Earthbound Labor and Incomplete Exit from Farming in China:
Multiple Distortions and Nonseparable Decisions

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Selected Paper prepared for presentation at the 2017 Agricultural & Applied Economics Association Annual Meeting, Chicago, Illinois, July 30-August 1

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July 2017

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Abstract

Smallholder farming remains the predominant production mode in China, despite continuous urbanization and economic reforms. Previous research considers inactive land markets as a direct cause, but has not counted for seasonal and partial land use. I conducted an innovative survey to reveal active seasonal and partial land arrangements and highlight incomplete exit from farming. I develop a two-period household model to explain why peasant households prefer incomplete exit under distorted incentives and nonseparable factor decisions. Under risks of land reallocation and expropriation, the use-based value of contract land induces households to retain labor with comparative advantages in farming on the farm and causes inefficient allocation of land and labor at the household and the individual levels. A wedge exists between productivity of full-time and part-time farming labor and the opportunity nonfarm wage rate, which cannot be eliminated by providing perfect factor markets. Tenure security, land quality, and factor markets are central determinants of households' exit decisions and their use of land and labor. Subsidies that aim to enhance welfare or promote advanced technologies are found to be an impediment to complete exit. Using an instrumental variable, I estimate how a household adjusts labor allocation as the cultivation size changes.

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1. Introduction

The persistence of smallholder farming has been an intensively discussed feature of China's transforming agricultural sector. Since the establishment of Household Responsibility System back in 1984, peasant households have held onto the medium-term contracts of use rights, instead of ownership, with village collectives and cultivated their titled filed.[1] The titled land is typically small and consist several discontinuous plots. Besides, contract of use rights is insecure due to reallocation and expropriation by local governments. Smallholder farming has been found to cause efficiency loss in land and labor use (Hare, 1999; Jin and Deininger, 2009) as well as in land-based agricultural investment (Jacoby, Li, and Rozelle, 2002).

The Chinese government has made efforts to consolidate farmland in hope to mitigate efficiency loss in the agricultural sector. Since 2003, the government has launched a series of policy reforms to strengthen tenure security, encourage transfers of contract land, and allow peasant households to exit from the agricultural sector and resettle in urban areas. The effects of reforms, however, seem quite disappointing. Little evidence has been found for systematic consolidation of farmland in most Chinese provinces. From 1986 to 2013, the percentage of Chinese population living in urban areas has gone up from 24.5% to 53.7%, while the average cultivation size per household only increased from the originally assigned size of 0.61 ha to 0.62 ha (Tan, Heerink, and Qu, 2006; Ji et al., 2016). By 2013, nearly half of cultivation sizes were less than 0.5 ha and only 20% of farmland was cultivated by farms larger than 2 ha.

Two direct causes to limited land consolidation are identified by the literature. First, land markets are not sufficiently active (Kimura et al., 2011). Second, smallholder households are not exiting from farming (Deininger et al., 2014; Wen, 2014). Empirical studies find land markets continue to be inactive, even after the 2003 Rural Land Contracting Law officially permitted renting contract land (Deininger and Jin, 2005; Yan et al., 2014; Ito et al., 2016). The participation rate of peasant households in land markets is only ten to twenty percent, and rental contracts are largely kinship-based, informal, and short-term (Otsuka, 2007; Jin and Deininger, 2009). Resettlement from rural to urban areas is also rare (Ji, Liu, and Zhong, 2010).

Remaining institutional restrictions are considered the central impediment to land transfers and smallholder exits. On one hand, imperfect property rights in land hinder efficient land reallocations among heterogeneous agricultural producers (Ji et al., 2016). On the other hand, the Household Registration System (i.e., the *hukou* System) in China maintains a rigid segmentation between rural and urban economies and societies. The *hukou* System is an ultimate reason why permanent relocation of labor from rural to urban areas cannot take place (Hare, 1999).

The standard insights into the agricultural sector of China fall short in two crucial aspects. First, previous analysis tends to have an over-simplistic view of how land is arranged by smallholders. Not accounting for land fragmentation, cropping seasonality, and informal land

[1] The ongoing contract of farmland came into effect back in 1998 and is 30-year long.

arrangements results in overseeing important complexity of land use.[1] Whether explicitly stated, earlier researchers focus on year-round, formal, and relatively easily observed land transfers. Actually, a large number of peasants have been conducting seasonal and partial arrangements of contract land, including land transfers and abandonment (Tan, 2010; Zhang, Li, and Song, 2014). Many of such informal and interim land arrangements can only be revealed by studying cropping behaviors by season. Surprisingly little research has been done to depict the facts or to figure out the reasons and consequences of such land arrangements.

Furthermore, most early analysis does not incorporate the interdependence between institutional restrictions or the nonseparability between decisions of factor use. Scholars may emphasize the importance of one policy distortion, either that in land or in labor institution, in explaining the slow consolidation of farmland and disregard the other (Yang, 1997; Yao, 2003; Kung and Bai, 2011), or they try to identify causality between two nonseparable factor decisions by directly regressing one on the other (Knight and Song, 2003; Deininger and Jin, 2005). Unfortunately, not fully taking care of the interdependence between distorted incentives and between factor decisions, prior research has not developed the most appropriate theoretical models nor econometric tests.

The first contribution of this research is reexamine land arrangements by smallholders in China. I designed an innovative survey to reveal seasonal and partial features of land use, including transfers and abandonment, and find land rearrangements to be active and complex. The complex land arrangements point out that exit from farming should not be simplified as a binary choice; there is an interesting continuum between exiting and staying. Instead of asking why smallholders are not exiting from farming, a perhaps more enlightening and important question is that why they prefer to exit incompletely. The second contribution is the two-period household model. I demonstrate how a peasant household optimizes the use of land and labor endowments under dependent distorted incentives and explain why incomplete exit from farming is preferred by peasant households in China. I estimate effects of key determinants to land and labor decisions using primary survey data that I collected from Southwest China. Tenure security, land quality, household human capital, government subsidies, and local land and labor markets impose critical impacts on exit decisions of households. In particular, land-based subsidies aiming to enhance peasant welfare or promote labor-saving technologies turn out to impede complete exit from farming, which indicates conflicting policy effects in China's agricultural sector.

Although this research focuses on China, it relates to the continuing discussion on impacts of use-based property rights in developing countries (Basu, 1986; Field, 2007; de Janvry et al., 2015). Furthermore, incomplete exit can have far-reaching effects on the entire Chinese economy. Because the model suggests potential labor can be supplied if mitigating institutional restrictions, the research also speaks to the discussion on whether China has depleted cheap labor supply to nonfarm sectors (Golley and Meng, 2011).

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[1] Based on the main staples grown, there are rice and wheat seasons in South China and corn and wheat seasons in North China. For some provinces along the south coast of China, three cropping seasons, of which two are rice seasons, are available. The rice or corn season starts in late April or early May and ends by October, while the wheat season typically over the rest of the year. The sample province, Sichuan in Southwest China, has diverse cropping conditions over its territory (Zhou, 1993). Yet the rice-wheat rotation is predominant and practiced by all sample villages.

2. Land and Labor Decisions of Peasant Households in China

To understand the persistence of smallholder farming is to understand land and labor decisions of Chinese peasants and peasant households.

Although markets for most agricultural inputs are unrestricted in China, the markets of two key factors, land and labor, have been under heavy policy constraints (Carter and Yao, 2002). With a complex history since the establishment of People's Republic of China in 1949, the land institution has always been an intriguing and important aspect of China's agricultural sector and received interest from scholars (Liu and Yang, 1990; Dong, 1996; Brandt et al., 2002; de Brauw et al., 2004). Selling contract land is still forbidden, although renting is allowed. Labor relocation and allocation has not been free from restrictions, either (Chan and Zhang, 1999). After non-price rationing on off-farm employment was removed, the *hukou* System remains as an internal passport system and restricts rural laborers from settling in cities (Xiong, 2015). The restriction of resettlement, fortunately, started to be relaxed since 2014.

There has been extensive discussion on the relationships between land and labor institutions and use of the two factors. Although scholars agree that imperfect property rights in land and restrictions on rural labor impose negative impacts on land and labor markets, they disagree over what the negative impacts are and whether institutional restrictions should be jointly considered. I classify the existing research into four analytical structures according to a two-by-two framework. The framework is constructed based upon how a study calibrates the relationship between multiple distortions and multiple factor decisions.

Let me first introduce the two dimensions of the framework. The first dimension is the set of institutional restrictions considered. A research either studies restrictions in one institution, for example the land institution, or considers restrictions of both institutions. The second dimension is the factor decisions to be explained. A research can investigate decisions of either or both land and labor. The two choices in each dimension translate to four analytical structures for any prior research to fall into.

Let me be specific. The structure adopted most is to investigate how restrictions of one institution, land or labor institution, affect the use of one factor, taking variables of the other factor market as exogenous. For example, researchers study how insecure tenure increases costs of land transfers and impedes the development of land markets, or the efficiency and equity implications of tenure insecurity (Yao, 2000a; Kimura et al., 2011). Carter and Yao (2002) provide a classic econometrics model and show evidence that less restricted land transfer markets can equalize labor productivity among peasants and reduce the Chayanov's effect of *self-exploitation*. However, Kung (2002) and Deininger and Jin (2005) do not find the negative impact of insecure tenure on land transfers to be statistically significant. Taking nonfarm labor markets as given, Deininger and Jin (2005) use panel data of more than one thousand households in three agricultural provinces in China and show that tenure security is not a sufficient condition to developing active markets of land transfers. The authors argue that security of land tenure is determined by the overall economic development of a region. As non-agricultural market activities grow and standardize, there would be strong demand for strengthening property rights in land and transfers of land between private parties are also expected to increase. They continue to argue that land transfers tend to be most beneficial to households with lower land endowments and productive laborers.

Also under this analytical structure, scholars try to identify the linkage between security of land tenure and sectoral labor reallocation, especially in the form of long-term migration. Contract land functions as a safety net and can encourage peasants to seek for riskier and better paid jobs in more distant places, especially given that government provides little social insurance to the migrants and laid-offs (Yao, 2000b; Wang, Weaver, and You, 2013). However, when tenure is not secure, the safety-net function of land becomes an institutional barrier to migration (Rozelle et al., 1999; de Brauw, Huang, and Rozelle, 2002). Mullan, Grosjean, and Kontoleon (2011) provide a theoretical model to show that insecurity of tenure can put positive or negative effects on migration, when there is no land market. Lohmar (2000) finds that in villages with more active reallocation of land by local governments, peasant households are less likely to participate in nonfarm labor markets and allocate more labor on the farm. Jin and Deininger (2009) make a similar point based on a nation-wide household survey dataset in the period of 2001 to 2004. Yan, Bauer, and Huo (2014) support this argument and point out that households with more laborers are more likely to send migrants. Some research studies the direct impacts of *hukou* restrictions on reallocation of rural labor. Despite rapid growth of per capital GDP, *hukou* restrictions deteriorate the problem of under-urbanization in China (Chan, 2010) and hinder optimizing inter-sector labor placement, causing serious misallocation of labor (Zhao, 1999; Cai and Du, 2011).

Two other analytical structures have been used. Scholars can study one set of restrictions and both factor decisions, or both sets of restrictions on one factor. For instance, one strand of literature argues that insecure land tenure deters migration and also leaves land rental markets imperfect (Deininger et al., 2015). Different from the majority of descriptive and empirical arguments, Yang (1997) provides an influential theoretical model based on the fact that peasants must return contract land to the village collective and is unable to cash in the implicit value of land if permanently leaving agriculture. In his household model, giving up land is treated as a fixed cost to long-term migration. However, Yang does not allow land transfers nor does he consider potential appreciation of farmland for nonagricultural use. He argues that land markets, of any form, simply did not exist or were extremely thin because of the poorly defined property rights in land back then. Land transfer markets in China today throw serious doubts on this key assumption made by Yang. Nevertheless, Yang acquires the insight that permanent migration is costly and hence a household tends to split its labor in farm and nonfarm sectors. He concludes that the development of land sales markets alone would remove the institutional constraints on migration, ignoring the restrictions on labor allocation.

On the other hand, researchers try to unearth how policies jointly affect use of a factor by peasant households. For instance, Yang and Zhou (1999) argue that restrictions in land and labor markets cause temporary migration. They blame the industry-oriented strategy of economic development as the main reason why there exist stark gaps between rural and urban incomes, in labor productivity, and segmentation between rural and urban economies. Hare (1999) finds that seasonal migration is a direct consequence of the rigid *hukou* combined with other imperfect factor markets. He emphasizes that the risk of land expropriation and restricted transferability of land leave a household dependent on its own labor for farming. When mechanization in agricultural production is still low, migrants even have to travel back home to farm during peak seasons. Therefore, many households frequently move labor cross sectors and regions. Hare's argument is supported by a household survey conducted in 1995, but no theoretical model is provided.

The most comprehensive analytical structure considers both sets of institutional restrictions and both factor decisions, highlighting the interdependence of key elements. A series of recent articles have made one insight clear that risks of land tenure and residential restrictions jointly create the strong reliance on the contract farmland, discourage participation in land markets, and alter labor allocations between farm and nonfarm sectors (Ji et al., 2010; Wen, 2014). Land reallocation and *hukou* restrictions are undeniably linked and have significant impacts on economic outcomes in a number of markets (Deininger et al., 2014). Deininger and co-authors do not, however, provide much empirical evidence to support this argument. Tao and Xu's research (2007) has so far been best in constructing an integrated analytical framework to study the linked restrictions and decision of land and labor. They start with the big-picture question of how high-level urbanization can be achieved in China by converting agricultural land to industrial use and transforming farmers to nonfarm workers. Insecure land tenure due to reallocation and expropriation by local governments has made peasant households, who earn most incomes from nonfarm sectors, to be unwilling and unable to give up the contract farmland. As a result, relatively little land has been released for large commercial farms to rent in, especially for a long-term. Unfortunately, the authors do not construct a theoretical model and only provide summary statistics to support the arguments.

Overall, previous literature has discussed intensively how institutional restrictions have affected land and labor use by peasant households. As a general anticipation, exit from farming should accelerate and the formation of large-scale farms follow once tenure security is guaranteed and residential restrictions are removed (Deininger et al., 2015). However, even after land certificates have been granted and restrictions on *hukou* relaxed in recent several years (Xiong, 2015), limited evidence has been found for systematic land consolidation.

3. A Household Model of Incomplete Exit from Farming

Before presenting empirical evidence on the ubiquity of seasonal and partial rearrangements of contract land, the model develops a theory of incomplete exit to rationalize the preference for incomplete exit at the household level. The model throws light upon choices of types of incomplete exit, either reducing the cultivation size or shortening the cultivation period. In the short-run, misallocation of land and labor translates into a wedge between the productivity of on-farm labor and market wage rates for both full-time and part-time labor. In the long-term, farmland consolidation and structural changes of agricultural production tend to be impeded.

In the baseline model, I assume away factor markets and consider discrete land use to illustrate the intuition. I then incorporate land markets and continuous farming scales. I study land and labor decisions at the individual as well as the household level. The model acquires insight beyond what determinants affect households' and individuals' land and labor decisions in maximizing household income. It proceeds to understand how the land and labor decisions are balanced in maximizing the income. I explain why even providing perfect land or labor markets may not eliminate efficiency loss due to incomplete exit. Several hypotheses and implications are drawn and different types of inefficiency are defined. Because mechanical power is not incorporated, the model does not characterize large-scale commercial farms and should only be used to explain economic behavior of smallholder farms.

Incomplete Exit from Farming

Let us define an incomplete farm exit, temporally ignoring livestock feeding activities that should be considered under a broader definition of *peasant farming*. Prior researchers consider exit as binary choice, either a household exits or not. Whether explicitly stated, they are likely to have permanent exit in mind. In other words, they focus on exit that result not only in stopping farming the contract land, but also resettlement of the households in towns and cities. This requires transferring out the contract land for long-term or returning the contract land to village collectives. Scholars, not too surprisingly, find that permanent exit from farming is rare due to high and increasing housing costs in urban areas (Wu et al., 2016), and difficult, due to residential restrictions (Ji et al., 2010).

However, smallholders exit and return to field from time to time, without giving up the contract land nor resettling to urban areas (Yang, 1997). In fact, it has been noticed for long that seasonal and partial transfers and abandonment of land exist in a number of provinces in China (Ran and Yang, 1985; Tan, 2010; Zhang, Li, and Song, 2014). Such observations indicate that exit of smallholders takes various forms and can happen on a yearly and even seasonal basis. In a sense, permanent exit is to exit throughout a year for all the years after a particular timing. To understand permanent exit, we should first understand exit from farming in each cropping year, which is more widely observed.

Three exit options for a given year are available. In addition to completely exiting and cultivating all the contract field, a complex continuum exists between the two extreme options. The distinction between complete and incomplete exit is crucial to characterizing flexible rearrangements of contract land by smallholders. More empirical evidence of the exit-stay continuum is provided in Section 4. For this moment, let me define in words complete and incomplete exit from farming according to land and labor use over a year.

The logic is straightforward. If all the contract land is cultivated throughout the year by household labor, no exit takes place or full cultivation is observed. When a household completely exits from farming, no contract land is cultivated using household labor. The contract land may be rented out, fallowed, or abandoned. The household may or may not allocate labor in nonfarm sectors. Any seasonal and partial land arrangements in-between the full cultivation and complete exit belong to incomplete exit from farming. To be specific, a household that exits incompletely cultivates some but not all the contract land or not over the entire year.

