# Reallocating wealth? Insecure property rights and agricultural investment in rural China

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**Abstract**

This paper evaluates the impact of village-level land reallocations in China on household economic outcomes. The primary objective is to analyze the effect of short-term differences in tenure security in the year of a reallocation, employing the past history of land shifts as a source of exogenous variation in current tenure security. The results show that a decrease in the probability of losing the current plot yields an increase in agricultural inputs and production with no change in non-agricultural investments, conditional on household fixed effects that control for any unobserved and time-invariant characteristics of the household. This suggests that even small increases in the security of tenure enjoyed by households could yield benefits in terms of greater agricultural output.

# 1 Introduction

The establishment of clear land rights has long been considered to be an important milestone in the development of the modern industrialized countries. Because land is the principal asset in a preindustrial economy, the development of an institutional structure that encourages its efficient use is argued to substantially enhance growth (North and Thomas, 1973). Conversely, many analysts have identified the absence of stable and enforced property rights as a major impediment to growth in today's developing countries (De Soto, 2000).

However, despite this emphasis on the importance of private property rights, collectively owned or managed land remains a widespread phenomenon in the developing world. Collective or partly collective land structures continue to be predominant in rural areas in China, Mexico, and many parts of sub-Saharan Africa. These forms of land ownership can yield substantial benefits in terms of equity, but they may also generate significant efficiency costs.

In China, the post-Mao period saw the emergence of a hybrid system of landownership, in which formal title to land is held by the village collective while use rights are held by households. Moreover, plots are subject to periodic reallocations among households, a process village officials conduct every three to five years, thereby generating systematic insecurity in land tenure. The objective of this paper is to estimate the economic costs of insecure land tenure induced by these periodic reallocations by analyzing a wide set of both agricultural and non-agricultural outcomes.

I examine variation in tenure insecurity within a village conditional on a reallocation being conducted. Households that have recently had their land reallocated are less likely to have their land reallocated in a subsequent round, and accordingly the past history of changes in landownership can be employed as a proxy for the probability of loss of the current plot. The results show that the reduction in the probability of losing the current plot as a result of past inclusion in a reallocation results in an increase in the use

of agricultural inputs and in total agricultural output of around .1 standard deviations, with no evidence of simultaneous substitution out of non-agricultural activities.

This effect of relatively more secure tenure is evident for households that gained land in the past, as well as for those that lost land in the past. Accordingly, any plausible alternative channel for the observed pattern would require that an unobservable shock correlated with reallocation affect both relatively land-rich and relatively land-poor households in the same way relative to the mean. The observed pattern of symmetric increased investments by households at both ends of the land-ownership distribution in the year of a reallocation is inconsistent with most obvious sources of omitted variable bias.

While these effects are not large in magnitude, they suggest that there are potentially meaningful gains from even marginal increases in the tenure security enjoyed by rural households. On the other hand, it is also useful from the perspective of policy implications to note that the negative spillover of insecure property rights on non-agricultural investment seems minimal.

This paper supplements an existing literature that has evaluated the impact of varying regimes of property rights in China. Feder et al. (1992) argue based on a before-and-after analysis that excessive investment in nonproductive assets such as housing is evidence of the negative impact of insecure land tenure. Brandt et al. (2002) analyze the impact of land tenure by comparing households' private plots, assigned permanently to households in some villages for their personal cultivation, with "responsibility land", acreage that is allocated to households for grain cultivation but subject to reallocations. Similarly, de la Rupelle et al. (2009) use household-level heterogeneity in land rights within a village to identify the impact of reallocations on outmigration, finding that insecure land rights induce temporary, rather than permanent, outmigration in order to ensure claims are retained on land left behind. Both papers make the assumption that plots are exogenously assigned to different contractual types within a village.

Jacoby et al. (2002) analyze the impact of insecure tenure on investment in rural China by using a hazard model to estimate predicted risks of expropriation for different plots held. They find that a higher expropriation risk decreases investment in organic fertilizer. More recently, Zhao (2014) finds in a difference-in-differences analysis that the elimination of reallocations leads to an increase in rural per capita net income, but also a large increase in inequality and a decline in agricultural output; Ma et al. (2013) report that perceived land tenure security significantly affects collectively governed investments (specifically, investment in irrigation canals) in a rural area of Gansu province, but does not significantly affect individual farmer investments; and Bai et al. (2014) find that a negative effect of reallocations on organic fertilizer use is driven entirely by full reallocations, as opposed to partial reallocations.

Two recent papers have focused on how reallocations interact with the rental market. Wang et al. (2015) find that more frequent reallocations discourage transfers of land to non-relatives in the rental market. Feng et al. (2010) analyzes investment in rented plots, and finds that the tenure status (rented or contracted) of plots is not a significant determinant of input use; while they do not directly address the question of variation in tenure security induced by reallocations, their results suggest that tenure security is not the only important determinant of input choice.

There is also a larger literature about the economic impact of property rights that evaluates land reforms in which tenants without formal title are endowed with stronger property rights (Banerjee et al., 2002; Besley and Burgess, 2000). Goldstein and Udry (2008) analyze property rights in Ghana and conclude that individuals with more secure tenure rights by virtue of their more powerful political positions invest more in maintaining soil fertility. Another set of papers focused on urban land policy in Latin America finds that land titling increases labor supply and investment (Besley, 1995; Field, 2005; Galiani and Schargrodsky, 2010). In the historical literature, Hornbeck (2010) analyzes the impact of the introduction of barbed wire on agricultural productivity in the western U.S., and concludes that the stronger protections of land title afforded by barbed wire led to a significant increase in settlement, land values and crop productivity.

Finally, it is useful to note that an alternate perspective on Chinese rural property rights suggests that these institutions should be analyzed in terms of their function, rather than their definition as private or collective, and emphasizes that the rural land tenure system is primarily designed as a system of social welfare, rather than a system for the commercial transfer of land (Ho, 2014). As such, this system may be perceived as both credible and desirable by rural households, even if it entails substantial insecurity. Ho (2014) presents evidence from a survey of 1140 households in 24 provinces suggesting there is a high level of popular support for the current system of land tenure, including reallocations, and a relatively low level of land conflict. Additional survey evidence suggests that a majority of rural households in fact do not support policies that seek to limit reallocations (Song, 2010).

Similarly, Andreas and Zhan (2015) argue that recent reforms designed to marketize collective ownership and reform the rural hukou will undermine the role of collective land rights as a social safety net, facilitating displacement and the transfer of land away from rural households. Fei (2011-12) suggests that reallocations should be limited, but not abolished. Ye (2015) provides a useful summary of this broader debate, emphasizing that while modernization of land tenure systems may increase overall agricultural productivity, enhance specialization, and allow labor to be transferred out of agriculture, it may also lead to increased inequity and increased risk for vulnerable rural households.

Relative to the existing literature, this paper employs a novel identification strategy to evaluate the impact of insecure tenure on an unusually large set of economic outcomes. To my knowledge, this is the first paper in the literature on reallocations in China that has estimated an impact of insecure tenure on household outcomes conditional on household fixed effects and without assuming exogenous assignment of plots to tenure types, thereby employing only variation in tenure security for the same household over time.

The remainder of this paper proceeds as follows. Section 2 provides an overview of the relevant institutional background. 3 describes the data. Section 4 presents the empirical results of interest, and Section 5 presents robustness checks. Section 6 concludes.

# 2 Background

Property rights in China have a long and tumultuous history in the post-1949 era, and the institutional framework that governs rural households remains unusually complex. This section provides a broad overview of the history of property rights during the Communist period, as well as the characteristics of the periodic reallocations that have been a feature of the rural land ownership system since 1983.

## 2.1 Property rights under the Household Responsibility System

For over thirty years, land rights in China have been characterized by a system of collective land tenure in which partial use rights are assigned to households. This Household Responsibility System was the result of reforms to an earlier system of collectivized farming implemented in a piecemeal fashion from 1979, beginning with a few isolated provincial or local experiments, and subsequently spreading widely to a point of almost total decollectivization by the end of 1983 (Unger, 1985).

Each household was provided with an allocation of land for its own use, while land title continued to be held by the village. The household also committed to the delivery of a fixed amount of quota grain sold to the state at a preset price, plus taxes owed. Excess production could either be sold to the state at a higher price, or at rural markets, with the household having full rights over residual, post-quota income (Lin, 1992).

Households were also allowed control over a private plot of land used to cultivate crops other than grain or to raise animals. Income from this plot accrued entirely to the household (Walker, 1984). The establishment of the Household Responsibility System led to a substantial increase in the growth rate of agricultural output – nearly eight percent annually between 1978 and 1984 (Lin, 1992).

## 2.2 Land reallocations

However, property rights under the Household Responsibility System remained crucially incomplete, principally because land was subject to periodic land reallocations. The stated aim of these reallocations was to promote equity in land ownership, and to adjust landholdings in response to changes in household size.[1] The focus of reallocations was generally responsibility land (again, land allocated to the household for grain production), while "ration land" allocated for production for household cultivation was in theory unaffected.

However, the policy clearly created a situation ripe for rent-seeking by local officials (either local government officials or Party leaders, known as cadres). Accordingly, the literature has observed that "it is not uncommon that a few village cadres or officials choose to conduct readjustments simply in order to exert their influence and authority for other dubious purposes" (Keliang et al., 2007). Another analysis noted that the threat of reallocation was frequently used as a carrot and stick to ensure compliance with other administrative goals (family planning targets, grain quotas,labor obligations, and taxes) relevant to local leaders' opportunities for promotion. Leaders employed the threat of land reallocation to minimize their enforcement costs and to punish households for an absence of compliance (Rozelle and Li, 1998).

At the same time, reallocations required considerable investment of time on the part of village leaders, entailing "countless discussions and negotiations among village cadres and the involved households pertaining to the new land assignment exercise" (Kung, 2000). To cite a specific example, a survey in July–August of 1999 found that a third of villages that had decided to carry out a reallocation in accordance with a land law passed the previous August had still not implemented it (Schwarzwalder et al., 2002). Though reallocations normally occurred at the end of the year during the fallow winter period, the lapse in time required for implementation introduced scope for strategic behavior, for example hastening the marriage of sons (or delaying the marriage of daughters) in order to maximize the number of family members in the household when its required allotment of land was determined (Unger, 2005).

A larger literature in both economics and political science has assembled descriptive evidence about the frequency and nature of land reallocations over time. Brandt et al. (2002) find that there is a negative correlation between the frequency of reallocations and the number of plots per household, as well as the total number of households in the village. Kung (2000) uses a separate survey of land reallocations and notes that reallocations

[1] Given that variation in the number of children is limited by the One Child Policy, the relevant changes in household size are normally driven by marriage of adult children. Daughters typically exit the household, while daughters-in-law will arrive. Other changes might be driven by migration, death, or changes in extended family structure.

decline in frequency when terrain is more rugged or hilly, and when landholdings are more scattered or fragmented. Unger (2005) also documents the negative relationship between topography and reallocations and finds a negative relationship between the frequency of reallocations and the availability of off-farm income-earning opportunities.

The central government has made periodic attempts to regulate reallocations. By the 1990s, national-level policymakers became increasingly concerned that insecure tenure was the primary reason for a decline in agricultural growth rates relative to the early years of the Household Responsibility System. As a result, a (nonbinding) policy directive was issued in 1993 establishing a fixed term of land tenure equal to 30 years. This policy was then written into law in 1998, requiring that land be contracted to households for 30 years. Readjustments during this period were still allowed, but only upon approval by two thirds of village members. Villages were also allowed to conduct a reallocation immediately after the introduction of the new policy.[2] The law also mandated the issuance of written contracts or certificates to farmers.

