If a household's agricultural profits are negative, we expect it to lobby the village government to reduce its land holdings. Therefore, if the reallocation process is sensitive to pressures from individual households, we will see reallocations increase with the quota level as people try to reduce their land holdings and the associated quota obligation. We note that negative household profits can occur whether the household's marginal products for land and labor are high or low. This "non-marginal effect" of the quota has the same implications for reallocation behavior as the tax collector hypothesis.

3.3. Redistribution hypothesis

In principle, a village leader can conduct a reallocation as an auction, giving each parcel to the household willing to pay the most for it, and then distributing land rents according to any arbitrary formula . In this case, redistribution of land rents is completely independent of how land is allocated. In practice, this sort of auction is rare, so that land rents remain at least partly tied to the land, and are redistributed with land. We want to determine how important redistributive pressure is as a determinant of reallocation behavior.

There is a large literature (e.g., Becker 1983) suggesting that the size of an interest group affects its ability to use the political process to effect favorable redistributions. If redistributive pressures influence reallocation behavior, we expect that the size of various interest groups will be an important determinant of this behavior. Our test for the importance of redistribution involves identifying interest groups and testing

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[8]The one percent figure is suggested by the authors' interviews with village leaders, and is corroborated by household level data.

whether the size of these groups is a significant determinant of reallocation behavior.

Our data record three interest groups: The proportion of the village population who are party members, the proportion of the village labor force that is old (50+), and the proportion of the village labor force that is young (18-25). We expect that redistributive activities will vary with the ability of these groups to influence the political process, which in turn varies with the size of the group.

While village leaders do not distribute land at auctions, it is still possible for them to collect some portion of land rents in the form of favors or bribes[9]. If redistribution of rents from the villagers to leaders is an important determinant of reallocation behavior, and if we think that the leader's propensity for collecting these rents is systematically related to observable characteristics of the leader, like age and education, then reallocation behavior will be sensitive to changes in the leader's characteristics.

3.4. Rational village hypothesis

Finally, we consider the hypothesis that land reallocations serve to maximize village agricultural profits in the absence of land and agricultural labor markets. There are three reasons why this hypothesis may have explanatory power. First, to the extent that villagers are able to affect reallocations by lobbying, we expect households that value land more highly to lobby more effectively for favorable reallocations. Second, as the village's agricultural profits increase, it is probably easier for the village leader to collect taxes and agricultural quotas. Since these responsibilities are important part of the leader's job, the leader may have an incentive to perform profit increasing trades. Third, to the extent that equity is a consideration, it will involve transfers to households with high labor-land ratios from those with low labor-land ratios. To the extent that equalizing labor-land ratios across households also equalizes the marginal productivity of land, these trades increase profits. All of these forces tend to push reallocated land into higher valued uses, which causes administrative reallocations to increase village profits. We want to know how important profit maximization is as an explanation of reallocation behavior.

If administrative reallocations increase village agricultural profits, then these reallocations will perform many of the same transactions that will occur in a decentralized

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[9]This sort of rent collection need not signal corruption. The leader may reallocate land in favor of households that pay their taxes without grumbling or comply with family planning programs.

land market. With this said, we expect that centralized administrative reallocations to mimic markets poorly[10]: Village leaders face problems in determining land qualities and household labor supplies that are less problematic in market transactions. It is also possible that much of the gain from administrative land reallocation is dissipated by lobbying activities.

To the extent that frequency and magnitude of land reallocation is essentially an inverse of tenure security, we expect reallocation behavior will affect investment behavior. Conversely, making investments in land may be a way to improve tenure security, and hence may reduce the amount of land reallocated. Since our data set contains very little information about household investments in agriculture, we ignore investment decisions in the formal model.

Formally, our hypothesis is that administrative land reallocations maximize the discounted present value of agricultural profits, net of costs to conduct reallocations. The resulting intuition about reallocation behavior is straightforward. Over time households change their labor supply to agriculture in response to changes in their off-farm opportunities or changes in household labor endowment. Since households cannot adjust land holdings, agricultural land and labor gradually become "less well matched" and the village's agricultural profits decline. Reallocations are a costly way to correct this deterioration. As such, they occur only when the land-labor match deteriorates sufficiently to warrant the cost.

We first formalize what it means for land and labor to become "less well matched". Second, we solve for optimal reallocation behavior when there is a fixed cost of conducting a reallocation. Finally, we discuss the role of agricultural quotas.

Land-labor match: Say that land and labor are *perfectly matched* if no possible reallocation of land can increase a village's agricultural profits in a given year. We define the *quality of the land-labor match* to be the amount of land that must be reallocated in order to move the village to this instantaneous optimum.

Introduce the following notation:

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[10]De Alessi (1980) surveys the literature that compares the government and private sector, and finds that governments are generally less efficient at providing good and services than markets. On the basis of this literature we expect that the centralized provision of "land exchange" will be inferior to the decentralized provision of the same service.

$$x_i \;=\; \text{household } i\text{'s land allocation,}$$

$$F(l_i, x_i) \;=\; \text{agricultural production function, } DF > 0, D^2 F < 0,$$

$$w_i \;=\; \text{household } i\text{'s off-farm wage,}$$

$$p \;=\; \text{price of agricultural products,}$$

$$l_i \;=\; \text{household } i\text{'s labor supply to agriculture .}$$

A profit maximizing household chooses its agricultural labor supply to maximize profits from agriculture:

$$l_i(x_i, w_i, p) = \arg\max_{l_i} pF(l_i, x_i) - w_i l_i.$$

It follows that households allocate labor to agriculture so that the marginal product of agricultural labor is equal to their off-farm wage, i.e.,

$$pF_l(l_i, x_i) - w_i = 0. \tag{3.1}$$

Differentiating implicitly, we obtain the effect of a change in household i's land allocation on their supply of labor to agriculture,

$$\frac{dl_i}{dx_i} = \frac{-F_{lx}(l_i, x_i)}{F_{ll}(l_i, x_i)}. \tag{3.2}$$

Consider a village with one unit of agricultural land divided between two households. Village agricultural profit in a given year is the sum of agricultural profits in the two households, or,

$$\Pi = pF(l_1, x_1) - w_1 l_1 + pF(l_2, 1 - x_1) - w_2 l_2. \tag{3.3}$$

The first order necessary condition for the instantaneous maximization of village agricultural profits is that $\Pi_x = 0$, which requires that the marginal productivity of land is equalized across households. After substituting from 3.1, this gives,

$$\Pi_x = p\left[F_x(l_1, x_1) - F_x(l_2, x_2)\right] = 0. \tag{3.4}$$

By definition, land and labor are perfectly matched if 3.4 is satisfied.

Suppose a village where land and labor are perfectly matched experiences a change in its agricultural labor supply profile, $(\Delta l_1, \Delta l_2)$. The amount of land that must be shifted from household 2 to household 1 to return to an instantaneous optimum is calculated by differentiating 3.4 implicitly and substituting from 3.2. This gives,

$$\frac{dx_1}{dl_1} = \frac{-F_{xl}(l_1, x_1)}{F_{xx}(l_1, x_1) - \frac{(F_{lx}(l_1,x_1))^2}{F_{ll}(l_1,x_1)} + F_{xx}(l_2, 1 - x_1) - \frac{(F_{lx}(l_2,1-x_1))^2}{F_{ll}(l_2,1-x_1)}} \quad (3.5)$$

$$\frac{dx_1}{dl_2} = \frac{F_{xl}(l_2, 1 - x_1)}{F_{xx}(l_1, x_1) - \frac{(F_{lx}(l_1,x_1))^2}{F_{ll}(l_1,x_1)} + F_{xx}(l_2, 1 - x_1) - \frac{(F_{lx}(l_2,1-x_1))^2}{F_{ll}(l_2,1-x_1)}}.$$

Using 3.5 we can write a first order approximation of the amount of land that must be reallocated to maximize one-year profits,

$$S = |\Delta x_1| = \left| \frac{dx_1}{dl_1} \Delta l_1 + \frac{dx_1}{dl_2} \Delta l_2 \right|. \quad (3.6)$$

Since the quality of the land-labor match is defined as the amount of land that must be reallocated to return to the instantaneous optimum, 3.6 describes how the quality of the land-labor match responds to changes in households' labor supplies[11].

Labor supply changes open the door to gains from land reallocation through their effects on households' marginal products of land. The numerators in 3.5 measure how sensitive the marginal product of land is to changes in households' labor supplies. The denominators measure how sensitive the marginal product of land is to changes in land allocations[12]. The resulting ratios measure the amount of land that must be reallocated to eliminate a divergence in household marginal products of land caused by small changes in labor supplies.

