

Sowing Seeds of Mobility: The Uneven Impact of Land Reform*

Ting Chen Jiajia Gu L. Rachel Ngai Jin Wang

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Abstract

Mobility barriers hinder structural transformation and economic growth. This paper examines how land market frictions constrain labor mobility. In many developing countries, rural households risk losing land if they stop cultivating it, causing wives to stay in agriculture while husbands move to non-agriculture. This implicit barrier is made explicit by China's hukou system. Using two land reforms that increased land security, we construct a county-level reform index and show that rural women left agriculture at higher rates than men, while urban women's employment and wages declined. Incorporating this index into a two-sector model with intra-household employment decisions replicates the observed uneven impacts and reveals significant effects on agricultural productivity.

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Ting Chen: Hong Kong Baptist University, tingchen@hkbu.edu.hk.

Jiajia Gu: International Monetary Fund, jgu@imf.org.

L. Rachel Ngai: London School of Economics, and CEPR, l.ngai@lse.ac.uk.

Jin Wang: Hong Kong University of Science and Technology, sojinwang@ust.hk.

1 Introduction

Structural transformation, arguably one of the most significant aspects of development, involves redistributing economic activities across sectors of the economy. As Kuznets highlighted in 1966, mobility barriers that impede the process of structural transformation hinder economic growth.¹ These barriers can lead to a misallocation of resources, contributing to the significant productivity gap between agriculture and non-agriculture observed in many developing countries (Restuccia et al., 2008; Gollin et al., 2014).

Land market frictions are widespread in rural areas of many developing countries due to incomplete property rights. In these settings, farmers often only have usage rights, while land ownership remains communal, resulting in absent or inefficient rental markets (Chen, 2017; World-Bank, 2024). Consequently, the opportunity cost of transitioning to nonfarm work includes not only the foregone labor income but also the potential loss of land income. The so-called “use-it-or-lose-it” practice represents a particularly acute manifestation of this form of land insecurity. These frictions pose significant barriers to labor mobility, especially when land accounts for a large share of agricultural production in developing countries. A common household response is for some members—often wives—to remain on the farm while others, typically husbands, migrate to the nonfarm sector. This pattern is consistent with evidence showing that lower-income countries have a higher proportion of women engaged in agricultural work (Lee, 2024). These observations underscore the importance of analyzing intra-household decision-making to fully understand the broader impacts of land insecurity.

In China, this implicit barrier to mobility is made explicit by the *hukou* (household registration) system, which provides a rare institutional context for directly measuring the impact of such mobility constraints. The system assigns citizens with two types of internal passport, categorizing citizens as either agricultural or non-agricultural *hukou*. Households with an agricultural *hukou* are entitled to farm government-allocated land rent-free, but they risk losing that land if they do not farm the land.²

The objective and contribution of this paper are twofold. Empirically, it uses large-

¹“A high rate of modern economic growth is attainable only if the required marked shifts in industrial structure are not too impeded by resistance of labor and of capital, of people and their resources in the old and accustomed grooves.” (Kuznets, 1966)

²Using five-wave of surveys spanning 1999-2010 covering 17 provinces and 77% of rural population, Feng et al. (2014) document substantial percentage of villages experiencing reallocation over time.

scale quasi-natural experiments from two land policy reforms to construct land reform index across Chinese counties as a direct measure of mobility barriers and identify the causal effect of mobility barriers. Using more than four thousand policy documents, we construct a reform index that displays temporal and spatial diffusion across counties. Our empirical studies reveal novel findings that land reforms have an uneven impact on gender and across the rural and urban population. They significantly increase the transition of rural women out of agriculture relative to men, but increase the gender gap in employment and wages for the urban population. Theoretically, to explain these new findings on the uneven impact of land reforms, the paper develops a two-sector, two-region model where a two-member household chooses which member to migrate and where to work. Using the land reform index constructed from the data as a direct measure of mobility barriers, the quantitative model matches well the uneven impact observed in the data. It also highlights the quantitative importance of land reforms for the dynamics of the relative productivity of agricultural.

Using Census data from China from 1990 to 2020, we begin by documenting two stylized facts on gender employment patterns during the structural transformation process. First, among those with an agricultural *hukou*, women have a lower employment rate in non-agricultural sectors relative to men. Household with non-agricultural *hukou* are almost entirely working in the non-agricultural sector. Second, among married couples with agricultural *hukou*, the most common pattern is that husband move to non-agriculture and wife stay agriculture. Both members work in non-agriculture becomes more common only after 2005.³

Motivated by these facts, we proceed to present empirical evidence on the uneven impacts of land reforms. We consider two land reforms. In 2003, China announced the Rural Land Contracting Law (RLCL), legally clarifying farmers’ right to rent out and rent in land. This was followed by the issuance of local regulations by provinces, prefectures, and counties, continuing until 2014. From 2009 to 2019, the land titling reform rolled out across China, establishing a national registration system for land ownership and issuing uniform land use certificates to further improve property rights. By comprehensively searching for more than 4,500 relevant legal and government documents, we construct a novel county-level land reform index that captures the temporal and geographic variations of these two reforms, and analyze their causal impacts. We find that these reforms significantly improve land security by strengthening the legal

³Cao et al. (2024) document similar employment pattern using 2000 and 2010 census.

protection of land ownership, particularly among households with migrant members. They have encouraged rural women to move out of agricultural sector more than men, and increased joint spousal employment in nonfarm work. For the urban population, we find that land reforms have increased the gender gap in employment and wages. The effects are stronger for the less educated group, indicating that the increase in rural women in non-agriculture sector has crowded out urban women due to the substitution effect.

To rationalize the empirical findings and quantify the effects of land reforms on migration and employment decisions, we build a two-region and two-sector model. The agricultural sector is located in the rural region, while the non-agricultural sector is located in the urban region. A household, comprising one female and one male member, can have an agricultural *hukou* or a non-agricultural *hukou*. Urban households decide for each member whether to supply fixed hours to work in the non-agricultural sector or specialize in home production.

Agricultural *hukou* households have homogeneous agricultural abilities but possess heterogeneous non-agricultural abilities. Households with agricultural *hukou* decide which member or both to work in the non-agriculture sector in the urban region. For the member or members who remain in the rural region, they decide the number of hours to work in the agricultural sector or in home production. The core ingredient of land policy is that households with agricultural *hukou* are entitled to farm land allocated by the government free of rent. We model land policy as a parameter that determines the fraction of land income a household can receive depending on their employment decision. This parameter is directly measured by the aggregate land reform index obtained by aggregating across all county-level land reform index.

The model incorporates two driving forces for changes in employment patterns over time. First, land reforms measured by the aggregate land reform index, which reduce the risk of losing land income if migrating, lower the opportunity costs for households with agricultural *hukou* to work in the non-agricultural sector. Second, the force of structural transformation increases the demand of labor in the non-agricultural sector. The differential effects across gender emerge from the assumption that the non-agricultural sector uses female labor less intensively than the agricultural sector and the home sector.

The remaining parameters of the model are calibrated to match the employment patterns in China in 2000 and simulated forward to 2020 to predict changes induced

by structural transformation and land policy reforms. A counterfactual exercise, a *no-reform scenario*, is conducted to examine the role of reform by fixing the land reform index to its 2000 level. We find that land reforms that improve land security (protect land income) have increased non-agricultural employment, especially joint spouse employment in non-agriculture. In its absence, the structural transformation would have been predominantly accompanied by husband-only migration, as wives are more likely to stay behind to work in the agricultural sector. The uneven impact on rural population has contributed to an uneven impact on urban population, leading to a rise in gender gap in employment and wage: the increase in rural female migrant relative to male has led to a decline in urban female employment and wages relative to male due to a substitution effect.

Reforms have also contributed to an increase in the relative productivity of agriculture through a work intensity channel and a selection channel. First, as more workers leave the agriculture sector, the land-per-worker ratio increases. This increases the return from agricultural work relative to non-market work, increasing hours per worker in agriculture. Second, the reform interacts with the usual selection mechanism by increasing the movement to non-agriculture, reducing the ability of marginal workers in the non-agricultural sector.^{4 5}

Recent literature has emphasized the impacts of mobility barriers on labor misallocation across sectors and occupations for sectoral productivity and aggregate productivity, with a particular focus on the allocation on female labor (Hsieh et al., 2019; Lee, 2024; Chiplunkar and Kleineberg, 2024). A common approach is to measure barriers as wedges to match some observed moments, and by assuming gender-specific wedges to explain the gender-specific trends. Our paper contributes to this literature by directly measuring an important form of mobility barriers (land insecurity) and showing its uneven impacts across gender, rural and urban populations. A key message of our paper is that a gender-neutral barriers (such as land market frictions) can generate

⁴This selection mechanism can lower the productivity growth of the expanding sector (i.e. non-agriculture in this case) has been shown in Young (2014). Imbert et al. (2022) show a different channel for higher migration to lower the non-agricultural productivity by inducing manufacturing firms to become more labor intensive.

⁵Young (2013) argues that the selection mechanism implies that the urban-rural gap in many developing countries largely reflects ability sorting rather than an efficiency gap. However, in the case of China there was an explicit restriction on migration and we find that this can contribute significantly to an efficiency gap. Our approach of allowing both the selection mechanism and mobility costs follows the recent literature that uses microdata to track individuals to show the importance of allowing both mechanisms (Lagakos, 2020; Lagakos et al., 2023).

gender-specific effects when non-agriculture sector uses female labor less intensively than the agricultural sector and the home sector.

Land insecurity and its economic implications have been discussed in the context of several developing countries, see for example, de Janvry et al. (2015), Chen (2017), Gottlieb and Grobovšek (2019), and Manysheva (2022). The two land reforms used in our analysis have been studied separately in recent empirical works. Chari et al. (2021) construct provincial-level land contracting reform index to show that it improves land allocation and agricultural productivity by increasing rental activity. However, they do not find significant evidence on labor reallocation away from agriculture or migration.⁶ Focusing on land titling reform, Liu et al. (2023) find that it has increased migration out of the farm.⁷ We contribute to this empirical literature by constructing granular *county-level* indices that include both land contracting and titling reforms, and by analysing their impacts across gender and across rural and urban populations.

Our quantitative model for studying the role of land insecurity is closely related to Ngai et al. (2019) and Adamopoulos et al. (2024), but differs in two key ways.⁸ First, rather than relying on survey data of reallocation frequencies, we construct land reform indices from comprehensive government documents to provide causal estimates of land insecurity and as a direct measure to feed into the quantitative model. Second, while Adamopoulos et al. (2024) examines migration decisions across age groups, we focus on uneven impacts across gender, rural and urban populations, driven by our empirical findings.⁹

Finally, our paper contributes to the recent macro and development literature on migration and employment in China. On the rural side, while Cao et al. (2024) also study the employment patterns of married households, we distinguish our work by linking empirical evidence from quasi-natural land reforms to a quantitative model. On the urban side, we propose a novel channel for the worsening of urban gender gaps (Feng et al., 2017; Brussevich et al., 2021; Qian, 2023) – the increase in

⁶Building on Chari et al. (2021) but using a different set of provinces, Shi et al. (2024) find that the provincial-level land contracting reform has encouraged labor movement into non-agriculture, but the effect is weaker for women.

⁷Specifically, Liu et al. (2023) find that farmers with higher human capital are more likely to migrate out of agriculture. It is important to note that their high human capital refers to more years of schooling within our less educated group, i.e. those without a college.

⁸See also Adamopoulos et al. (2022) on the role of land institutions in China that disproportionately constrain the more productive farmers and create substantial within-village frictions in land and capital markets, leading to lower aggregate agricultural productivity.

⁹Appendix Figure A2 show that our motivating figure Figure 1 holds for both young and old age defined by Adamopoulos et al. (2024).

rural female migrants imply an increase in urban gender gaps in wage and employment by crowding out urban female workers, highlighting the importance of studying the rural and urban population jointly. Our measure of mobility costs using land reforms as a natural experiment complements the work of Gai et al. (2024), who examined the new rural pension scheme. While our findings on migration and sectoral productivity are consistent with theirs, we highlight the uneven impact across gender, and between rural and urban population.

The rest of our paper is structured as follows. Section 2 provides a description of the background and presents the motivating facts. Section 3 presents the empirical evidence on the effects of land reforms on migration and employment. Section 4 presents the model, followed by the quantitative exercises. Finally, Section 5 concludes.

2 Background and Motivation

This section outlines the institutional background, including the land policy under the *hukou* system and related land reforms, followed by two motivating facts on employment and migration patterns.