Despite the seeming boldness of this reform, subsequent survey evidence indicated that its implementation was extremely mixed. A majority of farmers continued to express low confidence in their tenure security and believed subsequent reallocations were inevitable (Schwarzwalder et al., 2002). A law in 2002 outlawed reallocations completely except in extreme cases and spelled out the right to lease, exchange and carry out other land transactions, excluding sale and mortgage (Keliang et al., 2007). This reform is, however, beyond the chronological scope of this analysis , which will focus on the impact of reallocations on rural economic outcomes between 1987 and 2002.[3]

# 3 Data

The dataset employed here is a panel collected by the China Research Center for the Rural Economy (RCRE), comprising a sample of 206 villages in 13 provinces in China every year between 1986 and 2002, excluding 1992 and 1994. A randomly selected sample of households in each surveyed village forms the panel; the mean number of households in a village-year cell is 69. On average, the households observed cultivate only .4 hectare, and their endowments are often fragmented, with an average of six plots per household.

Measures of land reallocation are constructed using two sources: household reports

[2]The data on the delay inherent in the implementation of reallocations comes from a 1999 survey reported in Schwarzwalder et al. (2002), which inquired whether villages had decided to conduct such a reallocation and whether it had taken place.

[3]Data from the household survey employed here is not publicly available for the years after 2002; accordingly, it is not possible to employ data from the post-2002 period in a placebo test. There is, in addition, an ongoing debate about how well these subsequent reforms were implemented and thus how secure property rights in the post-2002 period are.

of changes in their household landholdings from year to year, and a village-level survey conducted in a subset of villages that asked village leaders to report years in which a reallocation was observed.[4] Past literature on reallocations that has estimated their frequency has largely used data drawn from two sources: surveys of village leaders, e.g. Kung (2000), or surveys of individual households conducted periodically by the Rural Development Institute that obtain retrospective statistics over a long recall period (Schwarzwalder et al., 2002). Survey data of leaders has the advantage of employing a clear definition of reallocation. However, leaders may also face incentives to bias reports of reallocations toward zero in order to avoid reporting reallocations that are not in line with national land policy guidelines. Retrospective data collected at the household level, on the other hand, may be imprecise and biased by recent events.

The objective here is to employ both sources of data available in order to minimize reporting bias by officials, as well as noise introduced by compiling reports by households who may report changes in land held for other reasons. A shift in landholdings is identified at the household level if a household reports any change in land area, excluding land leased.[5] I then identify the median proportion of households reporting a shift in landholdings, and the median proportion land reported transferred, in official reallocation years identified using the village data. These two proportions are 35 and 11 percent respectively.

Additional reallocations are then identified in any village and year where both the median proportion of households reporting a shift in landholdings, and the median proportion land reported transferred, exceed the medians in years with "official" reallocations. This definition is applied whether data reported by village officials is available for the village in question or not.

Figure 1 shows histograms for both measures used to define reallocations (i.e., proportion of households reporting transfers and proportion of land reported transferred) in official and non-official reallocation years. Again, official reallocation years are those in which a village leader reports a reallocation is conducted, and non-official reallocation years are years in which a reallocation is identified using household reports of land changes, either because data reported by the village leader was not available, or because the village leader did not report a reallocation despite widespread shifts in land. It is evident that official reallocations are characterized by greater intensity of land transfers compared to years in which no reallocation is reported, but there is considerable

[4]The village-level surveys provide information on reallocations for 44 percent of all village-years observations in the primary dataset. Five provinces were not included in the village-level surveying.

[5]There is no uniform policy regarding the legality of land leasing arrangements in rural China. In this sample, leasing is rare; only around 8% of household-year observations report any land leased in or out. Leased land is thus of limited relevance to the rural economy overall.

unexplained heterogeneity. This may reflect reallocations that have not been officially reported, noise in household reports of land transfers, or both. The primary specifications are robust to altering the definition of reallocations, and results employing varying definitions of reallocations will be shown in the robustness checks.[6]

While survey data of leaders indicate that reallocations occur around every five years (Kung, 2000), the reallocation measure constructed here shows reallocations occurring around every three years. It is plausible that a measure based on household reports of land shifts will be noisier and thus more likely to generate spurious reports of land reallocations. However, this strategy has the additional advantage of allowing the direct examination in a large sample of the changes in landholdings at the household level that were induced as a result of the reallocation. Further detailed discussion of potential bias induced by false reallocation reports can be found in Section 5.

In the primary analysis, the sample of years from 1995 to 2002 will be employed, given that 1995 saw the introduction of a more detailed survey that reported a full set of agricultural input variables. Table 1 reports summary statistics for the primary variables of interest in the sample. The average household cultivates around eight mu of land, equivalent to 1.3 acres.[7] Input use is relatively intensive; the total quantity of purchased fertilizer reported used in a year is around 500 kilograms. Around 60 percent of households report owning any agricultural structure. In addition, households report ownership of agricultural tools and animals valued around 600 yuan on average (slightly less than $80).

Total household labor days invested in agriculture and non-agricultural businesses are roughly equal, with labor input into outside enterprises somewhat lower. Around half of households report non-zero days worked in a non-agricultural business, while about 60 percent of households report non-zero days worked outside the household. Almost all households (96 percent across all household-year observations) report positive participation in agriculture.

[6]This definition makes no distinction between different types of plots that households may hold (e.g., responsibility land versus private plots); though the dataset reports limited information on holdings of responsibility land, inputs and agricultural production are not reported by type of plot. Accordingly, the resulting estimates should be viewed as mean effects across all household landholdings.

[7]The mu is a traditional Chinese unit employed to measure land.

# 4 Intravillage heterogeneity in security of tenure

## 4.1 Conceptual framework

Consider the decision made by a village leader whether or not to undertake a reallocation in a given village in a given year. A reallocation has both costs and benefits. The advantages may include private benefits for the official in rent extraction or future opportunities for promotion, as well as quasi-public benefits such as an increase in per-capita equity of landholdings that may also be valued by village households.

On the other hand, reallocations also have costs. Households that are uncertain about their long-term tenure on a given plot will not make investments the returns of which would accrue partly in the medium-term, leading to a decline in agricultural investment and output; a simple model of a household production function demonstrating this result is presented in Appendix A. These costs are clearly highly salient to households. For simplicity, I will assume here that officials are themselves indifferent to this loss in output. They are, however, forced to take into account the preferences of households by bargaining over whether or not to hold a reallocation.

Assume that the official and each household face a variant of the single-seller, single-buyer problem; they need to bargain over the sale of a single good, a reallocation of land. The official in village v, province p and year t places a value $B_{vpt}$ on this reallocation, capturing benefits that include opportunities for rent-seeking and decreased intravillage inequality.

Each household i in village v, province p and year t places a value on a reallocation that can be written as follows, equal to the negative of the value of continued land tenure $\bar{v}$ plus the value of the expected change in land $w(E[\Delta L])$. For simplicity, I assume that every household in the village would have its land tenure disrupted by the reallocation.

$$v_{ivpt} = -\bar{v}_{ivpt} + w(E[\Delta L_{ivpt}]) \tag{1}$$

$\bar{v}_i$ is defined more specifically as the loss in output due to foregone investments that are not made when tenure insecurity is introduced by a reallocation. Note that $X^{NR}_{ivpt}$ denotes a vector of agricultural investments made by household i in the absence of a reallocation, while $X^{R}_{ivpt}$ denotes investment in the case of a reallocation.

$$\bar{v}_{ivpt} \equiv F(X^{NR}_{ivpt}) - F(X^{R}_{ivpt}) \tag{2}$$

Some households may place a negative value on reallocation if they face significant losses due to reduced long-term investment, and thus they will seek to avoid a reallocation.

Others may place a positive value on reallocation if they expect to gain land in the process. Each household has the option to impose a bargaining or lobbying cost $c_i$ on the official in the case of the outcome they do not prefer: i.e., a household that prefers to avoid a reallocation can inflict a lobbying cost at the time of the reallocation, and vice versa for a household that prefers a reallocation.[8] A household that for which $v_{ivpt} < 0$ will set $c_{ivpt}(R = 1) = -v_{ivpt}$ and $c_{ivpt}(R = 0) = 0$; a household for which $v_{ivpt} > 0$ will set $c_{ivpt}(R = 1) = 0$ and $c_{ivpt}(R = 0) = v_{ivpt}$.

Total bargaining costs are summed across all households in the case of a reallocation or a non-reallocation. There is also a transactional cost of time and effort $T_v$ needed to redefine land boundaries in village v; this transaction time may also be higher in villages in which land titles have been distributed or there are other institutional restrictions on land reallocations. The village official will reallocate if the benefits exceed the sum of bargaining and transaction costs, a comparative static equivalently written as follows:

$$B_{vpt} > \sum_i c_{ivpt}(R = 1) - \sum_i c_{ivpt}(R = 0) + T_v \tag{3}$$

$$B_{vpt} > \sum_i (-v_{ivpt}) + T_v \tag{4}$$

Accordingly, the variable $R_{vpt}$, defined as equal to one if a reallocation occurs in village v in year t and zero otherwise, can be viewed as a function of benefits of the reallocation for the official, its costs in lost output, and the transactional costs of implementing a reallocation. For concision, $C_{vpt} \equiv \sum_i (-v_{ivpt})$.

$$R_{vpt} = f(B_{vpt}, C_{vpt}, T_v) \tag{5}$$

## 4.2 Identifying households at risk in a reallocation

Village leaders who have chosen to hold a reallocation then face another set of optimization decisions: how and to whom to reallocate land within the village. Some households will gain or lose land, while other households may not see changes to their landholdings.

The probability that a given household i in village v and year t will see its land reallocated is denoted $D_{ivpt}$; it is assumed to be a function of household characteristics $X_{ivpt}$, conditional on $R_{vpt} = 1$. If there is no reallocation, then $D_{ivpt} = 0$ for all households.

[8] This framework assumes that households can commit to imposing a certain cost on village officials. While this is clearly a strong assumption, it could be easily nested in a multi-period model in which households that fail to impose the postulated bargaining penalty on the official suffer a loss of credibility in future bargaining rounds.

$$D_{ivpt} = \begin{cases} f(X_{ivpt}) & \text{if } R_{vpt} = 1 \\ 0 & \text{if } R_{vpt} = 0 \end{cases} \tag{6}$$

Potential covariates $X_{ivpt}$ relevant to the reallocation decision could include demographic characteristics that render the household a poor match with its current land allotment; the household's current position in the overall distribution of landownership, given the village leader's interest in equity; and the past history of land shifts for the household.

Accordingly, there are two sources of variation in insecure tenure for the households of interest, corresponding to two separate optimization margins for the village official. There is variation in the household probability of land shifts $D_{ivpt}$ conditional on a reallocation occurring ($R_{vpt} = 1$), corresponding to the official's choice of which households to reallocate. There is also variation in the probability of reallocation across villages and years, corresponding the official's choice of whether or not to hold a reallocation.

In this analysis, I will focus on exploiting the first source of variation in tenure insecurity, taking as given the observed distribution of reallocations across different villages and years. When a reallocation does occur in the sample villages, ex ante all households face the risk of the suspension of their use rights and the transfer of their plot. However, not all households experience a change in landholdings in every reallocation.

In order to evaluate the effect of variation in security of tenure on economic outcomes, it is useful to first analyze the characteristics of households that do have their land reallocated. Assuming that the quantity of land already held is of first-order relevance, I first estimate the probability of a household's land being reallocated conditional on a reallocation occurring in the village for households in each decile of landownership. These probabilities are shown graphically in Figure 2.

The evidence indicates that land transfers are broadly progressive. The probability of receiving a positive transfer of land via a reallocation is generally decreasing by decile, and the probability of a negative transfer is increasing. Now, assume one reallocation has already occurred in every village in the past. Both reallocation "winners" and reallocation "losers" have experienced a shock to their landholdings and, presumably, to other economic outcomes as well. Two groups of households can be defined based on whether their land was affected in the last reallocation: $DP_{ivpt}^{-1} = 1$ defined for household i in village v in province p in year t denotes a household that gained land in the previous reallocation (on average, three to five years prior), and $DN_{ivpt}^{-1} = 1$ denotes a household that lost land. These households have received opposite shocks, relative to the unaffected households, with the median (absolute) change in landholdings observed as a result of a reallocation around one third of median land owned.