Our intuition is that the frequency of reallocations depends on the rate at which the land-labor match deteriorates, and that this deterioration is driven by changes in household demographics and off-farm opportunities. Holding technology fixed, we can write the rate of deterioration of the land-labor match as the time derivative of

[11]Our econometric results explain the *proportion* of land reallocated and the proportion of households which are subject to labor supply changes, rather than the levels. The analysis above extends to changes in proportions rather than levels. While this does not substantively change the intuition, it does make the exposition less transparent.

[12]The second term in the denominators reflects the fact that labor supplies respond to changes in land allocations, and that this change also affects the marginal product of land.

14

S:

$$\nu = \frac{dS}{dt} = \left| \frac{dx_1}{dl_1} \frac{dl_1}{dt} + \frac{dx_1}{dl_2} \frac{dl_2}{dt} \right|. \tag{3.7}$$

Equation 3.7 states that the rate at which land and labor become mismatched depends on the *product* of the rate of change of agricultural labor supply and the rate at which labor supply changes contribute to land-labor mismatch.

Optimal reallocation path: Let Π^* denote the maximal agricultural profits that can be obtained in any given year. Our intuition is that agricultural profits decline as the land-labor match deteriorates. That is,

$$\Pi(S) = \Pi^* - \alpha S, \tag{3.8}$$

where $\alpha = |\Pi_x|$ is given by 3.4, and measures the sensitivity of profits to changes in the land-labor match. Recalling 3.7, we note that the land-labor match is a function of time and the rate of change of household labor supplies, $S(t_0 + t) = S(t_0) + \nu t$. Substituting in 3.8 we have $\Pi(S(t_0 + t)) = \Pi^* - \alpha(S(t_0) + \nu t)$. This corresponds closely to our initial intuition. Village agricultural profits are decreasing in the time since the last reallocation and in the rate at which the land-labor match deteriorates. The rate at which the land-labor match deteriorates increases with the rate at which labor supplies to agriculture change.

Even if the only motivation for reallocations is to maximize agricultural profits, as long as there are fixed costs of reallocating land, it does not maximize village profits to maintain a perfect land-labor match ($S = 0$) at all times. Instead, villages periodically reallocate land when the existing allocation is "far enough" from the optimum. In order to analyze this behavior we require a dynamic model of optimal land reallocation. Introduce the following notation:

c_f = fixed cost of conducting a land reallocation,

c_v = marginal cost of reallocating a unit of land,

r = discount rate,

τ = time between reallocations,

t = time since a reallocation.

The problem of maximizing the discounted present value of agricultural profits generates the following value functional:

$$V(x) = \max_{\substack{\tau \geq 0 \\ y \geq 0}} \left\{ \int_0^\tau e^{-rt} \left(\Pi^* - \alpha(x + \nu t) \right) dt - e^{-r\tau} \left(c_f + c_v(x + \nu\tau - y) + V(y) \right) \right\}.$$

(3.9)

For any given initial state of the land-labor match, x, the village chooses the time until the next reallocation, τ, and the amount of land reallocated at the next reallocation, $(x + \nu\tau - y)$. Optimal reallocation behavior maximizes the discounted present value of the present cycle's profits, conditional on optimizing behavior thereafter.

This statement of the problem makes the following implicit assumptions. (1) Villages never make the choice "never reallocate". While our sample contains some villages that have not reallocated, we cannot distinguish the decision "never reallocate" from the decision "reallocate less often than every 15 years"[13]. Given this we opt for the simpler statement of the problem. (2) Equation 3.9 restricts attention to discontinuous reallocation behavior. In the presence of a discrete cost of reallocation, continuous reallocation cannot be optimal if the response to reallocations is continuous. (3) Equation 3.9 does not consider the case when the village's initial need to reallocate land is larger than the threshold. This is a simple extension of the analysis but is not indicated by the data, which suggest that first reallocations are like subsequent reallocations[14]. (4) If the leader can anticipate changes in households' labor supplies, he might choose to reallocate more land than is required to get to the optimum. Equation 3.9 does not allow this. This is a simplifying assumption consistent with the leader having little ability to predict the direction of change in any given household's labor supply.

The appendix solves this maximization problem explicitly. The reallocation path that maximizes the discounted present value of agricultural profits has the following characteristics. For a given initial value of the land-labor match, the planner allows the land-labor match to deteriorate until a threshold, $S = \nu\tau^* \left(\Pi^*, \alpha, \nu, c_f, c_v, r \right)$, is reached and then reallocates land until $S = 0$. Thereafter, the planner reallocates until $S = 0$ every τ^* years. The time path of village profits is illustrated in Figure 1.

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[13]The HRS was introduced in the early 1980's, about 15 years before our 1996-7 surveys.

[14]We cannot reject the hypothesis that the average amount of land changing hands in a village's first reallocation is the same as the average amount of land changing hands in subsequent reallocations.

16

Figure 1. Path of village profits with optimal reallocation.
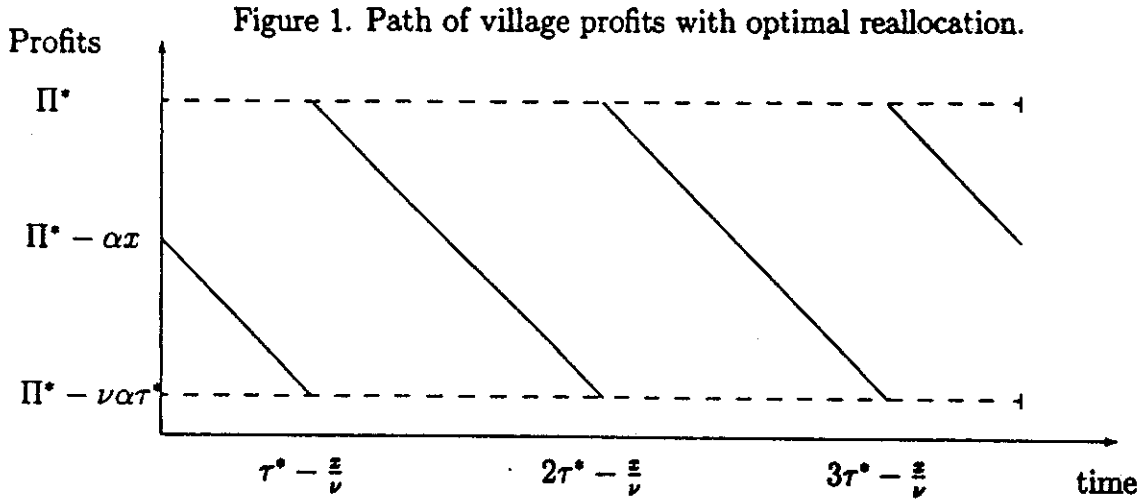
We note that if instantaneous profits were concave in the amount of land reallocated, e.g., $\Pi(S) = \Pi^* - \alpha S^2$, then the amount of land reallocated could depend on variable costs of reallocation, as could the upper and lower thresholds of the land-labor match. We assume that instantaneous profits are linear in the amount of land reallocated. We make this assumption because our data provide no basis for estimating second order terms of the instantaneous profit function, and because it simplifies the problem. An artifact of this assumption is that (barring a corner solution) variable costs of reallocating do not affect the amount of land reallocated, except by affecting the time between reallocations. In fact, variable costs may impact the amount of land reallocated directly, not just through their impact on time between reallocations.

Although we cannot find an analytical solution for τ^*, we can generate comparative statics. Unexpectedly, the time between reallocations need not be decreasing in α, ν, and c_v. Two countervailing forces are at work here. First, the "continuation payoff", i.e., the maximum present value of profits, conditional on a reallocation having just occurred, declines as α increases. Since α measures the sensitivity of agricultural profits to changes in the land-labor match, as α increases, the village must reallocate more often to maintain the same average profits. Consequently, either the average profits decline or expenditure on reallocations increases. In either event the continuation payoff declines. Therefore, as α increases, it becomes less costly to delay reallocating because the village delays a less valuable future. On the other hand, as α

17

increases, the marginal benefit from reallocating at any given time increases, since the village is further from the instantaneous optimum. Hence, as α increases, delay is less costly and the benefit of reallocation grows more quickly. Since these two effects work in opposite directions, the net effect of a change in α on τ^* is ambiguous. Similar arguments explain why the effect of changes in c_v and ν on τ^* are also ambiguous.