2.1 Background

Hukou System—The household registration system known as *hukou* was established in 1958, acting as an internal passport to regulate migration. There are two types of *hukou*: “agricultural” and “non-agricultural” *hukou*. In addition, individuals are also identified by whether they held a local *hukou* within an administrative region, such as a city or town. A person’s *hukou* status, is inherited at birth from one’s parents (or specifically the mother before 1998). Over the years, the system has gradually relaxed to permit changes in *hukou* status.¹⁰

We focus on the land policy aspect of the *hukou* system.¹¹ Individuals with agricultural *hukou* are allocated farmland for cultivation but they do not possess ownership rights. The land may be reallocated if they do not use it, which discourages individuals from leaving agricultural activities. More details on China’s *hukou* system are provided in Appendix A1.

¹⁰Overall, over 60 percent of population still has an agricultural *hukou* in 2015.

¹¹A second aspect is that entitlements to social services such as education and healthcare are often tied to one’s registered *hukou* area. Migrant workers who leave their *hukou* location typically do not have access to these services at the destination location.

Land Policy Reforms— The Household Responsibility System (HRS) granted agricultural households control over farming decisions and residual output rights. The 1986 Land Management Law reaffirmed collective ownership of agricultural land, while explicitly granting land usage rights to these households. The 1998 revision reinforced these rights through formal 30-year land contracts from village governments. However, farmers faced challenges as they were unable to transfer or lease these rights, leading to uncertain property rights due to land reallocation until the late 1990s and even after 2000. During this period, there is hardly a rental market. If there is any rental transactions, they are largely informal and based on verbal agreements with very low rent, which constrained both the scale and scope of the transaction.¹²

This paper focuses on two major land reforms, the land contracting reform (2003–2014) and land titling reform (2010–2019). The land contracting reform, initiated by the central government’s Rural Land Contracting Law (RCLC) in 2003, granted agricultural households the legal right to lease and rent farmland. However, legally clarifying agricultural households’ rights to lease land was only one part of safeguarding land property rights. Land titling or certification was crucial to ensure direct contracting between landowners and lessees. Initiated in 2009 with pilot programs in 8 villages, the land titling reform established a centralized national registration system for land ownership and issued uniform land use certificates. It is important to note that ownership here refers only to the right to lease but not the right to sell. This system records data on owner households, demographics, household heads’ identities, family relationships, and precise GIS data of land parcels, enhancing security for land usage and contracting rights for owners. The completion of land titling reform in 2019 marked a significant milestone in improving land security in China’s agricultural sector.

2.2 Motivating Facts

Using data from the Chinese Population Census and the One Percent Population Survey (1990–2020), this section presents two sets of motivating facts on employment patterns by gender and *hukou* status.¹³ They highlight the potential role of the *hukou*

¹²Less than 10% of farmers rent out their land by 2000, with large variations across regions Deininger and Jin (2005). See Ngai et al. (2019) for a model of how land insecurity can lead to low rental rate and transactions.

¹³We focus on the age group 18–55 for ease of discussing the urban female employment rate, as the official retirement age in China is 55 for women. The patterns observed as motivating facts remain robust when using the working age range of 17–64. Details about data sources and main variables

system as a barrier to mobility, particularly for rural women during the process of structural transformation.

First, we document employment patterns by gender and *hukou* in Appendix Figure A1. Given the land policy described above, it is not surprising that almost no households with a non-agricultural *hukou* work in the agricultural sector. Among those with an agricultural *hukou*, women are less likely than men to be employed in non-agricultural sector. We confirm this aggregate fact using individual data in Appendix Table A1 by controlling for a rich set of factors such as ethnic minorities, age, age squared, marital status, skill (education), province fixed effects, and year fixed effects.

Next we turn to the employment patterns of married couples with agricultural *hukou*.¹⁴ We categorize them into four types: (1) both in non-agriculture, (2) husband-only in non-agriculture, (3) wife-only in non-agriculture and (4) both not in non-agriculture. Figure 1 summarizes the results. In the early years, structural transformation is characterized mainly by husband-only in non-agriculture. The wife-only in non-agriculture remains low throughout. Over time, both spouses work in non-agriculture has increased, especially after 2005. This coincides with the start of land reform around 2003. These patterns suggest that the *hukou* system may have acted as a barrier preventing females from leaving agriculture, and land reform accelerates the movement of women from the agricultural sector to non-agricultural sectors.

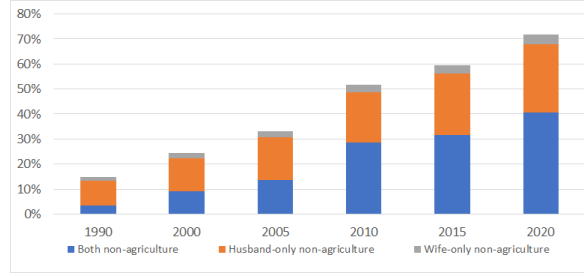
It is worth noting that non-agricultural employment includes both local nonfarm and migration out of county for non-farm jobs. To focus on the "use-it-or-lose-it" feature of land policy, we focus on the overall non-agricultural employment in most of our empirical analysis. Using data from the Chinese Household Income Project (CHIP) covering 1995 to 2018, Appendix A3 and Figure A3 shows that the migration patterns of married couples with agricultural *hukou* are consistent with the employment patterns in the Census.¹⁵

used can be found in Appendix A2 A and B.

¹⁴Most couples have the same type of *hukou*, the share of mixed *hukou* among aage 18-55 is around 5% throughout 1990-2010 and rise slightly to around 9% for 2015- 2020.

¹⁵The differences in the levels across the employment and migration patterns could be due to the presence of township and village enterprises (TVE), the non-agricultural sector in rural areas. During the 1980s and early 1990s, the growth of TVE was the main source of growth in non-agricultural employment. Since 2000, the growth in non-agricultural employment is dominated by non-agricultural sector in urban areas, see Ngai et al. (2019) Figure 1 using data constructed by Brandt and Zhu (2010).

Figure 1: Employment Pattern of Rural Married Households



Notes: Census. Pairs of rural husbands and wives aged 18–55 by sectoral employment. “Both non-agriculture” denotes that both the husband and wife are employed in non-agricultural sectors. “Husband-only non-agriculture” denotes that husbands work in non-agriculture and wives do not. “Wife-only non-agriculture” denotes that wives work in non-agriculture while husbands do not.

3 Empirical Analysis

This section presents empirical evidence on the uneven impact of land reforms since 2003 on migration and employment. We first examine land insecurity prior to the reforms. Next, we describe the construction of a county-level land reform index that captures the spatial and temporal variations in the intensity of the reforms. We then analyze how the reforms have affected rural individuals’ employment, migration, and household migration decisions. Finally, we explore the impact of land reforms on urban individuals’ employment.

To examine the impact of reforms on rural individuals and households, we use the Rural Fixed Points Survey (RFPS), which provides household-level data from 1995 to 2017 and individual-level data from 2003 to 2017. For the analysis of urban employment trends, we use the Chinese Household Income Project (CHIP) from 1995 to 2018. The RFPS tracks the same households and individuals over time, allowing us to control for unobserved selection factors at the individual level. To ensure demographic comparability between rural and urban samples, we restrict both groups to individuals aged 18 to 55 who self-report as “healthy” physically. Additional details about the data sources and the main variables used can be found in Appendix A2 C to E.

3.1 Land Reform Index

To understand the impact of the reforms mentioned in Section 2, we construct an index ranging from 0 to 3 to capture the post-2003 comprehensive land property rights reform. Specifically, we perform keyword searches in the database `pkulaw.com` to identify all legal and government documents relevant to both the land contracting reform and the land titling reform.¹⁶ Table A9 in the Appendix details the keywords used and document counts at different administrative levels. In total, we identify 3451 documents for the land contracting reform and 1071 documents for the land titling reform.

During the land contracting reform phase, in line with national legislation, provincial governments issued detailed regulations on leasing, lease transfers, and dispute resolution between 2003 and 2010. During this period, prefecture and county level governments also introduced specific administrative procedures and legal directives. By 2014, nearly all counties were governed by either provincial or local regulations, with many covered by both. A county receives 1 point if its provincial government has issued a relevant document, and an additional 1 point if the county itself has released a local regulation. Accordingly, a country can reach a maximum of 2 points with land contracting reform.

The land titling reform, launched in 2009, rapidly expanded across China. Provinces were granted autonomy to determine the commencement and implementation strategies of the reform. On average, registering and certifying all land parcels within a county took about two years. Due to the staggered rollout of the reform at the county level, there were significant spatial variations in the timing of its completion. We assign a score of 3 to counties that have completed the titling reform, regardless of the progress of the land contracting reform¹⁷.

Based on the above explanation, our land reform index ranges from 0 to 3. Figure 2 illustrates the spatial diffusion of the phased land reforms. Both reforms followed a top-down implementation process, initiated by the central government's "No. 1 Document" (Chari et al., 2021; Bu and Liao, 2022; Liu et al., 2023). The hierarchical diffusion of policies from provinces to prefecture and county levels suggests that the staggered

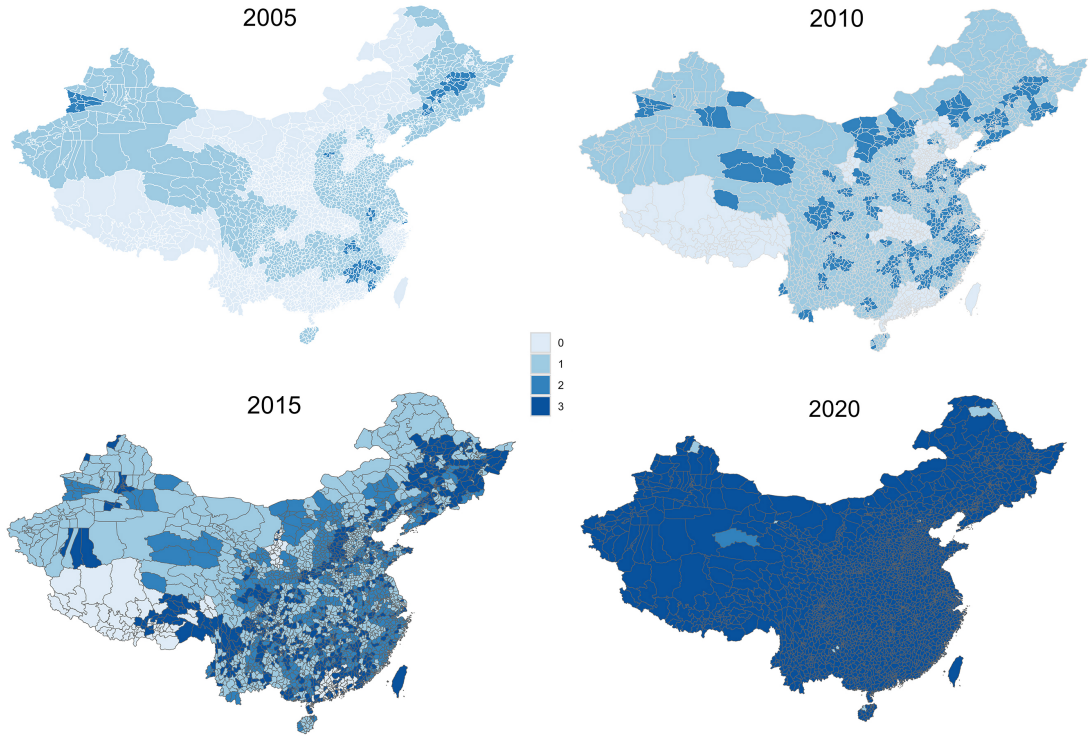
¹⁶As of September 2024, this database, one of the most extensive among its counterparts, has accumulated 4,049,703 documents issued by local governments (including provincial, prefectural, and county levels) and 454,035 documents issued by the central level government.

¹⁷Some counties did not complete the contracting reform, but completed the titling reform, which secured rental rights as well for agriculture *hukou* holders.

roll-out was likely independent of regional socioeconomic conditions. We verify this through balance tests (Table A10 in the Appendix) examining the randomness of the implementation timing.

Compared to existing indices, our land reform index advances in two fundamental ways. First, it exploits county-level variations stemming from the staggered roll-out of the contracting reform at provincial and prefectural/county tiers; Second, it integrates both contracting and titling reforms, representing a more comprehensive measurement of land property rights reform (2003–2019).

Figure 2: Spatial Diffusion of the Land Reform, 2003–2019



Note: This figure matched the county-level land reform index with the 2010 Chinese prefecture-level GIS map. Darker colors represent a higher Land Reform Index, reflecting greater depth and broader reform scope within each county. Our reform index takes three potential values: 0, 1, 2, and 3.