There is, however, one characteristic common to all households that had their land

reallocated in the previous round: a decline in the probability that their land tenure will be disrupted again in the next reallocation. Returning to the conceptual framework provided above, repeated reallocations of the same household's land in a short period of time would increase the loss of agricultural output due to the household's inability to invest in agricultural inputs that have long-term returns. This would increase the bargaining cost the household will impose on an official in the case of a reallocation, and render it less likely that a household recently included in a reallocation will again be included in a subsequent reallocation. Multiple reallocations of the same household's land also require that the village leader repeatedly incur transaction costs that may be non-trivial. For both reasons, I hypothesize that households previously included in a reallocation will have relatively greater tenure security in subsequent rounds of reallocation.

To test this hypothesis, I estimate the impact of past reallocation inclusion on a dummy variable capturing inclusion in the current reallocation, denoted $D_{ivpt}$ for household i in village v in province p in year t. $D_{ivpt}$ is defined to be equal to one if a household reports any change in total land owned in the year of the reallocation. $R_{vpt}$ is defined as equal to one if a reallocation is observed in village v in province p in year t. The independent variable of interest is a dummy variable for a household's past reallocation inclusion; I estimate the effect of this variable on $D_{ivpt}$ in years in which reallocation is observed, or $R_{vpt} = 1$. Controls are included for all land owned prior to reallocation $L_{ivpt}$, as well as for responsibility land and ration land, denoted $Res_{ivpt}$ and $Rat_{ivpt}$ respectively.[9]

The ultimate specifications of interest will include household fixed effects. However, this specification including the lagged dependent variable on the right-hand side cannot be estimated consistently with household fixed effects. Accordingly, I estimate this specification with village and year fixed effects $\lambda_v$ and $\kappa_t$, as well as separate time trends for villages in each decile of overall reallocation frequency, where these deciles are denoted $F_{vp}$. The specification of interest can thus be written as follows.

$$\begin{aligned} D_{ivpt} = \beta_1 DP_{ivpt}^{-1} + \beta_2 DN_{ivpt}^{-1} + \beta_3 L_{ivpt} + \beta_4 Res_{ivpt} + \beta_5 Rat_{ivpt} \\ + \lambda_v + \kappa_t + \sum_{i=1}^{10} F_{vp} t + \epsilon_{ivpt} \end{aligned} \tag{7}$$

The coefficients on $\beta_1$ and $\beta_2$ from estimating equation (7) are shown in Column (1) of Table 2, and are negative and significant. In other words, inclusion in a reallocation leads to a significant decrease in the probability that a given household will have its land adjusted again in the next reallocation for both past reallocation gainers and losers,

[9]Reallocations are assumed to be implemented at the end of period t; thus all variables measured in period t, including land owned, reflect the pre-reallocation status quo. The timing assumptions will be further elaborated and discussed in the next section.

compared to households that were not reallocated.

These results suggest that past reallocation history generates a plausible source of quasi-exogenous variation in current tenure insecurity, under the assumption that a reallocation has no differential impact on households that were included in a past reallocation and households that were not included other than via the channel of differential probability of current reallocation, and thus differential tenure insecurity. Column (2) shows the result of estimating the same equation with past reallocation inclusion pooled across gainer and loser households; the pooled dummy for past inclusion is denoted $D^{-1}_{ivpt}$.

$$D_{ivpt} = \beta_1 D^{-1}_{ivpt} + \beta_2 L_{ivpt} + \beta_3 Res_{ivpt} + \beta_4 Rat_{ivpt} + \lambda_v + \kappa_t + \sum_{i=1}^{10} F_{vp}t + \epsilon_{ivpt} \quad (8)$$

The same negative and significant relationship is evident. Households previously included in a reallocation show a decline in the probability of having their land reallocated again of around four percentage points relative to the mean probability of 60 percent, a proportional decline of around seven percent.[10]

It is important to note that many other factors may be simultaneously shaping households' de facto tenure security; however, I will focus on past reallocation history as a proxy for current tenure security given that I can plausibly argue this history is uncorrelated with other observed and unobserved characteristics of the household. In the primary analysis, I employ the same specification using the full sample of both reallocation and non-reallocation years. The coefficient on $D^{-1}_{ivpt}$ when $R_{vpt} = 0$ is zero by construction; having had land reallocated in the past is correlated with the probability of a disruption to current land tenure, but only if a reallocation is actually occurring in the village. Otherwise, the impact of past reallocation on current reallocation is precisely zero.

Moreover, the heterogeneity of past reallocation patterns (including both gainers and losers) allows for an additional test of possible omitted variable bias. Any bias in unobservables as a result of past reallocation-induced shocks to land is presumed to be of opposite sign for past land gainers, who now own more land than the mean household, and land losers, who now own less land. To confirm this pattern, I regress land owned $L_{ivpt}$ on the dummy variables $DP^{-1}_{ivpt}$ and $DN^{-1}_{ivpt}$ including the same basic set of control variables included in equation (7), but excluding the land variables on the right-hand side. I also include linear and quadratic controls for household size, denoted $Hh_{ivpt}$, as well the change in household size, denoted $Hhdif_{ivpt}$; the objective of including these control variables is to verify that the observed shifts in land endowment do not simply reflect

[10]This specification can also be re-estimated using first differences at the household level to verify that the same relationship persists when household-level variation is partialled out. The results are not reported for concision, but are available upon request.

underlying shifts in household demographics.[11] This yields the following specification.[12]

$$L_{ivpt} = \beta_1 DP^{-1}_{ivpt} + \beta_2 DN^{-1}_{ivpt} + \beta_3 Hh_{ivpt} + \beta_4 Hh^2_{ivpt} + \beta_5 Hhdif_{ivpt} + \beta_6 Hhdif^2_{ivpt} + \beta_5 R_{vpt} + \lambda_v + \kappa_t + \epsilon_{ivpt} \quad (9)$$

The results are reported in Column (3) of Table 2, and show coefficients $\beta_1$ and $\beta_2$ that are positive and negative as expected, and significant. These coefficients suggest that while reallocations are implemented to increase equity, the challenges inherent in subdividing plots to a precise size results in households that gain land in fact being relatively land-rich compared to households not included in a reallocation, while households who lose land experience an analogous but opposite shock. This is true even conditional on flexible controls for household demographic characteristics.

Non-parametric evidence consistent with these shifts in landownership is presented in Figure 3. The figure shows estimated kernel densities of land owned for households with past positive and negative shocks to landholdings in reallocations, partialling out household and year fixed effects. Both a shift right in the distribution for past land gainers and a shift left for past land losers are evident; in both cases, a Kolmogorov-Smirnov test rejects the null hypothesis of equality of the distributions at the one percent level.

Accordingly, if a significant effect of past reallocation status on economic outcomes in a reallocation year is observed for both past land gainers and past land losers, this suggests that the observed pattern is plausibly interpreted as a causal estimate of the impact of tenure security on economic outcomes. Systematic bias would be introduced only by a shock that affects both the relatively land-poor and the relatively land-rich, a non-monotonic pattern that seems a priori implausible. Further evidence on this point will be presented in the next section.

## 4.3 Tenure security and economic outcomes

The primary specification of interest will regress economic outcomes at the household level, $Y_{ivpt}$, on the interaction of a dummy for past reallocation inclusion and a current reallocation. Controls for lagged household reallocation $D^{-1}_{ivpt}$ and land, responsibility land and ration land owned prior to the reallocation $L_{ivpt}$ are included; each land variable is also interacted with the reallocation variable. For concision, I denote all the household-level land controls as $X_{ivpt}$.

$$X_{ivpt} \equiv L_{ivpt} + Res_{ivpt} + Rat_{ivpt} + L_{ivpt} \times R_{vpt} + Res_{ivpt} \times R_{vpt} + Rat_{ivpt} \times R_{vpt} \quad (10)$$

[11] The results are also consistent if estimated without these control variables.

[12] The full sample of reallocation and non-reallocation years is employed, and accordingly a dummy variable for $R_{vpt}$ is included.

In addition, I include a dummy variable for reallocations $R_{vpt}$ and separate time trends for villages in each decile of overall reallocation frequency, where these deciles are denoted $F_v$. The specification of interest can thus be written as follows, including household and province-year fixed effects to control for any time-invariant unobservable characteristics at the household level, as well as shocks experienced by a given province.

$$\begin{aligned} Y_{ivpt} = \beta_1 D_{ivpt}^{-1} \times R_{vpt} + \beta_2 D_{ivpt}^{-1} + \beta_3 X_{ivpt} + \beta_4 R_{vpt} \\ + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_v t + \epsilon_{ivpt} \end{aligned} \tag{11}$$

Reallocations are declining in frequency over this period, and the decline is more rapid in villages that had more frequent reallocations initially; this could be a source of bias if these differential trends also differentially affect households with different reallocation histories $D_{ivpt}^{-1}$. The decile-specific trends control for this source of bias.

The primary specification can also be estimated including dummy variables for gaining and losing land in a previous reallocation, $DP_{ivpt}^{-1}$ and $DN_{ivpt}^{-1}$, and the corresponding interactions as explanatory variables.

$$\begin{aligned} Y_{ivpt} = \beta_1 DP_{ivpt}^{-1} \times R_{vpt} + \beta_2 DN_{ivpt}^{-1} \times R_{vpt} + \beta_3 DP_{ivpt}^{-1} + \beta_4 DN_{ivpt}^{-1} + \beta_5 X_{ivpt} \\ + \beta_6 R_{vpt} + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_v t + \epsilon_{ivpt} \end{aligned} \tag{12}$$

The assumed timing in each year is as follows: a signal about the reallocation is received prior to household's investment decisions. Investments are made and output is realized. Subsequently, land is reallocated after the harvest.[13] Accordingly, any variable measured in period t, most importantly agricultural investments and land owned, is assumed to reflect the state of the world prior to reallocation.

While the exact timing of the reallocation decision doubtless varies, the assumption is that the considerable time required to implement a reallocation requires a decision to be made at a point that overlaps with the period of key investments, in line with the evidence that households are observed to respond strategically to early notifications about future reallocations in decisions about household formation and marriage. Such strategic behavior would be impossible if the decision to reallocate was simultaneous with the actual implementation.

Eight outcome variables are reported for each specification: area cultivated, fertilizer, agricultural labor, a dummy variable equal to one if the household reports any agri-

[13]There is considerable anthropological evidence that reallocations normally occur during the fallow period in winter. See for example Unger (2005).

cultural structures constructed (e.g., a fence, shed, etc.), the value of moveable capital (tools and animals), total agricultural output, and the number of days invested in a non-agricultural household business and in labor outside the household. All variables are then normalized by the mean and standard deviation of the outcome variable in the control (non-participating) households.[14]

**Primary results** Panel A of Table 3 shows the results from estimating the main specification. Note again that all dependent variables are normalized to have mean zero and standard deviation one. In Panel A, the coefficients on the interaction $D_{ivpt}^{-1} \times R_{vpt}$ are generally positive and significant with magnitude between .04 and .08, reflecting greater agricultural investments by households that were included in the last reallocation and accordingly enjoy greater tenure security. However, no effect is observed for moveable capital, labor input into household businesses or labor in outside enterprises.

These results are consistent with a model of household behavior in which households at lower risk of losing their current plot increase the use of inputs that have medium-term returns and inputs that are complementary to those medium-term investments. It is useful to consider each input separately.