Despite these ambiguous comparative statics, the rational villages hypothesis predicts that the time between reallocations should depend on:

- The rate at which household agricultural labor supplies change (ν),

- Sensitivity of agricultural profits to land-labor mismatches (α),

- Marginal and fixed costs of reallocation(c_v, c_f).

Furthermore, the amount of land reallocated at each reallocation should depend on:

- Time since the last reallocation (τ),

- Rate at which household agricultural labor supplies change (ν),

- Sensitivity of agricultural profits to land-labor mismatches (α).

Finally, the amount of land reallocated should depend on fixed costs only indirectly, through their impact on the timing of reallocations. We will test this exclusion restriction in our econometric work. Variable costs of reallocation may affect the amount of land reallocated directly or indirectly. These predictions, and those of other explanations of reallocation behavior are summarized in Table 3.1.

Quotas: Agricultural quotas require a household to sell a certain amount of output to the government at below market prices. As long as these quotas are enforced, they may constrain households to supply labor to agriculture past the point where its marginal product equals the off-farm wage. In this case, fulfillment of the agricultural quotas involves a deadweight loss, and causes the village to generate less profits. The rational village hypothesis implies that villages will search for a way to relax the quota constraint when faced with binding agricultural quotas.

Table 3.1:

Summary of testable implications

	Frequency	Amount
Rational village	$\pm \nu$	$+\alpha$
	$\pm \alpha$	$+\nu$
	$\pm$ Fixed costs	0 Fixed costs
	$\pm$ Variable costs	$\pm$ Variable costs
		$+$ Time since last reallocation
Tax Collector, Non-marginal effect	$+$quotas	$+$quotas
Redistribution	$\pm$ Leader characteristics	$\pm$ Leader characteristics
	$\pm$ % party members	$\pm$ % party members
	$\pm$ % old people	$\pm$ % old people
	$\pm$ % young people	$\pm$ % young people
Simple Rules	$\pm \frac{dl_i}{dt}$	$+$Time since last reallocation
		$+\frac{dl_i}{dt}$

There are two ways that this might be done. First, if the village converts the quota obligation to a cash obligation, then it no longer distorts labor supply behavior and does not involve a deadweight loss. This is observed in 58 percent of sampled villages. Second, the village can shift quotas to households for whom quotas will not affect labor supply decisions. Since more than 90 percent of villages report that household quota obligations are proportional to land holdings or the number of people in the household, this option does not appear to be widely used[15]. Thus, as a first approximation, the rational village hypothesis predicts that quotas will only have a small impact on the way that villages conduct land reallocations.

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[15]This not too surprising. We expect that the quota will distort labor supply decisions primarily for those households with high off-farm wages, the wealthiest households. Therefore, reducing the labor supply distortion requires transfering quota obligations from the rich to the poor, a regressive policy that is unlikely to find political support without side payments.

4. Description of data

The data we draw on are the product of a collaborative survey effort undertaken in the summers of 1996 and 1997. This survey covered 8 provinces: Zhejiang, Sichuan, Shanxi, Hubei, Hunan, Hebei, Liaoning, and Yunnan. Thirty two villages were sampled in the first five provinces, twenty four villages were sampled in Yunnan, and fifteen and sixteen villages were surveyed in Hebei and Liaoning. Altogether enumerators interviewed the village leader, party secretary, and village accountant in 215 villages in 50 counties. The sample of villages was constructed to provide a representative cross-section of villages in each province, while the eight provinces represent every major region of China.

The survey collected information on property rights in land, agricultural and off-farm labor markets, agricultural production, village governance structures, and other village characteristics. Data were collected for 1995, 1988, and for the year when the HRS was introduced, about 1980.

Below, we describe variables used in our empirical work. The variables are organized into groups: Reallocation behavior, demographics and labor supply, technology, transactions costs, redistribution, village governance, and other markets. Means and variances of all variables are reported in Appendix 2.

Reallocation behavior: For all villages, we know the total number of reallocations conducted since the inception of the HRS. We also know the year, the number of households, and the amount of land involved in each village's most recent, first, and largest reallocation. We also know, as of 1996, the amount of land that had not been reallocated since HRS was introduced. These data were reported in Table 2.1.

Demographics and labor supply: The simple rules hypothesis and the rational village hypothesis both predict that reallocation behavior depends upon the rates at which households' demographic or labor supply characteristics change. Let N be the number of households in a village, and let l_i^t denote the level of a demographic or off-farm labor supply variable for household i in time t. An ideal measure of the rate

of change of labor supply in an average household is:

$$\frac{1}{\sum_{i=1}^{N} l_i^t} \left[\sum_{i=1}^{N} |l_i^t - l_i^{t+1}| \right], \tag{4.1}$$

that is, the factor by which an average household's value of l changes during one unit of time. Since we observe village level data, it is not possible to construct this type of measure. However, we can construct something similar using aggregate data. Since we observe $\sum_{i=1}^{N} l_i^t$, and $\sum_{i=1}^{N} l_i^{t+1}$, the aggregate levels of l at t and $t+1$, we can calculate,

$$\frac{\left| \sum_{i=1}^{N} l_i^t - \sum_{i=1}^{N} l_i^{t+1} \right|}{\sum_{i=1}^{N} l_i^t} = \frac{\left| \sum_{i=1}^{N} (l_i^t - l_i^{t+1}) \right|}{\sum_{i=1}^{N} l_i^t}. \tag{4.2}$$

This expression is a lower bound for 4.1 and is used as a proxy for 4.1.

We construct the annual rates, r_l, that correspond to 4.2 in the usual way:

$$\left(\frac{1}{1+r_l} \right)^7 = \left(1 + \frac{\left| \sum_{i=1}^{N} (l_i^{88} - l_i^{95}) \right|}{\sum_{i=1}^{N} l_i^{88}} \right). \tag{4.3}$$

That is, r_l is the annual rate of change of aggregate quantities, which compounded over the time between observations, gives the normalized change in aggregate l.

We construct the measure corresponding to 4.3 for three variables:

- Rate of change of village population. This variable reflects the annual rate of change in the number of people officially registered as village residents, and therefore entitled to consideration in the land allocation process.

- Rate of change of off-farm non-migrant labor. This variable reflects the annual rate of change in the numbers of villagers who are employed off-farm, but live in the village.

- Rate of change of off-farm migrant labor. This variable reflects the annual rate of change in the numbers of villagers who are employed off-farm and work and live most of the year outside the village. We will sometimes aggregate the off-farm labor of migrants and non-migrants.

Technology: The rational village hypothesis predicts that reallocation behavior depends on the characteristics of the production functions in two ways. First, from 3.7, the rate at which land and labor becomes mis-matched, (ν), depends on the ratio of second and third order derivatives of the production function. Second, from 3.4, the sensitivity of agricultural profits to changes in the land-labor match, (α), depends on the marginal productivity of land.

Since these derivatives are not observed, we proxy them with the land-labor ratio and output-land ratio. For constant returns to scale technologies, $\frac{-F_{zl}}{F_{zz}} = \frac{z}{l}$, the land-labor ratio. Since $\frac{F_{zl}}{F_{zz}}$ is close to 3.5, we can use the land-labor ratio as a proxy for the technology's contribution to ν, provided we accept that the agricultural technology is approximately constant returns to scale. Since yields are the average product of land, and average product and marginal product move together, we can use yields to proxy for the technology's contribution to α. Even if we reject these structural interpretations of the land-labor ratio and yield, since the land-labor ratio and yield reflect heterogeneity in the underlying agricultural production technology, we can still use them to control for this heterogeneity.

Yield per mu (1 mu $\approx$ 1/6 acre) is calculated by dividing the total grain output by sewn area in grain[16]. To reduce the possibility that this quantity is affected by reallocation behavior, we use 1988 values for sewn area and output. These values predate the reallocations with which we are concerned. The land-labor ratio is calculated by dividing the total land in cultivation by the village population. As with yields, we also use 1988 estimates of the population and land in cultivation.

Transactions costs: The following variables capture the costs associated with reallocation. Because of difficulty in assigning them to either a "fixed" or "variable" costs category, we allow for the possibility that they contribute to both fixed and variable costs of reallocating a unit of land:

- Cropping Intensity: Administrative reallocations are more likely to disrupt farming as the land is farmed more intensively. The multiple cropping index indicates the average number of crops planted in a year and reflects the intensity with which land is farmed.

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[16]We use grain yields because we lack local price data to aggregate grain and non-grain crops. On average, nearly 80 percent of cultivated area is in grain.