3.2 Impacts of Land Reforms on Land Security

We use the rural sample from the China Family Panel Survey (CFPS) to check whether land reforms impact land security at the household level. In each wave of CFPS (2010,

2014, 2016, 2018, and 2020), rural individuals were asked whether their households had land expropriated by the village government in the past 12 months.¹⁸ We use this variable as a proxy for household-level land insecurity and test two questions: 1) Does the reallocation of household members to non-farm sector or migration increase the likelihood of land expropriation during land reform periods? 2) Do land reforms reduce the probability of land expropriation for households with reallocation or migration? We employ the following specification:

$$\begin{aligned} LandExpropriated_{hot} = & \alpha + \beta_1 Nonfarm_{hot} + \beta_2 LandReform_{ot} \\ & + \beta_3 LandReform_{ot} * Nonfarm_{hot} + \delta_h + \kappa_t + X_{ot}\Gamma + \epsilon_{hot} \end{aligned} \quad (1)$$

where $LandExpropriated_{hot}$ is a dummy variable equal to 1 if household h from county o lost land due to village government expropriation in year t . $Migration_{hot}$ is also a dummy variable, indicating if the household has at least one member who had non-farm employment or migrated out of county o in year t . $LandReform_{ot}$ is the county-level land reform index introduced in section 3.2. The parameter β_1 represents the likelihood of a household experiencing land expropriation due to reallocation or migration (the “use-it-or-lose-it” mechanism), while β_3 measures the extent to which land reforms reduce this likelihood. We control for household and year fixed effects (δ_h and κ_t), as well as county-level economic control variables (X_{ot}) to strengthen the exogeneity of the land reform index measure.

The results in Table 1 suggest that land insecurity issue persisted in the 2010s. Having at least one member reallocate to non-farm employment or migrate out of the household increases the likelihood of land expropriation by 1.5% and 1.3% (Columns (1) and (3)). While land reform does not directly reduce the average likelihood of land expropriation, it does significantly reduce the probability of land expropriation for those households with members migrating out and/or moving to the non-farm sector (Columns (2) and (4)).

3.3 Reform Impacts on Rural Migration and Employment

We then examine the impacts of the land reforms on rural individuals’ employment and migration outcomes, with a particular emphasis on the gender differences. We

¹⁸It is worth noting that the average expropriation rate is relatively low, at only 6.78%, considering that direct expropriation by the village government differs from standard land reallocations and should be viewed as an extreme violation of land security.

Table 1: Impact of Land Reforms on Land Security

	Rural Household Sample CFPS Rural Sample (2010–2020)			
	(1)	(2)	(3)	(4)
Land Reform	-0.005 (0.003)	-0.004 (0.003)	-0.006** (0.003)	-0.004 (0.003)
Non-farm Employment	0.015*** (0.005)	0.054*** (0.012)		
Migration			0.013** (0.005)	0.046*** (0.015)
Land Reform * Non-farm Employment		-0.021** (0.011)		
Land Reform * Migration				-0.013** (0.005)
County-level Control Variable	Yes	Yes	Yes	Yes
Household Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	47469	47469	47469	47469

Notes: CFPS Rural Sample (2010–2020). The dependent variable is a dummy variable indicating whether the household lost land due to expropriation in year t . County-level control variables include county and village GDP per capita (logged), Share of secondary and tertiary industries, and population size (logged). Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

employ the following specification:

$$Nonfarm_{iot} = \alpha + \beta_1 LandRef_{ot} + \beta_2 LandRef_{ot} * Female_i + X_{it}\Phi + \delta_i + \kappa_t + \epsilon_{iot} \quad (2)$$

where $Nonfarm_{iot}$ is a dummy variable indicating a rural individual i 's decision to join the non-farm sector and/or migrate from county o for non-agricultural work in year t . $LandRef_{ot}$ represents the land reform index in county o during year t . We interact this land reform index with the individual's gender to assess any differing impacts of the reform. The key explanatory variable, the land reform index, is unlikely to be endogenous due to omitted variables that could be correlated with individual outcomes. First, the staggered roll-out of land reforms was determined by provincial and/or prefecture/county governments, independent of individual factors. Second, we add a rich set of regional economic as well as policy control variables to capture the potential confounding factors for the reforms roll-out, including county and village GDP per capita (logged), share of manufacture, and tertiary industries, and population size

(logged) and the intensity of external Hukou Reforms and a dummy variable to capture whether a county adopted the New Rural Pension Reform. Third, to address potential selection bias in out-migration, we control for individual fixed effects δ_i , year fixed effects κ_t , and a rich set of individual-level variables X_{it} (such as age, education level, and marital status). Standard errors are clustered at the county level to safe guard against potential heteroskedasticity.

We construct two measures of rural individuals’ employment and out-migration activities using RFPS data from 2003 to 2017. In the context of China’s agricultural Hukou system, rural individuals may either work in the non-farm sector locally within their county or migrate to more urbanized areas in search of non-farm employment opportunities. Thus, the first is a binary variable equal to one if the respondent engaged in any non-farm employment—either locally or through migration—during the year (the extensive margin), and zero otherwise. The second measure, which represents a subset of the first, captures out-migration specifically: it is a binary variable equal to one if the individual participated in any migrant labor—i.e., non-farm employment outside their home county—during the year.

Empirical Results—Table 2, columns (1) and (4) present results using Equation (2) for the two outcome variables: the dummies of non-farm employment and migration on the whole sample rural individuals aged between 18 and 55, respectively. The findings reveal that land reform has a distinct, positive effect on increasing rural female residents’ participation in non-farm employment or out-migration activities. The likelihood of female transition to non-farm employment increases by about 0.8 percentage points more than that of males per unit increase of the land reform index. Given the index’s four-point scale (0, 1, 2 and 3), it translates to a 2.4 percentage points increase upon completion of the entire reform agenda (column (1)). While the pertinent probability for female’s migration increases by about 0.7 percentage points more than males with per unit increase of the land reform index (column (4)).

Next step, we further assess the effect of reform on female labor supply in the non-farm sector and migration pattern by education levels. We first categorize individuals from the RFPS into two groups: those with low education (high school and below) and those with high education (college and above). We then rerun the baseline regressions in columns (2)-(3) and (5)-(6) of Table 2 separately for the lower education sample (high school and below) are reported in the even columns, while those for the higher education sample (college and above) are in the odd columns. This shows that the

reform effect on females is driven by the lower education group, as only the coefficients for the interaction term between the land reform index and female in the even columns are significant and of similar magnitude to those in Table 2.

To assess the robustness of our baseline results across different age groups, we conducted additional analyses. We re-ran the regressions from Table 2 on two sub-samples: individuals aged 18–44 and those aged 45–55. The results, presented in Appendix Table A11, suggest that the gender-biased impact of land reforms is more pronounced among younger cohorts (aged 18–44), in line with our expectations.

Table 2: Impact of Reforms on Rural Individuals' Migration and Employment, by Gender

Dependent Variables	Rural Individual Sample RFPS (2003–2017)					
	Non-farm (=1)			Migration (=1)		
	All	High School and Below	College and Above	All	High School and Below	College and Above
	(1)	(2)	(3)	(4)	(5)	(6)
Land Reform	0.010* (0.005)	0.010* (0.005)	-0.001 (0.012)	0.010** (0.004)	0.009** (0.004)	0.020* (0.012)
Land Reform * Female	0.008** (0.004)	0.008** (0.004)	0.026 (0.017)	0.007*** (0.002)	0.008*** (0.002)	0.010 (0.017)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	358949	351461	6840	358949	351461	6840

Notes: Rural Fixed Point Survey 2003–2017, age 18–55. The dependent variable in columns 1 to 3: A dummy variable equal to one if the surveyed individual devoted any labor days to non-farm employment during a year, while that in columns 4 to 6: A dummy variable equal to one if the surveyed individual devoted any labor days to out-migration work during a year. Columns 1, 4 use the full sample, while columns 2–3, and 5–6 use sub-samples categorized by education level. Individual control variables include age, a dummy variable indicating whether one is cohabiting with a partner, and education level. Economic control variables include county and village GDP per capita (logged), share of manufacture, and tertiary industries, and population size (logged). Policy control variables include the intensity of external Hukou Reforms weighted by pre-reform migration flow and a dummy variable measuring whether a county adopted the New Rural Pension Reform. Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Heterogeneity Test by Gender and Married Status—To determine whether the positive effects of land reforms on females are driven by married or unmarried women, we divide the RFPS sample into four groups based on gender and marital status.

We replace the female dummy variable in Equation (2) with dummies representing three groups: married females, unmarried females, and unmarried males, with married males serving as the reference group. We then interact these dummies with the reform indices. The results, reported in Table 3, confirm that the positive impact of land reform on rural females' labor reallocation is primarily driven by married women. This supports our hypothesis that married women were constrained by land insecurity and intra-household migration decisions prior to the reform.

Table 3: Impact of Reforms on Rural Individuals' Migration and Employment, by Gender and Marital Status

Dependent Variables	Rural Individual Sample RFPS (2003–2017)	
	Migration (=1)	Non-farm (=1)
	(1)	(2)
Land Reform	0.009** (0.004)	0.009* (0.005)
Land Reform * Married Female	0.008*** (0.003)	0.007** (0.004)
Land Reform * Unmarried Male	0.002 (0.005)	0.003 (0.005)
Land Reform * Unmarried Female	0.004 (0.005)	0.013** (0.007)
Control Variables	Yes	Yes
Individual FE	Yes	Yes
Year FE	Yes	Yes
Observations	358949	358949

Notes: RFPS 2003–17, age 18–55. The dependent variable in column: A dummy variable equal to one if the surveyed individual devoted any labor days to non-farm employment during a year, while that in column 2: A dummy variable equal to one if the surveyed individual devoted any labor days to out-migration work during a year. Individual control variables include age, a dummy variable indicating whether one is cohabiting with a partner, and education level. Economic control variables include county and village GDP per capita (logged), share of manufacturing, and tertiary industries, and population size (logged). Policy control variables include the intensity of external Hukou Reforms weighted by pre-reform migration flow and a dummy variable measuring whether a county adopted the New Rural Pension Reform. Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

On Rural Households' Employment and Migration Decisions—To confirm that land reforms drove the shift in rural households' employment and migration pattern from predominantly husband-only to joint reallocation to non-farm employment and migration, we designed an empirical test. This involved extracting a sub-sample

from RFPS consisting of pairs of married couples.¹⁹

We first conduct a multinomial logistic regression to analyze rural couples' employment and migration choices based on the land reform index, considering three outcomes: both employment in agricultural sector, husband-only non-farm employment and joint non-farm employment of the couple in column (1) and no migration, husband-only migration, and joint migration of the couple in column (4).²⁰ And then use probit regression for two specific binary comparisons: joint non-farm employment versus husband-only non-farm employment in column (2) and joint non-farm employment versus both remains in agricultural sector in column (3). And the same comparisons for the migration decision in columns (4) and (5). In all specification, we add the same regional control variables as in Table 2, and the micro-level control variables including both the husband's and wife's education levels and ages, couple- and year-fixed effects.

Table 4, column (1) report the estimation results for husband-only and joint non-farm employment compared to both employment in agricultural sector's case, while column (4) for husband-only and joint migrations compared to the no-migration case. The results from both columns indicate that land reform significantly increases the odds ratio of husband-only employment in non-farm sector and migration compared to no transition or migration, but it has an even greater effect on the odds ratios for joint transition or migration. Specifically, when the land reform index increases by from zero to three, the relative probability of couples choosing joint non-farm employment over husband-only non-farm employment case rises by 8.9% (i.e., the corresponding log-odds change is $0.120 \times 3 = 0.360$ from column (2), which, when evaluated at the baseline predicted probability at 0.5, translates to an increase of predicted probability of 0.589, or a 8.9 percentage point), while the relative probability of choosing joint non-farm employment over both remain in agricultural sector increases by 13.3% (i.e., the corresponding log-odds change is $0.182 \times 3 = 0.546$ from column (3), which when evaluates at the baseline probability at 0.5, translates to an increase of predict probability of 0.633, or a 13.3 percentage point). The corresponding predicted percentage point changes for joint- versus husband-only migration case and joint- versus no migration case are 6.6 and 13.2 percentage point (columns (5) and (6)).

¹⁹Although RFPS does not provide identifiers for all married couples within sampled households, we utilized a sub-sample of household heads and their spouses using information about the relationship with the household head.