The shift in sown area seems primarily to reflect an increase in the prevalence of multicropping among households with greater tenure security.[15] Optimized multicropping yields long-term benefits in terms of soil nutrition and health (Zhang et al., 2004), and thus households expecting short tenure may be less likely to multicrop (or conversely, households expecting a long tenure are more likely to multicrop). Two additional sources of evidence are consistent with this interpretation: first, the primary specification can be re-estimated with a multicropping index, defined as cultivated area divided by the household's land endowment, as the dependent variable, and the same effect is observed. Second, the increase in sown area is of significantly smaller magnitude for households with a past history of reallocation inclusion that already report a high multicropping index the year prior to the reallocation, suggesting that households who have limited scope to increase multicropping are less responsive to greater tenure security.[16]

The use of fertilizer also has long-term returns, though in general the agronomic literature has emphasized the importance of organic fertilizer (e.g., manure) for medium-run soil fertility. Evidence in China, however, has shown that the combined use of organic

[14]Fertilizer is defined as the mean of total fertilizer and the most common subtype of fertilizer used, carbamide. The top 5% and bottom 1% of observations of each continuous outcome variable are trimmed to remove the influence of outliers. The asymmetry reflects the much longer right tail in the distribution of agricultural input variables.

[15]The average household in this dataset is multicropping around 50% of land owned, a rate consistent with previous estimates from agricultural censuses and remote sensing data (Frolking et al., 2004).

[16]Tabulations of these results are omitted for concision, but are available upon request.

and inorganic fertilizer has the highest long-term returns (Fan et al., 2005; Jiang et al., 2006). An important weakness of this dataset is that it reports only fertilizer purchased by the household, and thus use of any fertilizer that is not commercially purchased (including, presumably, manure) is not reported. The hypothesis that the magnitude of the increase in fertilizer use observed for overall fertilizer is equal to the magnitude of the increase observed in each reported subcategory of fertilizer (carbamide, potash, ammonium hydrogen phosphate, calcium superphosphate, and other fertilizers) can generally not be rejected.[17] This seems to suggest a balanced increase in fertilizer use across all types. Given that the reported data is restricted to primarily chemical fertilizers, a concomitant increase in the use of organic fertilizer cannot be detected.

The shift in agricultural structures is intuitive given that structures have medium-term returns: households that enjoy greater tenure security are more likely to invest in a new structure, while households at risk of disruption of tenure on their current plot are less likely to do so. Finally, agricultural labor is presumably a complementary input to fertilizer, sown area, and structures. Accordingly, when households with greater tenure security increase their use of inputs and their area sown, they also exhibit an increase in agricultural labor.

No effect is observed for non-agricultural activities. The difference between the substantial effect observed for agricultural investments and the null effect for non-agricultural investments primarily reflects the short time horizon of the tenure insecurity analyzed. Given that both the establishment of a non-agricultural household business and the search for outside employment may require considerable initial, and potentially irreversible, investments, it would be implausible to see a substantial divergence in non-agricultural investments between households with different short-term expectations of land tenure. Households who already had access to and the ability to exploit non-agricultural opportunities will presumably do so independent of short-term variations in their tenure security. Accordingly, the differential impact of reallocation history on agricultural and non-agricultural investment is consistent with the hypothesis that the observed impacts represent the effect of variation in short-term security in land tenure, rather than other unobserved differences between households with different reallocation histories.

To supplement this more disaggregated analysis, I also generate summary indices of agricultural investment (the mean of sown area, fertilizer, agricultural labor, a dummy for agricultural structures, other agricultural capital, and total agricultural production) and non-agricultural investment (the mean of days invested in a non-agricultural household business and days worked outside the household) and re-estimate equation (11) employing

[17]The hypothesis can be rejected for only two subtypes of fertilizer: the use of ammonium hydrogen phosphate seems to decline with greater security, and the increase in use of "other" fertilizer is larger than the increase in overall fertilizer.

these summary indices as dependent variables. These results show the same pattern: the coefficient $\beta_1$ is positive and significant (magnitude .05) for mean agricultural investment, and small in magnitude and insignificant for non-agricultural investment.[18]

An examination of the coefficients on $D_{ivpt}^{-1}$, the dummy for past reallocation inclusion shows that these coefficients are generally negative and significant. This suggests that households previously included in a reallocation may show different patterns of investment in non-reallocation years, and this may be suggestive of omitted variable bias. This potential source of bias is further analyzed in the next subsection.

**Estimating separate effects for past land gainers and losers** Panel B of Table 3 reports the results of estimating the "split" specification, equation (12). The coefficients $\beta_1$ are symmetrically positive and significant for households that gained and lost land in the past, with the exception of the coefficient on fertilizer, narrowly insignificant for households that previously gained land. This suggests that the positive effect of enhanced tenure security is observed symmetrically across both classes of households at lower risk of disruption of current tenure. Again, if these results are re-estimated for summary variables, the coefficients $\beta_1$ and $\beta_2$ are significant and positive for agricultural investment, while both coefficients are insignificant for non-agricultural investment.

In addition, the assumption that there is no omitted channel that is biasing the estimated effect for both land losers and land winners can be evaluated by examining the estimated coefficients on $DP_{ivpt}^{-1}$ and $DN_{ivpt}^{-1}$. Previously, there was some evidence of a decline in investment by households previously included in a reallocation in non-reallocation years. Here, it is evident that it is households that previously lost land who show evidence of lower investment in non-reallocation years. Households that previously gained land exhibit behavior that is not significantly different from households who were not included in the last reallocation.

Taken as a set, the coefficients $\beta_3$ and $\beta_4$ are varying in sign and generally not statistically significant; the only outcome for which symmetric and significant coefficients are observed is investment in structures. The absence of any pattern of symmetric and significant coefficients on the dummies for past reallocation gainers and losers suggests there is no common bias in observables across both sets of households.

In order for these results to capture a causal effect of reallocations on household economic outcomes, it is necessary to assume that there is no shock correlated with a village-level reallocation that differentially affects households included in the previous reallocation. If households that had their land previously reallocated either positively or negatively showed characteristics that were significantly different from households with no

[18]Tabulations are not reported for concision, but available upon request.

previous reallocations in non-reallocation years, this would suggest that the past history of reallocations generated different trends for land winners and land losers. If there were an interaction between these trends and $R_{vpt}$, the coefficients of interest would be biased.

Given the absence of any evidence of significant difference in outcomes for past reallocation participants in non-reallocation years, however, it seems implausible that there is another, independent shock correlated with $R_{vpt}$ that affects only these households in reallocation years. Further evidence about differing trends for past land gainers and land losers in the years prior to a reallocation will be presented in the robustness checks.

**Alternate specifications** Tables 4 and 5 show a number of alternate specifications. In Panel A of Table 4, I re-estimate the main specification interacting $R_{vpt}$, the dummy for reallocation, with province and year fixed effects $\omega_p$ and $\eta_t$ to allow for province and year-specific impact of reallocations. I also add linear and quadratic controls for household size and the change in household size. The objective of including these control variables is to verify that the observed shifts in agricultural investment do not simply reflect underlying shifts in household demographics.

$$\begin{aligned} Y_{ivpt} = \beta_1 D_{ivpt}^{-1} \times R_{vpt} + \beta_2 D_{ivpt}^{-1} + \beta_3 X_{ivpt} + \beta_4 Hh_{ivpt} + \beta_5 Hh_{ivpt}^2 + \beta_6 Hhdif_{ivpt} \\ + \beta_7 Hhdif_{ivpt}^2 + \nu_i + \gamma_{pt} + \omega_p \times R_{vpt} + \eta_t \times R_{vpt} + \sum_{i=1}^{10} F_{vp} t + \epsilon_{ivpt} \end{aligned} \tag{13}$$

In Panel B, I add distinct time trends for households in each decile of average reallocation frequency over the period, denoted $F_{ivp}^D t$. If households who are frequently included in reallocations are (for example) not politically well-connected or have other covariates that are associated with distinct trends over this time period, that could be a source of bias in the primary specification. This specification controls for these trends.

$$\begin{aligned} Y_{ivpt} = \beta_1 D_{ivpt}^{-1} \times R_{vpt} + \beta_2 D_{ivpt}^{-1} + \beta_3 X_{ivpt} + \beta_4 R_{vpt} \\ + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_i t + \sum_{i=1}^{10} F_{ivp}^D t + \epsilon_{ivpt} \end{aligned} \tag{14}$$

In Panel C, I calculate the time lapse between each observed reallocation and the previous reallocation, denoted $Lapse_{vpt}$, and add time lapse fixed effects $\eta_{vpt}^{lapse}$ to control for any systematic differences between village-years in which a reallocation is implemented following a lengthy period of stability and village-years in which a reallocation follows

another recent reallocation.

$$
\begin{aligned}
Y_{ivpt} = \beta_1 D_{ivpt}^{-1} \times R_{vpt} + \beta_2 D_{ivpt}^{-1} + \beta_3 X_{ivpt} + \beta_4 R_{vpt} \\
+ \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_i t + \eta_{vpt}^{lapse} + \epsilon_{ivpt}
\end{aligned}
\tag{15}
$$

In Panel D, I broaden the definition of households included in a reallocation, coding as $D_{ivpt}^{-1} = 1$ households who do not report any change in total land area, but report an increase (decrease) in the number of plots they own of at least 50% (e.g., a household reports an increase from two to four plots, or a decrease from six to three plots). The objective is to identify households whose approximate land area is identical but nonetheless experienced substantial changes in land configuration that are suggestive of a reallocation. The results in all four panels are highly consistent with the primary results, though the coefficient for fertilizer is smaller in magnitude and not significant in Panel D.

In addition, I estimate several specifications using subsamples in order to test whether there is any evidence of bias introduced by the possibility that some of the reallocations identified are what the literature has described as partial reallocations. Partial reallocations are distinguished by the fact that only households that have had changes in their household composition experience incremental shifts in landholdings, without full swaps of their plots. In this case, households that need more land might receive an incremental, additional transfer, while households that have too much land would lose part of their holdings (Keliang et al., 2007).

In order to address this possibility, there are two separate cases that should be considered. One is that the past reallocation, on the basis of which $DP_{ivpt}^{-1}$ and $DN_{ivpt}^{-1}$ were defined, is in fact not a full reallocation. The second is that the current event that is generating insecurity in tenure, captured by dummy $R_{vpt} = 1$, is not a full reallocation.

Under the first case, some households for which $D_{ivpt}^{-1} = 1$ may have previously had their land reallocated partly or primarily because of their changes in composition. If this were the case, then the primary specification captures a causal effect of reallocation on economic outcomes only if a reallocation has no differential effect on households that previously experienced a change in composition compared to those that did not, other than via the channel of differing tenure security. A violation of this assumption would arise if there is a shock correlated with reallocation that differentially affects households with a past history of demographic shifts.

On the other hand, if what I identify as a current reallocation is in fact a partial reallocation or some other type of irregularity in land transfer, and households' expectations are rational, then only some households are subject to decreased tenure insecurity: more

specifically, those households that expect to lose land based on a shift in their household composition. In this case, the primary specification captures a causal effect of reallocation on economic outcomes only if there is no shock correlated with land reallocations that differentially affects relatively land-rich (on a per capita basis) households.

In both cases, the primary specification (11) can no longer be interpreted as a symmetric and non-monotonic effect of greater tenure security observed for both relatively land-poor and relatively land-rich households. Accordingly, if miscoding is common and reallocation is correlated with other shocks that affect relatively land-rich households or households with previously unstable composition, this could generate bias. In order to test the robustness of the results to potential bias introduced by the miscoding of partial reallocations, I restrict the sample in several ways.

First, the sample is restricted to households that did not previously report a change in composition in the year of the previous reallocation. These are households that have a history of demographic stability. If the primary results represent bias introduced by correlated shocks for demographically unstable households, this specification should show no significant effect. The results are shown in Panel A of Table 5, and the estimated coefficients are consistent in both sign and magnitude.

Second, I evaluate the effect of reallocations on households that can reasonably be assumed to be land-poor on a per capita basis. If the miscoding of partial reallocations as $R_{vpt}$ is common and the estimated effect reflects a correlated shock only for relatively land-rich households, these specifications should show no effect. Panels B and C of Table 5 show the results of re-estimating equation (8) restricting the sample first to households that have grown or remained constant in composition (Panel B), and second to households in the bottom third of the land distribution in a particular village and year (Panel C). These are households that on the basis of demography and land ownership are plausibly land-gainers, not land-losers. The results again remain consistent in both sign and magnitude, suggesting that there is little bias introduced by miscoding and the potential of correlated shocks for land-rich households.

