Earthbound Labor and Transitory Exit from Farming in China

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Abstract:

Smallholder farming remains predominant in Chinese agricultural production, despite massive outflows of rural labor to nonfarm sectors. Although a large number of agricultural households in China rent out the farmland for which they hold contract use rights, most of them still partially or seasonally cultivate the contract land. I collected survey data from 512 households in Southwest China to examine the arrangements of farmland, including abandonment, as households make transitory reductions in cultivation sizes. I develop a theory to explain why households tend to maximize the expected income by reducing cultivation sizes partially and seasonally. The theory centers upon the value of farmland as a safety net and an appreciable asset for agricultural households under imperfect land tenure and limited access to social benefit programs. The non-productive, use-based value of contract land is characterized by a function of simultaneous choices of the cultivation size and farm labor. Flexible reallocation of land use rights helps maximize the expected income, but the inefficiency in labor allocation remains considerable. Using the survey data, I find on-farm productivity of part-time farmers to be significantly lower than the opportunity nonfarm wage rate, implying $45 billion nonfarm earnings to be forgone by agricultural households per year.

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EARTHBOUND LABOR AND TRANSITORY EXIT FROM FARMING IN CHINA

I. INTRODUCTION

Smallholder farming has been the predominant production mode in China, despite massive outflows of rural labor driven by substantially higher returns to nonfarm employment than to farming. Over 200 million agricultural households have been cultivating small and fragmented fields for which they hold contract use rights, but not ownership, under the Household Responsibility System.[1] Smallholder farms in China have been found to be inefficient in allocating capital, land, and labor (Jacoby, Li, and Rozelle, 2002; Ji et al., 2016).

The Chinese government has launched a series of policy reforms since 2003 to incentivize smallholders to cease farming, so that use rights in farmland can be transferred to relatively large farms. By removing restrictions on the reallocation and resettlement of rural labor, the government tries to encourage agricultural households to work and resettle in urban areas and return the contract farmland to local governments. However, not obtaining compensation from giving up the land rights nor enjoying sufficient social benefit programs in cities (Ji et al., 2010), only a small proportion of agricultural households have chosen to end their land contracts and permanently exit from farming.

The government also tries to motivate agricultural households to make transitory transfers of use rights in land, mainly through renting, with their contracts retained. Aware that insecure land tenure (i.e., risks of losing the land rented out) (Kumura et al., 2011) and high transaction costs due to administrative control (Jin and Deininger, 2009) both inhibit agricultural households

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[1] The ownership of farmland in China is complicated. Agricultural households do not own farmland. Village collectives officially own the farmland. However, the central government has legal rights to decide the use of farmland held by any local government (Wen, 2014).

from transferring their use rights, the government has been strengthening the security of land tenure and reducing administrative intervention in land rental markets.

Land rental markets have become considerably more active in recent years, but the consolidation of farmland remains limited. Less than 6% of the contract land was reallocated through rental markets back in 2007, while 30% was by 2014. Yet, from 1986 to 2013, the average farm size increased from 0.61 hectare to merely 0.62 hectare (Tan, Heerink, and Qu, 2006; Ji et al., 2016). Still 85% of Chinese farms are smaller than 0.67 hectare (Development Research Center or DRC, 2016). Together, these smallholder farms cultivate 80% of the nation's farmland.

It turns out that agricultural households actively rearrange their contract land through renting, but do not transfer out all their use rights even on a yearly basis. Many households cultivate part of the contract land (i.e., partial exit from the full cultivation) and/or cultivate for part of a cropping year (i.e., seasonal exit from the full cultivation). These two types of transitory exit from farming result in complex land arrangements season by season, a phenomenon rarely investigated by the literature.

This paper explains the persistence of smallholder farming in China by addressing two questions: 1) why do partial and seasonal reductions in cultivation sizes tend to be optimal for agricultural households, and 2) what are the efficiency implications of transitory reductions in cultivation sizes?

To understand decisions of farmland, I first examine the arrangements of land on a seasonal basis. Prior researchers have been most interested in whether households transfer land and by how much year by year. Many Chinese regions, however, enjoy two to three cropping seasons in a year (Cheung, 1969; Xie and Liu, 2015). Seasonal arrangements, especially temporary abandonment (Ran and Yang, 1985; Zhang, Li, and Song, 2014), of farmland have been noticed but rarely studied. I designed a unique survey to obtain information of seasonal land use from 512 agricultural households in Southwest China. My data show that rearrangements of use rights in land are considerably more active and more complex than the literature depicts. A quarter of the sampled households abandon some contract land seasonally or yearly, while 41% rent in or out contract plots. In the 2016 cropping year, 47% of the households make partial or seasonal reductions in cultivation sizes, but less than 6% reduce their cultivation sizes to zero.

I develop a theoretical model to explain the inclination of agricultural households to exit partially or seasonally from farming in a cropping year, highlighting the roles of imperfect land tenure and limited social benefits granted to Chinese farmers. Although the effect of farmland as a safety net on the allocation of rural labor have been extensively studied (Tao and Xu, 2007), that on land arrangements are not fully explored. Yet, decisions of land and labor are essentially nonseparable for agricultural households. Contract land is not only an insurance to off-farm rural labor, but also generates compensation payments to households when expropriated by the government. Under risks of unemployment and land expropriation, I characterize the non-productive value of land as a safety net and an appreciable asset by a function of simultaneous choices of the cultivation size and farm labor. The non-productive value is use-based and induces households to self-cultivate at least some of their contract land.