Distortion-Induced Value of Contract Land

It is widely known that village leaders in China have the power to reallocate land from households with fewer laborers to those with more, considering renting out or abandoning land as a signal of labor shortage (Liu et al., 1998; Kung, 2002; Deininger et al., 2014). On the other hand, farmland is faced with an increasing risk of being converted to nonfarm property for more profitable use and urbanization, which only grants limited compensation to peasants to whom the land is titled (Zhou, 2004; Lohmar, 2006; Ji et al., 2010). Under the new regulations on land requisition by local governments, the amount of compensation to peasants depends partly on recent production values of the land (Ding, 2007). Therefore, farming more intensively and growing valuable crops on one’s own contract farm can help claim more compensation.

In China, as well as in many other developing economies, losing farmland not only means forgoing an appreciable asset, but also giving up an important safety net to peasant households. Chinese peasants, in particular, have limited social benefits and insurances provided by the government under the dualistic socio-economic system (Carter and Yao, 2002). Especially for households that have farmer-workers who do not have any government-funded unemployment insurance against recessions in nonfarm sectors or retirement, the safety net value is fairly indispensable (Yao, 2000b). In the model, I consider both the safety net and the appreciable asset value of land. Any additional value attached to the contract land, such as its value as a collateral, strengthens the conclusions that I shall derive.

Baseline Model: Discrete Choices

Let me now define the cost of exit from farming, or equivalently the forgone value of self-cultivation, in a given year. I refer to this particular value as the property value of contract land, or V_p, in the rest of this article. In the baseline setup, I assume that abandoning land as the only alternative if land is not cultivated by a household. Nor do I consider markets of farming labor, both because it is not common in China (Wang et al., 2016) nor in my dataset, and because it simplifies calculation without changing the core insights. I further assume that only household labor affects the risk of land redistribution and not the risk of expropriation. Hired farming labor does not affect the value of contract land, though it affects the value of agricultural outputs.

I setup a two-period household model and assume that decisions of factors have no persistent effects from period to period. This assumption of time-separability allows modeling household decision making as a sequence of two-period income-maximizing problems and making analysis within each two-period window. In the context of sample data, a period refers to one cropping year that contains two cropping seasons. In the context of the sample data, one cropping season lasts from early May to September (i.e., the summer season) and the other from October to April (i.e., the winter season). The first and second periods refer to two consecutive cropping years. A representative household has a size of contract land equal $\bar{s}$ and its potential size for cultivation over two seasons is simply $2\bar{s}$.

Regarding labor endowment, over 90% of the sampled households have at least two adult laborers. Endowed with multiple laborers has important implications on labor allocation. I argue that any household with more than one laborer can classify two types of labor. Specifically, laborers with comparative advantages in farming are referred to as the *L-type* laborers, while those with comparative advantages off-farm are the *H-type*. In other words, for each unit of farming income, an H-type laborer earns an off-farm wage of w_H which is larger than the wage of $w_L$earned by the L-type labor. The H-type labor tends to be young, male, and relatively more educated. Assume that a household has $\overline{l_H}$ and $\overline{l_L}$ units of labor endowment for the two types of labor per cropping season, respectively.

To maximize the total expected income in two periods, a household has to allocate its land and labor across four cropping seasons. Assume that lay-off, land redistribution, and land expropriation by local governments may take place by the end of the first cropping year. The three risks are formalized as follows. First, the probability of losing one's nonfarm job by period two is $\rho \in (0,1)$. The probability is composed by systematic and idiosyncratic shocks. The former refers to business recessions and the latter relates to demographic features of a nonfarm laborer. I ignore idiosyncratic shocks and treat ρ as a systematic shock of unemployment for simplicity.

The second and third risks relate to the contract land. Suppose that the risk of land redistribution, or the risk of failing to reclaim land, is imposed on contract land not cultivated by the household. This risk of μ is in the domain of $(0,1)$ and exogenously determined at the village level. In addition, there is a risk of land expropriation of $\eta \in (0,1)$. If expropriation happens, I assume that all the contract land of a household shall be taken away regardless of the cultivation size. A victim household would be compensated for losing its farmland. The compensation is computed both based on the quality of land (e.g., soil type, size, and location) and on a rolling average of its crop value which is a function of the cultivation size and on-farm labor over a short period of time. For simplicity, I express the compensation as $C(\bar{s}) + C(s, l^f)$, where l^f refers to the total amount of on-farm labor in the first period. Require that redistribution of land does not happen simultaneously with expropriation of land for any household.

One or two of the three shocks may realize before the second period. It turns out that six possible scenarios exist with different probabilities. Referring to the proof in Appendix 1, I claim here that the property value of land can be expressed as in (1), where d is the discount factor that is positive and smaller than one. The value of land is added to the objective expected income function directly as a function of land and labor variables with a list of parameters. The variable s represents the cultivation size at the household level. The amount of labor put in farming is denoted as l_H^f and l_L^f for H-type and L-type labor, respectively.

$$V_p(s, l_H^f, l_L^f) \equiv V_p(s, l_H^f, l_L^f \mid \overline{l_H}, \overline{l_L}, \mu, \eta, \rho, d) \qquad (1)$$

Note that s is the summation of cropping sizes over the two seasons in each period. Ignore seasonality in land and crop quality and assume all plots to be homogenous. If a household has one unit of land, for instance one *mu* or a sixth of an acre, and cultivates the land for two seasons, then $s = 1 + 1 = 2$ units

To incorporate fragmentation of land, I assume that the representative household has two identical unit sized plots. In each year, the cultivation size of each plot is $s^1, s^2 \in \{0,1,2\}$. If cultivating both plots in both seasons, then $s = s^1 + s^2 = 4$ and no exit happens. If a complete exit happens, the cultivation size falls to zero. A cultivation size of one, two, or three indicates incomplete exit from farming. All the possible cultivation sizes over one cropping year are summarized in the following table.

[Tab 1]

Not considering difference in cropping conditions over seasons, I can reduce the number of land arrangements in Table 1 to the five basic cases in Table 2.

[Tab 2]

As a common requirement in functions of agricultural production, a minimum labor input and some package of capital inputs is required to generate positive harvest (Eswaran and Kotwal, 1986; Yang, 1997). I require an increasing amount of minimum labor input in the cultivation size (i.e., l_{min}^s), because more labor is needed as a fixed set-up cost to take care of a large area of field given fixed technologies. The minimum labor input serves to make the income function segmented mathematically. Assume perfect markets for farming outputs and that farming income, $F(s, l^f)$, depends on investment of land and labor only with price of agricultural outputs normalized to one. The income function can be expressed as below.

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

Require $F(s, l^f)$ to be concave and of differentiability class C^2 in land and labor as long as $l^f \geq l_{min}^s$. Labor and land are assumed to be complements in cropping.

$$\frac{\partial F}{\partial s} \geq 0,\ \frac{\partial F}{\partial l^f} \geq 0, \frac{\partial^2 F}{\partial s^2} < 0,\ \frac{\partial^2 F}{\partial l^{f2}} < 0, \frac{\partial^2 F}{\partial l^f \partial s} > 0, if\ l^f \geq l_{min}^s. \qquad (2)$$

Now comes the core assumption of the model. I do not assign a fixed wage rate to a laborer as classic household models do. Instead, I require that time devoted to farming, whose proxy is the cultivation size, determines wage rates a laborer is to earn. More intuitively, one's wage rate decreases in his time spent on the farm. It is the case, because if one does no farming, he is able to provide relatively continuous and full-time labor to potential employers. Continuity and intensity of labor are features that employers offer high payments for, given one's human capital. Working more continuously off-farm also means a wider market to seek for jobs, because he does not have to travel back to the field from time to time Being able to migrate is especially rewarding in a place where local nonfarm economy is under-developed and few well-paid jobs are available. Therefore, I express the wage rate for a laborer as $w_k(s|M_k)$ where $k \in \{H, L\}$ for the two types of labor and M_k stands for his human capital. One's human capital is predetermined for any period. I assume that $\frac{\partial w_k(s|M_k)}{\partial s} < 0$s. I shall show that this assumption is supported by empirical evidence and leads to crucial insight of efficiency effects of incomplete exit in Section 4.

In the case of complete exit (i.e., $s = 0$), a household has the maximized expected income expressed in (3). Because we do not consider leisure and the objective function is nonconvex, all the household labor in two seasons, namely $2\overline{l_H}$ and $2\overline{l_L}$, is put into nonfarm sectors. For simplicity, I do not write out parameters in the following functions and drop the household subscript of i.

$$\pi_0 = 2w_H(0)\overline{l_H} + 2w_L(0)\overline{l_L}. \quad (3)$$

If choosing a positive s, the normalized total income includes the property value of the contract land. Recalling equation (1) for the property value of land, we can derive (4). I refer to the maximized expected income for the household as π_s^*. The superscript of j refers to seasons and s_j refers to the cultivation size in season j.

$$\max_{\{s_j, l_H^{fj}, l_L^{fj}\}} \pi_s = w_H(s_1)(\overline{l_H} - l_H^{f1}) + w_L(s_1)(\overline{l_L} - l_L^{f1}) + F(s_1, l_H^{f1}, l_L^{f1})$$

$$+w_H(s_2)(\overline{l_H} - l_H^{f2}) + w_L(s_2)(\overline{l_L} - l_L^{f2}) + F(s_2, l_H^{f2}, l_L^{f2}) + V_p(s, l_H^f, l_L^f).$$

Subject to,

$$l_H^{fj} \leq \overline{l_H};\ l_L^{fj} \leq \overline{l_L},\ j \in \{1,2\};$$

$$l_H^{fj} + l_L^{fj} \geq l_{min}^{s_j},\ j \in \{1,2\};$$

$$s_j \in \{0,1,2\},\ j \in \{1,2\};$$

$$s = s_1 + s_2 \in \{1,2,3,4\}. \quad (4)$$

The five cases in Table 2 correspond to five pairs of s_j. In particular, case 2 refers to the pair of $s_1 = s_2 = 1$. Without loss of generality, assume that land is cultivated in the first season for case 3 and 4. Case 3 hence has $s_1 = 2$ and $s_2 = 0$, while case 4 has $s_1 = 2$ and $s_2 = 1$. The household calculates $\Delta\pi_s = \pi_0 - \pi_s^*$ to decide which exit mode to choose. When $\Delta\pi_s > 0$ for all $s \in \{1,2,3,4\}$, the household exits completely. It would not do so, if at least one $\Delta\pi_s < 0$. The household also compares between incomplete exits by computing $\Delta\pi_{s,s'} = \pi_s^* - \pi_{s'}^*$.

Throughout this article, I call the maximized income that a household makes the global maximum income and corresponding land and labor choices as the globally optimal factor decisions. I call each π_s^* as a local maximum income and corresponding land and labor choices as locally optimal factor decisions. I will refer to these terms in Section 4 as well.

Visualize the Model

For local optimal decisions, the trade-off is between cultivating more contract land for farming income and property value of land and exiting more completely for nonfarm income. If the household finds it marginally beneficial to keep labor on the farm, it should leave the L-type labor on the farm until it runs out of the L-type labor. Therefore, the question of whether a household completely exits from farming translates to whether the L-type labor can do so.

For the transformation of the objective function to be valid, an implicit assumption is that the household's contract land requires no more than the labor with comparative advantages in farming to fully utilize. This assumption is reasonable, because the average contract farmland for a household is as small as 0.6 ha nation-wide (Ji et al., 2016) and only 0.3 ha for the sampled households.[1] In the model, I argue that the H-type labor earns whatever he can off-farm (i.e., $2w_H(0)\overline{l_H}$), while the household maximizes income by allocating the L-type labor on and off-farm. I can hence simplify (4) as follows.

$$\max_{\{s_j, l_L^{fj}\}} \pi_s = w_L(s_1)\left(\overline{l_L} - l_L^{f1}\right) + F\left(s_1, l_L^{f1}\right) + w_L(s_2)\left(\overline{l_L} - l_L^{f2}\right) + F\left(s_2, l_L^{f2}\right) + V_p\left(s, l_L^f\right).$$

Subject to,

$l_L^{fj} \leq \overline{l_L},\ j \in \{1,2\};$

$l_L^{fj} \geq l_{min}^{s_j},\ j \in \{1,2\};$

$s_j \in \{0,1,2\},\ j \in \{1,2\};$

$s = s_1 + s_2 \in \{1,2,3,4\}.$ (5)

Let us visualize this model and see how L-type labor is allocated between farming and nonfarm activities. In Figure 1-1, I show the comparison between complete exit, partial exit (case 2), and full cultivation (case 5) from the L-type labor's perspective. In all the three cases, sizes of cultivation are equal across seasons.

To simplify the graphical exposition, ignore on-farm labor in V_p, so that the property value of land increases in s. The vertical axis measures the total expected income made by the L-type labor. The property value of cultivating s is captured by the jump by the farm income function (i.e., F_L^s) at $l_L^f = l_{min}^s$. That a larger effective size requires more fixed labor input is reflected by a larger value of l_{min}^s as s increases. The L-type labor earns a full-time nonfarm wage rate of w_L^0. The labor earns $w_L^s < w_L^0$ if he cultivates an area of s. The optimal amount of labor in farming is found where w_L^s is tangent to F_L^s and happens to be l_L^f in the figure.

As long as $l_L^f < \overline{l_L}$, part-time farming is preferred by the L-type labor. If w_L^s is small enough, l_L^f may be equal to l_L and full-time farming is preferred. If the optimal amount of farm

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[1] The nation-wide average is larger than the sample average, because the national survey includes a province in Northeast China that has much more per capita land endowment compared with any inland provinces.

labor is even larger than l_L, which is the case if w_L^2 is sufficiently low, some land may be rented in or some H-type labor may switch back to farming. The household income at $s = 0$ equals the segment π_L^0 and at $s = 2$ equals the segment π_L^2. In Figure 1-1,π_L^0 is the largest and hence the household exits completely. Nevertheless, in Figure 1-2, a household has π_2^* to be the largest and hence incomplete exit is preferred.

More interestingly, we can compare seasonal and partial exits using similar graphs. Let us focus on the cases where $s = 2$. If $s_1 = 1$ and $s_2 = 1$, it is a partial exit. If $s_1 = 2$ and $s_2 = 0$, it is a seasonal exit. I introduce superscript pt and ss to indicate partial and seasonal exits, respectively. In the first season (Figure 1-3), partial exit corresponds to a higher nonfarm wage rate (i.e., $w_L^{pt1} > w_L^{ss1}$) but lower productivity of on-farm labor. In the next season (Figure 1-4), the situation is reversed for the two cases so that $w_L^{pt2} < w_L^{ss2}$.

In each season, find the optimal farm labor input for as l_{pt}^{fj} and l_{ss}^{fj}, respectively. Combine income from the two seasons, we can compare the total incomes in Figure 1-5. In this illustrative scenario, the total income in season one is higher when $s_1 = 1$ and $s_2 = 1$. However, after summing up income from both seasons, $s_1 = 2$ and $s_2 = 0$ is the highest. In terms of the global optimum, however, neither outperforms the income earned from exiting completely or $s = 0$.

Extend the Baseline Model: Considering Land Transfers

So far, I have not considered labor or land markets. I have pointed out that hiring on-farm labor is not common and does not change risks of land redistribution nor expropriation. In regard of affecting the property value of contract land, therefore, hiring farm labor is essentially equivalent to reducing the cultivation size. Considering either labor or land market suffices examining the role of factor markets.

Let us now incorporate land transfers. The key point here is that plots transferred-in have no property value to the household. Denote the indicator function for transferring in land as $I(2\bar{s} - s)$. This function generates zero if $2\bar{s} \geq s$ and one if $2\bar{s} < s$. Assume zero transactions cost in land markets and rewrite (5) to (6). Denote the land rental rate per season by R.

$$\max_{\{s_j, l_L^{fj}\}} \pi_i = w_L(s_1)(\overline{l_L} - l_L^{f1}) + F(s_1, l_L^{f1}) + w_L(s_2)(\overline{l_L} - l_L^{f2}) + F(s_2, l_L^{f2})$$

$$+R(s - 2\bar{s}) + V_p(s + I(2\bar{s} - s), l_L^f),$$

$$l_L^{fj} \leq \overline{l_L},\ j \in \{1,2\};$$

$$l_L^{fj} \geq l_{min}^{s_j},\ j \in \{1,2\}. \tag{6}$$

I visualize the cases of $s_1 = s_2 = 1$, $s = 4$ and $s > 4$ in Figure 1-6. Note that under the assumption of zero transactions cost and identical plots, the household would never rent out its contract land and simultaneously rent in land. When the cultivation size in a period increases beyond $\bar{s}$, V_p stays unchanged in s. The derivation of (6) is provided in Appendix 1.

Extend the Baseline Model: Continuous Farming Scale

I have demonstrated how global and local optima are found if choices of land are discrete. This setup forbids us from solving for comparative statics that provide useful and important insight.