# 5 Robustness checks

This section presents a series of additional robustness checks on the above results.

**Trends in non-reallocation years** If households previously included in a reallocation show diverging trends compared to households not previously included in non-reallocation years, this could be a significant source of bias. In order to analyze these trends, I re-estimate the primary specification, equation (8), replacing the reallocation variable $R_{vpt}$

with variables corresponding to the pre-reallocation years t-1, t-2, etc. For year t-1, for example, the following equation is estimated.

$$\begin{aligned} Y_{ivpt} = \beta_1 D_{ivpt}^{-1} \times R_{vp,t-1} + \beta_2 D_{ivpt}^{-1} + \beta_3 X_{ivpt} + \beta_4 R_{vp,t-1} \\ + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_{vp} t + \epsilon_{ivpt} \end{aligned} \tag{16}$$

I then graph the coefficients $\beta_1$, normalized by the standard error, estimated for the reallocation year and each of the preceding four years.

The results can be seen in Figure 4. The first five subfigures show the primary outcomes of interest in the main analysis: sown area, fertilizer, agricultural labor, agricultural structures, and agricultural production. In each case, the coefficients $\beta_1$ are generally insignificant and of varying sign prior to the reallocation year, followed by large increases in the year of the reallocation.

There is also some evidence of anticipation in the year prior to the reallocation - i.e., an increase in investment in the year t-1 - though it is generally not statistically significant. This may reflect anticipation of an upcoming reallocation, leading households characterized by greater tenure security to show investment patterns that diverge (positively) from households characterized by weaker tenure security.

The second set of subfigures shows that for variables unaffected by tenure insecurity – portable investments and non-agricultural investments – there is little evidence of diverging trends for households who previously were included in a reallocation and those households not previously included in either reallocation or non-reallocation years. This evidence is consistent with the primary causal channel postulated for the main results: households previously included in a reallocation enjoy relatively more secure tenure and thus invest more in inputs with medium-term returns when the risk of reallocations recurs.

**Spurious reallocations** In the previous section, I explored bias that might be introduced by miscoding partial reallocations as full reallocations. Another potential source of bias could arise if some events identified as reallocations are not reallocations at all, but instead reflect households engaging in private swaps of land or simply misreporting the quantity of land held, either for strategic reasons or otherwise. In that case, households identified as "included" in a reallocation might be better described as households who have chosen to engage in unsanctioned manipulations of their land area in practice, or have reported such manipulations. These households might have systematically different characteristics from other households: it is possible that they are characterized by stronger (or weaker) political connections, are less engaged in agricultural production, experience frequent changes in the productive activities they pursue, or differ along other

observable or unobservable characteristics.

Again, to consider the potential bias in the primary specification induced by this phenomenon, it is useful to separately consider the possibility that the past reallocation is spurious, and the possibility that the current reallocation is spurious. The latter is an easier case to consider: if the root cause of instability in reported land endowments is in fact not a reallocation, there is no reason to expect any divergence in reported investments between households with different reallocation histories. This should attenuate the coefficient on $D_{ivpt}^{-1} \times R_{vpt}$ toward zero.

On the other hand, if the past reallocation is completely spurious, then households who were included in the reallocation might be those with non-standard characteristics along some dimensions as described above. This could be a source of bias if those households respond to future disruptions in tenure security differently from other households. For example, households who frequently transition between multiple productive activities and thus engage in unsanctioned land swaps might show investments that are unresponsive to a reallocation not because they have differentially greater tenure security (the channel postulated here), but because they are already optimally choosing not to make medium-term investments in agriculture.

In order to test for this channel, I focus on identifying whether the selection process for households included in reallocations of lesser "intensity" (i.e., potentially spurious reallocations) differs from the selection process for households included in reallocations of greater intensity. Evidence of dramatically differential selection might be suggestive that low-intensity reallocations are in fact spurious, and raise questions about bias induced by varying unobserved characteristics of households reporting inclusion in these events.

More specifically, I estimate the following equation. A dummy for inclusion in a reallocation $D_{ivpt}$ is regressed on lagged characteristics of the household $X_{iv,t-1}$, employing the same set of covariates used in the primary analysis, and the interaction of $X_{iv,t-1}$ with a measure of reallocation intensity $Int_{vpt}$. $Int_{vpt}$ is defined simply as the proportion of all households in the village reporting land changes in that reallocation; this is, of course, one of the variables used to identify reallocations. Household and province-year fixed effects $\nu_i$ and $\gamma_{pt}$ and the time trends by decile of reallocation included in the primary specification are also included.

$$\begin{aligned} D_{ivpt} = \beta_1 X_{iv,t-1} + \beta_2 X_{iv,t-1} \times Int_{vpt} + \beta_3 Int_{vpt} \\ + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_v t + \epsilon_{ivpt} \end{aligned} \tag{17}$$

The primary coefficient of interest is $\beta_2$; the objective is to identify whether the

relationship between household covariates pre-reallocation and the probability of inclusion varies systematically with the intensity of the reallocation. The results, presented in Table 6, show coefficients that are uniformly insignificant. There is some weak evidence that households with higher levels of agricultural investment are more likely to be included in a reallocation, though the coefficients are not significant.[19] Of primary interest for this analysis, the interaction terms $\beta_2$ are small in magnitude and insignificant. There is no evidence that the selection process in low-intensity reallocations differs along dimensions that would be suggestive that low-intensity reallocations are in fact spurious.

**Alternate measures of reallocation** As an additional robustness check, I re-calculate the primary measure of reallocation $R_{vpt}$ using alternate definitions based on varying cutoffs in the proportion of households reporting land transfers and the proportion of total land reported transferred. While the primary measure of reallocation employs a cutoff of 50 percent, I employ a range of cutoffs between 40 percent and 80 percent and then use these alternate measures to estimate the primary specification, equation (8), with sown area, agricultural inputs, agricultural labor and grain production as the dependent variables.[20] The primary coefficients of interest, $\beta_1$, along with a 90 percent confidence interval are then graphed in Figure 5.

The results show a consistently positive coefficient on the independent variable $D_{ivpt}^{-1} \times R_{vpt}$ regardless of the cutoff employed, and the estimated coefficients are also significant or close to significant over a wide range of potential definitions of $R_{vpt}$. This suggests that the observed results are not merely an artifact of the definition of reallocation employed.

**Information as a channel for predicting reallocations** One potentially plausible assumption about selection into reallocation holds that village officials, who execute reallocations, systematically have more information about households that have similar characteristics to themselves and thus are more likely to participate in their social networks. Given the greater informational salience of these households, officials may be more likely to alter their landholdings. This unobservable proximity to village officials could also generate other time-varying effects if, for example, village leaders prefer to simultaneously implement a reallocation with another policy shift that also differentially affects households with close ties to the village leadership.

[19]The underlying reason for this pattern is that households with high levels of investment are more likely to be included in a reallocation and gain land, while households of low level of investment are more likely to be included and lose land; however, the former effect is of somewhat greater magnitude. This may reflect the fact that even low-productivity households are considered entitled to a certain basic allotment of land, given the interest in equity, and thus the probability that they lose land is somewhat lower.

[20]Note that when $R_{vpt}$ is re-defined, $D_{ivpt}$ is also re-defined as household-level reallocation inclusion can only vary in a year where $R_{vpt} = 1$.

This hypothesis can be tested by examining whether there are any characteristics that, when shared with village officials, render proximate households symmetrically more likely to experience positive and negative reallocation shocks to their landholdings. A series of dummy variables are defined that capture households' economic specializations (whether they cultivate rice or wheat, and whether they report household businesses of any of the enumerated types), and a limited number of social characteristics enumerated in the survey (the presence within the household of an individual with education beyond high school, a veteran, resident grandparents or a Communist party member).

For each village-year cell, the mean of this dummy is calculated for households that are reported to be led by a village official, and this official mean is denoted $O_{vpt}$. The equations of interest regress the dummies for positive and negative reallocation in years in which $R_{vpt} = 1$ on the household indicator of interest $I_{ivpt}$, the official indicator $O_{vpt}$ and the interaction $I_{ivpt} \times O_{vpt}$. The equation also includes control variables for land measures, household and province-year fixed effects, and separate time trends by decile of reallocation frequency.

$$\begin{aligned} D_{ivpt}^{P/N} = {} & \beta_1 I_{ivpt} \times O_{vpt} + \beta_2 I_{ivpt} + \beta_3 O_{vpt} + \beta_4 L_{ivpt} + \beta_5 Res_{ivpt} + \beta_6 Rat_{ivpt} \\ & + \nu_i + \gamma_{pt} + \sum_{i=1}^{10} F_{vp} t + \epsilon_{ivpt} \end{aligned} \tag{18}$$

The specification is thus parallel to the previously estimated equation (8) capturing the relationship between past inclusion and current tenure insecurity, where the primary independent variable of interest is the interaction between official and individual characteristics. The objective is to test whether households with a particular economic or social characteristic are more likely to have their land reallocated in villages where officials share this characteristic.

The results shown in Table 7 indicate no clear pattern of coefficients across the various interaction terms. There is some evidence that in villages where officials cultivate rice, rice-cultivating households are more likely to gain land and less likely to lose it (i.e., they are favored). However, there are no covariates for which sharing this characteristic with a village official leads to significant increases in the probability of both gaining and losing land. Thus it is plausible to conclude that there is very little evidence that informational proximity to village officials serves as a common source of bias for both households that gain land and households that lose land in a reallocation.

To sum up, the evidence presented here suggests that households at greater risk of a disruption to their land tenure invest significantly less in agriculture, and produce less output. Equally important for policy implications, however, there is no evidence of

corresponding substitution into non-agricultural activities. While the estimated effects are not extremely large in magnitude, given that reallocations are observed relatively frequently in this context, they suggest a substantial cost to insecure property rights.

# 6 Conclusion

Although secure property rights are perceived as immensely important to economic development, the literature on the impact of inframarginal variation in property rights on economic outcomes remains limited. This paper contributes to this literature by evaluating one of the most unusual and far-reaching experiments in land property rights over the last half-century, the system of village-based reallocations of land in China. Implemented in order to maintain relative equity among households and to allow for adjustment of landholdings in absence of any rural land market, this system generates periodic disruptions in property rights for rural households, who have no guarantee that they will continue to farm the plot they currently hold.

Using an identification strategy that exploits intra-village variation in security of tenure, my analysis finds that a lower probability of land reallocation has a substantial impact on households' economic behavior. Households that are less likely to see their tenure on their current plot disrupted by virtue of their past inclusion in a reallocation employ more agricultural inputs and produce more output than other households, while there is little evidence of any significant effect on non-agricultural output. Though the magnitude of the gains in output may seem modest, this should be regarded as a lower bound on the potential gains from endowing rural households with full property rights.

# References


**Andreas, Joel and Shaohua Zhan**, "Hukou and land: Market reform and rural displacement in China," *Journal of Peasant Studies*, 2015.

**Bai, Ying, James Kung, and Yang Zhao**, "How much expropriation hazard is too much? The effect of land reallocation on organic fertilizer usage in rural China," *Land Economics*, 2014, *90* (3), 434–457.

**Banerjee, Abhijit, Paul Gertler, and Maitreesh Ghatak**, "Empowerment and efficiency: Tenancy reform in West Bengal," *Journal of Political Economy*, 2002, *110* (2), 239–280.

**Besley, Timothy**, "Property rights and investment incentives: Theory and evidence from Ghana," *Journal of Political Economy*, 1995, *103* (5), 903–937.

_ **and Robin Burgess**, "Land reform, poverty reduction, and growth: Evidence from India," *Quarterly Journal of Economics*, 2000, *115* (2), 389–430.

**Brandt, Loren, Jikun Huang, Guo Li, and Scott Rozelle**, "Land rights in rural China: Facts, fictions and issues," *The China Journal*, 2002, pp. 67–97.