Effects of tenure security, land and labor endowments, land-based subsidies, and local wage rates on the allocation of farmland and labor are estimated using my survey data. Exiting partially and seasonally from farming allows more flexibility in resource allocation, resulting in active and complex arrangements of land and labor. The flexibility helps households maximize the expected income, but does not eliminate the inefficiency in land and labor allocation caused by imperfect land tenure and limited social benefits. In my theoretical model, the inefficient allocation of resources is reflected by unequal marginal productivities of farmland and farm labor across households. Empirically, inefficient labor allocation is evidenced by significant wedges between on-farm productivities and off-farm wage rates of part-time farmers, implying $45 billion nonfarm earnings forgone by Chinese agricultural households per year.

This paper contributes to the literature on Chinese agricultural production in three ways. First, it provides the first rigorous examination of complex use of farmland in China today. Second, it develops the first model to rationalize complex transitory exit from farming and characterize the distorted resource allocation by agricultural households under imperfect land tenure and limited access to social benefit programs. Third, it estimates the efficiency loss in labor allocation by smallholder farmers using unique and up-to-date survey data.

Beyond the context of China, the research links to an active literature on the effects of imperfect property rights on economic efficiency and development (Besley, 1995; Besley and Ghatak, 2010). Particularly, my investigation of use-based land rights speaks to studies on how the allocation of resources is distorted by insecure land tenure (Banerjee, Gertler, and Ghatak, 2002; de Janvry et al., 2015). I have brought new modeling techniques and empirical evidence to the discussion.

The next section describes the institutions of farmland and labor faced by agricultural households in China. Limitations of existing models are highlighted. I develop the theory of transitory exit from farming in the third section. Empirical evidence and an estimation of efficiency loss in labor allocation are provided in the fourth section, before I conclude the paper with a discussion on the external validity and the broad relevance of my findings.

II. Institutional Background and the Use of Farmland in China

Farmland has been tightly controlled by the Chinese government. Instead of owning the farmland, agricultural households in China hold contracts of use rights which are thirty-year long. Selling contract land is forbidden, though renting is allowed. Reallocation of land is a major threat to tenure security, especially in early years (Liu, Carter and Yao, 1998). Local governments periodically redistribute land to maintain egalitarian landholdings among households. More recently, land expropriation becomes a top concern over tenure security (Kimura et al., 2011). Local governments expropriate farmland for nonfarm use with limited compensation paid to the victim households. In addition to restrictions on their land rights, agricultural households are entitled to low-level social benefits under the Household Registration or *hukou* System (Chan and Zhang, 1999). Particularly, migrant workers from rural areas have limited access to unemployment insurance, retirement pensions, health care, and government subsidized housing in cities (Xiong, 2015).

Researchers agree that the use of farmland at the household level has been distorted by such policies. A large number of studies examine how restrictions on farmland or on rural labor reduce the efficiency of land allocation by increasing transaction costs of land transfers. They find that enhancing tenure security and removing restrictions on labor markets can increase the efficiency of farmland allocation (Mullan, Grosjean, and Kontoleon, 2011; Deininger et al., 2015). I has also been argued that restrictions on farmland and *hukou* jointly make land rental markets inefficient (Deininger et al., 2014), because the use of farmland and rural labor are not separable.

Imperfect land tenure and limited social benefits granted to agricultural households not only add transaction costs to resource allocation, but also create considerable non-productive value in contract land (Tao and Xu, 2007; Wen, 2014). In particular, limited social insurance that off-farm rural laborers enjoy in cases of layoff and retirement makes farmland a valuable safety net. Compensation obtained after land expropriation by the government, which increases in recent farm outputs and standing crops (Ding, 2007), makes farmland an appreciable asset for the households.

Most prior studies only provide conceptual models regarding the use of farmland. Among a few papers with rigorous modeling, restrictions on land transfers and insecurity of tenure are treated as part of transaction costs in land rental markets (Jin and Deininger, 2009). Households decide how much land to rent in or out faced with varying transaction costs over time and space. The variation in transaction costs due to heterogeneous implementation of land policies is used to estimate the efficiency effects of policy restrictions. This type of models do not incorporate the non-productive value of contract land.

Yang (1997) models the asset value of land as potential rentals or sales generated by transferring land rights, when a household permanently exits from farming (i.e. migrates). However, households could only return the land to village collectives for no compensation upon exiting back in the 1990s, forgoing all the asset value. Yang argues that the loss of asset value adds a one-time cost to permanent exit and discourages long-term migration. In his model, partial or seasonal exit from farming is not considered. The cultivation size either equals zero or the entire contract area. Yang considers the asset value of land as a fixed amount independent from a household's farming activities.

In the context of urban Peru, Field (2007) models the endogenous, non-productive value of an insecure property. A household can allocate labor to work at home and protect its living space from the government's eviction. Household utility increases in home security which is a function of the *guard labor*. Field only considers using labor to protect the property, because the living space is not a production input for an urban household. In the next section, I show that being a production input complicates the non-productive value of farmland for an agricultural household.

III. A THEORY OF TRANSITORY EXIT FROM FARMING

This model derives a theory of transitory exit from farming to examine land and labor allocation by agricultural households under interrelated policy restrictions and specific agro-ecological conditions in China. It explains why an agricultural household tends to make a partial and/or seasonal reduction in the cultivation size over a year. Considering two cropping seasons, the model distinguishes cultivating fewer plots in a year from cultivating for a shorter period as a household makes transitory exit from farming. The use-based, non-productive value of contract land as a safety net and an appreciable asset is characterized by a function of both land and labor inputs. Furthermore, the model considers the division of labor within a household, so that an individual's working full-time off the farm is distinguished from a household's exiting from farming.

I aim to elucidate the intuition in the following, which rigorous proof is available upon request. I assume that an agricultural household maximizes the expected income over two periods. In each period, it decides how much land to cultivate and allocates its labor to farm and nonfarm sectors. Assume that decisions made in one period have no persistent effects, which allows modeling household decisions as a sequence of income-maximizing problems in independent two-period windows. The two periods refer to two consecutive cropping years, each containing two cropping seasons.