- Number of households: All else equal, as the number of households increases we expect the cost of conducting a reallocation to rise.

- Number of production teams. Prior to the HRS, households were organized into production teams. Their current counterpart is the small group (*xiao zu*). These teams are responsible for reallocating land among members during reallocations. In most villages, land is fixed within these groups, though some reallocation may occur between teams. Heterogeneity in administrative structures probably results in heterogeneity of reallocation costs.

- Number of plots: All else equal, we expect the costs of reallocations to rise as the village land is divided into more plots.

Since land reallocations decrease the private incentives for investment in agriculture, this disincentive may also be construed as a cost of reallocation. If this sort of investment cost is important, we expect it to be larger when agricultural investment is more important[17]. Our data record the proportion of village land that is rice paddy. Since paddy land is relatively investment intensive, if investment and tenure security are positively related, then fewer and smaller reallocations will occur in villages where paddy land is more common.

Redistribution: These are variables which reflect the characteristics of groups of villagers who may find it relatively inexpensive to manipulate the reallocation process for their own gain. As discussed in Section 3.2, candidates include:

- proportion of old villagers

- proportion of young villagers

- proportion of party members.

We do not have information on the demographic composition of the population, but do have information on the demographic composition of the labor force. We use this as a proxy for the proportions of old and young villagers. Note that the

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[17]We note that, as Besley (1995) points out, investment in land may serve to increase tenure security.

effectiveness of groups at using reallocations for redistribution depends on their levels, while the opportunity to increase profits through reallocations is a function of rates of change of proportions. Thus, at least in theory, we can separately identify redistributive and efficiency effects.

We are also interested to know the extent to which the village leader uses reallocations to extract rents for himself or the state. To the extent that village leaders' have different preferences for rent extraction, and these preferences are systematically related to observable characteristics like age and education, these characteristics should affect reallocation behavior.

Village Governance: Our survey describes village governance in some detail. Variables that we make use of are:

- The number of village "cadres", or bureaucrats employed by the village government.

- Age and education of the village leader and party secretary.

- Tenure of the party secretary and village leader.

- Distance from county seat.

- Whether village or township (county) governments make decisions about reallocations.

Other markets: Our survey describes the state of land rental markets in 1988 and 1995, as well as the state of the market for agricultural labor market. We note that the agricultural labor market is very thin and appears to consist primarily of large teams of people who move from village to village helping with seasonal tasks: Hiring casual agricultural labor from within the village is very rare. These data were reported in Table 2.2.

5. Econometric model

Our econometric inquiry is in two parts. We first analyze the frequency of village reallocations. We then analyze the duration of the most recent reallocation cycle and

24

the amount of land reallocated at the most recent reallocation.

5.1. Frequency of reallocations

In any given year, we know the time since each village last reallocated its land, and in principle, these data on reallocation periods in progress could generate a great deal of insight into reallocation behavior. Unfortunately these data are subject to two sampling problems: Interruption bias and length-based oversampling [18]. Salant (1977) proposes a method for dealing with these two problems. This method makes the following identifying assumptions:

1. For any given village, the probability of reallocating land is the same in any given year, and each village draws its constant hazard rate from a gamma distribution.

2. The birth process for reallocation periods is stationary over the entire period of the sample.

3. The cross-section of periods in progress is far enough away from time zero that the distribution of spells in progress is stationary.

About one-third of the villages in our sample have not reallocated since the advent of the HRS. This means, unlike our 1995 cross-section, a cross-section taken 50 years from now would not contain the spike of villages with a spell length of about 15 years. Thus, even if we are prepared to accept Salant's first two assumptions, the distribution of spells in progress is certainly not stationary. Moreover, because of the spike of villages with 15 year spell length, the likelihood function that Salant proposes does not converge. Consequently, we do not have a way to deal with the combination of length-based over-sampling and interruption bias that occurs in reallocation periods in progress data.

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[18]Interruption bias occurs because we observe interrupted reallocation periods, which are shorter than completed periods. To understand length-based oversampling, imagine that all villages are identical, and that each draws reallocation periods from a Bernoulli density which takes the values one day or 20 years with equal probability. Despite the fact that reallocation periods of one day and twenty years are equally likely, a cross-section of periods in progress over-samples long periods.

While we cannot use Salant's method to examine our periods in progress data, we can use a simpler method that has much the same spirit. If the number of times that a village reallocates during our 15 year window provides us with some information about the distribution from which villages draw hazard rates, then an attempt to explain this frequency data will provide some insight into the distribution of village hazard rates.

Column 1 of Table 5.1 reports the results of an OLS regression to explain the number of village-wide reallocations as a function of: Demographics and labor supply, technology, transactions costs, and village governance. The regression also includes village income and quota level as explanatory variables. We report heteroskedasticity corrected standard errors in parentheses. In order to check the robustness of these results, we conduct two related estimations. Column 2 of Table 5.1 reports the coefficients of a Probit explaining a dummy variable that is 1 if a village reallocated at least once since HRS was introduced. Column 3 of table 5.1 reports coefficients of the corresponding OLS regression. The results of the Probit and OLS regressions are similar to the frequency regression, though levels of significance are generally lower. Given that the second two specifications "throw away" observed variance in the LHS variable, the following discussion focuses primarily on the frequency regression.

Transactions Costs: Villages reallocate less frequently as the number of plots per household and the number of households in the village rise. Villages allocate more frequently as the number of "small groups" and cadres in the village increase, though the effect of the number of cadres is statistically insignificant. As predicted by the rational village hypothesis, these results indicate that reallocation behavior is sensitive to transactions costs. More specifically, if (1) the opportunity costs of a reallocation drops as the number of permanently employed bureaucrats (cadres) rises, and (2) the cost of a reallocation rises with the number of plots and households, then these results indicate that villages reallocate less often as the costs of reallocations rise.

As the percentage of cultivated area in paddy in the village increases, the frequency of reallocations decreases. Since paddy land requires more ongoing investment for maintenance, this may indicate that reallocation behavior is sensitive to the importance of investment. The intensity of cultivation as measured by the multiple cropping index, however, does not affect the number of reallocations, but does have

a statistically significant effect on the likelihood of reallocation since HRS.

Demographic and Labor Supply Variables: As predicted by the simple rules hypothesis, reallocations increase with the rate of change of population. As predicted by the rational village hypothesis, reallocation is sensitive to both the rate of change of population and the rate of change of off-farm opportunities. Specifically, all of the demographic and labor supply variables are statistically significant at least at the 10 percent level: Villages experiencing greater changes in population or off-farm non-local employment reallocate more frequently. Villages reallocate less frequently as local off-farm opportunities change faster.

The opposite effects of the two types of off-farm labor is a puzzle. From the point of view of a profit maximizing household, the only difference between local and non-local off-farm labor is that one must be supplied in much larger blocks than the other. It is not obvious why the "lumpiness" of non-local employment should be important. One possibility is that, absent off-farm opportunities, households experiencing an increase in labor supply are left to absorb this increase by working their own land more intensively. This leads to cross-household differences in the marginal product of land. The growth of local off-farm opportunities allows individuals to combine off-farm work with continued involvement in agriculture, and reduces the need for reallocation. Long-term migration, on the other hand, has a much larger impact on household farm labor supply, and requires more frequent reallocation to help minimize productivity differences arising across households.

This explanation is not entirely satisfying. Another possibility is that villagers who work outside the village (1) leave land behind unfarmed (or under-farmed), and (2) are not present to lobby for their continued tenure. Consequently, higher rates of reallocation associated with high rates of emigration may be a symptom of redistributions to those who live in the village from those who leave.

Technology: We include the land-labor ratio and yields to capture differences in technology. We find that yields are significant when the land-labor ratio is not in the regressions and only the land-labor ratio is significant when both are included. Consequently, we report regressions that include only the land-labor ratio.

We find that reallocations are more frequent as the land-labor ratio increases,

and that the coefficient is statistically significant. This is consistent with the rational village hypothesis, which predicts that reallocation behavior is sensitive to the characteristics of the technology.

Quotas: As the level of agricultural quota increases, the frequency of reallocations increases. This effect is statistically significant at the 5 percent level. This is consistent with the tax-collector or the non-marginal effects of quota.

Village Governance: Reallocation is less likely in villages in which decisions about reallocations are made by the township. This effect is especially pronounced in the Probit and linear probability model, and suggests townships are helping to enforce the fifteen year tenure security provision of the HRS law.