²⁰Multinomial logistic regression is employed when the dependent variable has multiple unordered

Table 4: Impact of Reforms on Rural Married Couples' Migration Patterns

Rural Couples Sample Rural Fixed Point Survey (2003–2017)						
	Multinomial Regression (1)	Probit Regression (2)	Probit Regression (3)	Multinomial Regression (4)	Probit Regression (5)	Probit Regression (6)
	Husband-only Non-farm vs. vs. Both Agricultural employment	Joint Non-farm vs. Husband-only Non-farm	Joint Non-farm vs. Both Agricultural employment	Husband-only Migration No Migration	Joint Migration vs. Husband-only Migration	Joint Migration vs. No Migration
Land Reform	0.174*** (0.036)	0.120*** (0.016)	0.182*** (0.023)	0.138*** (0.034)	0.088*** (0.024)	0.181*** (0.025)
Land Reform	Joint Non-farm vs. Both Agricultural employment 0.241*** (0.037)			Joint Migration vs. No Migration 0.225*** (0.044)		
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
Couple FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79046	58413	71437	79046	58413	76583

Notes: Individual control variables include husband's age, wife's age, husband's education level, and wife's education level. Economic control variables include county and village GDP per capita (logged), share of manufacture, and tertiary industries, and population size (logged). Policy control variables include the intensity of external Hukou Reforms weighted by pre-reform migration flow and a dummy variable measuring whether a county adopted the New Rural Pension Reform. Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Robustness—We also assess the robustness of our previous results by using alternative data sources: the rural samples from the CFPS and CHIP. The CFPS has the added advantage of providing more balanced sub-samples of rural residents across various education levels,²¹ spanning the period from 2010 to 2020, which is more recent than the RFPS data. Moreover, it is individual-level panel data similar to RFPS. In contrast, CHIP is a nationally representative, repeated cross-sectional survey covering a longer time frame, specifically the years 1995, 2002, 2007, 2013, and 2018. Therefore, we control for both year and individual fixed effects, as well as control variables similar to those in Table 2 in columns (1) to (3) using CFPS, while controlling for year and county fixed effects with additional controls in columns (4) to (9) using CHIP.

We first apply the specification in Equation (2) to the full rural samples of CFPS (reported in Panel A of Table A12 in the Appendix) and CHIP (and Panel B of Table A12). Consistent with the findings in Table 2, land reforms show positive effects on rural females' transition to non-farm employment, with a larger effect for females compared to males, both in CFPS and Chip (columns (1) in Panel A and (7) in Panel B of Table A12). The same extra effect on females' migration decision (columns (4) in Panel A and (10) in Panel B).

In the remaining columns, we then further divide the samples by education levels categories, comparing each category with a base category.

²¹In RFPS, the sample of rural individual with a college education and above accounts for only 2.2% of the total observations.

and apply the same regression to both low- and high-educated sub-samples to conduct a heterogeneity test similar to those in Table A12, confirming a similar pattern: land reforms benefit the low-educated rural females.

3.4 Reform Impacts on Urban Employment

To examine the spillover effect of land reforms on urban residents' employment, we utilize the urban sample from six waves of CHIP data (1995, 1999, 2002, 2007, 2013, 2018). The specification is as follows:

$$Emp_{jdt} = \theta + \gamma_1 Index_{odt} + \gamma_2 Index_{odt} * Female_j + \sigma_j + \pi_t + v_{jdt}, \quad (3)$$

where the key outcome is whether urban resident j of prefecture d at year t is currently working in a paid, full-time or part-time job. $Index_{odt} = \sum_{o=1}^O \frac{MigInflow_{od} * LandReform_{ot}}{MigInflow_d}$ represents the weighted land reform indices—a shift-share measure capturing the spillover effect of land reforms in all potential migration outflow counties o on urban employment in destination prefecture d . It is based on the pre-reform heterogeneity of migration flows between o and d , which is calculated as the share of migration flow from county o to prefecture d relative to the total migration inflow to prefecture d in the base year, the 2000 census. Similar to Equation (2), we also interact the weighted land reform index with gender to determine whether the reform has a larger impact on urban female or male residents. We add the same regional economic control variables of GDP per capita (logged), share of secondary, and tertiary industries, and population size (logged), and the individual level control variables including age, cohabitation with partner dummy, education level, work experience, ethnicity, as well as county- and year- fixed effects. Standard errors are clustered at the prefecture level to safe guard against potential heteroskedasticity.

Empirical Results—Table 5 reports results using full sample in columns (1) to (2), the low education sample (high school and below) in columns (3) and (4), and high education sample (college and above) in columns (5) and (6). The dependent variables include: employment status, where 1 denotes current employment in a paid, full/part-time job at the time of the survey for urban residents and annual logged income.

The results indicate that external land reforms significantly decreased the likelihood of urban females being employed (column (1)) and a significant decrease in their income (column (2)). In contrast, no similar effect of land reforms on urban male employment

is observed.

Table 5: Impacts of Reforms on Urban Employment

Dependent Variable	Urban Individual Sample CHIP (1995–2018)					
	Employed (=1)	Income (Logged)	Employed (=1)	Income (Logged)	Employed (=1)	Income (Logged)
	All		Low Education		High Education	
	(1)	(2)	(3)	(4)	(5)	(6)
Weighted Land Reform	-0.011 (0.644)	0.037 (0.046)	-0.017 (0.394)	0.096 (0.110)	-0.073 (0.195)	0.024 (0.081)
Weighted Land Reform * Female	-0.028*** (0.008)	-0.051** (0.026)	-0.042*** (0.009)	-0.071** (0.036)	0.070 (0.046)	-0.033 (0.118)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
County FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	104175	74175	69345	51678	24805	18496

Notes: CHIP (1995–2018), age 18–55. The dependent variables are employment status, where 1 denotes current employment in a full/part-time paid job at the time of the survey for urban residents (columns 1, 3, and 5) and annual logged income (columns 2, 4, and 6). Control variables include age, a dummy indicator for cohabitation with a partner, education level, work experience, ethnicity, city GDP per capita, shares of secondary and tertiary industries, and population size (logged). Standard errors clustered at the county-year level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

The negative impact of land reforms on urban female employment may result directly from the substitution effect caused by the influx of rural female migrants. If so, urban women with lower education are expected to experience a larger impact.

Columns (3) to (6) of Table 5 report estimation results using the low education (columns (3) and (4) and high education sample (columns (5) and (6), using employment status and logged annual income as dependent variables. The same specifications as in Table 5 are applied to each sub-sample. Overall, the results reported in Table 5 support a substitution effect stemming from the reform. The plausibly exogenous land reform implemented in rural areas significantly affected high school and below-educated urban females, which aligns with the findings in Table 2 showing that lower educated rural females were most likely to migrate in response to the reforms. In terms of magnitude, a one-unit increase in the weighted land reform index decreases the likelihood of employment by 4.2% for lower-educated urban women (column (3)) compared to that of men. Additionally, we also identify a significant drop in urban wages, particularly for lower-educated women: a 7.1% decrease in their wages with a one-unit increase in the weighted index (column (4)). Meanwhile, the corresponding

effect for higher-educated urban women on employment status and logged income is statistically insignificant (columns (5) and (6)).

4 A Quantitative Model

This section presents a model to understand the empirical findings in section 3 and to quantify the effects of mobility frictions due to land insecurity on employment decisions. There are two sectors, the agricultural sector (denoted by subscript a) and the non-agricultural sector (denoted by subscript u).

There is a continuum of households with measure 1, each consisting of one female and one male member. A fraction α^u of households have a non-agricultural *hukou*, and a fraction $1 - \alpha^u$ have an agricultural *hukou*.²² To focus on the analysis of migration and employment, we assume that the goods markets are frictionless and that all consumers face the same price.

Members of non-agricultural *hukou* households only work in the non-agricultural sector and have ability ϕ . Given the focus on land policy and empirical employment patterns, we abstract from the sector choice of urban households for simplicity.²³ We further assume that the non-agricultural sector requires a fixed number of work hours, denoted as $\bar{n}$. A representative household head makes consumption and employment decisions on behalf of all urban households.

Households with agricultural *hukou* have the right to farm land allocated by the government free of rent. Members of agricultural *hukou* households have homogeneous agricultural ability, but they possess heterogeneous non-agricultural abilities. They draw a pair of non-agricultural abilities (γ_f, γ_m) from a distribution $F(\gamma_f, \gamma_m)$ for the female member (f) and the male member (m).

Conditional on their non-agricultural abilities (γ_m, γ_f) , they decide whether to work in the non-agricultural sector and, if so, which family member – or both – should work in non-agriculture. Meanwhile, for those who remain in the agricultural sector, they choose the number of hours to work on the farm and non-market production. The sectoral choice implies that there will be four types of agricultural *hukou* households in equilibrium: both members remain in the agricultural sector (type o), the female member works in the non-agricultural sector (type f), the male member works in the

²²Both members of the household are assumed to hold the same type of *hukou*. As noted in footnote 14, couples with mixed *hukou* are rare.

²³Urban households are not entitled to farm land free of rent.

agricultural sector (type m), and both members work in the non-agricultural sector (type b). Let α^i , where $i = o, f, m, b$, represent the equilibrium share of these four types of households:

$$\alpha^o + \alpha^f + \alpha^m + \alpha^b = 1 - \alpha^u \quad (4)$$

The process of structural transformation is governed by the sectoral choice of agricultural households, which is crucially dependent on land policy. Agricultural *hukou* households are granted the right to use the allocated land without rent, but do not have the right to transfer it, as the ownership remains with the state. Depending on the land policy, households may be able to rent the land and earn some rental income. This potential return will be formalized later through a parameter λ^i , which varies depending on the type of agricultural household $i = o, f, m, b$.

4.1 Land Policy and Production

The production of agricultural goods requires land as an input:²⁴

$$Y_a = A_a N_a^{1-\beta} K^\beta; \quad N_a \equiv \left[\xi_a (N_{fa})^{\frac{\eta-1}{\eta}} + (1 - \xi_a) (N_{ma})^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \quad (5)$$

where K denotes land, while N_{fa} and N_{ma} denote the total female and male work hours in the agricultural sector, respectively. The gender-specific wage rate is equal to the value of the marginal product of the worker:

$$w_{fa} = (1 - \beta) p_a A_a \xi_a \left(\frac{K}{N_a} \right)^\beta \left(\frac{N_a}{N_{fa}} \right)^{\frac{1}{\eta}} \quad (6)$$

$$w_{ma} = (1 - \beta) p_a A_a (1 - \xi_a) \left(\frac{K}{N_a} \right)^\beta \left(\frac{N_a}{N_{ma}} \right)^{\frac{1}{\eta}} \quad (7)$$

The total land income is $\beta p_a Y_a$, which will be allocated to households with agricultural *hukou* according to their types due to land policy. Specifically, the land income received by a type i agricultural household is equal to:

$$\lambda^i I_k = \lambda^i \frac{\beta p_a Y_a}{\alpha^o \lambda^o + \alpha^f \lambda^f + \alpha^m \lambda^m + \alpha^b \lambda^b}; \quad i = o, f, m, b. \quad (8)$$

²⁴To focus on intra-household decision and the gender differential impacts of land reforms, we adopt an aggregate production for simplicity.

The land policy parameter λ^i determines the amount of land income received by the household i depending on their migration decision. Specifically, the policy implies:

$$0 \leq \lambda^b \leq \lambda^f = \lambda^m \leq \lambda^o = 1 \quad (9)$$

A λ^i value less than 1 captures our empirical findings in section 3, which indicate that land could be reallocated away from households when family members work in non-agricultural sector.²⁵ In the subsection 4.3, λ^i is calibrated to the land reform index constructed in the empirical section.

The production of the non-agricultural goods uses only labor:

$$Y_u = A_u N_u; \quad N_u \equiv \left[\xi_u (N_{fu})^{\frac{\eta-1}{\eta}} + (1 - \xi_u) (N_{mu})^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}. \quad (10)$$

where N_{fu} and N_{mu} denote the quantity of female and male labor used in the non-agricultural sector respectively. The wage rate per efficient unit of labor for females and males is equal to their corresponding value of the marginal product of labor.

$$w_{fu} = p_u A_u \xi_u \left(\frac{N_u}{N_{fu}} \right)^{\frac{1}{\eta}}, \quad w_{mu} = p_u A_u (1 - \xi_u) \left(\frac{N_u}{N_{mu}} \right)^{\frac{1}{\eta}} \quad (11)$$

4.2 Households

We consider a unitary household where the household members care about a joint utility function:

$$U^i = \ln \left[(c_a^i - \bar{c})^\omega (c_u^i)^{(1-\omega)} \right] + \theta^i \ln H^i, \quad i = a, u; \quad (12)$$

where $i = a, u$ indicates whether the household holds an agricultural or a non-agricultural *hukou*; $\bar{c}$ is the subsistence level of agricultural goods; and c_a^i and c_u^i represent the consumption of agricultural and non-agricultural goods by household type i . These goods are purchased at market prices p_a and p_u . The home-produced non-market good H^i is composed of female and male non-market hours h_f^i and h_m^i .