**de la Rupelle, Maelys, Deng Quheng, Qi Shi, and Thomas Vendryes**, "Land rights insecurity and temporary migration in rural China," 2009.

**Fan, Tinglu, B.A. Stewart, Wang Yong, Luo Junjie, and Zhou Guangye**, "Long-term fertilization effects on grain yield, water-use efficiency and soil fertility in the dryland of Loess Plateau in China," *Agriculture, Ecosystems and Environment*, 2005, *106* (4), 313–329.

**Feder, Gershon, Lawrence Lau, Justin Lin, and Xiaopeng Luo**, "The determinants of farm investment and residential construction in post-reform China," *Economic Development and Cultural Change*, 1992, *41* (1), 1–26.

**Fei, Tang**, "Land adjustment and ownership security during the post-agricultural tax periodCentered by the contractual operation right of land," *Journal of Yangtze University (Social Sciences Edition)*, 2011-12.

**Feng, Shuyi, Nico Herrink, Ruerd Ruben, and Futian Qu**, "Land rental market, off-farm employment and agricultural production in Southeast China: A plot-level case study," *China Economic Review*, 2010, *21*, 598606.

**Field, Erica**, "Property rights and investment incentives in urban slums," *Journal of the European Economic Association Papers and Proceedings*, 2005, *3* (2-3), 279–290.

**Frolking, Steve, Jianjun Qiu, Stephen Boles, Xiangming Xiao, Jiyuan Liu, Yahui Zhuang, Changsheng Li, and Xiaoguang Qin**, "Combining remote sensing and ground census data to develop new maps of the distribution of rice agriculture in China," *Plant and Soil*, 2004, *16* (4), 89–99.

**Galiani, Sebastian and Ernesto Schargrodsky**, "Property rights for the poor: Effects of land titling," *Journal of Public Economics*, 2010, *94* (9-10), 700–729.

**Goldstein, Markus and Christopher Udry**, "The profits of power: Land rights and agricultural investment in Ghana," *Journal of Political Economy*, 2008, *116* (6), 981–1022.

**Ho, Peter**, "The 'credibility thesis' and its application to property rights: (In)secure land tenure, conflict and social welfare in China," *Land Use Policy*, 2014, *40* (2), 1327.

**Hornbeck, Richard**, "Barbed wire: Property rights and agricultural development," *Quarterly Journal of Economics*, 2010, *125* (2), 767–810.

**Jacoby, Hanan, Guo Li, and Scott Rozelle**, "Hazards of expropriation: Tenure insecurity and investment in rural China," *The American Economic Review*, 2002, *92* (5), 1420–1447.

**Jiang, Dong, H. Hengsdijk, Ting bo Dai, W. De Boer, Qi Jing, and Wei-Xing Cao**, "Long-term effects of manure and inorganic fertilizers on yield and soil fertility for a winter wheat-maize system in Jiangsu, China," *Pedosphere*, 2006, *16* (1), 25–32.

**Keliang, Zhu, Roy Prosterman, Ye Jianping, Li Ping, Jeffrey Reidinger, and Ouyang Yiwen**, "The rural land question in China: Analysis and recommendations based on a seventeen-province survey," *International Law and Politics*, 2007, *38*, 761–839.

**Kung, James**, "Common property rights and land reallocations in rural China: Evidence from a village survey," *World Development*, 2000, *28* (4), 701–719.

**Lin, Justin Yifu**, "Rural reforms and agricultural growth in China," *American Economic Review*, 1992, *82* (1), 34–51.

**Ma, Xianlei, Nico Herrink, Ekko van Ierland, Marrit van den Berg, and Xiaoping Shi**, "Land tenure security and land investments in Northwest China," *China Agricultural Economic Review*, 2013, *5* (2), 281–307.

**North, Douglass and Robert P. Thomas**, *The rise of the Western world: A new economic history*, Cambridge University Press, 1973.

**Rozelle, Scott and Guo Li**, "Village leaders and land-rights formation in China," *The American Economic Review*, 1998, *88* (2), 433–438.

**Schwarzwalder, Brian, Roy Prosterman, Ye Jianping, Jeffrey Riedinger, and Li Ping**, "An update on China's rural land tenure reforms: Analysis and recommendations based on a seventeen-province survey," *Columbia Journal of Asian Law*, 2002, *16*, 141–225.

**Song, Han**, "Analysis about the legislative improvement for adjustment of contracting of land managerial authority," *Law Science Magazine*, 2010.

**Soto, Hernando De**, *The mystery of capital: Why capitalism triumphs in the west and fails everywhere else*, Basic Books, 2000.

**Unger, Jonathan**, "The decollectivization of the Chinese countryside: A survey of twenty-eight villages," *Pacific Affairs*, 1985, *58*, 585–606.

_ , "Family customs and farmland reallocations in contemporary Chinese villages," *Social transformations in Chinese society*, 2005, *82*, 113–130.

**Walker, Kenneth**, "Chinese agriculture during the period of the readjustment, 1978–83," *The China Quarterly*, 1984, *100*, 783–812.

**Wang, Hui, Jeffrey Riedinger, and Songqing Jin**, "Land documents, tenure security and land rental development: Panel evidence from China," *China Economic Review*, 2015, *36*, 220235.

**Ye, Jingzhong**, "Land transfer and the pursuit of agricultural modernization in China," *Journal of Agrarian Change*, 2015, *15*, 314–337.

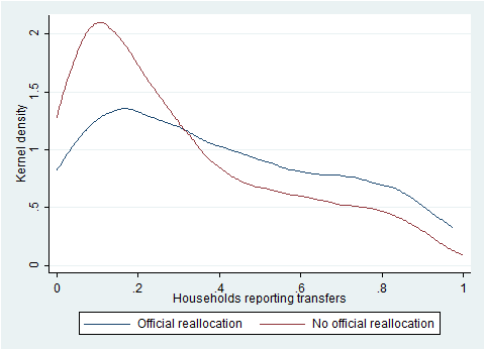
**Zhang, F., J. Shen, L. Li, and X. Liu**, "An overview of rhizosphere processes related with plant nutrition in major cropping systems in China," *Global Biogeochemical Cycles*, 2004, *260*, 1–10.

**Zhao, Xiaoxue**, "To reallocate or not? Optimal land institutions in rural economies: evidence from China," 2014.

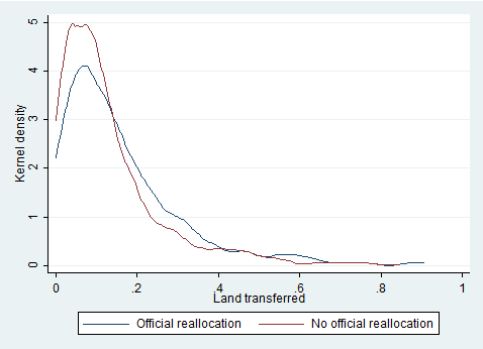
# 7 Figures and Tables

Figure 1: Land transfers and reallocations

(a) Prop. hh. reporting land changes

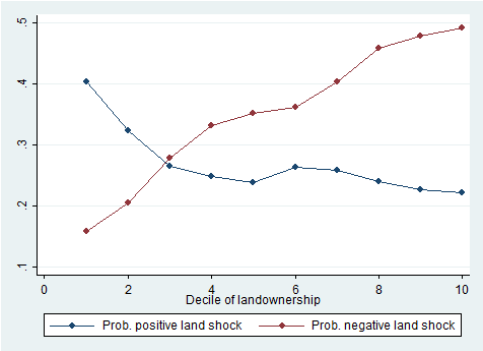



(b) Proportion land reported transferred




Notes: These graphs show estimated kernel densities for two variables: the proportion of households reporting land changes in each village and year, and the proportion of total village land reported transferred in each village and year. In each graph, the density function is displayed separately for villages and years in which a reallocation is reported by a village official (denoted "official reallocation") and for villages and years in which no official reallocation is reported. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

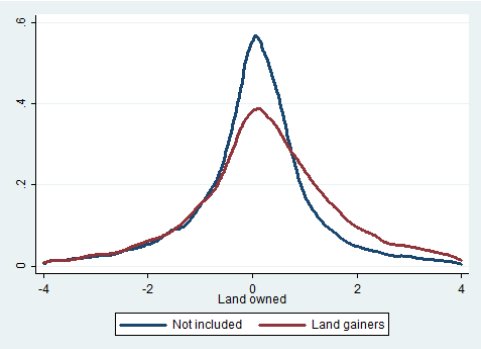
Figure 2: Probability of reallocation inclusion by decile of landownership



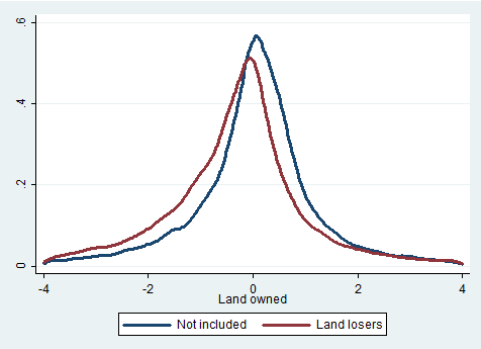

Notes: This figure shows the probability of a household being included in a reallocation and either gaining or losing land, according to its within-village decile of pre-reallocation landownership. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Figure 3: Kernel density estimates of landholding distributions

(a) Land gainers



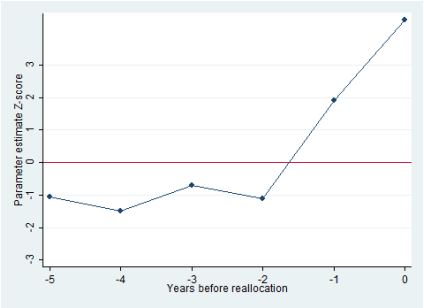

(b) Land losers



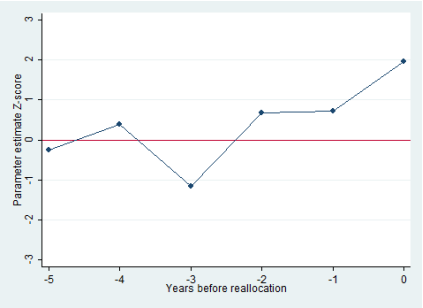

Notes: The figure shows estimated kernel densities of land owned for households that experienced positive and negative shocks to their landholdings in a previously reported reallocation, partialling out household and year fixed effects. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Figure 4: Trends in non-reallocation years