Miscellaneous: Village income is irrelevant, while the distance from the county seat increases the frequency of reallocations. An interpretation of this finding is that distance to the county seat is picking up some of the heterogeneity in local off-farm opportunities not fully captured by our labor variables: Villages located nearer to the county seat have access to better local off-farm opportunities.

In summary, the frequency regressions show that village reallocation behavior is responsive to the costs of reallocation and to the demographic and labor supply variables. This is consistent with the rational village hypothesis. The fact that population change also matters means that we cannot reject the simple rules hypothesis. The fact that the quota coefficient is significant and positive is consistent with the tax-collector story. The redistribution hypothesis remains untested.

5.2. Duration and amounts

5.2.1. Econometric issues

In 1994 and 1995 we observe 51 of the 215 villages reallocate land. For villages that reallocate, we observe the proportion of land that changes hands and the time since the preceding reallocation. That is, we observe 51 pairs of amounts and durations $(S_j, \tau_j) > 0$, and 164 villages with reallocation periods in progress for which $S = 0$. Since we cannot make use of the data on the length of periods in progress, we describe

28

Frequency regressions

N=215		(1)	(2)	(3)
Demographic Variables	Population	40.938***	34.374**	5.237
		(22.626)	(17.430)	(3.285)
	Off-farm local	-28.131**	-25.752	-5.593
		(16.163)	(18.13)	(4.693)
	Off-farm non-local	38.143*	28.660**	7.766**
		(13.747)	(14.261)	(3.731)
Technology	Land/Labor	0.365	0.278	0.049
		(0.225)	(0.234)	(0.054)
Transactions cost	# Plots	-0.051*	-0.059**	-0.0173*
		(0.015)	(0.024)	(0.006)
	# Households	-0.002**	-0.001	-0.0003
		(0.001)	(0.001)	(0.0002)
	# Production teams	0.112*	0.117*	0.023*
		(0.027)	(0.044)	(0.009)
	# Cadres	0.058	0.039	0.010
		(0.063)	(0.072)	(0.018)
	% Paddy	-0.689	-0.718***	-0.183***
		(0.437)	(0.377)	(0.099)
Quota		3.713**	1.573	0.373
		(1.688)	(1.277)	(0.301)
Township		-0.575	-0.883*	-0.262
		(0.415)	(0.316)	(0.877)
Income		-0.000	-0.000	-0.000
		(0.000)	(0.000)	(0.000)
County seat		-0.020*	-0.233*	-0.005**
		(0.007)	(0.009)	(0.002)

Note: Standard errors are reported in parentheses. *=1% significance, **=5% significance, ***=10% significance.

these data with a three equation model: 5.1 explains the amount reallocated; 5.2 explains the time since the last reallocation; and 5.3 explains whether or not we observe a reallocation in 1994 or 1995:

$$S_j = A_0 x_j + A_1 \tau_j + \mu_j, \tag{5.1}$$

$$\tau_j = B_0 x_j + B_1 z_j + \varepsilon_j, \tag{5.2}$$

$$I_j = \begin{cases} 1 & \text{if} \quad I_j^* > 0 \\ 0 & \text{else} \end{cases}, \tag{5.3}$$

$$I_j^* = C_0 x_j + C_1 z_j + \delta_j,$$

where we observe S_j and τ_j only if $I_j = 1$ and I_j^* is a latent variable. The third equation allows us to account for selection into the sample of villages which reallocate, but does not make use of the biased length data for periods in progress.

To estimate this system we must deal with two econometric problems. **(1)** Error terms in the amount and duration equations may be correlated. **(2)** There may be selection bias: Unobservables may differ between villages that reallocate and those that don't. We begin by estimating the model for a basic set of explanatory variables to assess the importance of these two econometric problems. This estimation proceeds in three stages:

1. Estimate the amount and duration equation with OLS. Provided that selection and endogeneity are not problems, these estimations generate consistent coefficient estimates.

2. Use predicted values of τ instead of actual values in the OLS amount regression to correct for possible correlation of ε and μ. Provided that $E(z\mu) = 0$ and there is no selection effect, the second stage OLS regression provides consistent estimates of all coefficients.

We also conduct two exercises to check if our results are influenced by selection, i.e., $E(\mu|I = 1) \neq 0$, or, $E(\varepsilon|I = 1) \neq 0$.

1. We calculate the Heckman correction based on a Probit estimation of 5.3. We then include this correction in the naive OLS regressions for duration and

amount[19].

2. Following Baker and Benjamin (1997), we use the naive OLS regressions to impute amounts and durations to the 164 villages for which we do not observe a reallocation in 1994-1995. By scaling all of the imputed estimates by a constant, we are able to adjust implicitly the mean of the unobserved component. Reestimating the naive regression on the full sample, and using the scaled, imputed values for villages which do not reallocate, allows us to check whether our results are sensitive to selection bias. We conduct these robustness tests by scaling imputed values up and down by 15 percent. If our results are not sensitive to this sort of manipulation, then we can be reasonably confident that selection bias is not an important problem.

Tables 5.2 and 5.3 report the regression results for the Duration and Amount regressions. In column 1 of Tables 5.2 and 5.3, we report the OLS results for the basic version of the time and size regressions. Column 6 of Table 5.3 reports TSLS estimates for the size regression[20]. The coefficient on Time in the TSLS estimation is about twice as large as that obtained using OLS. This suggests that the OLS coefficient of time since the last reallocation may be biased downward. However, the other parameter estimates are very similar in the OLS and the TSLS. Consequently, in several auxiliary versions of the Amount regression, we only report OLS estimations.

Inclusion of the Heckman correction in the basic model generates results indistinguishable from those obtained by OLS. This test, along with results obtained using the Baker and Benjamin procedure suggest that selection bias is not important.

5.2.2. Duration and Amount results

Table 5.3 reports estimates of regressions explaining the duration of the most recent reallocation period. These regressions are similar to the frequency regression,

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[19]Since all variables in the *duration* regression are present in the switching equation, we are able to identify parameters in the corrected duration regression only because of non-linearities in our estimate of $E(\varepsilon|I = 1)$.

[20]The instruments that we use to predict time since the last reallocation are: All explanatory variables as in column 1 of Table 5.3, plus interaction terms involving the transactions cost variables that appear in the duration, but not the amount regression. This instrument set passes the Hausman over-id test at the 5% level.

although the level of significance is considerably lower for some variables. Given the much smaller sample size, this is unsurprising. The size of the village and the average number of plots per household remain significant, and increases in either leads to increases in the expected duration of a reallocation cycle. The signs of the demographic and labor supply coefficients are unchanged, although only the rate of change of village population is statistically significant. Finally, the duration of the reallocation cycle is shorter in villages facing higher output quotas.

The remainder of this section discusses the results of a number of different amount regressions. The discussion is organized around the same groups of variables used earlier.

Duration: The amount of land reallocated depends significantly on the length of time since the last reallocation. The OLS (TSLS) coefficient suggests that for each additional year since the last reallocation, the amount of land reallocated increases by 3% (6%). This is consistent with the simple rules hypothesis and the rational village hypothesis.

Transactions Costs: We cannot identify *a priori* which of our transactions costs variables reflect fixed or variable costs of land reallocation (or both). However, the rational village hypotheses provides a method of accomplishing this identification: Variables capturing the fixed costs should be included in the duration regression and will influence the amount reallocated only through their effect on duration. Variables affecting variable costs belong in both duration and amount regressions. We find that only two of the transactions costs variables affect the amount of land reallocated: Amounts reallocated decrease with the number of plots and the percentage of paddy land. All other transactions cost variables affect amounts reallocated only through their effects on durations. In addition to confirming a prediction of the rational village hypothesis—some transactions costs variables only affect duration—these results allow us to categorize transactions costs variables into fixed or variable cost.

Using this categorization, the estimates reported in Table 5.3 indicate the variable costs of reallocating increase with the number of plots and the percentage of land in paddy, and that there is a negative relationship between these two variables and the size of the reallocation. Apart from the possibility that reallocating paddy land

reduces investment, the well-defined perimeter of a paddy field increases the cost of sub-division relative to that on non-paddy.

Demographics and Labor Supply: If the rational village hypothesis is true, then the size of a reallocation is positively related to the mismatch between land and labor caused by changes in local and non-local off-farm opportunities. We find that both off-farm opportunity variables have nearly identical, positive coefficients: Changes in different types of off-farm employment have about the same effect on the percentage of land reallocated. In Table 5.3, we aggregate off-farm opportunities into a single variable. This economizes on degrees of freedom and facilitates exposition of interaction effects. We find that villages experiencing more rapid change in population reallocate a larger percentage of land. This is evidence for the simple rules and the rational village hypotheses.