A household has contract land of a physical size equal to $\bar{s}$ and the potential arable size over two seasons is $2\bar{s}$. The amount of land cultivated during a period, s, is the summation of cultivation sizes in two seasons, s_1 and s_2. I consider no land market for now, so that abandoning land temporarily is the only option if any contract land is not cultivated by a household. I do not incorporate the market of farm labor, both because hiring farm labor is uncommon in China (Wang et al., 2016; in my dataset), and because the assumption simplifies my model without changing the core insights. Hiring farm labor or renting land is mathematically equivalent as long as only one market is missing (Eswaran and Kotwal, 1986). The effects of land markets are discussed later in this section.

A minimum input of labor, $l_{min}(s)$, is required to generate a positive farm output. The minimum amount increases in the cultivation size, because more labor is needed as a setup cost under fixed technologies of A. I assume that the farm output depends only on the use of two complementary inputs, land (s) and farm labor (l^f). The price of the farm output is normalized to one, so that the income function can be expressed below.

$$\begin{cases} F(s, l^f|A) = 0, if\ l^f < l_{min}(s) \\ F(s, l^f|A\ ) > 0, if\ l^f \geq l_{min}(s) \end{cases}$$

Requiring a minimum labor input allows the corner solution, $l^f = 0$, to be optimal for a household, even when $\frac{\partial F(s,l^f|A)}{\partial l^f}|_{l^f=l_{min}(s)}$ is infinitely large. To guarantee the second-order conditions under the Kuhn-Tucker Theorem, I require $F(s, l^f|A)$ to be twice differentiable and strictly concave in s and l^f for $l^f \geq l_{min}(s)$.

Assume that a household faces three risks, namely, risks of layoff regarding the nonfarm labor, land reallocation over the uncultivated land, and land expropriation over all the contract land. Contract land functions as a safety net for laid off labor and generates cash compensation to the household if expropriation takes place. Risks may be realized at the start of period two, creating different states. Each state corresponds to a specific endowment of farmland and compensation from land expropriation, both of which depend on the use of land and labor in period one.

In each period, the income consists of farm and nonfarm earnings which depend on the allocation of land and labor. The expected income over two periods can be expressed as

$\pi_1 + \delta \sum_i p_i \pi_{2,i}$,

where π_1 is the first-period income and $\pi_{2,i}$ is the second period income in state i. The parameter $p_i \in [0,1)$ refers to the probability of state i, while $\delta \in (0,1)$ is the time discount factor.

The marginal return to cultivating the contract land in period one contains two parts: the increment of farm income in period one and the increment of expected value of land as a safety net and an asset in period two. Similarly, the marginal return to farm labor in period one includes the increment of farm income in period one and that of expected compensation for expropriation in period two. Therefore, a household optimizes the use of land and labor by considering the tradeoff between farm and nonfarm earnings in the first period and that between production and non-productive earnings across periods. The optimal allocation of land and labor in the first period is acquired by maximizing the first-period income plus the expected non-productive value of contract land denoted by $V(s, l^f | \delta)$.

To allow a household with heterogeneous laborers to have full-time or part-term farmers and full-time nonfarm workers simultaneously, I classify labor into two types. For each household with multiple laborers, the ones with a comparative advantage in nonfarm sectors are the *H-type*, while the others are the *L-type*. For each unit of farm income forgone, an H-type laborer earns relatively more off-farm. An H-type laborer earns an off-farm wage of $w_H(\overline{m}_H)$, while an L-type laborer earns a lower wage of $w_L(\overline{m}_L)$. Parameters $\overline{m}_H$ and $\overline{m}_L$ are the predetermined human capital for H-type and L-type labor, respectively. In each season, a household is endowed with $\bar{l} - \overline{l_L}$ units of H-type and $\overline{l_L}$ units of L-type labor.

A household would only leave the L-type labor on the farm, when it is marginally beneficial to cultivate. Thus, the question of whether a household completely exits from farming in a year translates to whether the L-type labor cultivates any land. This transformation makes economic sense, especially because one or two L-type laborers in a household should be able to fully utilize the small amount of contract land. A household maximizes income by allocating land and the L-type labor, while the H-type labor only works off-farm until the L-type labor is used up.

I express the objective function in (1), leaving out the H-type's full-time nonfarm earnings of $\sum_{j=1}^{2} w_{H,j}\left(\bar{l} - \overline{l_L}\right)$. The wage rate in season j, $j \in \{1,2\}$, is measured relative to the normalized price of the farm output. Other parameters and the subscript for a household are not written out. No labor is idle under the strictly increasing objective function. The four choice variables are nonnegative. The Lagrange multipliers for season j are μ_j, ν_j and θ_j for the first to the third set of constraints, respectively. Let $l_{min}(s_j) < \overline{l_L}$ for all $s_j \leq \bar{s}$. The function of non-production value,$V\left(s, l_L^f\right)$, is determined by all the four choice variables.

$$\max_{\left\{s_j, l_{L,j}^f\right\}} E(\Pi) = \sum_{j=1}^{2} \left[w_{L,j}\left(\overline{l_L} - l_{L,j}^f\right) + F\left(s_j, l_{L,j}^f\right)\right] + V\left(s, l_L^f\right) \quad (1)$$

Subject to,

$l_{L,j}^f \leq \overline{l_L}, j \in \{1,2\}$;

$s_j \leq \bar{s}, j \in \{1,2\}$;

$l_{L,j}^f \geq l_{min}(s_j), j \in \{1,2\}$.