The production function of the non-market goods for agricultural households de-

²⁵See Ngai et al. (2019) for a model where the land policy is represented by interpreting $1 - \lambda^i$ as the probability of land being reallocated away from household i .

pend on the employment decision and is given by:

$$H^i = \delta_f^i \delta_s^i (h_f^i)^{\xi_h} (h_m^i)^{1-\xi_h}; \quad i = o, f, m, b. \quad (13)$$

$$\delta_f^i = \begin{cases} \delta_f \leq 1 & \text{if } i = f, b \\ 1 & \text{if } i = o, m \end{cases}; \quad \delta_s^i = \begin{cases} \delta_s \leq 1 & \text{if } i = f, m \\ 1 & \text{if } i = o, b. \end{cases}$$

where $\delta_f \leq 1$ captures that when female members works in the non-agricutlural sector in the urban region, the production of non-market goods becomes less efficient, and $\delta_s \leq 1$ captures the disutility when couples split. Each member of the agricultural households has one unit of time to allocate between market and non-market activities.

$$n_g^i + h_g^i = 1; \quad i = a; \quad g = f, m. \quad (14)$$

where n denotes work hours and h denotes non-market hours, which include both home production hours and leisure hours. After observing their non-agricultural ability, they first make the sectoral choice by choosing among the four types $i = o, f, m, b$, which imply different budget constraints for their consumption decisions:

$$p_a c_a^i + p_u c_u^i \leq I^i(\gamma_f, \gamma_m); \quad i = o, f, m, b. \quad (15)$$

For members in the agricultural sector, they choose the hours of work. If they decide to work in the non-agricultural sector, they work fixed hours, and receive a fraction μ of the wage received by local worker. This is motivated by the findings in the literature that migrants either face discrimination or possess skills that are not well suited to the requirements of urban sectors (Meng and Zhang, 2001). In other words, μ ($0 \leq \mu \leq 1$) captures other labor market barriers beyond the scope of this paper.

The total household income for each of the four types of agricultural households is:

$$I^o(\gamma_f, \gamma_m) = w_{fa} n_f^o(\gamma_f, \gamma_m) + w_{ma} n_m^o(\gamma_f, \gamma_m) + \lambda^o I_k, \quad (16)$$

$$I^f(\gamma_f, \gamma_m) = \mu \gamma_f w_{fu} n_f^f(\gamma_f, \gamma_m) + w_{ma} n_m^f(\gamma_f, \gamma_m) + \lambda^f I_k, \quad (17)$$

$$I^m(\gamma_f, \gamma_m) = w_{fa} n_f^m(\gamma_f, \gamma_m) + \mu \gamma_m w_{mu} n_m^m(\gamma_f, \gamma_m) + \lambda^m I_k, \quad (18)$$

$$I^b(\gamma_f, \gamma_m) = \mu \gamma_f w_{fu} n_f^b(\gamma_f, \gamma_m) + \mu \gamma_m w_{mu} n_m^b(\gamma_f, \gamma_m) + \lambda^b I_k. \quad (19)$$

There are two sources of income for households with agricultural *hukou*. In addition to the labor income from working in either of the two sectors, they also receive land

income $\lambda^i I_k, i = i, f, m, b$ depending on their migration decisions and the land policy.

Since the non-agricultural *hukou* always stay in the urban region, the non-market production simply follows:

$$H^u = (h_f^u)^{\xi_h} (h_m^u)^{1-\xi_h}. \quad (20)$$

The head of the household chooses the employment rates for the female (E_f) and the male (E_m) members of the household. Given non-agricultural work involves fixed hours, the time constraint implies:

$$h_f^u = 1 - E_f n_c, \quad h_m^u = 1 - E_m n_c, \quad (21)$$

and the budget constraint for the urban household is:

$$p_a c_a^u + p_u c_u^u \leq I^u = w_{fu} n_c \phi E_f + w_{mu} n_c \phi E_m. \quad (22)$$

where ϕ denotes the average efficiency of urban workers.

Let Γ^i be the set of abilities (γ_f, γ_m) for households that have chosen to be of type $i = o, f, m, b, .$ The labor market clearing conditions by gender and sector satisfy:

$$N_{fa} = (1 - \alpha^u) \iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=o, m} n_f^i(\gamma_f, \gamma_m) dF(\gamma_f, \gamma_m), \quad (23)$$

$$N_{ma} = (1 - \alpha^u) \iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=o, f} n_m^i(\gamma_f, \gamma_m) dF(\gamma_f, \gamma_m), \quad (24)$$

$$N_{fu} = (1 - \alpha^u) \iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=f, b} \bar{n} \gamma_f dF(\gamma_f, \gamma_m) + \alpha^u \bar{n} \phi E_f, \quad (25)$$

$$N_{mu} = (1 - \alpha^u) \iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=m, b} \bar{n} \gamma_m dF(\gamma_f, \gamma_m) + \alpha^u \bar{n} \phi E_m. \quad (26)$$

The full derivation of the model is presented in Appendix A4.

4.3 Calibration

We calibrate the model to match the observed household employment patterns between 2000 and 2020 and then perform a counterfactual exercise to evaluate the impact of land reform.

Table 6: Baseline Land Policy Parameters

	2000	2005	2010	2015	2020
$\lambda^o = \lambda^f = \lambda^m$	1	1	1	1	1
λ^b	0	0.32	0.55	0.76	1

Notes: The land policy parameter λ^b is calibrated to the national average of land reform index constructed in section 3.

The abilities γ_f and γ_m is assumed to follow a log-normal distribution $\ln \gamma_g \sim \mathcal{N}(0, \sigma)$, $g = m, f$, with a correlation of ρ . We allow δ_s and δ_f to vary over time, reflecting technological advancements that facilitate long-distance communication and reduce reliance on female home production, for example through household durables. We also allow μ to change exogenously over time to capture other labor market wedges outside our model.

With these assumptions, the set of parameters include time-invariant parameters α^u , K , β , η , $\bar{n}$, α_u , σ , ρ , θ , θ^u , δ_f , $\bar{c}$, μ , ξ_u , ξ_h , ξ_a , and ω , potentially time-varying parameters δ_s , δ_f and μ , time-varying productivity parameters A_a and A_u , and time-varying land policy parameters, λ^o , λ^f , λ^m , and λ^b .

For households with both members working in agriculture, λ^o is 1 throughout. For household with one member working in agriculture, we assume they can guard the land, so λ^f and λ^m are set to 1 as well. The land income for households with both members in non-agriculture, the parameter λ^b is calibrated using our empirical land reform index. Recall that our reform index ranges from 0 to 3 for each county. We divide it by 3, calculate its national average, and use this as the probability of retaining land when both members work in the non-agricultural sector. The values are summarized in Table 6.

The other forces driving the changes in employment patterns are the sector-specific productivity parameters (A_a, A_u) and the subsistence consumption parameter $\bar{c}$. The average growth rates of A_a and A_u , denoted by g_a and g_u , are calculated using employment and value-added data by sector from 2000 to 2019 from China Statistical Yearbook (CSY). We adjust A_a using the average hours worked by agricultural workers calculated from the China Health and Nutrition Survey (CHNS). Given sector-specific productivity growth rates (A_a, A_u), subsistence consumption $\bar{c}$ governs the speed of the decline in agricultural employment. We start by assuming a value for $\frac{\bar{c}}{Y_a}$ for 2000, calibrate the remaining parameters for 2000, then simulate the model for 2020, and

finally adjust the value of $\bar{c}/Y_a$ for 2000 to match the share of households with both members in agriculture ($\frac{\alpha^o}{1-\alpha^u}$) in 2020.

We now explain how we set the rest of the parameters to match 2000. Given the value of $\bar{c}/Y_a$ and the Stone-Geary preference, we can normalize A_a , A_u , and total land endowment K to be 1 in the base year. The elasticity of substitution between female and male workers, η , is set to 2, a common value used in the literature (Ngai and Petrongolo, 2017). The land share, β , is set to 0.5 to match the reported land income share in China in Cao and Birchenall (2013). The number of hours worked per employed individual in the non-agricultural sector is set to 45 hours per week, i.e., $\bar{n} = 0.45$, based on the average hours per worker over multiple years from the CHNS. The share of non-agricultural hukou α^u is set to be 0.27, calculated from Census 2000. We use the correlation in years of schooling among rural couples as a proxy for ρ , calculated from RFPS 2004.

The exogenous labor market wedge μ is set to match the agricultural productivity gap (APG), defined as the value added per worker in the non-agricultural sector relative to that of the non-agricultural sector. A lower μ contributes to a larger APG. We use ω , δ_f , and δ_s to match the share of agricultural hukou households without migrants ($\frac{\alpha^o}{1-\alpha^u}$), the share of migrant households with female migrants ($\frac{\alpha^f+\alpha^b}{\alpha^f+\alpha^m+\alpha^b}$), and the share of one-migrant households ($\frac{\alpha^f+\alpha^m}{\alpha^f+\alpha^m+\alpha^b}$).²⁶ A higher ω reduces the overall migration. A lower δ_f reduces household utility when females migrate, contributing to a lower $\alpha^f + \alpha^b$. A higher δ_s increases the utility of single-migrant households, contributing to more $\alpha_f + \alpha_m$.

We choose σ such that the standard deviation relative to the mean of the income of the model-generated migrants matches the corresponding data moment, calculated using non-self-employed migrant workers from RFPS 2004. The parameters ξ_a and θ are set to match the relative hours in agriculture between genders and the average hours per worker in agriculture. The gender parameter ξ_u is calibrated to match wage of female relative to male in the non-agricultural sector, ξ^h to match the employment rate of urban female relative to urban male, and θ^u to match the average urban employment rate. Finally, we calibrate ϕ such that the average disposable income of non-agricultural *hukou* holders relative to that of agricultural *hukou* holders is 2.79, reported in CSY 2001.

The model is simulated at five-year intervals up to 2020. From 2005 to 2020, we

²⁶Given the sum of different *hukou* types have to satisfy Equation 4, where α^u is given exogenously, the three targeted moments pin down the shares of four types of agricultural *hukou* households.

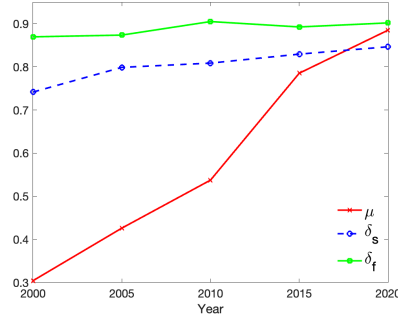
vary μ , δ_f and δ_s to match APG, the share of migrant households with female migrants ($\frac{\alpha^f + \alpha^b}{\alpha^f + \alpha^m + \alpha^b}$), and the share of migrant households with split migration ($\frac{\alpha^f + \alpha^m}{\alpha^f + \alpha^m + \alpha^b}$). Since $\bar{c}$ is set to target the share of households with both members in agriculture in 2020, the model exactly match the employment patterns of 2020. In 2005, 2010, and 2015, our approach matches the relative employment patterns. All parameter values are summarized in Table 7 and Figure 3.

Table 7: Baseline Parameters

Para.	Values	Data or targets
<i>Exogenously calibrated parameters</i>		
g_a	8.9%	Productivity growth, employment and value-added (CSY), hours (CHNS)
g_u	6.6%	Productivity growth, employment and value-added (CSY), fixed hours
η	2	Ngai and Petrongolo (2017)
$\bar{n}$	0.45	45 hours per week (CHNS)
β	0.5	Land share from Cao and Birchenall (2013)
α_u	0.27	Non-agricultural hukou share in Census 2000
ρ	0.48	Correlation in years of schooling among rural couples (RFPS 2004)
<i>Internally calibrated parameters to match 2000</i>		
ω	0.07	α_o share (Census)
σ	0.87	Income distribution of non-self-employed migrant workers (RFPS 2004)
ξ_a	0.49	Female over male hours of agricultural workers (CHNS)
θ	1.92	Average hours of agricultural workers (CHNS)
ξ_u	0.42	Female over male wage rate in the non-agricultural sector (UHS)
ξ_h	0.48	Female over male employment rate of non-agricultural hukou holders (UHS)
θ^u	2.53	Employment rate; non-agricultural hukou holders (UHS)
ϕ	2.40	Urban disposable income per person over that of rural counterpart (CSY)
<i>Strength of income effect</i>		
$\bar{c}$	0.38	α_o share 2020 (Census)

The *Reform* scenario is the model's prediction using parameters reported in Table 6, Figure 3 and Table 7. We conduct a counterfactual *No-Reform* scenario by fixing λ_f , λ_m , and λ_b at their 2000 values, while keeping all other parameters the same as in the *Reform* scenario. The impact of reform is measured as the difference between the two scenarios.