Quotas: In Table 5.3 we observe that in areas with higher quotas, the percentage of land that is reallocated increases. This is consistent with the tax collector or non-marginal effects of quotas described in section 3.2. If quotas are affecting the percentage of land allocated through these non-marginal effects, we expect to find that the effect of quotas should be greater in areas where returns to off-farm labor are greater. In other words, in areas with higher off-farm wages, a higher percentage of households will find the returns to farming (conditional on the quotas) negative. Thus, we anticipate that a higher percentage of land will be reallocated. In column 2 of Table 5.3, we add an interaction term between quotas and the off-farm wage to the basic amount regression. Quotas alone becomes insignificant, while the interaction term is positive and highly significant. This indicates that the effects of quotas are larger as agriculture is relatively less profitable[21]. This suggests that the non-marginal effect of quotas is important.

The rational village hypothesis also predicts that villages will look for ways to eliminate the deadweight loss associated with binding agriculture quotas. One way to do so is to allow quotas to be fulfilled in cash. The change to cash quotas reduces the deadweight loss associated with filling quotas, and increases the profitability of

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[21] As wages increase, all else equal, less labor is devoted to agriculture, and less rent is extracted from the land.

farming. If the non-marginal effect is important, this increase in profitability will lead to a decrease in the amount of land to be reallocated. In column 3, we include an interaction term involving quotas and the percentage of households paying their quotas in cash. Quotas continue to have an independent effect, but the interaction term is negative, and highly significant. For every ten percentage point increase in the number of households paying their quota in cash, the amount of land reallocated falls by six percent.

Finally, in column 4 we include both of the interaction terms involving quotas. The coefficients and the t-statistics on the interaction terms are slightly smaller than when the interaction terms are included separately, but both effects remain important. These regressions provide strong support for the importance of the non-marginal effect of quotas.

Technology: The rational village hypothesis predicts that the size of the realloca-tion depends on the production technology as proxied by the land-labor ratio and yield. In our estimation, yield was consistently insignificant. On the other hand, the amount of land reallocated is positively related to the land-labor ratio: areas with higher land-labor ratios reallocate more land. We also interacted the land-labor ratio with the change in off-farm opportunities, and find that the coefficient is significant at the 1% level. Both of these results are consistent with the rational village hypothesis, which predicts that these terms should be significant. None of the other hypotheses make such a prediction.

Interest groups and the local political economy: To try to assess the impor-tance of rent seeking by interest groups for reallocation behavior, we include interest group variables in the basic regression. Interest groups include the percentage of the labor force that is young (18-25), the percentage that is old (50+), and the percentage of party members. None of the variables was significant, whether we included them alone or in combination, and results are not reported.

We could also consider the proportions of villagers working off the farm locally and non-locally as interest groups. Since the rational village hypothesis relies on rates of change in the these two groups, while the interest group hypothesis would look for cross-sectional change in response to different levels of these groups, we could

in principle identify the two effects. We prefer the age group and party membership variables because there is less possibility that membership in these groups (party membership in particular) has efficiency implications.

To assess the importance of rent seeking by village leaders, we include attributes of party secretaries and village heads in the basic regression. Leader attributes included: Age, education, and tenure. The effect of leader education on reallocation behavior was ambiguous, however, the time since the last reallocation was negatively correlated with the age of both leaders, while the size of the reallocation was positively and statistically significantly related to age.

We also included a dummy that was coded 1 if the village experienced a contested election in the year of the reallocation, or the year before. A contested election in the year of the reallocation or the year prior to a reallocation significantly reduced the time since the last reallocation and the size of the reallocation. The precise mechanism through which these elections are influencing village behavior is unclear, but our results suggest potentially significant effects. Given the contention that has surrounded the importance of elections in China, this result is of interest in its own right.

These regressions also indicate that older leaders reallocate more, and that leaders elected in competitive reallocations reallocate less. Since leaders elected in contested elections are younger than the mean, this suggest the following story. Reallocating land is a way for leaders to collect rents. Old leaders are prone to collect more rents since they are closer to the ends of their careers and are less interested in their reputations or advancement. Contested elections tend to shift power to the villagers. The villagers exercise this power to select leaders who are young, and therefore have an incentive to restrict their rent seeking behavior in order to remain in office or otherwise advance their careers.

Administrative versus Market Exchange: Column 2 of Table 5.3 includes two measures of market activity as explanatory variables in the amount regression. The percentage of land rented is highly significant and negative: A one percent increase in the amount of land rented is associated with a 1.4 percent increase in the amount reallocated. A dummy variable indicating whether the market for agricultural labor

market was active[22] is also negative. The coefficient on the labor market dummy is not significant, though this is not surprising, given the crudeness with which this variable measures labor market activity. In Column 2 of Table 5.2 we include both measures of market activity as explanatory variables in the duration regression, and find that neither is statistically significant.

So far we find that (1) administrative reallocation behavior appears to move land to higher valued uses, and (2), that administrative reallocations decrease as market transactions increase. Together these two findings suggest that administrative reallocations are a substitute for land rental transactions. The data also show that villages overwhelmingly choose centralized land allocation over decentralized land exchange: In 1995 about 3 times as much land changed hands in administrative reallocations as changed hands in rental transactions[23].

If centralized reallocations are substitutes for decentralized rental markets, it is natural to ask why the villages have selected centralized over decentralized organization of their agricultural production. We consider three possible explanations. First, the past two generations of rural Chinese have grown up with a communist idealogy that regards land rental and the hiring of labor as exploitative. Given this, market participation may be low because of a taboo on this behavior. Alternately, market participation may be low because agents are reluctant to use an unfamiliar method of exchange. While this explanation for market thinness is plausible, it is not consistent with the rapid development of factor and product markets elsewhere during the reforms.

Second, while the tenant is obligated to pay the quota on rented land, in the event of default, the landlord is liable for the quota. This may provide an disincentive to land rental, and/or may cause leaders to discourage land rental. The data provide some support for this: In 1995, for a village without (with) an agricultural quota, on average 7.9% (2.2%) of land was rented. More generally, there is an almost total absence of formal mechanisms for enforcing contracts. In particular, courts are almost non-existent. Hence contracting costs may be prohibitive and lead to market failure.

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[22]Say the market is active if one or more people were hired as agricultural laborers during the year in which the reallocation occurred.

[23]In 1995, every seventh village reallocated land, and an average reallocation involved 60 percent of a villages land. Thus, on the order of 9 percent of land was reallocated administratively. On the other hand, about 3 percent of land was rented in 1995.

The fact that most rental transactions occur among relatives corroborates this story. In this case, rental markets fail because of factors that are beyond village control: Tax policies of the central government or the state of the judicial system[24].

Finally, any rental transaction signals gains from exchange. Given this, a self-interested village leader would like to appropriate some of these gains. In principle, a leader could reallocate rented land from the rentee to the rentor, divide the gains from trade with the rentor, and thereby make himself better off. There is anecdotal evidence that village leaders regard rental as a signal of land misallocation, and shift land away from households that rent out land (Li, 1998). In this case, administrative reallocations cause rental markets to fail: Since rental invites dispossession, no one will rent land.

A determination of the relative importance of each of these explanations is beyond the reach of our current data. At a minimum such an inquiry appears to require information about the access to courts or third party enforcement, or the details of rental contracts—none of which is currently available. Nevertheless, a determination of why markets are thin remains an important topic for future research.

Administrative and market reallocations provide a similar service, land reallocation, and they appear to be substitutes. This suggests that land rental and administrative reallocation may be simultaneously determined. In consequence, a full treatment of land allocation mechanisms would require the estimation of a simultaneous equations model. We note however that both administrative and market transactions appear to depend on almost the same set of variables[25]. Both should increase in response to increases in the need to exchange land. Both should respond to changes in the political environment, though in ways that are difficult to predict. Thus, the identification of parameters in a simultaneous equations model is difficult and requires finding suitable exclusion restrictions. Since the cost of contracting should affect rental but not administrative reallocation, data which reflect contracting costs

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[24]We occasionally hear the argument that rental markets are thin because of some other market failure. This argument ignores the fact that other market failures also increase the demand for rental land. For example, suppose households do not rent land because they would then have no other way to employ female labor (for which there are fewer off-farm opportunities). This also means that the demand for rental land would be higher. Thus the net effect on land market activity resulting from a failure in the market for female labor is ambiguous.