III.A. Exit Decisions and the Inefficient Resource Allocation

I now solve for exit decisions of a household in a cropping year. With no land market, three exit options are available. A household can choose to 1) fully cultivate its contract land (i.e., no exit or $s_1 = s_2 = \bar{s}$), 2) not cultivate any contract land (i.e., complete exit or $s_1 = s_2 = 0$), or

3) cultivate part of the contract land and/or cultivate in only one season (i.e., incomplete exit or $0 < s_1 + s_2 < 2\bar{s}$).

The non-productive value of contract land would be zero if no risk or restrictive policy existed, because land would not function as a safety net for laid-off labor or an appreciable asset under expropriation. Among households that would have exited completely if the non-productive value of land did not exist or were exogenous, the positive and use-based non-productive value may incentivize some of them to farm by increasing the marginal return to self-cultivation. The non-productive value depends on a set of exogenous factors, including risks, land-based subsidies, and land and labor endowments of a household.[1] The larger $V(s, l_L^f)$ or the larger the marginal increase of $V(s, l_L^f)$ in the cultivation size, the more likely that a household draws back from exiting completely. For households that would have exited incompletely under no risk nor restriction, their cultivation sizes increase as $V(s, l_L^f)$ becomes positive and endogenous.

If the optimal cultivation size is in the range of $(0, 2\bar{s})$, a household maximizes its income by exiting incompletely, or by abandoning some arable area, in exchange for off-farm earnings. Compared to no exit and complete exit, incomplete exit allows for more flexibility in the allocation of resources. As an interior solution, incomplete exit tends to be optimal for households who maximize the expected income under risks in land use rights and off-farm labor markets.

Regarding $s \in (0, 2\bar{s})$, how cultivation sizes differ over two seasons depends on relative seasonal wage rates to farm income functions. For example, if $w_{L,1} < w_{L,2}$, a household tends to farm only in the first season and allocate all the labor to nonfarm sectors in season two (i.e., a

[1] Land-based subsidies to a household refer to subsidies based on the size of contract land. The subsidies are direct cash transfers from the government to contract-holding households, aiming to encourage the protection of farmland, the production of grains, and the use of high-quality agricultural inputs.

seasonal exit from farming). If $w_{L,1} = w_{L,2}$, the household may choose to farm the same size of land in both seasons (i.e., a partial exit from farming). In the places covered by my survey, productivity of farm labor is likely to be significantly lower during the winter, making relative wage rates in wintertime high. Not surprising, agricultural households reduce the cultivation size more in winter by renting or abandoning land.

At corner solutions of $l_{L,j}^f = \overline{l_L}$, the H-type labor may return to the field. Therefore, shocks that change the non-productive value of land and, consequently, the optimal $l_{L,j}^f$ also determine whether the H-type labor works full-time in nonfarm sectors. For example, when the risk of expropriation increases due to a new real estate project near the village, the increased $V\left(s, l_L^f\right)$ may draw H-type migrant workers back to the farm. As $V\left(s, l_L^f\right)$ varies, an H-type laborer migrates and returns to local nonfarm markets accordingly. This insight speaks to temporary migration which is widely observed in China (Mullan, Grosjean, and Kontoleon, 2011).

The first-order-conditions (FOCs) of cultivated farmland and farm labor in season j are:

$$\frac{\partial \pi}{\partial s_j} = \frac{\partial F\left(s_j, l_{L,j}^f\right)}{\partial s_j} + \frac{\partial V\left(s, l_L^f\right)}{\partial s_j} - \nu_j = 0;$$

$$\frac{\partial \pi}{\partial l_{L,j}^f} = \frac{\partial F\left(s_j, l_{L,j}^f\right)}{\partial l_{L,j}^f} - w_{L,j} + \frac{\partial V\left(s, l_L^f\right)}{\partial l_{L,j}^f} - \mu_j + \theta_j = 0.$$

Because the non-productive value is endogenous and depends on household land and labor endowments, marginal productivities of land are unequal across households, which suggests an inefficient allocation of land. A household equalizes the marginal farm income, plus the marginal non-productive value of $\frac{\partial V\left(s, l_L^f\right)}{\partial s_j}$, to the shadow market price of land. The marginal productivity of cultivated land is lower than the shadow market value and indicates an overuse of farmland.

On-farm marginal productivities of farm labor are also unequal across households and lower than the corresponding nonfarm wage rates of $w_{L,j}$. Standard household models suggest that marginal productivities may be lower than market wage rates only for full-time farmers (Jacoby, 1993; Skoufias, 1994), assuming zero transaction costs. But I find that wedges also exist between on-farm productivities and nonfarm wage rates for part-time farmers.

Hypothesis 1*: On-farm marginal productivities of part-time farmers are lower than their opportunity market nonfarm wage rates*.

Considering transitory land transfers, a key is that land rented-in adds no non-productive value to the lessee-household. Use $I(s_j) = \min(s_j, \bar{s})$ to represent the size of land carrying non-productive value in each period. The relative land rental in season *j* equals $R_j(q)$ and increases in q which is the quality (e.g., sizes and locations) of rented plots. Again, the function, $V\left(I(s), l_L^f\right)$, is determined by all the four choice variables in equation (2). For households renting in land, wedges between the marginal productivities and rentals of land can be mitigated. For households renting out land or staying in autarky, however, wedges remain. Land productivities still differ among households.

$$\max_{\{s_j, l_{L,j}^f\}} E(\Pi) = \sum_{j=1}^{2} \left[w_{L,j}\left(\overline{l_L} - l_{L,j}^f\right) + F\left(s_j, l_{L,j}^f\right) + R_j(\bar{s} - s_j) \right] + V\left(I(s), l_L^f\right) \tag{2}$$

Subject to,

$l_{L,j}^f \leq \overline{l_L}, j \in \{1,2\};$

$l_{L,j}^f \geq l_{min}(s_j), j \in \{1,2\}.$

III.B. Comparative Statics and Further Interpretation

Using the implicit function theorem, I derive the comparative statics from functions (1) and (2). Marginal changes of the optimal cultivation size and farm labor are in the same directions.