I now consider s as a continuous variable within $(0, \bar{s})$ and rates change continuously vary in s. I can set up the Lagrange function based on (5).

$$\max_{\{s_j, l_L^{fj}\}} \pi_s$$

$$= w_L(s_1)\left(\overline{l_L} - l_L^{f1}\right) + F\left(s_1, l_L^{f1}\right) + w_L(s_2)\left(\overline{l_L} - l_L^{f2}\right) + F\left(s_2, l_L^{f2}\right) + V_p\left(s, l_L^f\right).$$

Subject to,

$$l_L^{fj} \leq \overline{l_L},\ j \in \{1,2\} \qquad (\gamma_{1j});$$

$$l_L^{fj} \geq l_{min}^{s_j},\ j \in \{1,2\} \qquad (\gamma_{2j});$$

$$s_j \leq \bar{s} \qquad (\theta_j);$$

The first-order-necessary-conditions (FOCs) of land and labor decisions are specified as follows, assuming that the Hessian matrix is negative semi-definite and symmetric.

$$\frac{\partial \pi_s}{\partial s_j} = \frac{\partial F^j}{\partial s_j} + \frac{\partial w_L^j}{\partial s_j}\left(\overline{l_L} - l_L^{fj}\right) + \frac{\partial V_p}{\partial s_j} - \frac{\partial l_{min}^{s_j}}{\partial s_j}\gamma_{2j} - \theta_j = 0;$$

$$\frac{\partial \pi_s}{\partial l_L^{fj}} = \frac{\partial F^j}{\partial l_L^{fj}} - w_L^j + \frac{\partial V_p}{\partial l_L^{fj}} + \gamma_{1j} - \gamma_{2j} = 0.$$

The absence of separability in factor decisions can be immediately read from the FOCs. Assume interior solutions, we can easily verify that $\frac{\partial s_j}{\partial \mu} > 0$ and $\frac{\partial l_L^{fj}}{\partial \mu} > 0$ at the optimum, using the implicit function theorem (IFT). Similarly, optimal land and labor used in farming increases in η and ρ. It simply means that the more insecure land tenure is, *ceteris paribus*, less complete the exit from farming and more labor is retained in farming. Regarding each cropping season, the shadow values of effective land (i.e., SV_{s_j}) and that of farm labor (i.e., $SV_{l_L^{fj}}$) are derived from the following equations.

$$SV_{s_j} = \frac{\partial F^j}{\partial s_j} = -\frac{\partial w_L^j}{\partial s_j}\left(\overline{l_L} - l_L^{fj}\right) - \frac{\partial V_p}{\partial s_j} \rightarrow SV_{V_{s_j}} < \left|\frac{\partial w_L^j}{\partial s_j}\left(\overline{l_L} - l_L^{fj}\right)\right|;$$

$$SV_{l_L^{fj}} = \frac{\partial F^j}{\partial l_L^{fj}} = w_L^j - \frac{\partial V_p}{\partial l_L^{fj}} \rightarrow SV_{l_L^{fj}} < w_L^j.$$

Not surprising, both shadow values are smaller than the marginal value of the corresponding factor on the market, suggesting suboptimal resource allocations due to positive property value of contract land. Therefore, inefficiency of factor allocation can be measured by the wedge between the shadow value of a factor and its market value. As a critical contrast with standard household models, lower shadow rates are not limited to laborers who fail to work in the nonfarm sectors (Jacoby, 1993; Skoufias, 1994), but also apply to part-time farming labor who earn nonfarm wages. The wedge between remains even if transactions costs were zero in labor markets. I draw the first hypothesis as follows.

Hypothesis 1*: The on-farm labor productivity is lower than the corresponding off-farm wage rate for full-time and part-time farming laborers*.

As illustrated by Figure 1-7, when I allow for continuous land and labor input in a given cropping season. In addition, I set V_p as a function of both factors, the curve of farming value (i.e., F_L^s) for a particular effective size is pushed up by an increase in V_p as farming labor increases. The shadow or perceived value of farming (i.e., $\widetilde{F_L^s}$), therefore, is above the pure crop value of farming. At the optimum, the marginal productivity of cropping and the corresponding shadow wage rate equals w_L^s which is lower than the effective market wage rate of $\widetilde{w_L^s}$. This suggests an over use of labor on the farm and efficiency loss. More specifically, the optimal on-farm labor input (i.e., $\widetilde{l_L^s}$) for the laborer is located where the effective wage rate is tangent to the curve of shadow farming value. This amount of labor, however, is more than the optimal labor input (i.e., l_L^s) where $\widetilde{w_L^s}$ is tangent to F_L^s.

So far, the model has elucidated why incomplete exits from farming may be preferred by peasant households and how land may be rearranged seasonally and partially. When millions of smallholders prefer to retain their contract land, the average farming scale inevitably remain similar and small. With a small scale of farming, returns to on-farm labor are low. This induces households to rely heavily on off-farm earnings. The model also confirms that the L-type labor is likely to maximize earnings by transferring out or even abandoning some contract land in exchange for off-farm earnings.

On the other end, large farms face a supply of relatively short-term and geographically disaggregated farm plots and are unable to make systematic improvement of the plots. With under-standardized plots, large farms may only marginally outperform smallholders in production efficiency nor realize fully the increasing returns to scale. In many ways, the seemingly large-scaled farms are more of a collection of numerous low-quality plots, not of an integrated production unit.

Testable Hypotheses and Three Degrees of Inefficiency

I have shown that property value of contract land, which is rooted in interdependent policy distortions, causes a wedge between productivity of on-farm labor and market wage rates. Had there not been the property value, the household and its L-type labor may have completely, or relatively completely, exited from farming. I define the inefficiency due to misallocated factors as *the first degree of inefficiency* under incomplete exit.

Labor and land endowment of a household and tenure quality affect its probability of suffering from the first degree of inefficiency. In particular, enhanced property rights through obtaining land certificates should increase tenure security and encourage nonfarm, especially full-time, employment. Less fragmented field, measured by the average plot size, implies larger rental rate and less transactions costs. Thus, less fragmentation encourages land transfers and releases on-farm labor. Property value of contract land, local wage rates, and human capital impose impacts on land decisions and allocation of labor, especially the L-type labor.

At local optima, when the household marginally increases the cultivation size, the H-type labor is likely to respond more by returning from employment off-farm as the L-type has already invested a considerable amount of time in farming. The argument is summarized in Hypothesis 1-1 regarding global optimum decisions and Hypothesis 1-2 about local optima.

Hypothesis 1-1: *Household labor, especially the L-type, tends to farm for more days if the contract land is less fragmented, tenure security is lower, risk of urbanization is higher, local wages are lower, land markets are less active, or if he is being endowed with less human capital.*

Hypothesis 1-2: *Household labor, especially the H-type, is more likely to farm more if the cultivation size of the household increases.*

What about land and labor use at the household-level? When the amount of on-farm labor changes in w_L and V_p, some laborers may switch from part-time to full-time farming. Or if the cultivation size increases, labor may switch from full-time off-farm to part-time farming. Thus, the number of laborers in each working status may change. The patterns are directly comparable to Hypotheses 1-1 and 1-2. I state the first hypothesis below in regard of globally optimal choices and the second on locally optima. The more labor is released from farming, the more likely a household fully exit from farming.

Hypothesis 2-1: *When the contract land is less fragmented, tenure security is lower, risk of urbanization is higher, local wages are lower, land markets are less active, the number of full-time farm laborers tends to increase, the number of full-time nonfarm labor tends to decrease, and the household is more likely to exit from farming completely.*

Hypothesis 2-2: *When the cultivation size of the household increases, the number of full-time and part-time farming laborers increases and that of full-time nonfarm laborers fall.*

A household with more labor endowment tends to allocate more laborers on and off the farm compared with a household with fewer laborers. In fact, peasant households usually have two and more generations. A household that has more generations tends to have some senior and less-educated labor with significant comparative advantage in farming. It would hence encourage H-type labor in such a household to take full-time employment off-farm. In contrast, if a household has one or two generations, implying laborers with similar quality, the distinction between H-type and L-type is less clear-cut. Some labor with good chances in nonfarm sectors have to do the cultivation. It is likely that part-time farming would be preferred by such households.

Hypothesis 3: *The more labor and more generations a household is endowed with the larger the more full-time nonfarm laborers it tends to have and large cultivation size it tends to choose.*

In Figure 1-8, I abstract from seasonality. An interesting effect can occur if w_L^s is sufficiently low. The wage rate w_L^1 is so low that the optimal farm labor to put at $s = 1$ is even considerably more than the minimum labor required for cultivating $s = 2$. Because F_L^2 lies on the top at l_L^f, the household would be able to obtain a higher income by choosing $s = 2$ as long as w_L^2 is not too much smaller than w_L^1. As the household switches to $s = 2$, the nonfarm wage rate drops more, pushing the optimal farm labor further to the right. Now at l_L^{f2} the household should cultivate even more land, because F_L^4 lies on the top of F_L^2. The household hence ends up cultivating all the contract land and bringing the nonfarm wage rate down to the lowest, earning a highest income with a large V_p^4. However, had there not been such a large V_p, the household may have exited completely to maximize income. To generalize this observation, whenever the optimal l_L^f for a cultivation size of s lies to the right of the intersection point of F_L^s and $F_L^{s'}$ for $s < s'$, the chain effect of increasing the cultivation size is triggered. The loop stops at s' if the corresponding $l_L^{f'}$ is found to the left of $I_{s's''}$ and $s' < s''$.

Call such a tendency of enlarging the cultivation size and causing more efficiency loss the *second-degree inefficiency* or a *property trap*. It is effectively a chain effect that traps more labor on the farm because of an endogenous wage rates. As we can see from Figure 1-8, larger V_p and the more fragmented farm pushes a household towards the property trap at global optima. The decreasing marginal productivity of on-farm labor implies constant labor-to-land ratio if the return to farming scale decreases (see proof in Appendix 2).

Hypothesis 4-1: *Tenure insecurity and land fragmentation pushes a household closer to the property trap, implying higher intensity of farming and lower marginal productivity of labor.*

Hypothesis 4-2: *Farming intensity and marginal productivity of labor decreases in the cultivation size if the return to farming scale is constant or increasing. Farming intensity may remain constant if returns to scale is decreasing.*

Unless the rural-to-urban transformation takes place at the household level, the elderly and less educated, who inclines to be L-type labor, would be staying in farming. Because elderly and less educated peasants tend to be relatively slow in adopting new technologies, mastering modern farm managing techniques and investing in agricultural infrastructure, additional inefficiency would incur in the long-term.

Implication 1: *In the long term, incomplete exit from farming results in an increasingly aged and less educated labor force in agriculture, discouraging technology adoption and infrastructure investments.*

Worse still, government's land-based subsidies that create extra income flows to tenure rights, such as direct income transfers to contract holders, shall cause side effects by increasing V_p. Subsidies on mechanization can lower l_{min} and hence encourages incomplete exit. Thus, subsidizing machinery purchase or mechanical services can hinder farmland consolidation instead promoting it. Call such an indirect and chronic efficiency loss the *third-degree inefficiency*. Unintended policy effects can take place, suggesting systematic conflicts among agricultural policies in China.

Hypothesis 5: *Land-based income transfers to peasant households and subsidies on mechanization can discourage complete exit from farming.*

The three degrees of inefficiency are household-specific, meaning that they only selectively strike households. The three degrees of inefficiency are also transformable among each other, so that mitigating any may aggravating another. For example, when local wages increase, a household tends to keep a smaller s (i.e., reducing the second-degree inefficiency), but is also more likely to choose a positive s (i.e., increasing the first-degree inefficiency). If not subsidizing machinery purchase or mechanical services, probability of falling in a property trap can be reduced (i.e., reducing the second-degree inefficiency), but the adoption of new technologies and increase of farm labor productivity is slowed down in the meantime (i.e., increasing the third-degree inefficiency). The second scenario suggests a potential for peasant households to be trapped in a low-efficiency equilibrium and not able to jump out of the trap unless substantial compensation is provided to encourage exit from farming.

Land transfers would help save a household from efficiency loss by compensating exiting households in losing property value of land (see Figures 1-6 and 1-8). However, as long as V_p exists, inefficiency remains regardless of transactions costs in markets. It is the role of farmland as a safety net and retirement buffer that imply positive V_p. In this sense, relaxing residential restrictions does not remove the risk of land expropriation and the potential benefits from asset appreciation, either. Partial and seasonal land and labor arrangements shall stay, unless the dualistic socio-economic system is removed.

Hypothesis 6: *Efficient land markets can encourage exit from farming, reduce the inefficiency of land and labor arrangements, but not eliminate efficiency loss due to distorted incentives.*

4. Empirical Evidence

In this section, I estimate impacts of predetermined factor endowments and other exogenous variables in achieving globally optimal allocations of land and labor. The tests are performed at the household and the individual level, respectively. Following the theoretical model, I classify laborers into two groups based on their comparative advantages in nonfarm sectors and are tested separately. Second, I try to identify the relationship between locally optimal land and labor decisions. Because the two decisions are nonseparable, instrumental variables should be used to identify how a household or an individual balances between the two decisions. I also try to identify the determinants to a household's decision on exiting from farming. Tests on wage wedges and the property trap are presented by the end of this section.

Design of the Survey on Land Use

Let me first explain how the survey is designed. The household survey as carried out during July 14th and August 2nd 2016 in Sichuan Province of China. In total, 512 households from 14 villages were interviewed. One member of each household was responsible to answer the questions. Each interview took 40 to 80 minutes to complete, depending on the complexity of demographic structure, factor endowments, and economic activities of a household.

Previous household surveys conducted in China typically ask the interviewees directly about how land is used over a year. Little attention has been put to distinguish seasonality in the use of farmland. Information collected in such a way does not capture inform and seasonal arrangements of land well, both because of how questions are formed and the unwillingness of reporting some politically sensitive activities.

For instance, when asked *did you transfer out (in Chinese, liuzhuan) any land last year*, two types of misunderstanding may occur. One is that the term of transfer out may refer to relatively formal transfers through markets and involve rental payments in an interviewee's mind, so that transfers to relatives and friends without contract or rentals would not be reported. Another possibility is that interviewees may not count or forget about small-scale and seasonal transfers, especially when hearing the term *last year*.

Regarding land abandonment, asking the interviewees directly becomes even less appropriate due to the political sensitivity of such questions. When asked *did you abandon any land last year*, interviewers typically give a quick "No", which would be easily proven inaccurate by cross-checking other data. The intention to lie is not hard to understand. In China, abandoning land is officially forbidden by local governments and land-based subsidies would be reduced if one's contract land is not cultivated. Therefore, few interviewees are willing to state accurately how much land they abandoned if they did so. Such information can be best and perhaps only uncovered through indirect questions.

The indirect way of uncovering land arrangements is centered upon questions on crops and corresponding areas by season. In the pilot survey, I talked with local officials who were in charge of agricultural activities and acquired knowledge of cropping seasons and corresponding crops grown by peasants. Based on the knowledge, I grow crops into 11 categories according to their growing patterns. The categories are rice, wheat, barley, rapeseeds, corn, soybeans or sweet potatoes, summer vegetables (e.g., cucumbers and eggplants), winter vegetables (e.g., garlics and radishes), annual herbs or fruits, perennial herbs or fruits, and finally trees or horticulture. Rice, corn, soybeans, sweet potatoes, and summer vegetables are grown during early May to September. Wheat, barley, rapeseeds, and winter vegetables are grown during September to late April. Other crops occupy the land year-round. For each crop category, I asked the interviewees how much land is used for the crop and if there is intercropping. Therefore, I can easily figure out the actual cultivation size in each season. Detailed information on numbers of plots used and input costs was recorded as well.

Again for illustration, let us think of a household titles to 10 *mu* of contract land. Over two seasons, there are effectively 20 *mu* of arable area to cultivate. Suppose that the household cultivates 8 *mu* of rice, 1 *mu* of corn, 6 *mu* of wheat, 1 *mu* cabbage, and 1 *mu* of medical herbs. The medical herb grows for the whole year. Therefore, I know that the household utilizes $8+1+1=10$ *mu* of land during summertime, but only $6+1+1=8$ *mu* during winter. Its total cultivation size over the year equals 18 *mu*. Compared with its land endowment, the household does full cultivation in summer, but in winter. If the household does not report any seasonal land transfer, which is directly asked in my survey, the household must be abandoning 2 *mu* of arable area in winter.[1] Using the terminology of incomplete exit, this household seasonally and partially exits from farming.

Overview of the Sample Data

The province of Sichuan in Southwest China has a population of 82.6 million and a territory of 486 thousand square kilometers, out of which more than 5.9 million hectares of land is arable. The province is rich in natural resources and land forms. Its Gross Domestic Production (GDP) was 503 billion USD in 2016 out of which 12% came from the agricultural sector. Sichuan has been a major agricultural producer in China, especially of staples, oil-bearing crops, and vegetables. According to China's National Bureau of Statistics, Sichuan is the fifth largest grain production province and the second largest producer of rapeseeds in 2015 (NBS, 2015). It also produced more than 42.4 million metric tons of vegetables in that year, generating 105 billion RMB in value (i.e., about 16 billion USD).

The stratification of the sample aims to capture information of three typical county-level economies in Sichuan based upon their relationships with the capital city. The capital city of Chengdu is the economic center and imposes critical impacts on surrounding county-level economies. Chengdu is the fifth most populous metropolitan China and houses over 14 million residents. It provides millions of jobs to local and migrant workers each year.

Three types of county-level economies are selected to form a representative sample of rural households in the province. County 1 and County 2 are both located near the downtown of Chengdu and lie almost entirely within the Chengdu Plain. Their urbanization rate are over 60% and agriculture contributes less than 5% of the GDP by 2015. They represent counties that are endowed with leveled and fertile farmland, highly developed local nonfarm markets, developed but minor agricultural sectors. County 3 is located 60 miles to the North of Chengdu and has 15% of its GDP from the agricultural sector. Half of its area is flatland and the other half hilly or mountainous. It represents county-level economies that have developing local nonfarm markets,

[1] Note that I know the uncultivated land is not fallowed, because I do not observe the household growing any cover crop to recover biomass during the period. Abandonment typically happens during the winter season.

medium farming conditions and considerable importance of farming. The last county lies 90 miles to the South of Chengdu and has more than 30% of its GDP from agricultural production. Most land is hilly. This county represents an economy that relies heavily on the agricultural sector, but has poor farming conditions and underdeveloped local nonfarm markets. Rice and wheat are the staple crops for the first three counties, while corn and rice are staples for County 4. There are 512 households in the sample. More details are found in the following table.

[Tab 3A]

Within each county, the selection of households is randomized.[1] I first select one to three townships in a county and then two villages in each township. Based on the importance of agriculture and the size agricultural population in a township, different numbers of households were randomly picked. Face-to-face interviews were conducted with each household by a group of fourteen interviewers, including the author. The team collected information on two summer and two winter seasons through May 2014 to May 2016. The four harvests happened in May and September of 2015 or 2016. Hereafter, I refer to the first period as 2015 and the other as 2016 cropping year.