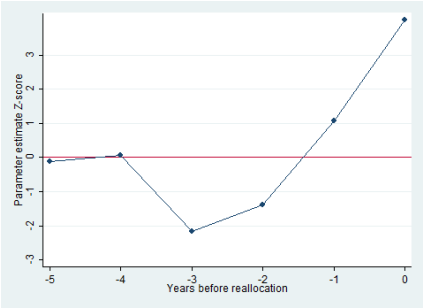
(a) Area sown



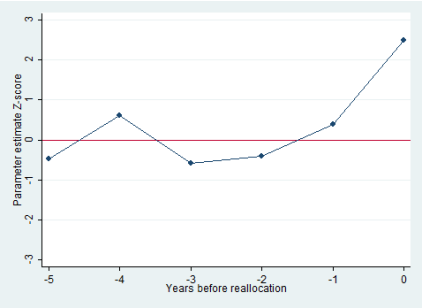

(b) Fertilizer



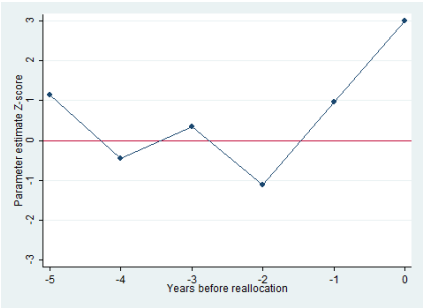

(c) Agricultural labor



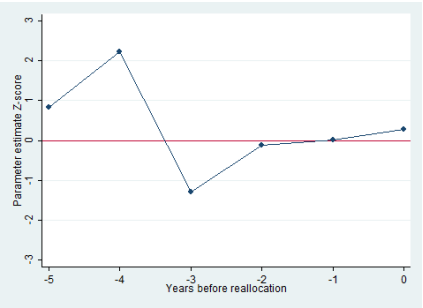

(d) Agricultural structures



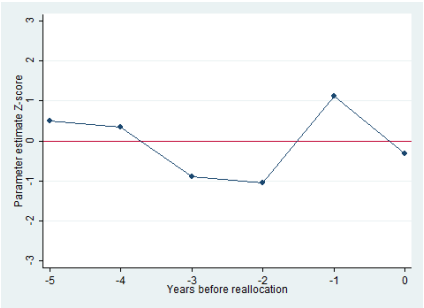

(e) Agricultural production



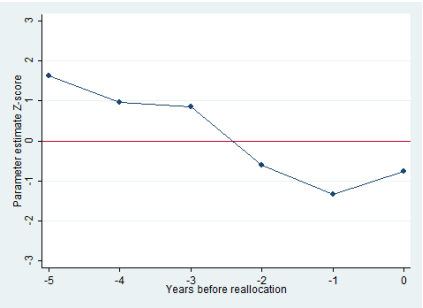

(f) Moveable capital




(g) Non-agricultural business



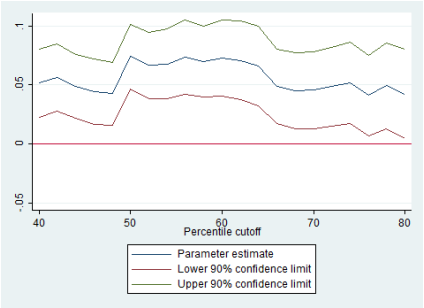

(h) Outside labor



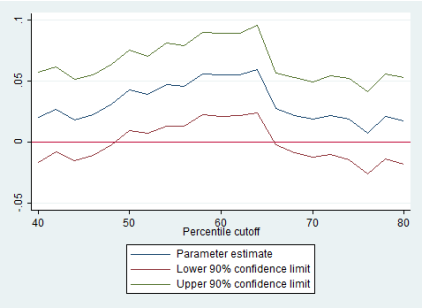

Notes: Each figure shows the results of a series of specifications in which the specified dependent variable is regressed on a dummy for a household's lagged reallocation status interacted with a dummy for current reallocation, the dummy for lagged reallocation status, household and province-year fixed effects, control variables for land, ration land and responsibility land entering linearly and interacted with a reallocation dummy, a dummy variable for reallocations, and separate time trends for villages in each decile of overall reallocation frequency. This specification is re-estimated for current reallocations as well as for reallocations lagged by one, two, three four and five years. Each subgraph reports the Z-score (coefficient divided by standard error) for the estimated coefficient on the interaction of lagged reallocation status and current reallocation. The dependent variables are sown area, fertilizer, agricultural labor, a dummy variable for agricultural structures, tools and animals owned, agricultural output produced and days worked in a non-agricultural business or outside labor; all variables are normalized relative to the mean and standard deviation of the control observations. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Figure 5: Estimated effect of tenure security for alternate definitions of reallocation

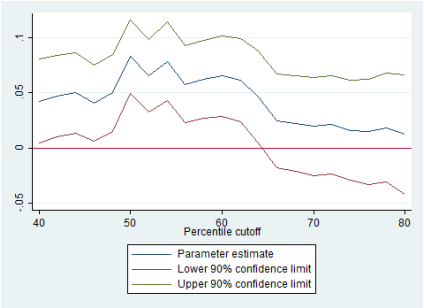
(a) Area sown



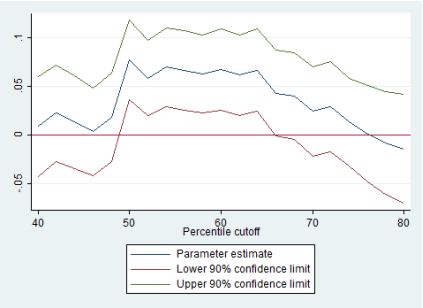

(b) Fertilizer




(c) Agricultural labor




(d) Grain production




Notes: These graphs show the results of re-estimating the primary specification using alternate definitions based on varying cut-offs in the proportion of households reporting land transfers and the proportion of total land reported transferred to define reallocations. While the primary measure of reallocation employs a cutoff of 50 percent, I employ a range of cutoffs between 40 percent and 80 percent and then use these alternate measures to re-estimate the primary specification, in which economic outcomes are regressed on the interaction between a pooled dummy equal to one if the household had its land reallocated in a previous reallocation and a dummy for a current reallocation; the lagged reallocation status dummy; and a range of controls (household and province-year fixed effects, control variables for land, ration land and responsibility land entering linearly and interacted with a reallocation dummy, a dummy variable for reallocations, and separate time trends for villages in each decile of overall reallocation frequency). Standard errors are clustered at the village-year level.

Each coefficient is graphed with a 90% confident interval. The dependent variables are sown area, fertilizer, agricultural labor, and agricultural output produced; all variables are normalized relative to the mean and standard deviation of the control observations. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

## Table 1: Summary statistics

| | | | |
|---|---|---|---|
| Sown area (mu) | 7.99 | 5.85 | 52381 |
| Fertilizer employed annually (kg) | 523.48 | 410.56 | 48977 |
| Carbamide employed (kg) | 103.86 | 114.78 | 48892 |
| Days worked in agriculture | 187.29 | 133.22 | 49701 |
| Dummy for owning structure | .59 | .49 | 52381 |
| Value of animals and tools (yuan) | 566.55 | 833.57 | 52366 |
| Days worked in non-agricultural household businesses | 158.73 | 165.35 | 52381 |
| Days worked outside the household | 127.31 | 173.33 | 49129 |

Notes: This table reports summary statistics for the primary variables employed in the analysis. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

## Table 2: Reallocation history and tenure security

| | $D_{ivpt}$ (1) | | $D_{ivpt}$ (2) | Land held (3) |
|---|---|---|---|---|
| $DP_{ivpt}^{-1}$ | -.025 | | | .518 |
| | (.014)* | | | (.059)*** |
| $DN_{ivpt}^{-1}$ | -.045 | | | -.638 |
| | (.014)*** | | | (.056)*** |
| $D_{ivpt}^{-1}$ | | | -.037 | |
| | | | (.013)*** | |
| Mean dep. var. | .617 | | .617 | 5.68 |
| Sample | | Reallocation years | | Full sample |
| Obs. | 18083 | | 18083 | 51377 |

Notes: All specifications include village and year fixed effects and standard errors clustered at the village-year level. Specifications in Columns (1) and (2) also include control variables for total land, responsibility land, and ration land held prior to the reallocation; the specification in Column (3) includes linear and quadratic controls for household size. The independent variables in Column (1) and (3) are dummy variables equal to one if a household's land was reallocated positively ($DP_{ivpt}^{-1}$) or negatively ($DN_{ivpt}^{-1}$) in the previous reallocation. The independent variable in Column (2) is a pooled dummy equal to one if the household had its land reallocated in a previous reallocation, $D_{ivpt}^{-1}$. The sample in Columns (1) and (2) is restricted to village-years in which a reallocation is observed; Column (3) employs the full sample. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Table 3: Tenure security and economic outcomes

| | Sown area (1) | Fertilizer (2) | Labor (3) | Structures (4) | Other cap. (5) | Agri. prod. (6) | Hh business (7) | Outside labor (8) |
|---|---|---|---|---|---|---|---|---|
| | | | | **Primary specification** | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .067 | .037 | .074 | .043 | .003 | .070 | -.006 | .002 |
| | (.016)*** | (.020)* | (.020)*** | (.015)*** | (.019) | (.025)*** | (.024) | (.024) |
| $D_{ivpt}^{-1}$ | -.057 | -.033 | -.066 | -.030 | -.022 | -.070 | .010 | .007 |
| | (.014)*** | (.017)* | (.017)*** | (.011)*** | (.014) | (.022)*** | (.018) | (.018) |
| Obs. | 52378 | 51017 | 49699 | 52378 | 52364 | 47425 | 52378 | 52378 |
| | | | | **Panel B: "Split" specification** | | | | |
| $DP_{ivpt}^{-1} \times R_{vpt}$ | .044 | .020 | .042 | .035 | .002 | .057 | .003 | .026 |
| | (.022)** | (.023) | (.023)* | (.018)* | (.026) | (.034)* | (.035) | (.035) |
| $DN_{ivpt}^{-1} \times R_{vpt}$ | .102 | .060 | .103 | .046 | .006 | .073 | -.004 | -.005 |
| | (.020)*** | (.024)** | (.025)*** | (.018)** | (.024) | (.033)** | (.026) | (.026) |
| $DP_{ivpt}^{-1}$ | .0003 | .012 | .008 | -.029 | -.023 | -.032 | -.002 | .021 |
| | (.017) | (.017) | (.017) | (.014)** | (.018) | (.025) | (.020) | (.022) |
| $DN_{ivpt}^{-1}$ | -.104 | -.069 | -.114 | -.032 | -.028 | -.089 | .017 | -.008 |
| | (.018)*** | (.023)*** | (.023)*** | (.014)** | (.019) | (.030)*** | (.020) | (.021) |
| Obs. | 52378 | 51017 | 49699 | 52378 | 52364 | 47425 | 52378 | 52378 |

Notes: All specifications include household and province-year fixed effects, control variables for land, ration land and responsibility land entering linearly and interacted with a reallocation dummy, a dummy variable for reallocations, separate time trends for villages in each decile of overall reallocation frequency, and standard errors clustered at the village-year level. The independent variable in Panel A is the interaction between a pooled dummy equal to one if the household had its land reallocated in a previous reallocation, $D_{ivpt}^{-1}$, and a dummy for a current reallocation $R_{vpt}$. The independent variables in Panel B are the interactions between dummy variables equal to one if a household's land was reallocated positively ($DP_{ivpt}^{-1}$) or negatively ($DN_{ivpt}^{-1}$) in the previous reallocation and $R_{vpt}$. The dependent variables are sown area, fertilizer, agricultural labor, a dummy variable for agricultural structures, tools and animals owned, agricultural output produced and days worked in a non-agricultural business or outside labor; all variables are normalized relative to the mean and standard deviation of the control observations. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Table 4: Tenure security and economic outcomes: Alternate specifications

| | Sown area (1) | Fertilizer (2) | Labor (3) | Structures (4) | Other cap. (5) | Agri. prod. (6) | Hh business (7) | Outside labor (8) |
|---|---|---|---|---|---|---|---|---|
| **Panel A: Primary specification with additional fixed effects and demographic controls** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .070 | .037 | .073 | .044 | -.0005 | .063 | -.008 | -.005 |
| | (.017)*** | (.019)* | (.020)*** | (.015)*** | (.020) | (.024)*** | (.023) | (.023) |
| Obs. | 52187 | 50839 | 49517 | 52187 | 52174 | 47252 | 52187 | 48954 |
| **Panel B: Primary specification with trends by decile of reallocation probability** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .033 | .039 | .042 | .024 | -.034 | .061 | -.039 | -.013 |
| | (.020)* | (.017)** | (.018)** | (.022) | (.028) | (.024)** | (.032) | (.028) |
| Obs. | 52378 | 51017 | 49526 | 52378 | 52364 | 47206 | 52378 | 52378 |
| **Panel C: Primary specification including time lapse fixed effects** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .067 | .036 | .074 | .041 | .004 | .071 | -.002 | .005 |
| | (.016)*** | (.020)* | (.020)*** | (.015)*** | (.019) | (.025)*** | (.024) | (.024) |
| Obs. | 52378 | 51017 | 49699 | 52378 | 52364 | 47425 | 52378 | 49128 |
| **Panel D: Primary specification including households with changes in plot numbers** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .065 | .015 | .048 | .046 | .019 | .043 | -.040 | -.005 |
| | (.019)*** | (.021) | (.022)** | (.018)** | (.022) | (.026) | (.027) | (.028) |
| Obs | 45963 | 44714 | 43527 | 45963 | 45953 | 41446 | 45963 | 42974 |