I find that increased non-productive value of land induces a household to cultivate a larger area, put more labor into farming, and not exit completely from farming. To be specific, lower risks on land contracts encourage a household to reduce the cultivation size. A larger size of contract land, larger labor endowment, and more land-based subsidies imply higher non-productive value of land and encourage a household to cultivate more land.

Decreased opportunity cost of self-cultivation leads to larger cultivation sizes and more farm labor at the optimum, too. Lower land rentals imply lower returns to renting out land and encourage hence households to enlarge cultivation sizes. Lower human capital implies lower opportunity nonfarm wages and induces more labor to be put on the farm. The effect of higher local wages is two-sided. When local wages increase, local labor works more off-farm. In the meantime, relative wage rates of migrant workers fall. Instead of making all its labor migrant workers, leaving some to do part-time farming may become optimal for a household, especially if the non-productive value is considerable.

Furthermore, I argue that a household with clearer division of labor types tends to cultivate more land. Intuitively, think of a household with both young and senior laborers. The elderly are the L-type with a clear comparative advantage in farming. As the L-type labor farms for full-time and cultivates a relatively large area, the H-type labor can focus on off-farm jobs. In contrast, another household has the same number laborers who are all middle-aged. The laborers tend to have similar and high nonfarm wage rates. Given the same non-productive value of land, laborers from the second household are more likely to do part-time farming on a smaller area or not cultivate at all.

Hypothesis 2-1: *When the contract land is larger or more fragmented, tenure security is lower, local wages or land-based subsidies are higher, the endowment of labor is larger, or the division of labor types is clearer, a household tends to increase the cultivation size.*

Hypothesis 2-2: *Labor, especially the L-type, tends to spend more time on the farm if the contract land is larger or more fragmented, tenure security is lower, local wages and land-based subsidies are lower, or being endowed with less human capital. Clearer the division of labor types is in a household, the more the L-type labor farms and the H-type labor works off-farm.*

IV. EMPIRICAL EVIDENCE

To test the hypotheses derived from the theory, I need information of land use season by season. In this section, I first explain how I can obtain the information using a unique survey design. Based on the survey data, I estimate the causal effects of tenure security, land and labor endowments, land-based subsidies, and local nonfarm wages on farmland and labor decisions. Evidence of the inefficient use of labor is provided. Specifically, I find empirical evidence of wedges between on-farm productivities and nonfarm wage rates for part-time farmers. The magnitude of efficiency loss in labor allocation is estimated. I also provide evidence of a property trap effect by showing that labor-to-land ratios at the individual level increase in the fragmentation of contract land.

IV.A. Design of the Survey

Previous household surveys conducted in China typically asked the interviewees to report how land was used in a year. Information collected in this way tends to miss informal and seasonal arrangements of land, both because of the ambiguity of questions and the unwillingness of farmers to report politically sensitive activities. In particular, abandonment of contract land is officially forbidden in China.

An indirect way of collecting information of seasonal land use centers upon crops grown by households. Based on the knowledge of agricultural production in the sampled villages, I grouped crops into 11 categories. The categories include rice, wheat, barley, rapeseed, corn, soybeans and/or sweet potatoes, summer vegetables (e.g., cucumbers and eggplants), winter vegetables (e.g., garlic and cabbage), annual herbs and fruits, perennial herbs and fruits, and, finally, trees and horticulture. Rice, corn, soybeans, sweet potatoes, and summer vegetables are grown during late May to October. Wheat, barley, rapeseed, and winter vegetables are grown from November to early May. Other crops occupy the land all the year. Interviewees reported how much land was used for each crop category and if there was intercropping, which allows me to infer the accurate cultivation size season by season.

IV.B. Overview of the Sample Data

The province of Sichuan in Southwest China has a population of 83 million, half of which live in rural areas, and covers a territory of 486 thousand square. The province is a major agricultural producer and has been included in many nation-wide surveys on agricultural issues in China (Jin and Deininger, 2009; Deininger et al., 2014; Ji et al., 2016).

In the summer of 2016, I surveyed 512 households from 14 villages in Sichuan Province. The four most recent cropping seasons were covered. The two seasons lasting from May 2014 to May 2015 form the 2015 cropping year, while the two from May 2015 to May 2016 belong to the 2016 cropping year. Sampled households are from four counties around the economic center of Sichuan, the capital city of Chengdu. The counties are endowed with three typical types of local economies regarding the economic conditions of farming and nonfarm sectors, making the sample representative of the province. Details of the survey are available upon request.

On average, each household is entitled to 4.1 *mu*, or 0.7 acre, of contract. Six *mu* equals one acre, and fifteen *mu* is one hectare. The contract land is divided into seven plots, so that the average plot size is only 0.1 acre. In the 2016 cropping year, 68% of the households rearranged the contract land. Over 79% of the rearrangements were partial or seasonal rent-outs or abandonment of contract land. A quarter of the households abandoned contract land, leaving 11% of the arable area uncultivated over the year. Only 6% of the households exited completely in the 2016 cropping year, while 47% exited in a variety of incomplete ways.

I exclude the twelve observations of large farms (i.e., farms cultivating more than 30 *mu* or 5 acres in at least one season in a year) in the following analysis, because assumptions in the theoretical model only apply to smallholders. For instance, the assumptions of not hiring labor and not using mechanical power are not appropriate for relatively large farms.

IV.C. Tests on Land and Labor Decisions

Land and labor decisions depend on three groups of determinants under Hypotheses 2-1 and 2-2. First, a household tends to reduce the cultivation size and farm labor if the safety net and asset value of contract land decreases. I use land and labor endowments of a household to proxy the non-productive value of land. Land-based subsidies, which increase in the size of contract land, also add to the asset value of contract land. The non-productive value also increases in risks over a household's land contract. I use a dummy variable, *land certificate*, as a proxy for the security of a land contract. Holding a certificate protects a household from land reallocation, though not from expropriation, and pushes down the non-productive value.