Intra-household variation is limited over the two consecutive years. Based on data of 2016 cropping year, let me delineate the sampled households by county. On average, a household has about four members and three laborers out of whom two work full-time or part-time on the farm (Table 3B). Each household is title to about 4.1 *mu*, or 0.7 acre, of contract land. As widely known, the contract farmland is extremely fragmented in China. The households in this sample have their land divided into seven plots with an average plot size of only 0.6 *mu*. Over 80% of plots are paddy fields where rice can grow, though this ratio is considerably lower in the fourth county.

[Tab 3B]

Since 2004, about 11% of the households have experienced either land redistribution or expropriation. At the village level, half of the fourteen villages have reallocated contract land and all have expropriated land since 2004. Regardless of insecure tenure, land markets are active yet not stable. A variety of land arrangements have been observed. As defined in the model, there can be seasonal, partial, seasonal-partial, and yearly land transfers or abandonment. The distribution of land arrangements are summarized in Table 3C. About two thirds of the households conduct some form of land rearrangements, but only 12 percent transfer land yearly. All other land rearrangements involve seasonal and partial features. Over 30% of households abandon some of their contract land, resulting in forgoing about 12% of arable area in the cropping year of 2016. More than 85% of the transactions rent out or abandon land, while others transfer in. Less than 6% of the households exit completely, while nearly 47% exit in a variety of incomplete ways.

[Tab 3C]

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[1] A fundamental problem exists in this selection design. That is, I could not include any household whose *hukou* remains in the village but has moved to live in urban areas. I am aware that such households are indeed the complete exiting households. It would be ideal to obtain information about them and study how they differ from all the other households that continue to live in the village. By 2015, about 12% of registered households have left the village. The percentages are highest in the fourth county. The households that have moved out of the village are likely to have kept rights to contract land and can choose to return if needed.

There is substantial variation across households in terms of off-farm employment. On average, each household allocates one laborer to specialize in nonfarm sectors. As reported in Table 3D, a large proportion, averaging at 84%, of household income is generated by its off-farm labor.[1] Each household earns 44,000 RMB (about 6,770 USD) in 2015. Households in the fourth county earn least on average, while those in county one make highest income

[Tab 3D]

The dataset also provides rich information about household members. There are 1,855 and 1,864 individuals captured in the sample in 2015 and 2016, respectively. Over 87% of the individuals are adults (i.e., male and female at least 18 years old) and about 83% are laborers, meaning that they are able to work on or off-farm (i.e., male and female over 16 years old and not seriously ill nor disabled). Slightly over half of the labor force are males and aged 48 at the mean, with the ages ranging from seventeen to ninety-five. More than 83% of the laborers were married in 2015. On average, they have finished seven to eight years of formal education.

I classify labor into three working statuses, full-time farming, part-time farming, and full-time off-farm, depending on the time allocated on-farm and off-farm. About 7.5% of the laborers were laid-off, in school or in military, in either cropping year. The distribution of individual-level working statuses in 2016 is summarized in Table 3E. Note that laborers who work full-time and who migrate earn significantly higher monthly wages than other off-farm laborers do, echoing to the assumption of decreasing expected wages in farming commitment.

[Tab 3E]

Full-time off-farm workers are twelve years younger (i.e., mean age equals 36) and more educated on average compared with part-time workers. Comparing the locations and types of off-farm jobs by part-time and full-time workers, some interesting observations can be made. As seen in Table 3F, almost 90% of part-time workers work within Sichuan Province, while 74% of full-time workers do so. In fact, more than 88% of part-time workers find jobs within home counties, so that they can transit daily to work. But more than 45% of full-time workers choose to migrate. Occupations of part-time and full-time workers differ as well. About 48% of part-time workers have jobs in the manufactural industry, including food processing and construction. Another 45% work in the service industry, with 5% taking white-color jobs. In contrast, 45% full-time workers work in mines, factories or construction sites. Half of them work in the service industry and over 9% take white-color jobs.

[Tab 3F]

Truncated Sample and Key Variables

In 2015 cropping year, there are five households who cultivate at least thirty *mu* (i.e., five acres) of land in at least one of the two cropping seasons. This number becomes seven in the 2016 cropping year. According to the government, such households are large farms and are titled to special assistance under conditions. As stated in the modeling section, assumptions and hypotheses apply best to smallholders. Once a household becomes a large farm, for example, the assumption of ignorable hired farming labor and substitution of mechanical power labor becomes

[1] If considering income from raising livestock, the proportion of income from nonfarm activities fall to 77.2%.

questionable. Therefore, I first truncate the dataset by excluding twelve large farm observations and focus on the remaining 1012 observations over the two-year period.

Because most of the variation is inter-household, I do not adopt a fixed-effect nor first-difference model to eliminated unobserved household fixed effects. If I did, the estimation would be rely mostly on households that experienced major changes in human, land and labor endowments within the two cropping years and not characterize patterns of economic behavior for the majority of households.

I include individual, household, and village level explanatory variables in the baseline tests. Dependent variables are household or individual specific. The variables are defined and grouped based on what they measure in Table 4-1. Except for the cultivation size, the variables are considered exogenous to dependent variables and identify causality directly. The number of observations for household variables equals 1012, except for the variable of average plot size and that of the percentage of paddy field out of contract land. The number of observations of the two variables is 1006, because three households are not titled to any contract land in both years.

[Tab 4-1]

Tests on Global Optimum Decisions

I am most interested in checking how changes in the property value of contract land and conditions of factor markets affect factor use decisions at the household and individual levels. I adopt linear specifications in the baseline tests. Let us start with the hypotheses on global optimum decisions at the household level, or Hypothesis 2-1 and Hypothesis 3.

The subscripts $j, i,$ and t are used to indicate villages, households, and years. The vector HV_{jit} contains the set of household-level land and labor endowments listed in Table 4-1. The other vector VV_{jt} contains village-level controls. The dependent variable refers to household land or labor decisions. Year and village fixed effects are controlled for.

$$y_{jit} = \beta_0 + \sigma_1 HV_{jit} + \sigma_2 VV_{jt} + \gamma_1 Yr_t + \gamma_2 V_j + \mu_{jit} \qquad (7)$$

Error terms are clustered at the sub-village level to take care of covariance among households from the same sub-village and serial correlation in errors within households. There are in total forty-five sub-villages in the sample, which is an appropriate number of groups for clustering according to Cameron and Miller (2015). I also cluster the errors at the village level and obtained highly similar standard errors. Regression outcomes are summarized in Table 4-2.

[Tab 4-2]

As shown in the table, having more generations in a household has a positive impact on the cultivation size and the number of full-time nonfarm laborers. Having more laborers impose similar effects on land and labor use of the household as Hypothesis 3 suggests. Regarding tenure security of contract land, the positive effects of receiving land certificates is reflected by a reduction of the cultivation size, though statistically insignificant, and an increase of full-time workers. Specifically, every five households who have obtained land certificates send one more laborer to work full-time in nonfarm sectors by reducing the number of part-time farmers. Having experienced land changes recently, on the contrary, induces households to cultivate more farmland and leave more labor working full-time on the farm. Such impacts are minor.

Households with more contract land tend to cultivate a larger area. For every additional *mu* of contract land a household is titled to, it only cultivates 0.4 more *mu*, suggesting again a tendency of exiting incompletely. As stated by Hypothesis 2-1, households is more likely to allocate labor to work full-time in nonfarm sectors if contract land is less fragmented.

As suggested by Hypothesis 5, the variable of land-based subsidies is found to impose a positive effect on the cultivation size and trap labor to work full-time on the farm. The subsidy effectively functions as income transfer and adds property value of the contract land. When subsidies increase by 1,000 RMB, the household cultivates an increment of almost 1.5 *mu* of land.

Classify Labor into Two Types

At the individual level, I first classify labor into two groups according to one's comparative advantage in farming within each household. I use a *Probit* model to estimate a laborer's probability of working off-farm. If a laborer currently works part or full-time off-farm, the dependent dummy variables equals one. All variables in Table 4-1 are included. For each laborer, a probability of working off-farm is estimated from the *Probit* model. Whoever has the highest estimated probability of taking off-farm jobs in a household is categorized as a laborer with comparative advantage in nonfarm sectors, or the H-type labor as defined in the theoretical model. Other laborers are L-type. At most, two laborers within a household are classified H-type laborers, if two members get the same estimated probabilities of working off-farm.

Simple *t-tests* between the two types of labor confirms that H-type laborers are significantly more likely to be male, young, and well educated. It turns out that 44.4% of the H-type labor works full-time off-farm and 25.8% works part-time off-farm. In contrast, 54.1% of the other types of labor spends all working days on the farm.

I perform the tests on the two types of labor, respectively, and highlight heterogeneity in the effects of interested variables on the two types of labor. The dependent variables are proxies an individual's land and labor decisions. One is the number of days a labor works on-farm, and the other is that off-farm during a year. The subscripts p refers to individuals. The vector of PV_{jipt} contains variables of individual characteristics listed in Table 4-1.

$$y_{jipt} = \beta_0 + \sigma_1 PV_{jipt} + \sigma_2 HV_{jit} + \sigma_3 VV_{jt} + \gamma_1 Yr_t + \gamma_2 V_j + \mu_{jipt} \qquad (8)$$

Again, to take care of correlated error terms across households and over time, I cluster errors at the level of sub-village. As shown in the table below, getting aged reduces numbers of days working on and off the farm. Yet the decrease of days worked off-farm is faster as the H-type labor becomes older. Having received more education decrease days spent on-farm and increases the days working off-farm for both types of labor. More generations and more labor endowment in the household together encourage more days spent off-farm.

[Tab 4-3]

As stated in Hypothesis 1-1, owning land certificates encourage laborers with comparative advantages in farming, who tend to be retained on-farm, to work more off-farm. Specifically, if a household receives the land certificate, each L-type laborer works for 37 days more in nonfarm sectors. Because the number of days worked on the farm for the L-type labor does not decrease, the total working days over a year must be increasing after receiving the certificate. It suggests that the L-type labor reduces the amount of leisure or underemployment, implying further increase of labor use efficiency.

Having experienced land expropriation recently would encourage off-farm work for the H-type labor and reduces on-farm work for the L-type labor. This is probably because that households have experienced expropriation do not expect the next land change to come any soon and can shift more labor to off-farm employment. Expropriation of land also serves as a signal for urbanization and economic growth in nearby areas. Increasing job opportunities locally can attract more labor to work off-farm as well. The subsidies again lead to more days spent on farming, especially from the H-type labor. When land-based subsidies increase by 1,000 RMB, such a laborer farms for thirteen more days.

Local Optimum Decisions

To see how labor decisions change as the household increases its cultivation size marginally, I have to use an instrumental variable (IV). There are at least two major concerns over the potential bias of the estimator without an IV. First, the causal relationship may be reversed. Instead of an increment of the cultivation size affects the number of full-time laborers, for example, it could be a shock on labor allocation that induces a change in the cultivation size. Second, there can be omitted variables that affect both factor decisions. For instance, I do not have control variables for unobserved heterogeneity in farming and nonfarm skills of the household as a whole or of individuals. The former bias tends to cause an overestimation of the coefficient, while the latter one is likely to result in an underestimation.

If variables of contract land size and quality were not incorporated in the specification as explanatory variables, they would be ideal IVs. I choose to make use of the cultivation size of each household's peer households ($CulS\_\mathrm{P_{jit}}$) to identify the relationship. The average cultivation size of peer households for household i is computed as

$$CulS\_\mathrm{P_{jit}} = \sum_{-i} \frac{CulS_{jit}}{n_j - 1},$$

where n_j equals the number of sample households in a village. The IV is household specific and ranges from 1.9 to 17.4 *mu*. The variance of $CulS\_\mathrm{P_{jit}}$ relies mostly on the existence of large-scale farms in a village. The existence of large farms is dependent critically on capital endowment and managerial skills of households and can be seen as exogenous to any smallholder.

Identification relies on the following argument. I argue that the IV has a direct impact on cultivation sizes of smallholders only through local land markets, but does not affect their labor decisions directly. More specifically, given a fixed amount of land endowment in a village, the more land cultivated by other villagers, the less is to be cultivated by household i. The first stage outcomes using $CulS\_\mathrm{P_{jit}}$ show that its coefficients are significantly negative (see Table 4-4). The errors are clustered at the sub-village and the village level, respectively. The two estimation results do not differ significantly. If not including $CulS\_\mathrm{P_{jit}}$, the R-squared of the model falls to 0.47, suggesting explanatory power of the IV.

[Tab 4-4]

Let us again start with household level decisions under Hypothesis 2-2. A two-stage-least-square model is adopted. For comparison, I also list the estimation results acquired without an IV. The model is specified as below and resembles equation (7) except for the variables of cultivation size. The dependent variables are household labor decisions.

$$y_{jit} = \beta_0 + \sigma_0 CulS_{jit} + \sigma_1 HV_{jit} + \sigma_2 VV_{jt} + \gamma_1 Yr_t + \gamma_2 V_j + \mu_{jit} \qquad (9)$$

The two sets of results, using IV or not, have identical signs and comparable magnitudes. As suggested by Hypothesis 2-1, increasing the cultivation size draws laborers from working full-time off the farm to stay part-time in farming. Specifically, if increasing the cultivation size by 16.7 *mu* translates to one less full-time worker and about one more part-time farmer.

[Tab 4-5]

When it comes to Hypothesis 1-2, I perform the tests on the two types of labor, respectively. The model is similar to (8) and includes an additional variable of $CulS_{jit}$. As shown in the table below, the estimated coefficients for different labor types are similar. To increase the time on-farm by one day, laborers have to give up off-farm days by about three. This again indicates a loss of efficiency when dragging labor from working off-farm back to the field.

[Tab 4-6]

Household Exit Decisions

Finally, let us return to the central question of what affects exit decisions of a hosuehold. I construct a categorical variable, HEx_{jit}, which equals zero if not exiting, one if exiting incompletely, and two if completely exiting. Except for three landless households, 47.6% of sampled households have HEx_{jit} equal zero, 46.7% with HEx_{jit} of one, and only 5.6% completely exit from farming over the two years.

I adopt a multi-logit model and cluster the error terms at the sub-village level. I take $HEx_{jit} = 0$ as the baseline.

$$HEx_{jit} = \beta_0 + \sigma_1 HV_{jit} + \sigma_2 VV_{jt} + \gamma_1 Yr_t + \gamma_2 V_j + \mu_{jit} \qquad (10)$$

As expected, having more laborers would discourage exit from farming. Having experienced land reallocation does the same. More secure land tenure, through receiving land certificates, encourages exiting and complete exiting from farming. Owning more contract land has a negative impact on complete exit, because more property value of land can be acquired. If the contract land is less fragmented, the household is more likely to exit completely as it can more easily transfer out the land at a relatively high rental rate. In contrast, higher subsidies impede complete exit. As suggested by Hypothesis 6, we can see that more active local land markets encourage exiting from farming, especially exiting completely.

[Tab 4-7]

Wedges between On-farm and Off-farm Labor Productivities

The household model predicts a wedge between productivity of on-farm labor and the market wage rate, whether the labor works full-time or part-time on the farm. Hypothesis 1 differs from a general conclusion from classic household models that only individuals failing to enter local labor markets have a shadow wage rate lower than the market wage rate; and as soon as a laborer manages to participate in the labor market, the wedge in productivity shall disappear if transactions costs are ignorable (Jacoby, 1993; Skoufias, 1994).

To estimate labor productivity on-farm, I adopt a double-log specification and assume a Cobb-Douglas production function. The specification is as follows. The letter *S* stands for size, *D* for the number of days, and *C* for cost in RMB. In particular, the variable of $InpC_{it}$ includes expenditure on fertilizers, chemicals, irrigation, mechanical power and hired labor. The subscript of *i* indicates a household and *t* the year. The dependent variable is the annual crop value produced by the household. The nominal value of crop production is measured in RMB (1 USD is about 6.5 RMB in 2015).

$$\ln(CpV_{jit}) = a + b_1 \ln(CulS_{jit}) + b_2 \ln(CulD_{jit}) + b_3 \ln(InpC_{jit}) + \gamma X_{ijt} + u_{jit} \qquad (11)$$

I control for a vector of X which includes the reception of government subsidies, the value of household machinery, the ownership of land certificate, the experience of land changes, the housing land size, quality of cultivated field, and whether a household grows perennial crops. Including all the households in an OLS regression, I cluster the error term at the level of sub-villages. Village and time fixed effects are included as usual.

In fact, 75% of the households raise livestock as well. The value of livestock is as much as 45.4% of the value of crops grown on average. We tend to underestimate productivity of labor that stays on the farm if not accounting for value of livestock production. I define the dependent variable HpV_{it}, the value of all home production, equal to the summation of crop and livestock value.[1] To avoid bias in estimation due to outlier households, I exclude fifteen observations of large farms and large ranches that produce livestock worth over 100,000 RMB per year. The variable of HpD_{jit} is the summation of cultivating and animal-feeding days. In addition to the controls included in (11), I also include a dummy variable which indicates if the households hires labor to feed livestock and the number of livestock types.

$$\ln(HpV_{jit}) = a + b_1 \ln(CulS_{jit}) + b_2 \ln(HpD_{jit}) + b_3 \ln(HpC_{jit}) + \gamma X_{jit} + u_{jit} \qquad (12)$$

There are zero observations in the sample. I follow Jacoby (1993) and add a constant of one to the input cost and cultivation sizes, but not labor days, and then take the logarithm. The transformation is reasonable, particularly because the smallest positive value of input costs are considerably larger than one. As a comparison, I also estimated the function without excluding large ranches. Outcomes of different regression specifications are presented in Table 4-8, including estimation without the adjustment of zero observations. All the regressions have R-square higher than 0.75, indicating high explanatory power of the variables included and good fitness of the specification.