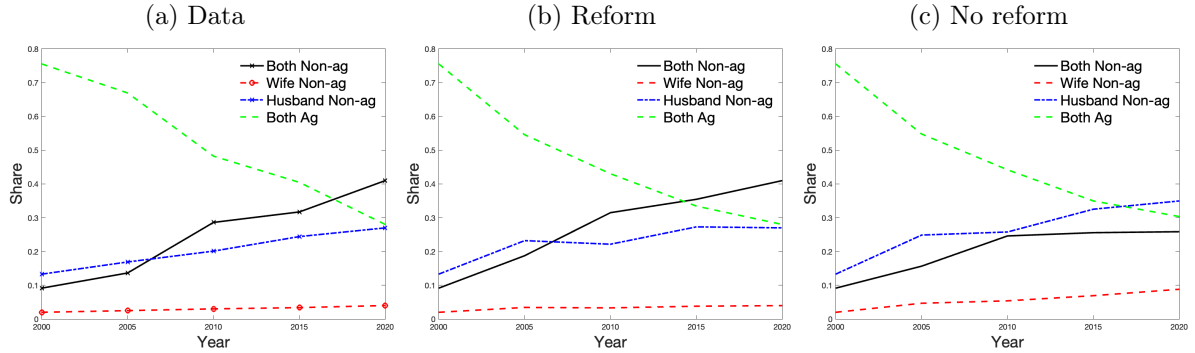
Figure 3: Baseline Time-varying Parameters



4.4 Uneven Impact of Land Reform

Figure 4 shows the effect of land reform on the employment pattern of households with agricultural *hukou*. Consistent with empirical results, land reform has significantly encouraged women to transit out of agriculture by increasing joint employment in non-agriculture. In the absence of land reform, the husband-only in non-agriculture will continue to dominate the joint-employment in non-agriculture.

Figure 4: Employment Pattern of Agricultural *Hukou* Households

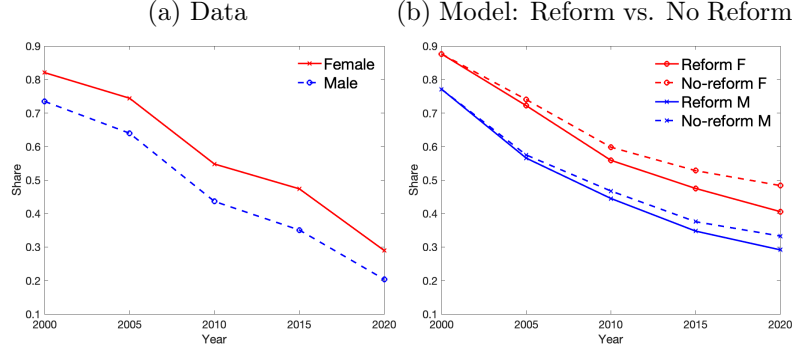


Notes: This figure plots the employment pattern of households with agricultural *hukou*. The four types sum to one.

The employment patterns of the households with agricultural *hukou* implies a gender-specific structural transformation, as shown in Figure 5, which plots the agricultural employment shares for female and male (untargetd moments). Land reform accelerates the transition out of the agricultural sector especially for female. With reform (Panel b), the agricultural employment shares decline by 47 percentage points (pp) for female and 48 pp for male. In the absence of land reform, the decline are only 39 pp and 44 pp respectively. In other words, the reform has speeded up the

female-specific structural transformation by 8pp, doubling its effect for male (4pp).

Figure 5: Gender-specific Structural Transformation



Notes: This figure calculates the non-agricultural employment share of female and male agricultural hukou holders. The no-reform case sets λ_i to their 2000 values.

Table 8: The Uneven Impact of Land Reforms

	Empirical Results 2000-2020	Model predictions 2000-2020
<i>Agricultural hukou</i>		
Non-ag employment rate, female – male	+2.4 pp	+3.1 pp
Type <i>b</i> compared to type <i>o</i> $\left(\frac{\alpha^b - \alpha^o}{1 - \alpha^u}\right)$	+13.3 pp	+17.5 pp
<i>Non-agricultural hukou</i>		
Female – male, employment rate	–2.8 pp	–3.1 pp
Female/male, wage ratio	–5.1 pp	–1.9 pp

Note: The empirical results are calculated based on regression coefficients and the change in national level land reform index. The model result is the difference between the reform and no-reform scenarios.

The prediction of an increase in female migrant workers in comparison to males generates a substitution effect on urban females. It raises the relative supply of female workers for the non-agricultural sector, lowering the equilibrium female wage relative to male in that sector. Within urban households, more female specialize in non-market production, leading to a decline in female employment rate relative to male.

Table 8 compares the predictions of the model with the econometric evidence of section 3. For households with agricultural *hukou*, the model predicts the reform increases the non-agricultural employment of female by 3.1pp more than the increase

for male. In the data the difference is 2.4pp, obtained by multiplying 0.8 in Table 5 by 3 (the full extent of reform from 0 to 3). It also accounts for the increase in joint employment in non-agricultural employment relative to joint employment in agriculture. Compared to the econometric evidence, which is explained in subsection 3.3, the model imply a larger impact of the reform on the increase in the share of households with both members working in non-agriculture. For households with non-agricultural *hukou*, the model predicts 3.1pp (1.9pp) decline in the female employment (wage) rate relative to the male, compared to the 2.8pp (5.1pp) in Table 5. In other words, the model slightly over-predicts the decline in female employment rate and account for 37% of wage rate relative to men.

Finally, we turn to the impact of land reform on the agricultural productivity gap (APG), defined as the value added per worker in the non-agricultural sector relative to that in the agricultural sector.²⁷ Figure 6a plots APG in the data, the reform and no-reform case. By construction, the reform case match the data exactly by setting the exogenous labor market wedge μ . In the absence of reform, the APG would have been 20% (at 4.5 instead of 3.7) higher in 2020 due to labor misallocation.²⁸

Figure 6c and Figure 6b highlight two channels that contribute to different APG levels under reform and non-reform cases. First, as workers leave the agricultural sector, the land-per-worker ratio increases. This increases the return from agricultural work relative to non-market. Hence, the hours worked per worker is higher under the reform relative to the no-reform case, as shown in Figure 6b. The second channel of the land reform interact with the usual selection mechanism, shown in Figure 6c. Workers with higher non-agricultural ability are the first one to move to the non-agricultural sector. As more workers move, the non-agricultural ability of the marginal worker decreases, contributing to a lower average ability of migrant workers. Since the reform case generates more migration, the average ability decreases more under the reform

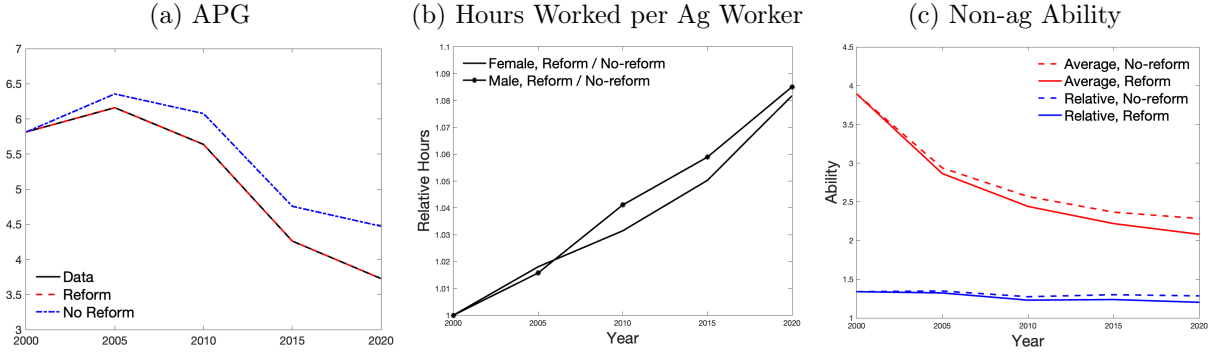
²⁷It is the ratio of $p_u y_u$ relative to $p_a y_a$, where

$$\frac{p_u y_u}{p_a y_a} = \frac{p_u Y_u / [\alpha_f + \alpha_m + 2\alpha_b + \alpha_u(E_f + E_m)]}{p_a Y_a / \left[(1 - \alpha_u) \left(\iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=o, m} \mathbb{1}_f(\gamma_f, \gamma_m) dF(\gamma_f, \gamma_m) + \iint_{(\gamma_f, \gamma_m) \in \Gamma^i, i=o, f} \mathbb{1}_m(\gamma_f, \gamma_m) dF(\gamma_f, \gamma_m) \right) \right]}$$

where y_u and y_a denote output per worker in the non-agricultural and agricultural sectors. $\mathbb{1}_f$ and $\mathbb{1}_m$ are indicators for if rural women and rural men work. Note that in the setup of our model, migrants always work.

²⁸The comparison here highlight the contribution of labor reallocation for APG. Land reform can also contribute to a decline in APG via reducing land and capital misallocation (Chari et al., 2021; Adamopoulos et al., 2022, 2024).

Figure 6: Agricultural Productivity Gap and Channels



Note: Panel(a): APG Data series are calculated using output and employment by sector from China Statistical Yearbook. Panel (b): "Non-ag Ability" refers to the non-agricultural ability of agricultural *hukou* holders working in the non-agricultural sector. Panel (c): "Hours Worked per Ag Worker" denotes the hours worked per employed agricultural worker.

scenario. It also reduces the ability gap between female and male migrant workers because the reform induces more female workers to move.

5 Conclusion

The unique feature of China's *hukou* system and its subsequent reforms allow us to identify and quantify the role of labor mobility barriers during the early stages of structural transformation from agriculture to non-agriculture. By employing quasi-natural experiments resulting from *hukou* reforms, we find that seemingly gender-neutral mobility barriers have gender-specific effects on employment patterns of rural population, which spillover to have an impact on gender gaps among urban population. Using a model that focuses on employment decisions within households, we show that removing these labor mobility barriers is quantitatively important for the transition of women out of agriculture and the emergence of joint migration relative to husband-only migration in developing countries. Our focus on land policy reforms echos the general consensus that land institutions and policies are critical for resilient and equitable growth (World-Bank, 2024).

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Appendix

A1 China's Hukou System

This section summarizes the current status and recent changes in the hukou system, drawing from comprehensive reviews conducted by Chan (2019). Since the early 2000s, certain cities, including Wuhan, in 11 provinces have eliminated the agricultural/non-agricultural classification in their local hukou systems. Residents in these areas now typically hold a unified hukou type known as “jumin hukou.” In some cases, rural hukou holders were required to give up their land for urban development in exchange for urban *hukou*, which grants access to social security benefits like old-age support. For those who retained their land, the hukou change may be mostly symbolic, providing fewer benefits.

The National New-Type Urbanization Plan announced in 2014 set a target of granting 100 million new urban hukou between 2015 and 2020 to facilitate migrant workers settling in cities. While priority was given to skilled workers and long-term migrants, many current and former farmers were also included. In July 2014, the State Council issued Opinions on Hukou Reform, which detailed measures to merge agricultural and non-agricultural *hukou* into a single classification—a move that began in some provinces in 2005. However, this formalization has not significantly improved migrants’ access to urban benefits.

In summary, while these reforms exist, they have not meaningfully narrowed the rural-urban gap nationally. The changes mainly affect specific urban areas. Despite various hukou reform initiatives, many remain limited in scope or merely cosmetic. In major cities where migrants reside and work, hukou restrictions still prevent full access to benefits, underscoring the ongoing significance of the hukou system.

Finally, census 2015 indeed did not provide hukou type, likely reflecting the unification of the hukou type. We used whether an individual has rural land contracting rights to proxy for the de-facto hukou type. As the 2015 data suggested, 62% had land rights, indicating the hukou type unification does not radically change the underlying land use rights linked to the previous agricultural-hukou population.

A2 Data

This section provides the details on the data used in the paper.

A. Censuses and One Percent Population Surveys

Our data on employment, structural transformation, and hukou status were obtained from the Chinese Population Censuses (1990, 2000, and 2010) and One Percent Population Surveys (2005 and 2015). This microdata is nationally representative and offers detailed information on gender, age, employment status, occupation, industry, hukou status (rural agricultural or non-agricultural urban),²⁹ current residence, marital status, and education across survey waves.

We start by constructing a key variable in our dataset: the employment status of the working-age population. We define an individual as being employed if a woman (man) aged 17 through 64 who reported her (his) work status as employed, and 0 otherwise. On that basis, we also compute the aggregate time series of female (male) employment rate by hukou, which is obtained by dividing the number of employed women (men) by the total number of women (men) in the same working age interval and hukou type in China. Next, we categorize industry information at the individual level into three primary sectors (primary, secondary, and tertiary) following the National Statistical Bureau’s sectoral classification system.³⁰ We then construct the sectoral employment rates (%) by gender (and hukou) to illustrate the process of structural transformation at an aggregate level.