[25]This is confirmed by preliminary regressions to explain amount rented.

could serve to identify parameters. In future survey work, we hope to obtain data of this sort, along with better data on village governments' roles in rental markets.

6. Conclusion

Since the early 1980's much of agricultural land in rural China has been allocated by local governments. We consider four hypotheses about the behavior of these governments: The simple rules hypothesis, the tax collector or non-marginal effects hypothesis, the redistribution hypothesis, and the rational village hypothesis.

The simple rules hypothesis makes only two predictions testable with this data set: That reallocations will increase with the rate of change of population and with the time since the last reallocation. All three sets of regressions, frequency, amount, and duration, confirm these predictions.

The tax-collector or non-marginal effects hypothesis predicts that administrative reallocations will increase with the quota level. As quotas rise, land becomes less valuable to villagers and punitive dispossessions must be larger if they are to affect villagers' quota fulfillment. Alternately, as quotas rise villagers with high off-farm wages find agriculture unprofitable and lobby to reduce their land holdings. This prediction is also confirmed by all three regressions.

The redistribution hypothesis predicts that administrative reallocations will serve to redistribute rents in favor of particular interest groups. We find surprisingly modest support for this hypothesis. We could not identify a statistically significant response to changes in the size of any of three interest groups, old, young, or party members. We did find that older village leaders reallocated more land than their young counterparts, and that leaders elected in competitive elections reallocated less land. These results suggest that, to the extent that redistribution is an important determinant of reallocation behavior, it is the redistribution of rents between the villagers and the village leaders that matters, not redistribution between different groups within a village.

The rational village hypothesis makes a large number of predictions about reallocation behavior: Amounts and frequencies of administrative land reallocations should depend upon rates of change of population and off-farm labor supply; reallocation behavior should depend upon measures of the agricultural technology; the interaction

38

Table 5.2:
Time since last reallocation

N=48		(1)	(2)
Demographic Variables	Population	-70.278**	-91.114*
		(33.815)	(32.777)
	Off-farm	67.517	58.545
		(63.421)	(65.054)
	Off-farm Non-local	-18.097	-34.592
		(66.124)	(74.041)
Technology	Land/Labor	-0.295	0.166
		(0.747)	(0712)
Transactions cost	# Plots	0.287*	0.399*
		(0.070)	(0.069)
	# Households	0.007	0.007
		(.004)	(0.004)
	# Production teams	-0.126	-0.097
		(0.100)	(0.112)
	# Cadres	0.382	0.680
		(0.437)	(0.519)
	% Paddy	2.743	2.910
		(1.965)	(1.932)
	Multiple Cropping	-1.864***	-1.314
	Index	(1.004)	(1.077)
Quota		-7.756**	-6.257**
		(3.531)	(2.881)
Township		1.237	1.319
		(1.849)	(2.139)
Income		-0.0015	-0.002
		(0.001)	(0.0013)
County seat		0.031	0.024
		(0.040)	(0.044)
Farm Factor Markets:	Land Rental (%)		-6.618
			(5.578)
	Hired Farm labor (%)		-0.826
			(1.458)
R^2		0.43	0.51

*=1% significance, **=5% significance, ***=10% significance.

Table 5.3:

Amount reallocated

N=48		(1) OLS	(2) OLS	(3) OLS	(4) OLS	(5)OLS	(6) TSLS
Time	Years since	0.029***	0.039*	0.031**	0.025***	0.028	0.062**
	Last Reallocation	(0.016)	(0.014)	(0.013)	(0.016)	(0.131)	(0.028)
Demographic	Population.	4.994	7.138**	5.980**	6.200**	7.202**	6.579**
		(3.354)	(2.899)	(3.043)	(3.554)	(3.246)	(2.690)
	Off-farm	28.415*	29.635*	31.132*	21.705**	20.758*	27.960*
		(7.666)	(9.915)	(9.337)	(10.205)	(10.523)	(8.025)
Technology	Land/Labor	0.187**	0.168***	0.168**	0.185**	0.149**	0.163**
		(0.080)	(0.089)	(0.078)	(0.075)	(0.068)	(0.077)
	Land/Labor*Off-farm	-8.458**	-8.106**	-9.630**	-7.642***	-7.136	-8.273**
		(3.823)	(4.252)	(4.297)	(4.851)	(4.684)	(3.894)
Transactions	# Plots	-0.017***	-.0266*	-0.016**	-.0011	-0.011	-0.026**
cost		(0.009)	(0.007)	(0.008)	(0.009)	(0.008)	(0.011)
	% Paddy	-0.192	-0.205***	-0.401*	-0.259**	-0.446*	-0.258**
		(0.121)	(0.124)	(0.157)	(0.124)	(0.156)	(0.123)
Quota	Quota	0.604**	0.467**	-0.521	0.806*	-0.187	0.796*
		(0.254)	(0.222)	(0.560)	(0.254)	(0.568)	(0.286)
	Quota*Off-farm Wage			0.058**		0.048***	
				(0.026)		(0.026)	
	Quota*Cash				-0.067*	-0.058*	
					(0.010)	(0.010)	
Income		0.0004*	0.0005*	0.0004*	0.0004*	0.0039*	0.0004*
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Farm	Land Rental		-1.349*				
Factor			(0.443)				
Markets	Hired Farm labor		-.104				
			(0.094)				
R^2		0.50	0.63	0.56	0.57	0.61	0.53

*=1% significance, **=5% significance, ***=10% significance.

of rates of change with measures of agricultural technology should affect reallocation behavior; reallocation behavior should depend upon the costs of administering a reallocation and some transactions costs (fixed costs) should affect the time between reallocations but not amounts reallocated; and villages should seek out ways to reduce deadweight the cost of fulfilling agricultural quotas. The data confirm all of these predictions.

The rational village hypothesis requires that villages move land from low to high valued uses. We can imagine several reasons why this might occur: Households that value land more highly may lobby more effectively for favorable reallocations; higher agricultural profits may ease the village leader's efforts to collect grain quotas and taxes; efforts to increase equity will transfer land to households with high labor-land ratios from those with low labor-land ratios and hence tend to equalize the marginal productivity of land across households. Since our data do not allow us to do more than speculate about the relative importance of these effects, we do not reject the possibility that reallocation behavior, whose effect is to increase village income, is motivated by the desire to increase equity.

The property right, "security of tenure" is determined by the frequency and magnitude of administrative reallocations. Consequently, our analysis of reallocation behavior is also an analysis of how this right is formed. The degree to which tenure is insecure depends upon the amount of land that the government must reallocate to maximize village income, given that changes in population and off-farm labor supply cause land and labor to become mis-matched over time.

We also find that administrative land reallocations decrease by more than one percent for every one percent increase in the amount of land rented. Given our finding that administrative reallocations, like markets, tend to move land from low to high valued uses, this suggests that administrative reallocations and rental markets are substitute providers of "reallocation services". To the extent that administrative reallocation drives out (or is driven out by) market transactions, our analysis of reallocation behavior also describes the choice between centralized and decentralized organization of production and exchange. As reliance on markets increases, reliance on administrative reallocations decreases.

In conclusion, we note some tentative policy implications of this research. It is well established that investment is important for economic growth and that tenure security

41

is important for investment. This research indicates that one reason for insecure tenure is that rental markets do not function. Hence, a natural way to increase tenure security is to encourage the development of a rental market for agricultural land. This research also suggests that, as long as land markets continue to be thin, policies restricting the rights of village leaders to reallocate land may not be desirable: In the absence of markets, administrative reallocations are the only way exploit gains from land exchange. Finally, our results suggest that encouraging competitive elections may also serve to increase the security of tenure.

7. References

Agnello, Richard P., and Donnelley, Lawrence P. "Property Rights and Efficiency in the Oyster Industry". J. of Law and Econ. 18 (October 1985): 521-34.

Baker, Michael, and Benjamin Dwayne. "The Role of the Family in Immigrants' Labor-Market Activity". A.E.R. 87(4): 705-27, 1997.

Becker, Gary. "Public Policies, Pressure Groups, and Dead Weight Costs". J. of Public Econ. 28 (1985): 329-47.

Besley, Timothy. "Property Rights and Investment Incentives: Theory and Evidence from Ghana". J.P.E. 103(5) (1995): 903-937.

Bottomley, Anthony. "The Effect of Common Ownership of Land upon Resource Allocation in Tripolitania". Land Econ. 39 (February 1963): 91-95.