[Tab 4-8]

The next step following (Skoufias, 1994) is to make a linear prediction of cropping value and livestock value based on estimated coefficients. The predicted values of home production are highly correlated with the actual values. The contribution of farming or feeding days to the final production value equals the relative scale of the coefficient of the variable $log(HpD_{jit})$. Assuming constant marginal productivity of labor, I can estimate the shadow wage of home production labor as below. Assume a laborer works for thirty days per month.

$$monthly\ shadow\ wage_{it} = \left[\frac{\widehat{HpV_{jit}} \times \widehat{b_2}}{HpD_{jit}}\right] \times 30.$$

The estimated shadow wage rates are summarized as below. As a comparison, I list the local wage rates for unskilled labor. The estimated wage of all farm labor is even lower than this

[1] More accurately, the livestock value equals the incremental value of livestock over a year as livestock can be medium-term assets. However, most households do backyard livestock raising and consume the meat within a year. Jacoby (1993) counted for value of livestock in the estimation of agricultural production function, too. He computed livestock value in a different way.

benchmark. The average monthly off-farm wage rate for the 528 observations of part-farm farming laborers equals 2206 RMB. Such substantial wedges may not be all attributed to transactions costs in labor markets and support the argument of property value of land.

[Tab 4-9]

The key test is to see if the shadow wage changes proportionally with the off-farm wage. If applying the OLS model to the shadow wage rate and put actual off-farm wage rates on the right-hand-side, I can test the coefficient estimated for the off-farm wage rate. If the coefficient equals one, then there is no wedge between farming and off-farm productivity of labor. It turns out, as shown in Table 4-10, the coefficients estimated is not even close to one for part-time farming laborers. If using gender, age, and schooling as IVs, I can perform similar tests. The coefficient is found to be insignificant consistently. Note that other than the reason specified in the theoretical model, transactions costs and discrete choices of employment can also result in a similar, yet perhaps not so wide, wedge between on-farm and off-farm productivity.

[Tab 4-10]

Evidence for the Existence of a Property Trap

Under Hypothesis 4-1, more secured tenure and less fragmented farmland should reduce the probability of falling in a property trap and reduce farming intensity. I perform tests on the relationship between the number of farming days per unit of land for each individual laborer, denoted as $FI_{jipt} = \frac{days\ spent\ in\ cultivation}{cultivation\ size}$. Using an OLS model, the estimation equation is specified as follows.

$$FI_{jipt} = \beta_0 + \sigma_1 PV_{jipt} + \sigma_2 HV_{jit} + \sigma_3 VV_{jt} + \gamma_1 Yr_t + \gamma_2 V_j + \mu_{jit} \quad (13)$$

The first two columns on the left of the table below display evidence for this hypothesis, because the coefficient of receiving land certificate is negative and that of land fragmentation is also negative. Having experienced land reallocation and expropriation also imply lower risk of land changes in the future and reduces intensity of farming.

[Tab 4-11]

Let me now test Hypothesis 4-2. Table 4-8 indicates that decreasing returns to farming scale in land and labor is more appropriate for smallholder farms in this sample dataset. If wage is fixed in the commitment to farming, Appendix 2 has shown that the labor-to-land ratio shall decrease. But if wage decreases in farming commitment, the ratio can stay constant, implying a disproportional increase of labor input as the cultivation size increases. Note that by construction, any shock on $CulS_{jit}$ also directly affects farming intensity. The IV for $CulS_{jit}$ is at best weakly exogenous. As Hypothesis 4-2 assumes no mechanical power to substitute away labor input, I further trim the sample and exclude households using mechanical power intensively. Mechanical cost per *mu* varies from four to 398 RMB for the smallholder farms. The mean and the median is at 110 RMB.

Whether the IV is employed, estimated coefficients display the same pattern. I find a trend of decreasing farming intensity in the cultivation size weakens as I exclude households using mechanical power intensively. Logically, when a household employs mechanical power to substitute for labor, farming intensity does not have to increase to lower the marginal productivity of on-farm labor. As soon as I perform the tests on households that use no more than 100 RMB worth of mechanical power per *mu*, the coefficient estimated is no longer significant. The further I exclude mechanized household, the smaller the magnitude of the coefficient tends to be.

[Tab 4-12]

In conclusion, I have found empirical evidence for all the hypotheses derived from the theoretical model using a sub-sample of small-scale households. More secured land tenure, less fragmented land, and more active local factor markets are found to encourage complete exit and release labor from farming to working off-farm. The two types of labor behave in interesting and significantly different ways as responding to exogenous variance. I also find evidence for wedges between on-farm and off-farm labor productivities. Supportive evidence has been found for the existence of a property trap as well as for unintended effects of welfare policies.

5. Concluding Remarks

Smallholder farming has remained the predominant mode of agricultural production in China. Although a large number of rural laborers are working off-farm, no systematic consolidation of land has taken place. The innovation survey that I designed obtained detailed data of cropping practice at the household level. Inferring from the data, I manage to reveal active land markets and complex land arrangements by smallholders. I show that exit from farming is not a binary choice, but involves a complex continuum. The household model elucidates the theory of incomplete exit under interdependent policy distortions. I point out key determinants of factor decisions of peasant households. Using recently collected household data, I have estimated effects of tenure security, land quality, government subsidies, and factor markets on farm exit land and labor decisions of households and individuals.

The article suggests that systematic consolidation of farmland would not come unless the role of farmland as safety net, retirement buffer, and appreciating asset under expropriation is ended. Incomplete exit from farming has been causing considerable efficiency loss among smallholders and also impeding the formation of large-scale farms. This in turn delays the upgrading of agricultural supply chain. Without integrating the dualistic socio-economy, which sets apart urban and rural China, inefficient use of production factors and small-scale farming tend to continue.

The persistence of smallholder farming also implies low productivity of labor and low competitiveness of Chinese producers in international commodity markets. With an increasing pressure from international food exporters, China now faces a dilemma of purchasing relative cheap commodities from international markets but not crowd domestic producers out of agricultural production too rapidly. Not having systematic resettlement of households from rural to urban areas has imposed impacts far beyond agricultural production. One important issue is the supply of cheap labor to nonfarm sectors. As suggested by this article, great potential supply of labor is stored in the part-time labor force that stays in farming for property value of contract land. Incomplete exit from farming leads to unstable supply of labor as well. Such issues cast worries over the ongoing upgrading of China's manufactural sector.

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Table 1. Sizes of Cultivation with Two Plots and Two Seasons

	Plot 2, $s^2 = 0$	Plot 2, $s^2 = 1$	Plot 2, $s^2 = 2$
Plot 1, $s^1 = 0$	$s = 0$	$s = 1$	$s = 2$
Plot 1, $s^1 = 1$	$s = 1$	$s = 2$	$s = 3$
Plot 1, $s^1 = 2$	$s = 2$	$s = 3$	$s = 4$

Note: the table is drawn by the author.

Table 2. Five Basic Land Arrangements in the Baseline Model

Case 1	$s = 1$	Farming one plot in one season
Case 2	$s = 2$	Farming one plot in both seasons
Case 3	$s = 2$	Farming two plots in one season
Case 4	$s = 3$	Farming one plots in one season and the other plot in both seasons
Case 5	$s = 4$	Farming two plots in both seasons

Note: the table is drawn by the author.

Table 3A. Overview of Sample Counties

County-level Variables	1	2	3	4
Distance to Chengdu (miles)	17.4	15.6	59.9	88.8
Area (square kilometers)	438	1,032	1,245	841
Population (1,000)	558.6	532.6	520.0	420.0
Urbanization%	64.5	66.5	45.8	34.0
Per capita GDP (RMB)	76,391	111,528	36,294	14,727
Agricultural GDP%	4.9	2.4	15.0	30.8
Landform	Plain	Mostly plain	Semi-plain	Hilly
Farmland (square kilometers)	465	442	607	473
No. townships	1	1	3	2
No. villages	2	2	6	4
No. households	54	36	301	121

Note: information is obtained from official data listed online. I report 2015 demographic figures, 2015 GDP and 2014 urbanization rates of the counties.

Table 3B. Household Features and Farming Conditions

County-level Variables	1	2	3	4	All
No. household members	4.0	4.4	3.6	3.5	3.7
	(1.3)	(1.5)	(1.5)	(1.5)	(1.5)
No. full-time farm laborers	1.2	0.8	1.4	1.6	1.4
	(0.9)	(0.9)	(0.8)	(0.8)	(0.8)
No. part-time farm laborers	0.9	1.3	0.6	0.3	0.6
	(1.1)	(1.3)	(0.8)	(0.6)	(0.9)
No. full-time nonfarm laborers	0.9	0.9	0.9	0.8	0.8
	(0.9)	(0.9)	(1.0)	(1.0)	(1.0)
Contract land, *mu*	4.4	4.1	3.7	5.1	4.1
	(1.6)	(2.7)	(2.0)	(3.0)	(2.3)
No. plots, contract land	6.1	6.8	5.5	11.4	7.1
	(2.8)	(4.5)	(2.4)	(7.7)	(5.1)
% paddy field, contract land	93.2	73.6	90.1	52.1	80.3
	(13.6)	(21.8)	(16.0)	(23.8)	(24.5)

Note: the total number of observations is 512. Standard deviations are in the parentheses. The mean of each variable is presented above the corresponding standard deviation. Only information in 2016 cropping year is considered.

Table 3C. Distribution of Land Arrangements

Types of land arrangements	1	2	3	4	All
2014					
Seasonal%	3.7	0.0	3.7	9.1	4.7
Yearly-partial%	24.1	47.2	21.9	6.6	20.3
Seasonal-partial%	9.3	16.7	14.6	75.2	28.5
Yearly%	13.0	13.9	12.3	9.1	11.7
No transfers%	50.0	22.2	47.5	0.0	34.8
Rent-in%	14.8	5.6	11.3	21.5	13.7
2015					
Seasonal%	5.6	0.0	3.3	9.1	4.7
Yearly-partial%	24.1	47.2	22.9	7.4	21.1
Seasonal-partial%	11.1	16.7	14.3	75.2	28.5
Yearly%	13.0	13.9	15.6	8.3	13.5
No transfers%	46.3	22.2	43.9	0.0	32.2
Rent-in%	16.7	5.6	12.0	23.1	14.6

Note: the total number of observations is 512 for each panel. Percentages are reported. Each row contains percentages of households within each county that conduct a specific form of land arrangement.

Table 3D. Household Income

Household income	1	2	3	4	All
2015					
Household nonfarm income, 1,000 RMB	53.1	51.9	33.6	29.3	35.9
	(38.5)	(32.0)	(35.8)	(30.9)	(35.5)
Household farming income, 1,000 RMB	25.5	1.9	8.1	1.6	7.9
	(23.7)	(7.0)	(56.50)	(6.7)	(44.6)
Household farming income%	37.6	3.1	16.8	9.2	16.3
	(28.6)	(8.4)	(25.7)	(21.4)	(25.7)

Note: the total number of observations is 512. Standard deviations are in the parentheses. Only information in 2016 cropping year is considered. Households also have comparable income from livestock as that from cropping. If not including large farms, the farming income for County 3 falls to 2.2 thousand on average with a standard deviation of 2.7 thousand. The mean of farming income for County 4 falls to 1.0 thousand with a standard deviation of 1.9 thousand. The mean farming income for all the counties becomes 4.4 thousand with a standard deviation of 11.0 thousand. The percentage of income from farming for all the counties falls to 15.4.

Table 3E. Individual Working Statuses and Wage Rates

Household income	1	2	3	4	All
Working statuses					
No. Laborers	172	121	909	347	1549
Full-time farming	39.0%	24.0%	44.8%	54.5%	44.7%
Part-time farming	29.1%	38.0%	19.1%	11.8%	20.1%
Full-time off-farm	27.3%	25.6%	28.2%	27.7%	27.8%
in school/military	0.6%	5.0%	4.4%	2.0%	3.5%
Unemployed	4.1%	7.4%	3.5%	4.1%	4.0%
Mean wages (RMB/month)					
Monthly wage, part-time	2793	2253	2034	2482	2244
	(1746.8)	(1211.3)	(1033.1)	(1951.4)	(1353.1)
Monthly wage, full-time	3485	3663	3000	2744	3045*
	(1946.0)	(3192.6)	(2023.7)	(1373.5)	(2006.7)
Monthly wage, local	3068	2900	2227	2618	2513
	(1898.2)	(2411.8)	(1578.2)	(1945.4)	(1836.7)
Monthly wage, migrate	4240	2000	3433	2704	3155*
	(766.8)	(866.0)	(1839.1)	(1298.6)	(1668.0)

Note: only 2016 data are considered. Standard deviations are in the parentheses. Superscript * indicates the figure is statistically larger than the figure above at 1% significance level.

Table 3F. Comparison between Part-Time and Full-Time Workers

	Part-time workers	Full-time workers
No. Observations	311	430
Age	48.2	35.6
	(11.0)	(10.2)
High school graduate (%)	9.3	32.8
Work within Sichuan (%)	90.0	74.2
Migrate to work (%)	88.8	54.2
Manufactural industry (%)	47.7	45.3
Service industry (%)	45.5	50.1
White-collar jobs (%)	4.8%	9.0%

Note: only 2016 data are considered. Standard deviations are in the parentheses. The last five variables are percentages.

Table 4-1. Descriptive Statistics of Dependent and Explanatory Variables

Variables	Type	Mean	Std. dev.	Min	Max
Dependent variables					
Cultivation size	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	6
No. working days	Integer	152	141.4	0	360
% farming days	Percentage	51.6	47.2	0	100
Mechanical cost (RMB)	Continuous	676.4	741	0.0	3960.0
Human capital, individual					
Male	Dummy	0.5	0.5	0	1
Age	Integer	44.5	20.9	0	95
Born local	Dummy	0.9	0.3	0	1
Education	Categorical	2.3	1.1	1	6
Married	Dummy	0.7	0.4	0	1
CCP member	Dummy	0.04*	0.2	0	1
Human capital, household					
No. generations	Integer	2.2	0.8	1	3
No. laborers	Integer	3	1.1	0	6
No. dependents	Integer	0.8	0.9	0	5
No. high school graduate	Integer	0.5	0.7	0	3
No. middle school graduate	Integer	1	1	0	4
No. young males (17-50)	Integer	0.8	0.7	0	4
No. young males (17-45)	Integer	0.6	0.6	0	2
Contract land, quality and value					
Size of contract land	Continuous	8.2	4.3	0	30
Average size of contract plots	Continuous	0.7	0.4	0.04*	4.2
% paddy of contract land	Percentage	80.1	24.5	12.5	100
Land certificate owned	Dummy	0.2	0.4	0	1
Land reallocated, recent decade	Dummy	0.01	0.1	0	1
Land expropriated, recent decade	Dummy	0.1	0.3	0	1
Land-based subsides (RMB)	Continuous	473.1	449.2	0	3300
Size of housing land	Continuous	0.4	0.33	0.04	3
Village factor markets					
% land cultivated by large farms	Percentage	21.2	15.8	0	49
Daily wage for skilled labor (RMB)	Integer	174.2	36.2	120	260
Daily wage for unskilled labor (RMB)	Integer	99.2	21.6	60	150
No. local firm employees	Integer	50.9	78.3	0	334
% seniors (>60)	Percentage	20.2	4.1	15.1	28.4

% households left	Percentage	12.1	13.6	0.5	49.8
% tilled by machinery	Percentage	85.8	26.5	15	100
% planted by machinery	Percentage	8.8	19	0	50
% transplanted by machinery	Percentage	12.1	11.4	0	36
% harvested by machinery	Percentage	67.1	44	0	100

Note: * Two decimal points are kept to avoid reporting 0.0. # The variable uses the unit of hundred RMB in all the regressions.