We also compile several control variables we expect are related to employment, including an ethnic minority indicator, age, a marital indicator, and a high skill indicator. Appendix Table A2 provides the summary statistics for the pertinent variables.

B. CHIP

We integrate data from the nationally representative Chinese Household Income Project (CHIP) surveys conducted in 1995, 2002, 2008, 2013, and 2018 to shed light on the rural household migration patterns. Therefore, we utilize rural surveys from

²⁹For 2015, we use whether an individual has rural contracting rights as a proxy for hukou.

³⁰Refer to IPUMS1982–2000; GB/T 4754–2002; GB/T 4754–2010; GB/T 4754–2011. The primary sector includes agriculture, forestry, and fishing.

CHIP. Married households are defined as couples aged 17 to 64, accommodating multiple couple setups, including intergenerational families like parents and children. The rural household questionnaires in CHIP surveys, besides gathering employment and demographic data, consistently inquire about time spent away from the household or hometown. Respondents indicating “ ≥ 6 months (180 days)” are classified as migrants. While the question’s wording may vary slightly across survey waves, its core objective remains constant. This classification enables us to make meaningful comparisons across households and over time.³¹ Appendix Table A3 presents the summary statistics for the relevant variables.

C. Rural Fixed Point Survey

The Rural Fixed Point Survey (RFPS) is a longitudinal panel survey conducted by the Research Center of Rural Economy of the Chinese Ministry of Agriculture, providing micro-level data on rural household agricultural production. Initiated in 1986, the survey tracks a nationally representative sample of approximately 20,000 rural households across 300 villages in all 31 Chinese provinces.

These villages were carefully selected to ensure representativeness based on factors such as region, income, cropping pattern, population, and non-farm activities. Random sampling was employed to select households within each village for the survey. Renowned for its data quality, the RFPS dataset has been utilized in various influential studies such as Chari et al., (2021) and Adamopoulos et al., (2024). Our study utilizes RFPS data from 2003 to 2017 to examine rural residents’ migration, sectoral employment, and intra-household migration pattern. Appendix Table A5 presents the summary statistics for the pertinent variables used in our analysis.

D. China Family Panel Studies (CFPS)

The China Family Panel Studies (CFPS) is a biennial longitudinal survey conducted by the Institute of Social Science Survey (ISSS) at Peking University. Launched in 2010, the CFPS tracks a nationally representative sample of approximately 19,237 individuals from 8,582 households across 1,004 counties. The survey spans from 2010 to 2020, covering both rural and urban populations, which are both integral to our study.

³¹Note that none of the existing datasets in China is perfect at including migrants in their original households surveyed.

Using the six waves of data provided by CFPS, we construct two individual panels—one for urban non-agriculture residents and the other for rural agriculture residents—containing details on migration, employment, and income. This panel structure allows for two-way fixed effect estimation, enabling us to control for unobserved, time-invariant individual heterogeneities. Appendix Tables A6 and A7 provides the summary statistics for the pertinent variables for the rural and urban sample, respectively.

E. Urban Household Survey

The Urban Household Survey (UHS) is designed to study the living conditions and standards of urban households in China. Conducted directly by the National Bureau of Statistics, this survey employs stratified sampling techniques and daily accounting methods to collect comprehensive data from non-agricultural households across various cities and counties. The UHS captures various household information, including income, consumption expenditure, demographic characteristics, work and employment details, and accommodation data.

This long-standing large-scale socio-economic survey dates back to 1955. For our analysis, we leverage UHS data from 2002 to 2009, marked by consistent sampling frames and questionnaire designs. By constructing an individual-level repeated cross-sectional dataset from this source, we can explore the impacts of reforms on urban residents' employment. Appendix Table A8 displays the summary statistics of the variables used in our study.

A3 Migration Patterns of Married Households

This section documents the migration patterns of agricultural *hukou* married couples using CHIP data, reproted in Figure A3. We categorize them into four types: (1) both spouses migrate, (2) only the husband migrates, (3) only the wife migrates, and (4) neither spouse migrates. The patterns are consistent with employment patterns, with husband-only migration being the dominated type and joint migration increasing over time. We would like to caveat that no existing datasets perfectly capture migrants with a consistent calibre over time. To address the potential concern that the married agricultural hukou samples of CHIP may not adequately cover migrants, we repeat our analysis using the China Family Panel Studies (CFPS), which confirm our CHIP estimates for data period 2010-2020.

A4 Model Derivations

This section derives the household migration and employment decisions, taking the ability distribution, wage rates, and prices as given.

A4.1 Consumption Choices

Our utility function implies that the relative consumption of c_a^i and c_u^i satisfies:

$$\frac{\omega}{1-\omega} = \frac{p_a}{p_u} \frac{c_a^i - \bar{c}}{c_u^i}, \quad (27)$$

Together with the budget constraint, we get:

$$c_a^i - \bar{c} = \frac{\omega (I^i - p_a \bar{c})}{p_a}; \quad c_u^i = \frac{(1-\omega) (I^i - p_a \bar{c})}{p_u} \quad (28)$$

Given income I^i , the consumption decisions do not depend on hours allocation. The utility function can be rewritten as:

$$\begin{aligned} U^i &= \ln \left[(c_a^i - \bar{c})^\omega (c_u^i)^{(1-\omega)} \right] + \theta \ln H^i \\ &= \ln \left[\left(\frac{\omega (I^i - p_a \bar{c})}{p_a} \right)^\omega \left(\frac{(1-\omega) (I^i - p_a \bar{c})}{p_u} \right)^{1-\omega} \right] + \theta \ln H^i \\ &= \ln \left[\left(\frac{\omega}{p_a} \right)^\omega \left(\frac{(1-\omega)}{p_u} \right)^{1-\omega} \right] + \ln(I^i - p_a \bar{c}) + \theta \ln H^i \end{aligned}$$

Note that the first term, involving ω , p_a and p_u , is the same for all households. Hence maximizing U^i is equivalent to maximizing $\bar{U}^i$:

$$\bar{U}^i \equiv \ln(I^i - p_a \bar{c}) + \theta \ln H^i$$

A4.2 Agricultural Hukou Households

To determine a household's optimal migration and hours decisions, we solve the utility maximization problem under each migration scenario and select the one that yields the highest utility. Households take wage rates (w_{fu} and w_{mu}), land income (I_k), and its allocation rules (λ_i s) as given.

A4.2.1 Type o Households

In our setup, home hours h_g^i is always positive. A corner solution arises when one member's marginal utility from home hours h_g^i exceeds that of work hours n_g^i , even when work hours n_g^i approaches 0.

A type o household solves the following problem:

$$\begin{aligned} \max_{n_g^o, h_g^o} \quad & \ln [w_{fa}n_f^o + w_{ma}n_m^o + \lambda^o I_k - p_a \bar{c}] + \theta \ln [(h_f^o)^{\xi_h} (h_m^o)^{1-\xi_h}] \\ \text{s.t.} \quad & n_g^o + h_g^o = 1; \quad g = f, m. \end{aligned}$$

We first consider the interior solutions. The first order conditions for h_f^o and h_m^o are given by:

$$\frac{w_{fa}}{w_{fa}n_f^o + w_{ma}n_m^o + \lambda^o I_k - p_a \bar{c}} = \frac{\theta \xi_h}{h_f^o} \quad (29)$$

$$\frac{w_{ma}}{w_{fa}n_f^o + w_{ma}n_m^o + \lambda^o I_k - p_a \bar{c}} = \frac{\theta (1 - \xi_h)}{h_m^o} \quad (30)$$

They imply the following relative home hours:

$$\frac{w_{fa}}{w_{ma}} \frac{1 - \xi_h}{\xi_h} = \frac{h_m^o}{h_f^o} \quad (31)$$

Use Equation 31, Equation 29, and $n_g^o + h_g^o = 1$, we get a closed form solution for h_f^o :

$$h_f^o = \frac{\theta \xi_h}{1 + \theta} \frac{w_{fa} + w_{ma} + \lambda^o I_k - p_a \bar{c}}{w_{fa}} \quad (32)$$

Knowing h_f^o , Equation 31 solves h_m^o .

If the above solution for h_f^o yields a value greater than one, the female member has a corner solution. She specializes in home activities with $h_f^o = 1$. In this case, the hours allocation for the male member is given by:

$$\frac{w_{ma}}{w_{ma}n_m^o + \lambda^o I_k - p_a \bar{c}} = \frac{\theta (1 - \xi_h)}{h_m^o} \quad \longrightarrow \quad h_m^o = \frac{\theta (1 - \xi_h)}{\theta (1 - \xi_h) + 1} \frac{w_{ma} + \lambda^o I_k - p_a \bar{c}}{w_{ma}}$$

Similarly, when a male member specializes in home activity, we have $h_m^o = 1$. The

hours allocation of the female member is given by:

$$\frac{w_{fa}}{w_{fa}n_f^o + \lambda^o I_k - p_a \bar{c}} = \frac{\theta \xi_h}{h_f^o} \longrightarrow h_f^o = \frac{\theta \xi_h}{\theta \xi_h + 1} \frac{w_{fa} + \lambda^o I_k - p_a \bar{c}}{w_{fa}}$$

A4.2.2 Type f Households

A type f household solves the following problem:

$$\begin{aligned} \max_{n_g^f, h_g^f} \quad & \ln \left[\mu \gamma_f w_{fu} n_f^f + w_{ma} n_m^f + \lambda^f I_k - p_a \bar{c} \right] + \theta \ln \left[\delta_f \delta_s \left(h_f^f \right)^{\xi_h} \left(h_m^f \right)^{1-\xi_h} \right] \\ \text{s.t.} \quad & n_g^f + h_g^f = 1; \quad g = f, m. \end{aligned}$$

The migrating member, in this case the female, does not choose the hours.

$$n_f^f = \bar{n}; \quad h_f^f = 1 - \bar{n};$$

The first order condition for the hours choice of the male member is given by:

$$\frac{w_{ma}}{\mu \gamma_f w_{fu} \bar{n} + w_{ma} n_m^f + \lambda^f I_k - p_a \bar{c}} = \frac{\theta (1 - \xi_h)}{h_m^f}$$

Together with $n_m^f + h_m^f = 1$, we get an explicit solution for h_m^f :

$$h_m^f = \frac{\theta (1 - \xi_h)}{\theta (1 - \xi_h) + 1} \frac{\mu \gamma_f w_{fu} \bar{n} + w_{ma} L_m + \lambda^f I_k - p_a \bar{c}}{w_{ma}}$$

If the above formula gives a value of $h_m^f > 1$, we set $h_m^f = 1$, and this becomes the corner solution for the male member.

A4.2.3 Type m Households

In this case, the female member stays behind, while the husband migrates. Households solve the following problem:

$$\begin{aligned} \max_{n_g^m, h_g^m} \quad & \ln \left[w_{fa} n_f^m + \mu \gamma_m w_{mu} n_m^m + \lambda^m I_k - p_a \bar{c} \right] + \theta \ln \left[\delta_s \left(h_f^m \right)^{\xi_h} \left(h_m^m \right)^{1-\xi_h} \right] \\ \text{s.t.} \quad & n_g^m + h_g^m = 1; \quad g = f, m. \end{aligned}$$

In this case, male hours are given by:

$$n_m^m = \bar{n}; \quad h_m^m = 1 - \bar{n};$$

The first order condition of female hours is given by:

$$\frac{w_{fa}}{w_{fa}n_f^m + \mu\gamma_m w_{mu}\bar{n} + \lambda^m I_k - p_a \bar{c}} = \frac{\theta \xi_h}{h_f^m}$$

Together with $n_f^m + h_f^m = 1$, we get:

$$h_f^m = \frac{\theta \xi_h}{\theta \xi_h + 1} \frac{w_{fa} + \mu\gamma_m w_{mu}\bar{n} + \lambda^m I_k - p_a \bar{c}}{\gamma_f w_{fa}}$$

If the hours is greater than one ($h_f^m > 1$), we set $h_f^m = 1$. This becomes a corner solution for the female member.

A4.2.4 Type b Households

Both members of a type b household migrate. Since we assume migrants work fixed amount of hours in the non-agricultural sector, type b households do not choose hours. Their utility is given by:

$$\bar{U}^b = \ln [\mu\gamma_f w_{fa} n_f^b + \mu\gamma_m w_{mu} n_m^b + \lambda^b I_k - p_a \bar{c}] + \theta \ln \left[(h_f^b)^{\xi_h} (h_m^b)^{1-\xi_h} \right]$$

where

$$n_f^b = n_m^b = \bar{n}; \quad \& \quad h_f^b = h_m^b = 1 - \bar{n}; \quad g = f, m.$$

So far, we have shown the optimal hours decisions for each migration scenario. Knowing hours, the corresponding utility $\bar{U}^i$ can be calculated. A household can then pick the migration scenario (i) that generates the highest utility, given its non-agricultural ability pair (γ_f, γ_m) .