Second, when the opportunity cost of self-cultivation increases, a household is more likely to reduce the cultivation size and farm labor. Land fragmentation, measured by the average size of contract plots, is employed as a proxy for land rentals. A larger average plot size implies higher land rentals to give up if self-cultivating the contract land. Higher local wages are expected to lower the opportunity cost of part-time farming relative to migration and encourages farming a larger area.

Third, if the division of labor types is clearer, a household tends to increase the cultivation size and farm labor. I use the number of generations as the proxy for the division of labor types. The more generations in a household, clearer the division between labor types is for a given number of laborers. All these explanatory variables are measured at the household level, except for the local wage rate measured at the village level.

At the household level, I consider four dependent variables: the cultivation size and the numbers of full-time farmers, part-time farmers, and full-time nonfarm workers. The econometric model is specified below. The subscripts $i, j,$ and t indicate households, villages, and years.

$$y_{ijt} = \sigma_0 + \sigma_1 H_{ijt} + \sigma_2 V_{jt} + \tau_t + \gamma_j + \mu_{ijt} \quad (3)$$

Because most variation in explanatory variables is inter-household, fixed-effect or first-difference models are not employed. Otherwise, the estimates would be largely driven by a few households that experienced major changes within the two consecutive years and would not characterize economic patterns of the majority. Instead, I employ a set of household variables to control for potential household characteristics that simultaneously affect the explanatory and the dependent variables. The control variables include the numbers of high school graduates, young males and females in a household, the size of housing land that a household owns and so on.[1]

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[1] The size of housing land is of particular importance as a control variable. Housing prices in urban China has been tens of times of the annual income of rural laborers (Wen, 2014). Having a house in the home village, but cannot afford a living place in cities, may be a key reason as to why an agricultural household does not completely exit from farming. The size of housing land is the proxy for the value of a village house.

Household-level explanatory and control variables are denoted as H_{ijt} in equation (3). The vector V_{jt} includes the local wage rate and village-level control variables. Summary statistics of all the dependent and explanatory variables are found in Table AI. Year fixed effect, τ_t, and village fixed effects, γ_j, are included. Error terms, μ_{ijt}, are clustered at the village level to account for potential covariance among households in the same village and serial correlation in errors within households.

Some dependent variables contain nontrivial numbers of zero observations (see *% zero obs.* in Table I). Tobit models can be used to generate unbiased estimates of average marginal effects of the explanatory variables. I report marginal effects estimated by Tobit models in columns (1) to (4) of Table I. The marginal effects of a variable are computed at zero if it is a dummy variable and at the mean otherwise. Ultimately, I rely on the signs of estimates to determine whether the hypotheses hold.

Holding a land certificate, a household reduces its cultivation size by 0.5 *mu*. Simultaneously, it decreases the number of part-time farmers in exchange for more full-time nonfarm workers. Every five households who have land certificates can turn one part-time farmer to work as a full-time nonfarm worker. As shown in column (1), a household only cultivates another 0.4 *mu* for every additional *mu* of contract land, suggesting a positive impact of land endowment on the probability of taking incomplete exit. On average, a household endowed with one more laborer cultivates 0.8 more *mu* of land. Simultaneously, it has larger numbers of full-time farmers and full-time nonfarm workers. The number of full-time farmers goes up with the cultivation size. When subsidies increase by 10,000 RMB or 1,600 USD for a given contract size, the household cultivates an increment of 15 *mu* of farmland and uses one more full-time farmer.

Comparing a household with an average plot size of 0.7 *mu* (i.e., the mean of the average plot size) to a household with that equal to 1.7 *mu*, the latter on average has a cultivation size smaller by 0.9 *mu*. A larger average plot size also allows part-time farmers to switch to full-time nonfarm jobs. Every ten households endowed with one more generation have five more full-time nonfarm workers and cultivate six more *mu* of farmland. The simultaneous increases in farm and nonfarm labor support the hypothesis of more generations allowing for shaper intra-household division of labor.

TABLE I

LAND AND LABOR DECISIONS OF HOUSEHOLDS

Household level	(1)	(2)	(3)	(4)
Dep. Var.	CulS	#FTF	#PTF	#FTW
Land	-0.45	0.09	-0.12	0.21**
certificate (1, yes)	(0.31)	(0.11)	(0.16)	(0.09)
Size	0.37***	0.02**	0.01	-0.02*
contract land	(0.06)	(0.01)	(0.01)	(0.01)
Number	0.80***	0.54***	-0.07	0.21***
laborers	(0.21)	(0.04)	(0.06)	(0.05)
Land-based	1.49***	0.10	0.02	-0.02
subsidies (1,000 RMB)	(0.35)	(0.13)	(0.09)	(0.08)
Avg. size	-0.89**	-0.09	-0.44***	0.33***
contract plots	(0.42)	(0.11)	(0.09)	(0.07)
Local	2.79**	-0.13	0.39***	0.26**
skilled wage (100 RMB/day)	(1.11)	(0.11)	(0.13)	(0.12)
Number	0.64**	0.10	0.02	0.50***
generations	(0.28)	(0.10)	(0.10)	(0.07)
% zero obs.	5.7%	16.7%	59.8%	51.3%
Household controls	Yes	Yes	Yes	Yes
Village controls	Yes	Yes	Yes	Yes
No. Obs.	1,006	1,006	1,006	1,006
Pseudo R^2	0.11	0.15	0.10	0.27

Note. Standard errors are in parentheses; *** implies p<0.01, ** p<0.05, * p<0.1. Tobit models are used. Marginal effects are reported. *CulS* stands for the cultivation size, *#FTF* for the number of full-time farmers, *#PTF* for part-time farmers, and *#FTW* for full-time nonfarm workers. Household and village level explanatory variables listed in Table AI are included in the regressions. All regressions include year fixed effects and village fixed effects. Standard errors are clustered the village level.