Table 4-2. Determinants of Household Land and Labor Decisions

OLS: household level	Cultivation size	#Full-time farming	#Part-time farming	#Full-time nonfarm
# Generations	0.61*	0.06	-0.00	0.35***
	(0.329)	(0.085)	(0.088)	(0.085)
# HH labor	0.75***	0.52***	-0.07	0.27***
	(0.237)	(0.052)	(0.052)	(0.052)
Land certificate owned	-0.51	0.05	-0.14	0.21
	(0.506)	(0.190)	(0.137)	(0.178)
HH land reallocated	0.26	0.01	-0.04	-0.04
	(0.892)	(0.232)	(0.229)	(0.217)
HH land expropriated	0.26	0.06	-0.05	0.04
	(0.586)	(0.127)	(0.147)	(0.121)
HH contract land	0.39***	0.01*	0.01	-0.02*
	(0.054)	(0.008)	(0.010)	(0.011)
HH contract plot size	-0.74*	-0.03	-0.34***	0.37***
	(0.400)	(0.087)	(0.080)	(0.100)
HH subsidies (1,000)	1.49***	0.11	0.02	-0.03
	(0.355)	(0.084)	(0.098)	(0.073)
% Land by large farms	-0.03	0.001	0.001	-0.0003
	(0.024)	(0.002)	(0.002)	(0.002)
Local skilled wage	2.95	-0.18	0.14	0.18
	(2.164)	(0.236)	(0.230)	(0.143)
Local unskilled wage	-8.65	-2.04	-0.08	1.69
	(9.182)	(1.915)	(1.774)	(1.065)
Yr and Vil FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
R-squared	0.47	0.33	0.23	0.49
No. Obs.	1,006	1,006	1,006	1,006

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-3. Determinants of Individual Labor Decisions: On and Off-Farm

OLS: individual level	Comp. Adv. Off-farm		Comp. Adv. On-farm	
	On-farm days	Off-farm days	On-farm days	Off-farm days
Male	-12.27	-15.33	7.05	17.97***
	(9.220)	(15.306)	(4.866)	(5.938)
Age	1.69*	2.87**	5.72***	0.36
	(0.877)	(1.460)	(0.924)	(1.128)
Age squared	1.59	-6.90***	-3.78***	-3.23***
	(0.975)	(1.621)	(0.886)	(1.080)
Education	-10.90***	6.59	-2.71	6.41*
	(3.566)	(5.920)	(2.908)	(3.540)
# Generations	10.80	37.84***	14.39**	29.55***
	(6.906)	(11.474)	(6.209)	(7.552)
# HH labor	-8.40*	-5.22	-14.27***	-1.83
	(4.357)	(7.236)	(3.950)	(4.807)
Land certificate owned	18.83	10.26	2.98	37.06**
	(13.313)	(22.108)	(13.536)	(16.456)
HH land reallocated	21.46	10.51	7.08	9.27
	(25.363)	(42.111)	(26.333)	(32.015)
HH land expropriated	-4.76	18.99	-20.85***	-12.04
	(8.334)	(13.835)	(7.564)	(9.196)
HH contract land	0.39	-0.23	-0.09	0.11
	(0.683)	(1.133)	(0.628)	(0.765)
HH contract plot size	-2.52	-15.67	3.23	-0.78
	(8.381)	(13.914)	(7.339)	(8.930)
HH subsidies (1,000)	13.34**	11.04	4.48	-11.74*
	(6.388)	(10.605)	(5.844)	(7.108)
% Land by large farms	-0.33	-0.95	-0.12	0.23
	(0.781)	(1.300)	(0.728)	(0.886)
Local skilled wage	-20.25	98.67	-13.01	-28.80
	(102.460)	(170.114)	(99.385)	(120.906)
Local unskilled wage	3.95	516.94	131.65	189.11
	(624.781)	(1,037.251)	(583.584)	(709.859)
Yr and Vil FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
R-squared	0.36	0.35	0.27	0.23
N	946	945	2,093	2,086

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-4. First Stage Outcomes

OLS: household level	Dependent variable: household cultivation sizes		
Peer cultivated	-2.91***	-2.91**	No IV
	(0.730)	(1.225)	
Yr and Vil FE	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	No	Yes
Cluster at Vil	No	Yes	No
N	1,006	1,006	1,006
R_sq	0.51	0.51	0.47

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-5. Effects of Land Use on Household Labor Decisions

IV-2SLS: Household level	#Full-time farming	#Part-time farming	#Full-time nonfarm
Cultivated size	0.01	0.04***	-0.06***
	(0.011)	(0.013)	(0.013)
Cultivated size (no IV)	0.02	0.03***	-0.04***
	(0.010)	(0.008)	(0.009)
Yr and Vil FE	YES	YES	YES
Cluster at Sub-Vil	YES	YES	YES
No. Obs.	1,006	1,006	1,006
R-squared (IV)	0.33	0.24	0.51

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-6. Effects of Land Use on Individual Labor Decisions

IV-2SLS: Individual level	Comp. Adv. Off-farm		Comp. Adv. On-farm	
	On-farm days	Off-farm days	On-farm days	Off-farm days
Cultivated size	0.91	-3.33*	0.78	-2.97*
	(1.011)	(1.917)	(1.212)	(1.622)
Cultivated size (no IV)	1.69**	-3.49***	0.93	-1.56*
	(0.805)	(0.991)	(0.690)	(0.835)
Yr and Vil FE	YES	YES	YES	YES
Cluster at Sub-Vil	YES	YES	YES	YES
No. Obs.	946	945	2,093	2,086
R-squared	0.36	0.36	0.27	0.23

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-7. Determinants of Exit Modes

Mlogit: Household level	All households		Excl. large farms	
# Generations	0.39	-1.32	0.32	-1.37
	(0.264)	(0.929)	(0.282)	(0.936)
# HH labor	-0.58***	-1.21***	-0.58***	-1.23***
	(0.210)	(0.429)	(0.207)	(0.426)
Land certificate owned	0.55	0.89	0.49	0.87
	(0.481)	(0.925)	(0.476)	(0.910)
HH land reallocated	-1.69**	-13.19***	-1.79**	-14.55***
	(0.832)	(0.981)	(0.865)	(0.938)
HH land expropriated	-0.65	0.67	-0.59	0.66
	(0.448)	(0.591)	(0.451)	(0.594)
HH contract land	-0.26	-5.04***	-0.28	-5.07***
	(0.229)	(1.689)	(0.232)	(1.675)
HH contract plot size	0.18***	-0.09	0.19***	-0.08
	(0.032)	(0.086)	(0.030)	(0.086)
HH subsidies (1,000)	-0.97**	2.78***	-0.98**	2.77***
	(0.418)	(0.839)	(0.450)	(0.836)
% Land by large farms	0.04***	0.05***	0.04***	0.05***
	(0.013)	(0.018)	(0.014)	(0.018)
Local skilled wage	0.22	1.20	0.25	1.18
	(0.790)	(1.650)	(0.800)	(1.649)
Local unskilled wage	0.84	-0.77	0.93	-0.65
	(0.973)	(2.750)	(0.973)	(2.767)
Yr and Vil FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
No. Obs.	1,018	1,018	1,006	1,006

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-8. Estimate Cobb-Douglas Home Production Functions

OLS	Exclude large farms and ranches	Exclude large farms and ranches
Cultivation size	0.35***	0.38***
	(0.123)	(0.111)
Home production days	0.06*	0.07**
	(0.032)	(0.029)
Home production costs	0.74***	0.75***
	(0.080)	(0.074)
Constant	2.56***	2.28***
	(0.609)	(0.548)
Household controls	Yes	Yes
Yr and Vil FE	Yes	Yes
Cluster at Sub-Vil	Yes	Yes
No. Obs.	934	953
R-squared	0.753	0.757

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-9. Estimated Monthly Wage Rates

	No. Obs	Mean	Std. dev.	Min	Max
Home production shadow wage 1	1931	257.5	771.5	0	14430
Home production shadow wage 2	1961	319.5	1107.5	0	22044
Vil unskilled wage	1961	1356.7	303.4	825	1950
Part-time wage	523	2206.1	1236.1	0	10000

Note: estimation 1 uses data excluding large farms. Estimation 2 uses data excluding large farms and ranches.

Table 4-10. Tests on Wedges between On-Farm and Off-Farm Wage Rates

	Home production shadow wage 1		Home production shadow wage 2	
Off-farm wage rate	0.11	-0.51	0.13	-0.44
	(0.19)	(0.37)	(0.18)	(0.35)
Constant	4.00	8.71	3.99	8.36
	(1.35)***	(2.79)***	(1.31)***	(2.62)***
IV	No	Yes	No	Yes
Yr FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
N	526	526	528	528
R_sq	0.004	n/a	0.004	n/a

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1. Shadow wage 1 uses data excluding large farms. Shadow wage 2 uses data excluding large farms and ranches.

Table 4-11. Determinants of Farming Intensity: No IV

OLS: Individual level	Days farmed per *mu*		Days farmed per *mu* (No IV)	
Cultivated size			-6.01***	-8.19***
			(1.993)	(2.781)
Male	1.36	7.13	1.91	8.46
	(5.222)	(7.357)	(5.146)	(7.264)
Age	0.10	0.80	-0.10	0.52
	(1.577)	(1.927)	(1.581)	(1.927)
Age squared	1.84	1.14	1.93	1.20
	(2.017)	(2.355)	(1.993)	(2.295)
Education	3.86	4.13	2.41	1.83
	(3.736)	(4.542)	(3.403)	(4.091)
# Generations	2.58	2.81	5.31	7.03
	(9.493)	(13.043)	(9.221)	(12.403)
# HH labor	-16.87*	-18.57	-14.24	-13.75
	(9.074)	(12.369)	(8.473)	(11.436)
Land certificate owned	-5.33	-6.31	-7.78	-10.12
	(8.579)	(11.756)	(9.231)	(12.177)
HH land reallocated	-51.26	-52.99	-58.79	-59.40
	(36.443)	(37.970)	(40.225)	(42.315)
HH land expropriated	-0.36	-0.28	2.18	4.17
	(6.141)	(8.019)	(7.051)	(10.224)
HH contract land	-3.12**	-3.87**	-0.91	-0.81
	(1.200)	(1.629)	(1.293)	(1.843)
HH contract plot size	-8.19	-11.53	-7.29	-12.24
	(12.898)	(17.728)	(11.400)	(16.045)
HH subsidies (1,000)	1.13	0.34	9.82	11.43
	(4.689)	(6.381)	(6.509)	(8.344)
% Land by large farms	0.07	0.09	-0.11	-0.16
	(0.166)	(0.208)	(0.129)	(0.179)
Local skilled wage	-0.65	7.39	10.96	28.83*
	(15.484)	(17.728)	(14.998)	(16.294)
Local unskilled wage	39.91	29.34	12.61	-18.61
	(103.738)	(122.847)	(93.313)	(112.728)
Farming labor only	No	Yes	No	Yes
Yr and Vil FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
R-squared	0.12	0.13	0.13	0.15
No. Obs.	2,928	2,175	2,928	2,175

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Table 4-12. Determinants of Farming Intensity with IV

2SLS: Individual level	Mech. cost per mu < 200 RMB	Mech. cost per mu < 150 RMB	Mech. cost per mu < 100 RMB	Mech. cost per mu < 80 RMB
Cultivated size	-5.61***	-5.19**	-5.19	-4.77
	(1.925)	(2.151)	(3.527)	(3.574)
Cultivated size (no IV)	-5.61***	-5.19**	-5.19	-4.77
	(1.968)	(2.207)	(3.636)	(3.688)
Yr and Vil FE	Yes	Yes	Yes	Yes
Cluster at Sub-Vil	Yes	Yes	Yes	Yes
R-squared	0.14	0.18	0.21	0.22
No. Obs.	2,338	1,701	1,335	1,275

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1.

Appendix 1. Derivation of the Objective Functions

I now demonstrate why the comparison of expected incomes for a household over two periods can be expressed as that of the first-period income plus an income-equivalent as specified in (3) and (4) in Section 3. The proof focuses a case where factor and multiple seasons are not considered. I demonstrate that this proof can be extended to cases where land and labor markets are active or multiple seasons are available. I continue to assume that resource allocation decisions have no persistent effects.

To start, let me clarify the three sources of risks. First, the probability of losing one's nonfarm job by period two is $\rho \in (0,1)$. This probability is composed by systematic and idiosyncratic shocks. The former refers to business recessions and the latter relates to demographic features of a nonfarm laborer. I ignore idiosyncratic shocks and treat ρ as a systematic shock of unemployment for simplicity. As a result, laborers taking nonfarm jobs would be laid-off simultaneously. If a peasant-worker is laid-off, he could not rely on unemployment insurance from the government but do farming to generate income, at least in the short-run. If there is no systematic lay-off, an on-farm laborer is assumed to be able to start working off-farm once losing land. After all, he is free to work in nonfarm sectors in any period. He did not work off-farm not because he was not able to find a job but he maximized the expected income by farming. He would be ready to switch to an off-farm job once land is expropriated. Moreover, as local governments usually play an active role in assisting landless peasants in job-hunting after expropriation, the victim households are anticipated to start earning off-farm income soon enough. Specifically in this model, it means that labor is able to switch to off-farm jobs in the second period if contract land is lost by the end of period one and there is no shock of lay-off.

The second and third risks strike directly on the contract land. Suppose that a risk of redistribution, or the risk of failing to reclaim land, exists for households that do not cultivate fully during the first period. If the size of contract land is $\bar{s}$ and cultivation size equals s, the size of land under risk is $\bar{s} - s$. This risk of μ is in the domain of $(0,1)$ and exogenously determined at the village level. In addition, there is a risk of land expropriation of $\eta \in (0,1)$. Assume that if expropriation happens, all the contract land of a household shall be taken away regardless of the cultivation size. A victim household would be compensated for losing its farmland. The compensation is computed based on the quality of land (e.g., soil type, size, and location) and on a rolling average of its crop value, which is a function of cultivation size and on-farm labor over a recent period. I set the first portion of compensation as a function of the size of contract land. Thus, the compensation can be characterized as $C(\bar{s}) + C(s, l^f)$, where l^f refers to the total amount of on-farm labor in the first period. Require that redistribution of land cannot happen simultaneously with expropriation of land for a particular household.

In period one, a household decides its land and labor use. The, one or two of the three *bad states* may be realized by the second period, creating different scenarios in the second period. According to a specific scenario, the household arranges its land and labor to maximize the expected income. Six possible scenarios and the corresponding probabilities (p_i) are listed below.

S1: no lay-off and no change of land, $p_1 = (1-\rho)(1-\eta)(1-\mu)$;

S2: no lay-off but uncultivated land redistributed, $p_2 = (1-\rho)(1-\eta)\mu$;

S3: no lay-off but all contract land expropriated, $p_3 = (1-\rho)\eta(1-\mu)$;

S4: laid-off but no change of land, $p_4 = \rho(1-\eta)(1-\mu)$;

S5: laid-off and uncultivated land redistributed, $p_5 = \rho(1-\eta)\mu$;

S6: laid-off and all contract land expropriated, $p_6 = \rho\eta(1-\mu)$.

Note that the value of contract land as safety net and that as an appreciable asset is realized only if there is lay-off or land expropriation, respectively. In the second scenarios, for example, no lay-off strikes off-farm labor and hence the value of land as safety net is not realized. This resembles an insurance that does not pay if the bad state does not realize.

Recall that land endowment of the household is $\bar{s}$. The discount factor for second-period income is d and is between zero and one. If the household exits completely (i.e., $s = 0$), the present value of its total income equals the summation of first-period income and the discounted expected income in the multi-scenario second period. The household's endowment of the two types of labor in each year is put entirely into nonfarm sectors. The farm production function is denoted by $F(s, l^f)$ and depends only on the cultivation size and total labor input. Although I do not consider soil quality or other exogenous factors that can affect agricultural production, such factors can be easily added to $F(s, l^f)$. The present value of the expected income is expressed as

$$E(\pi_0) = I_0 + E(I_0')$$
$$= I_0 + d\{I_0 p_1 + I_0 p_2 + (I_0 + C(\bar{s}))p_3 + F(\bar{s}, 2\bar{l})p_4 + 0p_5 + C(\bar{s})p_6\},$$
$$\text{where } I_0 = 2w_H(0)(\bar{l} - \overline{l_L}) + 2w_L(0)\overline{l_L} \qquad \text{(A1)}$$

Similarly, I can express the present value of the expected income for a household that does farming as follows. The superscript or subscript of 1 and 2 attached to choice variables indicate one of the two cropping seasons available in a period. The parameter i refers to the cultivation size during the first period. Denote the amount of farming labor in period one as l_H^f and l_L^f for the H and L-type labor, respectively. Here, $s_j \in \{0,1,2\}$, $j \in \{1,2\}$, and $s = s_1 + s_2 \in \{1,2,3,4\}$.

$$E(\pi_i) = I_i + E(I_i')$$
$$= I_i + d\left\{I_i p_1 + I_i p_2 + \left[I_0 + \left(C(\bar{s}) + C\left(i, l_H^f, l_L^f\right)\right)\right]p_3 + F(\bar{s}, 2\bar{l})p_4 + F(s, 2\bar{l})\,p_5 + \left(C(\bar{s}) + C\left(s, l_H^f, l_L^f\right)\right)p_6\right\},$$

$$\text{where } I_0 = 2w_H(0)(\bar{l} - \overline{l_L}) + 2w_L(0)\overline{l_L};$$
$$l_H^f = l_H^{f1} + l_H^{f2};\; l_L^f = l_L^{f1} + l_L^{f2};$$
$$I_i = w_H(s_1)(\bar{l} - \overline{l_L} - l_H^{f1}) + w_L(s_1)(\overline{l_L} - l_L^{f1}) + F(s_1, l_H^{f1}, l_L^{f1})$$
$$+ w_H(s_2)(\bar{l} - \overline{l_L} - l_H^{f2}) + w_L(s_2)(\overline{l_L} - l_L^{f2}) + F(s_2, l_H^{f2}, l_L^{f2}). \qquad \text{(A2)}$$

Combining like terms, I can rewrite (A1) as

$$E(\pi_0) = I_0[1 + d(p_1 + p_2)] + d\left[I_0 p_2 + C(\bar{s})(p_3 + p_6) + F(\bar{s}, 2\bar{l})p_4\right]. \qquad \text{(A3)}$$

Similarly, I can rewrite (A2) as follows.

$$E(\pi_i) = I_i[1 + d(p_1 + p_2)]$$

$$+ d\left[I_0 p_2 + C(\bar{s})(p_3 + p_6) + F(\bar{s}, 2\bar{l})p_4 + F(s, 2\bar{l})\,p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right].$$

It has thus become clear that comparing $E(\pi_0)$ and $E(\pi_i)$ is equivalent to calculating

$$E(\pi_0) - E(\pi_i)$$
$$= (I_0 - I_i)[1 + d(p_1 + p_2)] - d\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right], \quad \text{(A5)}$$

which can be written as

$$E(\pi_0) - E(\pi_i)$$
$$= \left\{(I_0 - I_i) - \frac{d}{1+d(p_1+p_2)}\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right]\right\}[1 + d(p_1 + p_2)].$$

Because $[1 + d(p_1 + p_2)]$ is positive, I know that

$$E(\pi_0) - E(\pi_i) \propto (I_0 - I_i) - \frac{d}{1+d(p_1+p_2)}\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right].$$

If denoting $\frac{d}{1+d(p_1+p_2)}\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right]$ as $V_p\left(s, l_H^f, l_L^f \mid \bar{l}, \mu, \eta, \rho, d\right)$ or $V_P\left(s, l_H^f, l_L^f\right)$ for short, I know that

$$E(\pi_0) - E(\pi_i) \propto (I_0 - I_i) - V_p\left(s, l_H^f, l_L^f\right) = I_0 - \left(I_i + V_p\left(s, l_H^f, l_L^f\right)\right). \quad \text{(A6)}$$

Therefore, I have demonstrated that comparing $E(\pi_0)$ and $E(\pi_i)$ in (A1) and (A2), respectively, is equivalent to comparing (A7) and (A8) as follows.

$$E(\pi_0) = I_0$$
$$= w_H(0)\left(\bar{l} - \overline{l_L}\right) + w_L(0)\overline{l_L}; \quad \text{(A7)}$$

For cases of incomplete exit, we have

$$E(\pi_i) = I_i + V_p\left(s, l_H^f, l_L^f\right)$$
$$= w_H(s_1)\left(\bar{l} - \overline{l_L} - l_H^{f1}\right) + w_L(s_1)\left(\overline{l_L} - l_L^{f1}\right) + F\left(s_1, l_H^{f1}, l_L^{f1}\right)$$
$$+ w_H(s_2)\left(\bar{l} - \overline{l_L} - l_H^{f2}\right) + w_L(s_2)\left(\overline{l_L} - l_L^{f2}\right) + F\left(s_2, l_H^{f2}, l_L^{f2}\right) + V_p\left(s, l_H^f, l_L^f\right). \quad \text{(A8)}$$

The two objective functions have identical structures as (3) and (4), respectively. Similarly, $s_j' \in \{0,1,2\}$, $j \in \{1,2\}$, and $s' = s_1' + s_2' \in \{1,2,3,4\}$. I can show that comparing $E(\pi_i)$ and $E(\pi_{i'})$ is essentially calculating

$$(I_i - I_{i'})$$
$$+ \frac{d}{1+d(p_1+p_2)}\left\{\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right] - \left[F\left(s', 2\bar{l}\right) p_5 + C\left(s', l_H^{f\prime}, l_L^{f\prime}\right)(p_3 + p_6)\right]\right\}.$$

This is equivalent to comparing $\pi_i = I_i + V_p\left(s, l_H^f, l_L^f\right)$ and $\pi_{i'} = I_{'} + V_p\left(s', l_H^{f\prime}, l_L^{f\prime}\right)$. Therefore, considering the property value of land as an income equivalent in the objective function is validated. The simplification allows us to discuss discrete and continuous choices of land and labor graphically.