Notes: All specifications include household and province-year fixed effects, control variables for land, ration land and responsibility land entering linearly and interacted with a reallocation dummy, a dummy variable for reallocations, separate time trends for villages in each decile of overall reallocation frequency, and standard errors clustered at the village-year level. The independent variable is the interaction between a pooled dummy equal to one if the household had its land reallocated in a previous reallocation, $D_{ivpt}^{-1}$, and a dummy for a current reallocation $R_{vpt}$. The dependent variables are sown area, fertilizer, agricultural labor, a dummy variable for agricultural structures, tools and animals owned, and days worked in a non-agricultural business or outside labor; all variables are normalized relative to the control observations. In Panel A, the linear term for reallocations $R_{vpt}$ is replaced with $R_{vpt}$ interacted with province and year fixed effects and linear and quadratic controls for household size are added; in Panel B, time trends for households in each decile of reallocation frequency are added; in Panel C, fixed effects for the reported time lapse between this reallocation and the previous reallocation are added; in Panel D, reallocation dummy is re-defined equal to one for households who report relative changes in the number of plots they hold of at least 50%. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Table 5: Tenure security and economic outcomes: Results for subsamples

| | Sown area | Fertilizer | Labor | Structures | Other cap. | Agri. prod. | Hh business | Outside labor |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| **Panel A: Primary specification excluding households with past demographic instability** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .068 | .033 | .068 | .046 | .008 | .069 | -.019 | .008 |
| | (.018)*** | (.022) | (.021)*** | (.017)*** | (.021) | (.027)** | (.024) | (.024) |
| Obs. | 38894 | 37870 | 36683 | 38894 | 38883 | 34945 | 38894 | 38894 |
| **Panel B: Primary specification excluding shrinking households** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .075 | .036 | .074 | .041 | .009 | .071 | -.006 | .005 |
| | (.016)*** | (.020)* | (.019)*** | (.015)*** | (.021) | (.026)*** | (.025) | (.024) |
| Obs. | 45963 | 44714 | 43379 | 45963 | 45953 | 41230 | 45963 | 45963 |
| **Panel C: Primary specification for households below median of landownership** | | | | | | | | |
| $D_{ivpt}^{-1} \times R_{vpt}$ | .033 | .039 | .042 | .024 | -.034 | .061 | -.039 | -.013 |
| | (.020)* | (.017)** | (.018)** | (.022) | (.028) | (.024)** | (.032) | (.028) |
| Obs. | 19354 | 18449 | 17428 | 19354 | 19346 | 16492 | 19354 | 19354 |

Notes: All specifications include household and province-year fixed effects, control variables for land, ration land and responsibility land entering linearly and interacted with a reallocation dummy, a dummy variable for reallocations, separate time trends for villages in each decile of overall reallocation frequency, and standard errors clustered at the village-year level. The independent variable is the interaction between a pooled dummy equal to one if the household had its land reallocated in a previous reallocation, $D_{ivpt}^{-1}$, and a dummy for a current reallocation $R_{vpt}$. The dependent variables are sown area, fertilizer, agricultural labor, a dummy variable for agricultural structures, tools and animals owned, and days worked in a non-agricultural business or outside labor; all variables are normalized relative to the control observations. In Panel A, the sample is restricted to households with no past history of demographic shifts in reallocation years; in Panel B, the sample is restricted to households that report either constant or increasing household size; in Panel C, it is restricted to households in the lowest tercile of landownership. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Table 6: Selection into reallocations and reallocation intensity

| | Dep. var: Allocation dummy | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| $X_{iv,t-1}$ | .009 | .014 | .009 | -.023 | .009 | .001 | .003 | .003 |
| | (.024) | (.032) | (.036) | (.016) | (.022) | (.022) | (.016) | (.017) |
| $X_{iv,t-1} \times Int_{vpt}$ | .045 | .057 | .036 | .020 | -.037 | .023 | .011 | -.0006 |
| | (.030) | (.040) | (.050) | (.020) | (.029) | (.032) | (.026) | (.026) |
| Covariate | Sown area | Fertilizer | Labor | Structures | Other cap. | Agri. prod. | Hh business | Outside labor |
| Obs. | 11924 | 11536 | 11473 | 11920 | 11924 | 10790 | 11924 | 11924 |

Notes: The dependent variable is a dummy for household inclusion in a reallocation, regressed on the specified covariate at the household level in the year prior and the interaction of this covariate with reallocation intensity $Int_{vpt}$. The covariate is denoted $X_{iv,t-1}$, and the specific variable employed is denoted at the bottom of the table; thus in Column (1), the allocation dummy is regressed on sown area and its interaction with reallocation intensity, in column (2) it is regressed on fertilizer and its interaction with reallocation intensity, etc. All specifications include household and province-year fixed effects, control variables for total land, responsibility land, and ration land held, a dummy for a reallocation and $Int_{vpt}$ entering linearly, and separate time trends for villages in each decile of overall reallocation frequency. $Int_{vpt}$ is defined as the proportion of households reporting land shifts in a given village and year. The specification is estimated only for the years in which a reallocation is identified. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

Table 7: Information as a channel for predicting reallocations

| | Allocation pos. (1) | Allocation neg. (2) | | Allocation pos. (3) | Allocation neg. (4) |
|---|---|---|---|---|---|
| Rice int. | .050 | -.075 | Retail | -.013 | -.003 |
| | (.021)** | (.039)* | | (.018) | (.020) |
| Wheat int. | .015 | -.098 | Fish | -.003 | .028 |
| | (.027) | (.041)** | | (.033) | (.039) |
| Husbandry int. | .010 | .004 | Education | .033 | .016 |
| | (.018) | (.019) | | (.019)* | (.022) |
| Manu. int. | -.053 | .007 | Veteran | .047 | .022 |
| | (.028)* | (.032) | | (.043) | (.044) |
| Trans. int. | -.003 | .090 | Grandparents | -.020 | .011 |
| | (.028) | (.039)** | | (.043) | (.016) |
| Const. int. | .069 | -.010 | Party member | -.038 | .009 |
| | (.044) | (.054) | | (.020)* | (.021) |

Notes: Each cell corresponds to a separate regression including household and province-year fixed effects and controls for land, responsibility land and ration land; standard errors are clustered at the village-year level. The dependent variable is a dummy for positive or negative changes in land in a reallocation as indicated; the independent variable reported is the interaction between a household dummy of interest and the mean of that dummy among government officials' households in that village-year. The dummy variables are indicators for whether the household engages in rice or wheat cultivation, or husbandry, manufacturing, transportation, construction, retail or fishing as a household business, as well as indicators for the presence within the household of a principal laborer with education beyond high school, a veteran of the armed forces, residential grandparents, or a member of the Communist party. Additional independent variables not reported are the household and official dummy entering linearly. The sample is restricted to years in which a reallocation occurs. Asterisks denote significance at the ten, five and one percent level. The data source is the RCRE Household Panel, employing data between 1993 and 2002.

# A Household optimization problem

Assume the household seeks to maximize revenue from agricultural production; the production function is not constrained to be constant returns to scale, and evidence suggests it is in fact decreasing returns to scale. I postulate a standard Cobb-Douglas production function in which there are lagged returns to investment (fertilizer). Note that fertilizer is assumed to be a flow variable: $F_t$ is equal to fertilizer applied in period t only. However, fertilizer applied in period t-1 is allowed to continue to have a direct effect on soil productivity.

$\gamma$ is equal to the probability of reallocation, identical in every period; in the case of a reallocation, lagged returns to fertilizer are lost. Accordingly, the production function and revenue $\pi_i$ take the following form. The contemporaneous return to fertilizer will be denoted $\alpha_C$, and the lagged return to fertilizer denoted $\alpha_F$.[21]

$$Y_t = \tilde{A}_t L_t^{\alpha_L} N_t^{\alpha_N} F_t^{\alpha_C} (1-\gamma) F_{t-1}^{\alpha_F} \tag{19}$$

$$\pi_t = P_t Y_t \tag{20}$$

Assume further that the household optimally chooses $F_t$ and $N_t$, fertilizer and labor inputs, and that land cultivated $L_t$ is a mechanical function of inputs chosen: i.e., when a household optimally uses more inputs, it will cultivate more of its land allotment. I will focus on analyzing the household's optimization problem in period t, assuming there was no reallocation in the last period (t-1). For simplicity of notation, in the subsequent analysis denote $A_t = \tilde{A}_t L_t^{\alpha_L} F_{t-1}^{\alpha_F}$.[22]

Define $\sigma_t$ as the return next period to this period's investment in the absence of a reallocation.

$$\sigma_t = \frac{\partial \pi_{t+1}}{\partial F_t} \tag{21}$$

$$= \alpha_F \tilde{A}_{t+1} L_{t+1}^{\alpha_L} F_t^{\alpha_F - 1} F_{t+1}^{\alpha_C} N_{t+1}^{\alpha_N} \tag{22}$$

The first-order condition governing optimal fertilizer and labor can then be written as follows.

[21] This model could easily be generalized to allow for lagged returns to all agricultural inputs. For simplicity, I focus here on the exposition for the case in which only fertilizer has lagged returns.

[22] If there was a reallocation in period t-1, then $A_t = \tilde{A}_t L_t^{\alpha_L}$. This assumption does not affect the analysis that follows.

$$\frac{w_t}{r_t} = \frac{P_t \alpha_N A_t F_t^{\alpha_C} N_t^{\alpha_N - 1}}{P_t \alpha_C A_t F_t^{\alpha_C - 1} N_t^{\alpha_N} + P_{t+1} \sigma_t (1-\gamma)} \tag{23}$$

$$0 = \frac{P_t \alpha_N A_t F_t^{\alpha_C} N_t^{\alpha_N - 1}}{P_t \alpha_C A_t F_t^{\alpha_C - 1} N_t^{\alpha_N} + P_{t+1} \sigma_t (1-\gamma)} - \frac{w_t}{r_t} \tag{24}$$

Denoting the right-hand side of (24) by $\psi$, the implicit derivative of fertilizer investment with respect to the probability of reallocation can be calculated as $\frac{\partial F_t}{\partial \gamma} = -\frac{\psi'(\gamma)}{\psi'(F_t)}$. Again for ease of notation, define $\lambda_1$ and $\lambda_2$:

$$\lambda_1 = P_t \alpha_N A_t F_t^{\alpha_C} N_t^{\alpha_N - 1} \tag{25}$$

$$\lambda_2 = P_t \alpha_C A_t F_t^{\alpha_C - 1} N_t^{\alpha_N} + P_{t+1} \sigma_t (1-\gamma) \tag{26}$$

The implicit derivative can then be calculated employing the following formula:

$$\begin{aligned} \psi'(\gamma) &= \frac{\lambda_1}{(P_t \alpha_C A_t F_t^{\alpha_C - 1} N_t^{\alpha_N} + P_{t+1} \sigma_t (1-\gamma))^2} \\ \psi'(F) &= \frac{1}{\lambda_2^2} (\lambda_2 P_t \alpha_N \alpha_C A_t F_t^{\alpha_C - 1} N_t^{\alpha_N - 1} \\ &\quad - \lambda_1 P_t \alpha_C (\alpha_C - 1) A_t F_t^{\alpha_C - 2} N_t^{\alpha_N} \\ &\quad - \lambda_1 P_{t+1} (1-\gamma) A_{t+1} \alpha_P (\alpha_F - 1) F_t^{\alpha_F - 2} F_{t+1}^{\alpha_C} N_{t+1}^{\alpha_N}) \end{aligned} \tag{27}$$

Given that both the numerator and denominator are positive, the implicit derivative formula yields that $F'(\gamma) < 0$. This is intuitive: optimal fertilizer investment declines when the probability of reallocation increases.