Boycko, Maxim; Shliefer, Andrei, and Vishny, Robert. "Privatizing Russia". Cambridge Massachusetts: MIT Press, 1995.

Burgess, Robin. "Land, Welfare and Efficiency in Rural China". Manuscript London: London School of Economics, January 1997.

De Allessi, Louis. "The Economics of Property Rights: A Review of the Evidence". Research in Law and Economics 2 (1980): 1-47.

Li Guo, "The economics of land tenure and property rights in China's agriculture." Ph.D. dissertation, Food Research Institute, Stanford University, 1998.

Ho, Samuel. "Rural China in Transition: Non-agricultural Development in Rural Jiangsu, 1978-1990". New York: Oxford University Press, 1994.

Huang, Jikun. "Agricultural Production, Policies, and Outlook for 1998".

Working Paper, Beijing, China: Center for Chinese Agricultural Policy, Chinese Academy of Agricultural Sciences, 1997.

Jimenez, Emmanuel. "Tenure Security and Urban Squatting". Rev. Econ. & Stat. 66(4) (November 1984): 556-67.

Kung, James Kaising. "Equal Entitlement versus Tenure Security under a Regime of Collective Property Rights". J. Comparative Economics 21 (1995): 82-111.

Libecap, Gary D., and Wiggins, Steven N. "The Influence of Private Contractual Failure on Regulation: The Case of Oil Field Unitization". J. of Public Econ. 93(4) (1985): 690-714.

Maddala, G.S. "Limited-Dependent and Qualitative Variables in Econometrics". Cambridge University Press, 1991.

Malik, Arun, and Schwab, Robert M. "Optimal Investments to Establish Property Rights in Land". J. Urban Economics 29(291): 295-309.

Olson, Mancur, Jr. "Distinguished Lecture on Economics in Government". J. of Econ. Perspectives 10(2) (Spring 1996): 3-24.

Ostrom, Elinor. "Governing the Commons: Evolution or Institutions for Collective Action". Cambridge University Press, 1990.

Pashigan, B. Peter. "Consequences and Causes of Public Ownership of Urban Transit Facilities". J.P.E. 84(6) (December 1976): 1239-59.

Peltzman, Sam. "The Growth of Government". J. of Law and Econ. 23 (October 1980): 209-87

Rozelle, Scott. "Decision making in China's rural economy: Linkages between village leaders and farm households". *China Quarterly*, 137 (March 1994): 99-124.

Salant, Stephen W. "A Theory of Sorts". Q.J.E. February 1977, 91(1): 39-57.

Sicular, Terry. "Redefining State, Plan, and Market: China's reforms in agricultural; commerce." China Quarterly, 144(December 1995): 1020-46.

Stokey, Nancy L., and Lucas, Robert E. "Recursive Methods in Economic Dynamics". With Edward Prescot. Harvard University Press, 1989.

ZGTJNJ (Statistical Yearbook of China). Beijing; State Statistical Bureau Publishing, 1996.

8. Appendix 1

The problem of maximizing the discounted present value of agricultural profits generates the following value functional:

$$V(x) = \max_{\substack{\tau \geq 0 \\ \nu \geq 0}} \left\{ \int_0^\tau e^{-rt} \left(\Pi - \alpha(x + \nu t) \right) dt - e^{-r\tau} \left(c_f + c_v(x + \nu\tau - y) \right) + e^{-r\tau} V(y) \right\}.$$

That is, for any given initial state of the land-labor match, x, the optimal reallocation behavior maximizes the discounted present value of the next cycle's profits, conditional on optimizing behavior thereafter.

This statement of the problem makes the following implicit assumptions. (1) Villages never make the choice "never reallocate". While our sample contains some villages which do not reallocate, we cannot distinguish the decision "never reallocate" from the decision to "reallocate less often than every 13 years". Given this we opt for the simpler statement of the problem. (2) Equation 3.9 restricts attention to discontinuous reallocation behavior. That is, the solution "reallocate land continuously" is not allowed. In the presence of a discrete cost of reallocation, this type of continuous reallocation cannot be optimal given that the response to reallocations is continuous. (3) Equation 3.9 does not consider the case when the village's initial need to reallocate land is larger than the threshold. This is a simple extension of the analysis but is not indicated by the data, which suggests that first reallocations are like subsequent reallocations—we cannot reject the hypothesis that first reallocations the same mean as subsequent reallocations. (4) If the leader can anticipate the changes in households' labor supplies then he might choose to reallocate more land than is required to get to the optimum. Equation 3.9 does not allow this. This is a simplifying assumption consistent with the leader having little ability to predict the direction of change in any given household's labor supply.

To find the value function V define

$$Y^* = \max_{\tau \geq 0} \frac{1}{1 - e^{-r\tau}} \left[\int_0^\tau e^{-rt} \left(\Pi - \alpha(x + \nu t) \right) dt - e^{-r\tau} \left(c_f + c_v(x + \nu t - y) \right) \right]. \quad (8.1)$$

That is, if we constrain all reallocation cycles to be of the same length, each reallocation to completely exhaust gains from trade, and for the initial state of the village to be the instantaneous optimum, then Y^* is the best we can do. Let

$\tau^* = \tau^*(\Pi, \alpha, \nu, c_f, c_v, r)$ be the optimal time period in 8.1. Given Y^*, the value function for 3.9 is given by:

$$V(x) = \int_0^{\tau^* - \frac{x}{\nu}} e^{-rt}\left(\Pi - \alpha(x + \nu t)\right) dt - e^{-r\left(\tau^* - \frac{x}{\nu}\right)}\left(c_f + c_v \nu \tau^*\right) + e^{-r\left(\tau^* - \frac{x}{\nu}\right)} Y^*, \quad (8.2)$$

where $\alpha - rc_v > 0$. That is, for any given starting value the optimal reallocation path involves waiting until the village needs to reallocate a certain optimal amount of land, $\tau^* \nu$, in order to return to the instantaneous optimum. When the village reaches this state, it reallocates until the instantaneous optimum is reached.

To verify that 8.2 is a solution to 3.9, substitute 8.2 into 3.9. Since this expression is an identity when $y = 0$, and $\tau = \tau^* - x/\sigma$, it is sufficient to show that these two values are optimizing. To do this take derivatives with respect to y, and τ. To verify that the τ derivative is zero, differentiate 8.1 and substitute. To verify that the constraint $y > 0$ binds, follow the same procedure. This analysis follows Lucas and Stokey 1989, p123.

Differentiating 8.2 with respect to τ gives:

$$-rY^* + [\Pi - \alpha\nu\tau] - c_v\nu + r\left(c_f + c_v\nu\tau\right) = 0. \quad (8.3)$$

This expression does not have an analytical solution for τ^*, however we can differentiate implicitly. This yields two unambiguous comparative statics: $\frac{d\tau^*}{d\Pi} = 0$, and For the first, most recent, and largest allocations, information on the year, the number of households, and the amount of land involved; 3. The amount of land as of 1996 that had not been reallocated since HRS was introduced; and 4. The year of the next reallocation, if one has been announced. $\frac{d\tau^*}{dc_v} > 0$.

9. Appendix 2

Descriptive Statistics 1

Demographics and labor supply:	
Annual rate of change of population	1.08%
	(1.00)
Annual rate of change of off-farm non-migrant labor	0.85
	(0.85)
Annual rate of change of off-farm migrant labor	0.71
	(0.80)
Transactions costs:	
Number of households	295.1
	(168.6)
Number of production teams/small groups	7.1
	(4.7)
Number of plots	6.4
	(5.5)
Cropping intensity(multiple cropping index)	1.7
	(0.5)
% Paddy	43.8
	(37.1)

Descriptive Statistics 2	
Village governance:	
Number of Cadres	5.1
	(1.8)
Reallocation decision made by township (Coded 1 if township decides)	0.14
Attributes of party secretary:	
Age	45.5
	(7.9)
Education	7.7
	(2.6)
Tenure	6.5
.	(6.8)
Attributes of village head:	
Age	42.6
	(7.1)
Education	7.3
	(2.7)
Tenure	4.8
.	(5.2)
Distance from county seat	19.8
	(14.8)

Descriptive Statistics 3

Technology	
Land-labor ratio (1988) (mu per capita)	1.53
Yields (1988)	533.6
	(285.9)
Redistribution	
% of labor force 18-25	30.4
	(13.2)
% of labor force 50+	20.4
	(11.2)
% party members	8.7
	(4.5)
Quota (Required gross sales/total output)	11.2
	(11.6)
Village income (1988 Yuan)	654.7