IV.D. Wedges between On-Farm Productivity and Nonfarm Wage Rates

Recall the first hypothesis, a wedge exists between the on-farm productivity of a part-time farmer and the opportunity nonfarm wage rate. To perform a test, I need to first estimate the unobserved productivity of farm labor. I closely follow the estimation strategy introduced by Jacoby (1993) and Skoufias (1994). Similar as what Jacoby (1993) finds, three quarters of the households in my sample raise livestock. To ensure that the results are not driven by outliers, I exclude observations of large farms as defined earlier and large ranches that produce livestock worth over 100,000 RMB (i.e., 15,380 USD) per year. The mean of livestock value in the truncated sample is 3,845 RMB which is worth 45% of the average annual crop sales.

I define the dependent variable as the value of home production, HpV_{ijt}, which is the summation of crop and livestock production value in a year. The variable, HpD_{ijt}, is the number of home production days, while HpC_{ijt} is the total expenditure on seeds, fertilizers, chemicals, irrigation, and animal feed. The vector, X_{ijt}, represents a group of household-level control variables, including the size of contract land and the number of laborers. A double-log specification is employed and expressed below.

$$\ln(HpV_{ijt}) = b_0 + b_1 \ln(CulS_{ijt}) + b_2 \ln(HpD_{ijt}) + b_3 \ln(HpC_{ijt}) + b_4 X_{ijt} + \tau_t + \gamma_j + u_{ijt}$$

Following Jacoby (1993), I add a constant of one to all the input variables before taking the logarithm. A linear prediction of the home-production value (i.e., $\widehat{HpV_{ijt}}$) is made accordingly. By assuming an equal on-farm productivity of all the farm laborers in a household, I estimate the monthly shadow wage as the shadow production value of a farm laborer in thirty days as $\left[\frac{\widehat{HpV_{ijt}}\times\ \widehat{b_2}}{HpD_{ijt}}\right]\times 30$.

The estimated coefficient of home-production days, HpD_{ijt}, is $\widehat{b_2}$ and measures the percentage contribution of HpD_{ijt} to the predicted home-production value. The average estimated monthly wages in RMB for part-time farmers is 303 with a standard deviation of 588, while the mean of observed monthly nonfarm wages equals 2014 with a standard deviation of 1315. The wedge between on-farm and off-farm labor productivities is substantial.

TABLE II

WEDGES BETWEEN SHADOW ON-FARM PRODUCTIVITIES AND MARKET WAGE RATES

Individual level	(1)	(2)	(3)
Dep. Var.	Estimated shadow wage rates		First-stage
Off-farm wage rates	0.01	0.05	-33.94***
	(0.02)	(0.11)	(4.37)
Constant	282.03***	195.07	3637.86***
	(53.86)	(205.28)	(232.89)
No. Obs.	602	602	602
R^2	0.001	-0.009	0.080

Note. Large farms and large ranches are excluded. Standard errors are in parentheses; *** implies p<0.01, ** p<0.05, * p<0.1. OLS model is used in column (1) and IV-2SLS is used in column (2). Column (3) reports the first-stage outcome using the IV, the age of a part-time farmer, for an observed nonfarm wage rate.

Taking the shadow wage rate as the dependent variable (sw_{pijt}), I test the null hypothesis that the coefficient of the observed nonfarm wage rate (w_{pijt}) equals one and the constant equals zero using the econometric model below. Year and village fixed effects as well as all the subscripts are the same as the ones in equation (3). Subscript p indicates individuals.

$$sw_{pijt} = \alpha + \beta w_{pijt} + \tau_t + \gamma_j + u_{pijt}$$

If the null hypothesis is not rejected, no wedge exists. I use the age of a part-time farmer as the instrumental variable (IV) for a laborer's off-farm wage rate. Estimates are reported in Table II. It turns out that the null hypothesis, $(\alpha, \beta) = (0,1)$, is rejected at 1% level using an F-test either under an OLS or IV-2SLS model. Transaction costs and discreteness in working time can result in similar, yet perhaps not so wide, a wedge between on-farm and off-farm productivities. Even if allowing α to be nonzero, the estimated β is not close to one, though weakly positive.

At least part of this wedge between shadow farm wages and market nonfarm wage rates can be attributed to the non-productive value of land. Assuming transaction costs cause half of the wedge, I make a back-of-envelope calculation of the shadow non-productive value of land, or nonfarm earnings forgone, for part-time farmers. The mean of nonfarm earnings forgone is $\frac{2014-303}{6.5} \times 3 \times \frac{1}{2} \approx$ \$395 per year for a part-time farmer, given that a part-time farmer spends 84 days, or three months, on home production on average. Though, note that the standard deviation of the point estimate is as wide as \$330.

In my sample, a households has 0.6 part-time farmer on average, and 98% of the households are small-scale. Regarding the 18.3 million active agricultural households in Sichuan Province, the total forgone nonfarm earnings are worth \$395×18.3 million×98%×0.6=\$4.3 billion per year or 8.3% of 2015 agricultural GDP in Sichuan. Similarly, I can do the calculation for 200.2 million farms in China, knowing that 95% are smaller than 30 *mu* (DRC, 2016). Thus, the annual forgone nonfarm earnings equal \$45.1 billion or 5.1% of 2015 agricultural GDP in China.