If considering land rental markets, a similar proof can be derived. Denote land rental as R which is exogenous. For a household that chooses to cultivate a size of s, the rental income equals $R_i \equiv R(\bar{s} - s)$. Express the household's income as

$$E(\pi_i) = (I_i + R_i)$$

$$+d\left\{(I_i + R_i)p_1 + I_i p_2 + \left[I_0 + \left(C(\bar{s}) + C\left(s, l_H^f, l_L^f\right)\right)\right] p_3 + F(\bar{s}, 2\bar{l})p_4 + F\left(s, 2\bar{l}\right) p_5 + \left(C(\bar{s}) + C\left(s, l_H^f, l_L^f\right)\right) p_6\right\},$$

Using the same mathematical transformation, I know that comparing $E(\pi_i)$ is equivalent to comparing (A9) below.

$$(I_i + R_i)[1 + d(p_1 + p_2)]$$

$$+d\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6) - R_i p_2\right]. \qquad \text{(A9)}$$

Comparing $E(\pi_i)$ and $E(\pi_{i'})$ is essentially calculating

$$(I_i - I_{i'}) + R(s - s')$$

$$+\frac{d}{1+d(p_1+p_2)}\left\{\left[F\left(s, 2\bar{l}\right) p_5 + C\left(s, l_H^f, l_L^f\right)(p_3 + p_6)\right] - \left[F\left(s', 2\bar{l}\right) p_5 + C\left(s', l_H^{f\prime}, l_L^{f\prime}\right)(p_3 + p_6)\right] - R(s - s')p_2\right\}.$$

If V_p is expressed as$V_p\left(s, l_H^f, l_L^f \,|\, R, \bar{l}, \bar{s}, \mu, \eta, \rho, d\right)$, we can again compare adopt the same objective function for the income maximization problem of households.

Appendix 2. Farming Intensity and Returns to Scale

I demonstrate how the intensity of farming labor changes when the cultivation size increases under different assumptions of returns to scale. The agricultural production function is in the Cobb-Douglas form and concave in labor input (i.e., l), land size (i.e., s), and input costs of c.

$F(l,s) = l^{\alpha} s^{\beta} c^{\gamma}, \alpha, \beta \in (0,1).$

Taking the first-order-necessary-condition of the production function, I can express the optimal labor input as a function of the opportunity wage rate and the cultivation size.

$$\frac{\partial F}{\partial l} = \alpha l^{\alpha-1} s^{\beta} c^{\gamma} = w(s) \rightarrow l^{*} = \left(\frac{\alpha c^{\gamma}}{w(s)}\right)^{\frac{1}{1-\alpha}} s^{\frac{\beta}{1-\alpha}}.$$

The intensity of farming can thus be expressed as

$$\frac{l^{*}}{s} = \left(\frac{\alpha c^{\gamma}}{w(s)}\right)^{\frac{1}{1-\alpha}} s^{\frac{\alpha+\beta-1}{1-\alpha}} \propto w(s)^{\frac{1}{\alpha-1}} s^{\frac{\alpha+\beta-1}{1-\alpha}}.$$

I can take the first derivate of $\frac{l^{*}}{s}$ with respect to s.

$$\frac{\partial \frac{l^{*}}{s}}{\partial s} \propto \frac{\partial\left(w(s)^{\frac{1}{\alpha-1}} s^{\frac{\alpha+\beta-1}{1-\alpha}}\right)}{\partial s} = \left(w(s)^{\frac{1}{\alpha-1}} s^{\frac{\alpha+\beta-1}{1-\alpha}}\right)\left(\frac{1}{\alpha-1} w(s)^{-1} \frac{\partial w}{\partial s} + \frac{\alpha+\beta-1}{1-\alpha} s^{-1}\right),$$

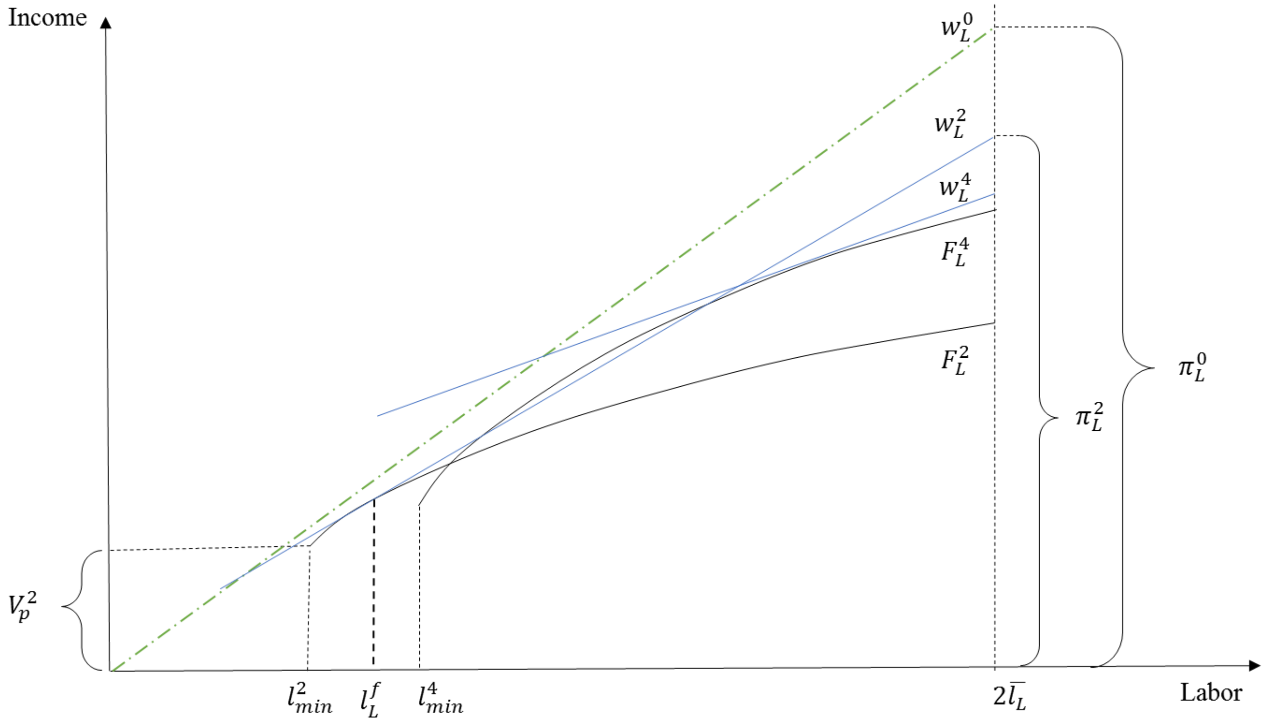
Because $w(s)^{\frac{1}{\alpha-1}} s^{\frac{\alpha+\beta-1}{1-\alpha}} > 0$, the first derivative can be further simplified to

$$\frac{\partial \frac{l^{*}}{s}}{\partial s} \propto \frac{-1}{1-\alpha} w(s)^{-1} \frac{\partial w}{\partial s} + \frac{\alpha+\beta-1}{1-\alpha} s^{-1}. \quad \text{(A10)}$$

If assuming constant returns to scale or $\alpha + \beta = 1$, then $\frac{\partial \frac{l^{*}}{s}}{\partial s} \propto \frac{-1}{1-\alpha} w(s)^{-1} \frac{\partial w}{\partial s}$. As long as $\frac{\partial w}{\partial s} < 0$, $\frac{\partial \frac{l^{*}}{s}}{\partial s}$ is positive and hence the farming intensity increases in the cultivation size. If assuming increasing returns to scale or $\alpha + \beta > 1$, then (A10) is positive unless $\frac{\partial w}{\partial s}$ is sufficiently larger than zero. Finally, if assuming decreasing returns to scale, (A10) has an ambiguous sign. If $\frac{\partial w}{\partial s} \geq 0$, then (A10) is negative. But (A10) may be constant or positive if $\frac{\partial w}{\partial s}$ is negative.

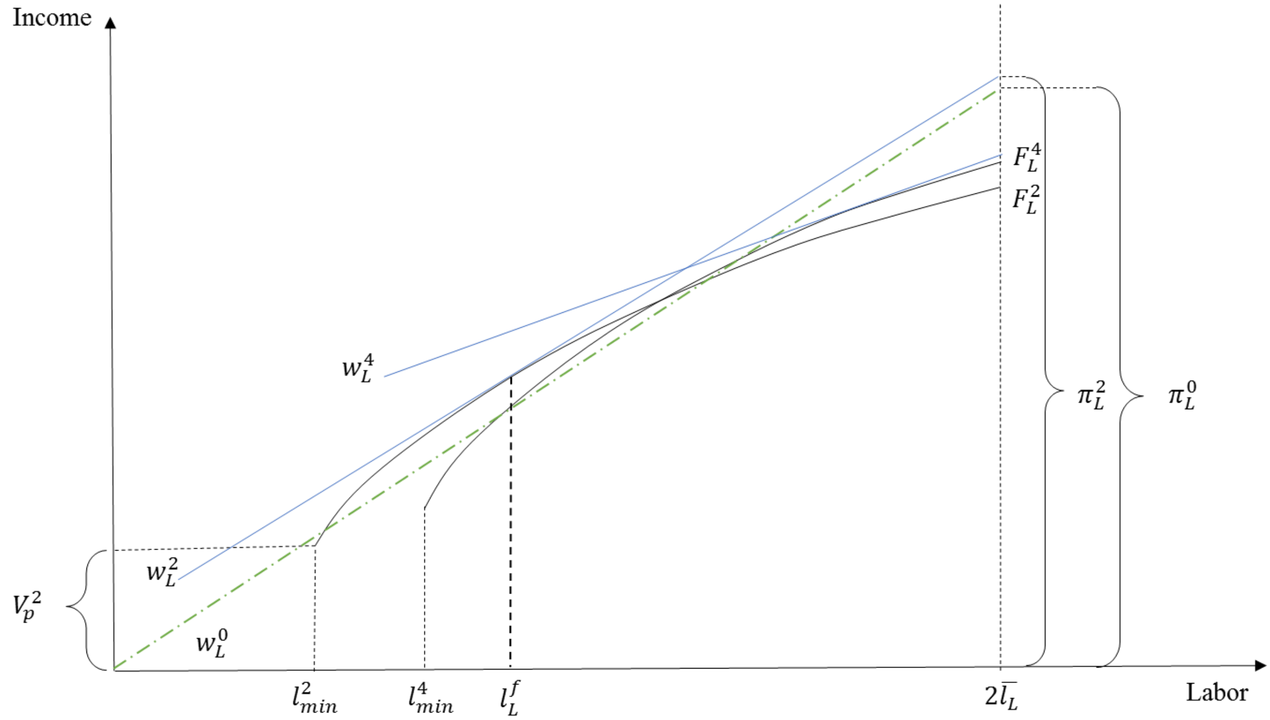
Note that if $\frac{\partial w}{\partial s}$ is zero or wage rate is fixed, then $\frac{\partial \frac{l^{*}}{s}}{\partial s} \propto \frac{\alpha+\beta-1}{1-\alpha} s^{-1}$. If assuming $\alpha + \beta = 1$, $\frac{\partial \frac{l^{*}}{s}}{\partial s}$ zero and $\frac{l^{*}}{s}$ is unchanged. If $\alpha + \beta > 1$, then $\frac{l^{*}}{s}$ increase in the cultivation size. If $\alpha + \beta < 1$, then $\frac{l^{*}}{s}$ decreases in s. This suggests, unless we assume increasing returns to scale for smallholder do we expect to see the labor-to-land ratio increase in the cultivation size if assuming a fixed wage rate. Increasing returns to scale is typically not a good assumption regarding smallholder farming. Yet if $\frac{\partial w}{\partial s} < 0$, we may see constant and increasing $\frac{l^{*}}{s}$ under any assumption on returns to scale. In particular, if there is a decreasing return to scale but a constant $\frac{l^{*}}{s}$ in the cultivation size, it must be that $\frac{\partial w}{\partial s} < 0$.

Figure 1-1. Baseline Model: Complete Exit is the Globally Optimum



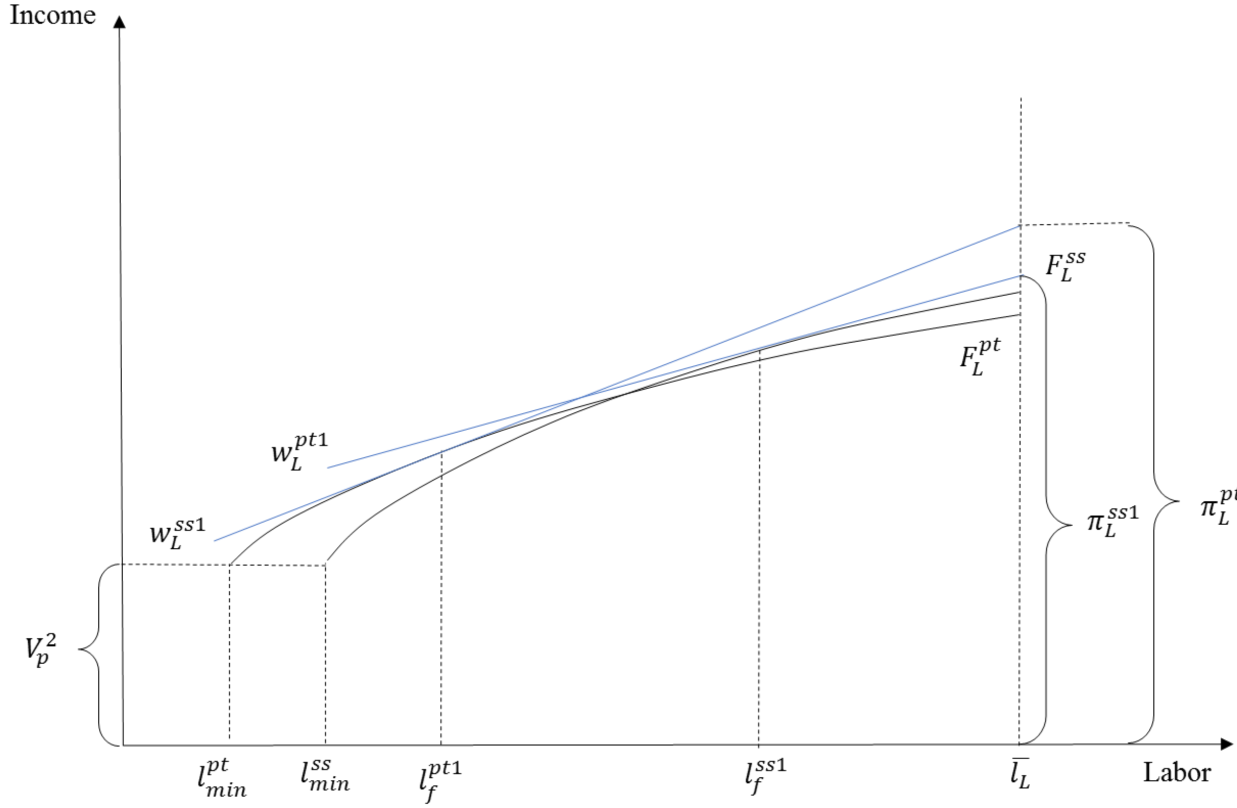
Note: the vertical axis measures household incomes from farming and nonfarm work done by the low-capacity labor. The total income is denoted as π_L^s. Farm income F_L^s follows a concave function with marginal productivity of labor increasing in s. The slope of w_L^s is the wage rate given s which decreases in the effective size of farm kept by the household. The optimal allocation of labor is determined when F_L^s is tangent to the corresponding w_L^s. All the following graphs adopt the same definitions of variables.