The estimated loss is substantial, yet may only be a lower bound of the forgone nonfarm earnings to agricultural households. It is likely to be a lower bound, both because part-time farmers should earn higher off-farm wage rates if spending more time in nonfarm sectors, and because the forgone off-farm earnings by current full-time farmers, who could do nonfarm jobs had the non-productive value of land not existed, are not yet accounted for.

V. Concluding Remarks

Although land markets have become significantly more active in recent years, smallholder farms remain the predominant production mode in China. Numerous agricultural households are observed to reduce cultivation sizes seasonally and partially from the entire contract areas within each cropping year. But the causes and implications of incomplete and transitory exit have not been thoroughly understood.

I collected unique survey data which uncovered complex rearrangements of contract land, including renting and abandonment, conducted by agricultural households in China. I developed a theory to explain the persistence of smallholder farming by elucidating why households tend to find it optimal to reduce cultivation sizes partially and seasonally. In the model, I incorporated cropping seasonality and characterized the safety net and asset value of contract land as a function of simultaneous choices of the cultivation size and farm labor. Using the survey data, I estimated the effects of tenure security, land and labor endowments, land-based subsidies, and local wage rates on land and labor decisions. Empirical evidence was provided for the inefficient allocation of labor. Nonfarm earnings forgone by part-time farmers in China can be $45 billion per year.

My empirical findings rely upon the agro-ecological conditions in Sichuan Province and should be applied to other parts of China with caution. Nevertheless, the theory of transitory exit sheds light upon the flexibility and complexity of land allocation in a fairly general sense: whenever multiple cropping seasons are available or farmland is fragmented, seasonal and partial arrangements of farmland should be taken into account.

More generally, when policy restrictions constrain one channel of resource allocation, for instance, selling land, various side channels tend to emerge to restore an equilibrium (Cheung, 1969). Flexible arrangements of farmland through exiting incompletely is one such example from rural China. Active and complex reallocation of resources maximizes household income in this setting, but does not eliminate the considerable inefficiency caused by imperfect land tenure and limited social benefits granted to agricultural households.

Active land transfers are not sufficient for enlarging farm sizes in China. Transitory, especially incomplete, exit from farming may actually impede the effective consolidation of farmland. Relatively large farming units may not be able to maximize economies of scale, because they cannot merge or standardize numerous small plots rented from a large number of households and under short-term renting contracts. Unless households systematically make complete and stable exit from farming, effective land consolidation cannot be realized in China.

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TABLE AI: SUMMARY STATISTICS OF DEPENDENT AND EXPLANATORY VARIABLES

Variables	Type	Mean	Std. dev.	Min	Max
Dependent variables					
Household-level					
Cultivation size (*mu*)	Continuous	5.8	4.1	0	29.6
No. full-time farmers	Integer	1.3	0.8	0	4
No. part-time farmers	Integer	0.6	0.9	0	4
No. full-time workers	Integer	0.8	1.0	0	6
Home production value (1,000 RMB)	Continuous	12.3	16.7	0.0	180.5
Explanatory variables					
Household-level (H_{ijt})					
No. generations	Integer	2.2	0.8	1	3
No. laborers	Integer	3.0	1.1	0	6
No. dependents	Integer	0.8	0.9	0	5
No. high school graduates	Integer	0.5	0.7	0	3
No. middle school graduates	Integer	1.0	1.0	0	4
No. young males (17-50)	Integer	0.8	0.7	0	4
No. young females (17-45)	Integer	0.6	0.6	0	2
Size of housing land (*mu*)	Continuous	0.4	0.3	0.04	3.0
Size of contract land (*mu*)	Continuous	8.2	4.3	0	30.0
Avg. size of contract plots (*mu*)	Continuous	0.7	0.4	0.04	4.2
% paddy of contract land	Percentage	80.1	24.5	12.5	100
Land certificate	Dummy	0.2	0.4	0	1
Land reallocated	Dummy	0.01	0.1	0	1
Land expropriated	Dummy	0.1	0.3	0	1
Land-based subsides (RMB)	Continuous	473.1	449.2	0	3300.0
Village-level (V_{jt})					
Local skilled wage (RMB/day)	Integer	174.2	36.2	120	260
Local unskilled wage (RMB/day)	Integer	99.2	21.6	60	150
No. local firm employees	Integer	50.9	78.3	0	334
% land cultivated by large farms	Percentage	21.2	15.8	0	49
% seniors	Percentage	20.2	4.1	15.1	28.4
% households left the village	Percentage	12.1	13.6	0.5	49.8
% tilled by machines	Percentage	85.8	26.5	15	100
% transplanted by machines	Percentage	12.1	11.4	0	36
% harvested by machines	Percentage	67.1	44.0	0	100

TABLE AI

(CONTINUED)

Note. The number of observations for household variables equals 1012, except for the variables of *avg. size of contract plots* and *% paddy of contract land*. Their number of observations is 1006, because three households are entitled to no contract land in both years. The number of observations for *home production value* is 997, because both large farm and large ranches are excluded. The definition of large ranches is found in Section IV.D. The dummy variable *land certificate* equals one if a household holds a land certificate by the beginning of a cropping year. The dummy variable *land reallocated (expropriated)* equal one if the household has experienced land reallocation (expropriation) within the recent ten years. *Size of contract land* is the total arable size of contract land in a year and is twice as large as its physical size. The variable *No. local firm employees* is the number of employees hired by local nonfarm firms. The variable *% land cultivated by large farms* is the percentage of village farmland that is cultivated by large farms. The variable *% seniors* is the proportion of village popular that is more than 60 years old. The variable *% households left* is proportion of registered households that have left the village. The last three variables are the percentages of village farmland that is tilled, transplanted, and harvested by machines, respectively. Village-level variables are weighted by numbers of households in the sample when means and standard deviations are computed. The denotation of H_{ijt} and V_{jt} are defined in equation (3).