Figure 1-2. Baseline Model: Partial Exit is the Globally Optimum



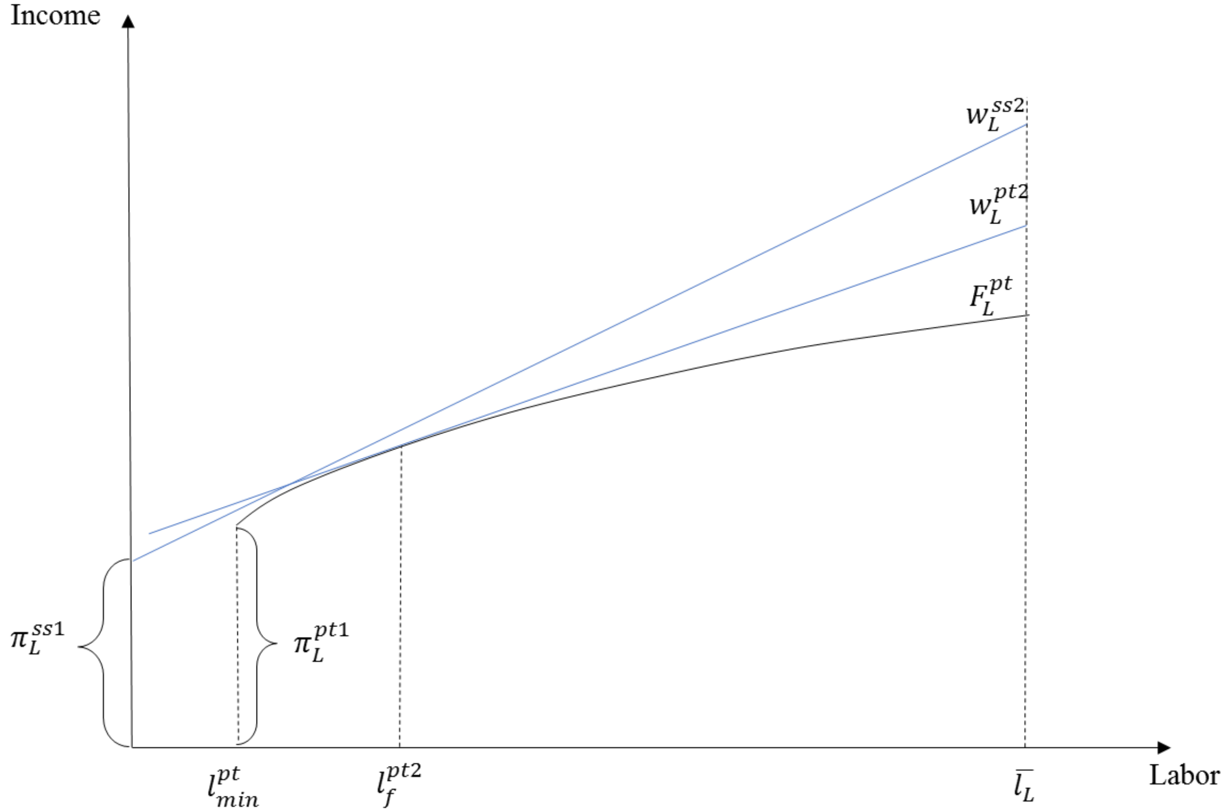
Note: same as the note for Figure 1-1.

Figure 1-3. Baseline Model: Compare Partial and Seasonal Exits (Season 1)



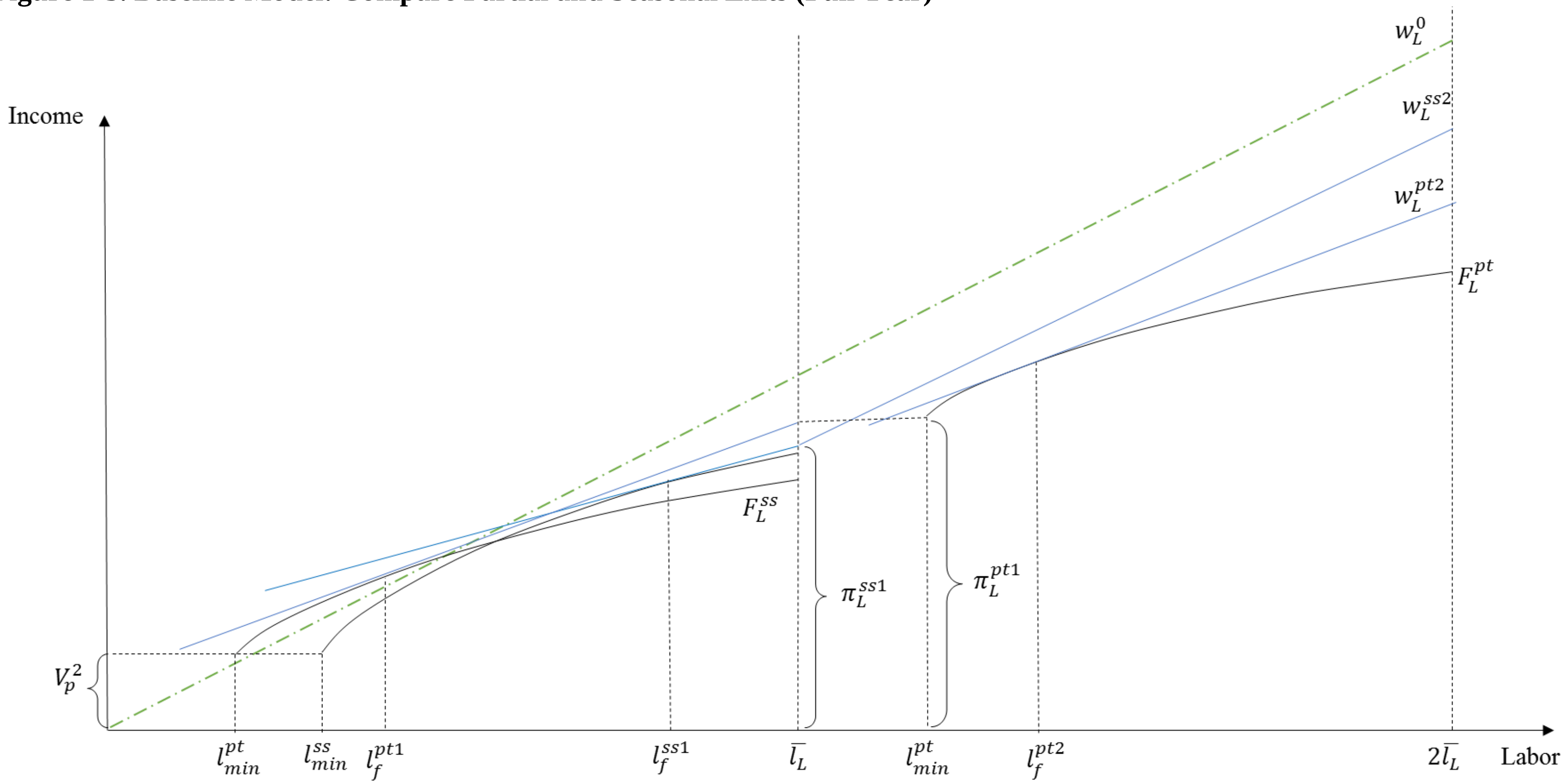
Note: same as the note for Figure 1-1. The superscript ss refers to seasonal exit and pt partial exit.

Figure 1-4. Baseline Model: Compare Partial and Seasonal Exits (Season 2)



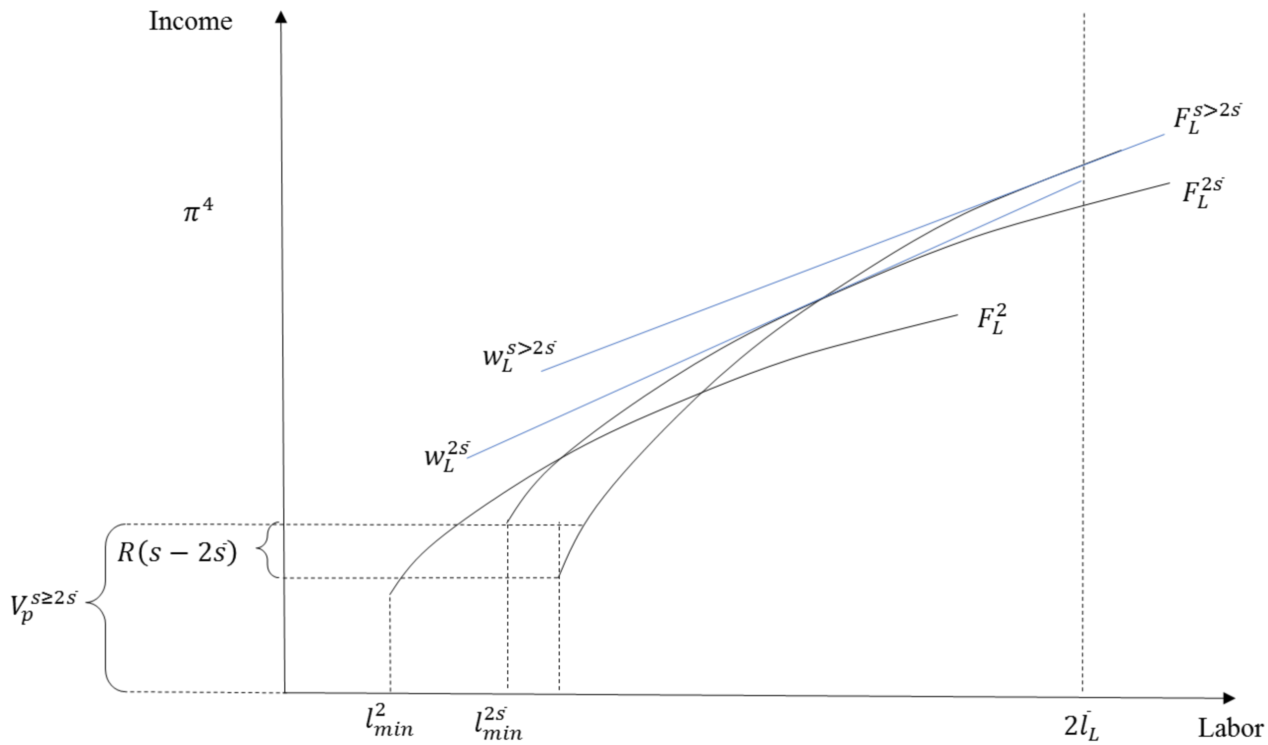
Note: same as the note for Figure 1-1. The superscript ss refers to seasonal exit and pt partial exit.

Figure 1-5. Baseline Model: Compare Partial and Seasonal Exits (Full Year)



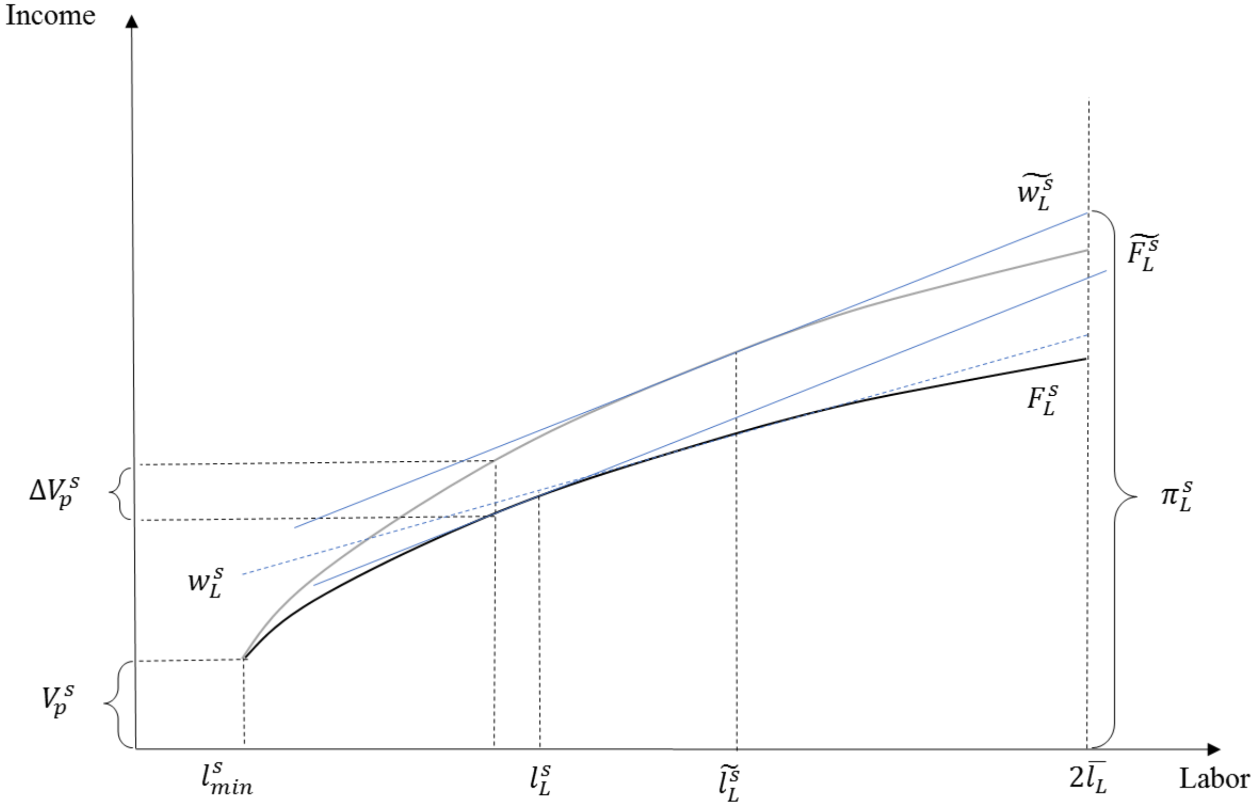
Note: same as the note for Figure 1-1. The superscript ss refers to seasonal exit and pt partial exit.

Figure 1-6. Baseline Model: Land Transfers



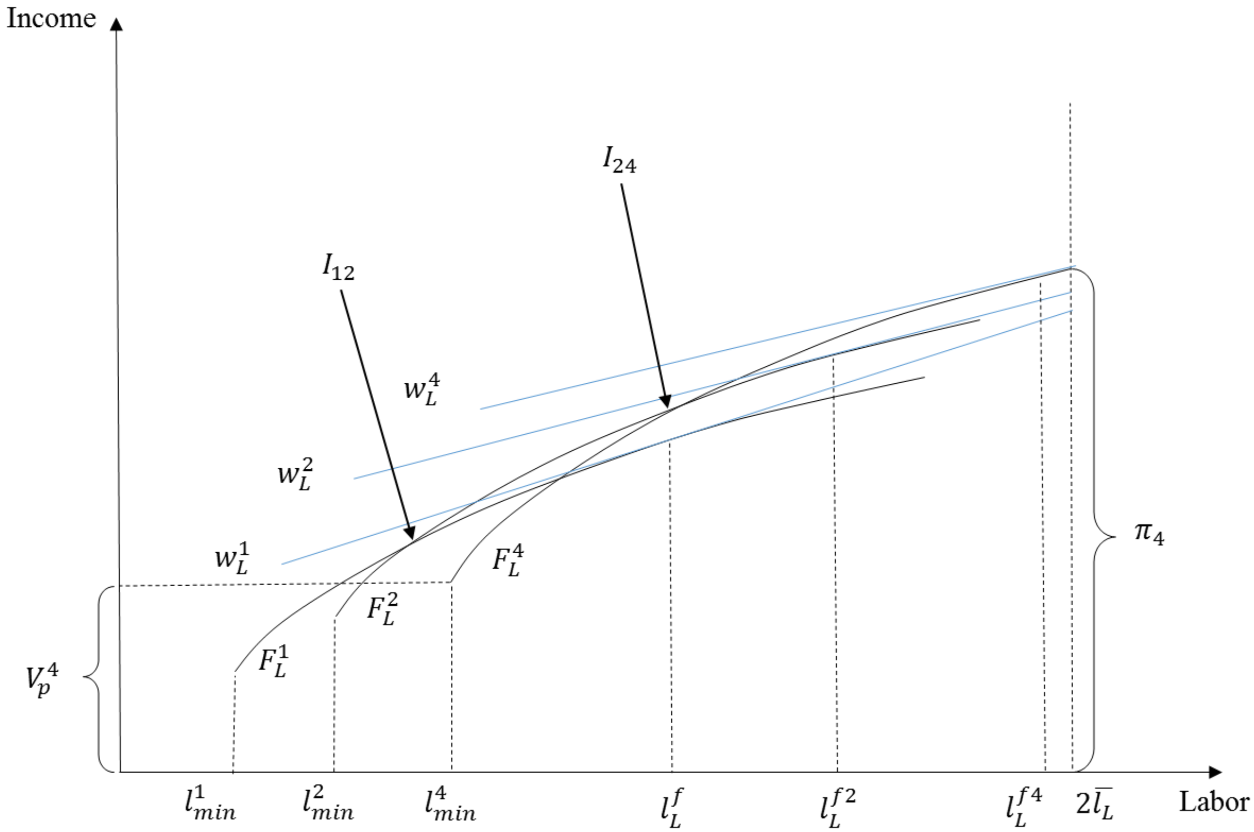
Note: same as the note for Figure 1-1.

Figure 1-7. Baseline Model: Continuous Choice of Land Size



Note: same as the note for Figure 1-1. The superscript ~ indicates shadow productivity of labor and shadow production function of cropping.

Figure 1-8. Baseline Model: the Property Trap



Note: same as the note for Figure 1-1.