A4.3 Non-agricultural Hukou Households

We assume urban households are homogeneous, and a representative household head decides how many women and men work in the paid sector. The household head

maximizes the utility:

$$\begin{aligned} \max_{E_f^u, E_m^u} \quad & \bar{U}^u = \ln [w_{fu}\bar{n}\phi E_f^u + w_{mu}\bar{n}\phi E_m^u - p_a\bar{c}] + \theta^u \ln [(h_f^u)^{\xi_h} (h_m^u)^{1-\xi_h}] \\ \text{s.t.} \quad & h_g^u = 1 - E_g^u \bar{n} \quad g = f, m. \end{aligned}$$

where E_f^u and E_m^u denote urban female and male employment rates.

The representative household head chooses the optimal E_f^u and E_m^u . The corresponding FOCs are given by:

$$\frac{\phi w_{fu}}{\phi w_{fu}\bar{n}E_f^u + \phi w_{mu}\bar{n}E_m^u - p_a\bar{c}} = \frac{\theta^u \xi_h}{h_f^u} \quad (33)$$

$$\frac{\phi w_{mu}}{\phi w_{fu}\bar{n}E_f^u + \phi w_{mu}\bar{n}E_m^u - p_a\bar{c}} = \frac{\theta^u (1 - \xi_h)}{h_m^u} \quad (34)$$

This implies the relative non-working population:

$$\frac{w_{fu}}{w_{mu}} = \frac{\xi_h}{1 - \xi_h} \frac{h_m^u}{h_f^u} \quad (35)$$

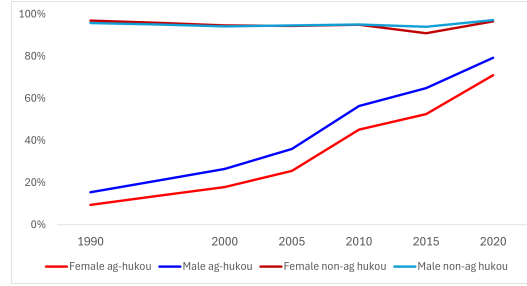
The implied female h_f^u is:

$$h_f^u = \frac{\theta \xi_h}{1 + \theta} \frac{\phi w_{fu} + \phi w_{mu} - p_a\bar{c}}{\phi w_{fu}} \quad (36)$$

Knowing h_f^u , we can solve for h_m^u , and calculate the corresponding employment rate E_f and E_m .

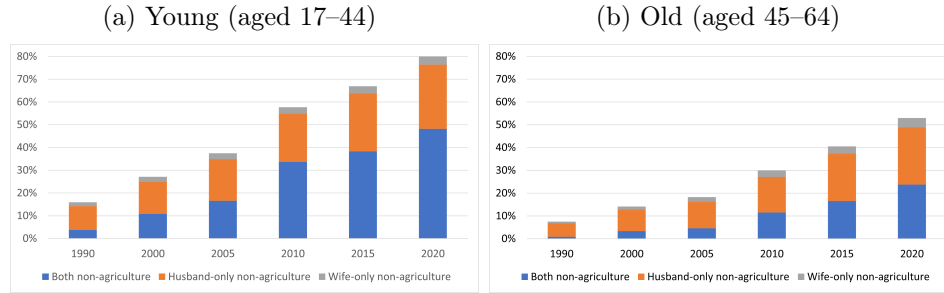
A5 Appendix Figures and Tables

Figure A1: Non-agricultural Employment Share by Gender and *Hukou* (1990–2015)



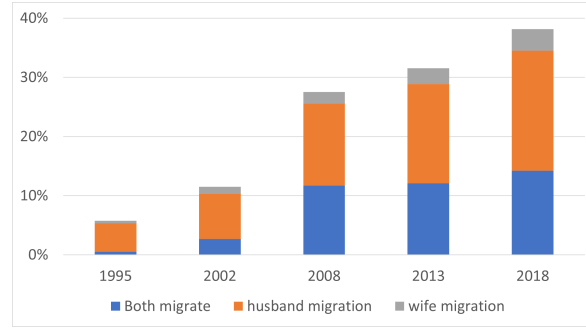
Notes: Census and one percent population survey. The figure displays the non-agricultural employment share by gender and hukou for aged 18 through 55 from 1990 to 2015.

Figure A2: Employment Pattern of Rural Married Households by Age Groups



Notes: Census. Pairs of rural husbands and wives aged 17–44 (young) in Panel A and 45–64 (old) in Panel B. “Both non-agriculture” denotes that both the husband and wife are employed in non-agricultural sectors. “Husband-only non-agriculture” denotes that husbands work in non-agriculture and wives do not. “Wife-only” denotes that wives work in non-agriculture while husbands do not.

Figure A3: Migration Pattern of Rural Married Households



Notes: CHIP. Pairs of rural husbands and wives aged 18–55 by migration mode: both spouses migrate, only the husband migrates, and only the wife migrates. Migrants: if an individual answers ≥ 6 months (180 days) to “How many days did you work away (live/work outside) from the household (your hometown)?”

Table A1: Sectoral Employment of Agricultural-hukou Holders

Dependent Variable	Non-Ag Employment
Female	-0.095*** (0.007)
Individual Controls	Yes
Province Fixed Effects	Yes
Year Fixed Effects	Yes
# of Obs	13785210
adj. R-sq	0.194

Notes: Census and One Percent Population Survey data from 1990, 2000, 2005, 2010, and 2015. Sample: agricultural-hukou holders (aged 18-55). Standard errors in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Controls include minority, age, age squared, marital status, and skill (education).

Table A2: Summary Statistics: Census 1990–2015

Variables	Obs.	Mean	SD	Min	Max
Employment	21,822,272	0.81	0.39	0	1
Ag Employment	21,822,272	0.50	0.50	0	1
Non-ag Employment	21,822,272	0.31	0.46	0	1
Gender (1=female)	21,822,272	0.49	0.50	0	1
Ag Hukou	21,788,012	0.73	0.45	0	1
Minority	21,822,272	0.08	0.28	0	1
Age	21,822,272	36.72	12.87	17	64
Marital Status	21,822,272	0.76	0.43	0	1
Education (high skill)	21,822,272	0.19	0.40	0	1

Notes: This table displays summary statistics for the variables described in Section 2.2.

Table A3: Summary Statistics: CHIP 1995–2018

Variable	Obs	Mean	Std. Dev.	Min	Max
Employment	89,258	0.87	0.33	0	1
Non-ag employment	89,258	0.39	0.49	0	1
Ag employment	89,258	0.48	0.5	0	1
Age	89,258	43.93	10.54	17	64
Education (skill)	89,258	0.15	0.35	0	1
Number of children	89,258	1.46	0.95	0	7
Live with extended family	89,258	0.3	0.46	0	1
No one migrate	89,258	0.81	0.4	0	1
Wife migrates only	89,258	0.02	0.13	0	1
Husband migrates only	89,258	0.11	0.31	0	1
Both migrate	89,258	0.07	0.25	0	1

Notes: This table displays summary statistics for the variables described in Section 2.2.

Table A4: Types of Rural Married Households by Sectoral Employment

Rural Household Type	1990	2000	2005	2010	2015	2020
Both not in non-agriculture	85%	76%	66%	48%	40%	28%
Both non-agriculture	3.3%	9.2%	14%	29%	32%	41%
Husband-only non-agriculture	9.9%	13%	17%	20%	24%	27%
Wife-only non-agriculture	1.6%	2.0%	2.5%	3.0%	3.4%	4%

Notes: Census. The table reports the share of four types of rural married households by sectoral employment. Sample: Rural married households consisting of pairs of husbands and wives aged 18–55, both with agricultural hukou. For 2015, we use whether an individual has rural contracting rights as a proxy for hukou. “Both non-agriculture” denotes that both the husband and wife are employed in non-agricultural sectors. “Husband-only non-agriculture” denotes that husbands work in non-agriculture and wives do not. “Wife-only” denotes that wives work in non-agriculture while husbands do not.

Table A5: RFPS: Summary Statistics

Variable	N	Mean	SD	Min	Max
Land Reform Index	537896	1.04	0.75	0	3
Weighted Hukou Reform Index	537896	2.94	0.87	1.03	5.93
Farm Labor Days	537896	2.49	2.37	0	5.90
Local Off-Farm Working Days	537896	1.32	2.21	0	5.90
Migration (=1)	537896	2.09	2.66	0	5.90
Migration Days	537896	0.39	0.49	0	1
Migration Days (Ratio)	475257	0.38	0.46	0	1
Migration Total Income	537896	1.56	3.33	0	15.43
Migration Cost	537896	1.99	3.41	0	17.89
Female	537896	0.48	0.50	0	1
Age	537896	37.23	10.91	18	55
Primary School and Below	168269	31.28%			
Middle School	299408	55.66%			
High School	56200	10.45%			
College or Above	14019	2.61%			
Married (=1)	537896	0.83	0.38	0	1

Notes: Rural Fixed Point Survey (RFPS), aged 18–55, agricultural hukou individuals.

Table A6: CFPS (Rural): Summary Statistics

Variable	N	Mean	SD	Min	Max
Land Reform Index	120734	1.78	0.83	0	3
Weighted Hukou Reform Index	120734	3.52	0.88	1.10	5.92
Migration (=1)	120734	0.11	0.32	0	1
Female	120733	0.50	0.50	0	1
Age	120734	36.77	10.86	18	55
Married (=1)	120734	0.74	0.44	0	1
Primary School and Below	48778	40.48%			
Middle School	45484	37.75%		0	1
High School	17556	14.57%		0	1
College or Above	8682	7.20%		0	1

Notes: China Family Panel Studies (CFPS), aged 18–55, agricultural hukou individuals.

Table A7: CFPS (Urban): Summary Statistics

Variable	N	Mean	SD	Min	Max
Weighted Land Reform Index	35038	1.75	0.54	0.15	2.86
Hukou Reform Index	35038	4.01	1.71	1	6
Employment (=1)	35038	0.72	0.45	0	1
Dropout Labor Market (=1)	35038	0.14	0.35	0	1
Income (Logged)	26686	7.94	4.25	0	14.9
Age	35038	38.4	9.95	18	55
Female	35035	0.50	0.50	0	1
Married (=1)	33345	0.81	0.39	0	1
Primary School and Below	7754	16.9%			
Middle School	12644	27.5%			
High School	12182	26.5%			
College or Above	12320	26.8%			

Notes: China Family Panel Studies (CFPS), aged 18–55, non-agricultural individuals.

Table A8: UHS: Summary Statistics

Variable	N	Mean	SD	Min	Max
Weighted Land Reform Index	463134	0.293976	0.211925	0	1.006811
Hukou Reform Index	463134	2.415916	1.19436	1	6
Employment (=1)	463134	0.820713	0.383593	0	1
Dropout Labor Market (=1)	463134	0.12356	0.32908	0	1
Income (Logged)	463134	8.672882	2.701076	0	13.49594
Female	463134	0.505351	0.499972	0	1
Age	463134	39.89515	9.601407	18	55
Married (=1)	458824	0.846019	0.360931	0	1
Working experience	411692	799.9661	962.8757	1	2009
Han (=1)	463134	0.969963	0.170688	0	1
Primary School and Below	13705	2.97%			
Middle School	114322	24.77%			
High School	181289	39.28%			
College or Above	152176	32.97%			

Notes: Urban Household Survey (UHS), aged 18–55, non-agricultural hukou individuals.

Table A9: Keywords: Search Documents from pkulaw.com

Keywords	Total	Province	City	County
Land Contracting Reform				
<i>Land Contracting</i> (“土地承包 ”)	1390	182	646	562
<i>Land Transfer</i> (“土地流转” or “土地转让 ”)	574	142	289	143
<i>Land Contracted Management</i> (“土地经营 ”)	1487	126	739	622
Total Number of Documents	3451	450	1674	1327
Unique Administrative Unit Issuing Policy		(27)	(256)	(348)
Land Titling Reform				
<i>Land Titling</i> (“土地确权 ”)	303	27	199	77
<i>Land Certification</i> (“土地登记 ”)	768	31	375	362
Total Number of Documents	1071	58	574	439
Unique Administrative Unit Issuing Policy		(31)	(286)	(431)

Notes: This table presents the keywords used in the search for land contracting law and land titling reform, along with the corresponding document counts at various administrative levels sourced from pkulaw.com.

Table A10: Balance Tests

	Land Reform Index						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP Per Capita	0.016 (0.047)	-0.183 (0.228)	-0.255 (0.289)	0.182 (0.170)	-0.074 (0.126)	-0.203 (0.228)	-0.089 (0.121)
GDP Growth Rate	-0.065 (0.037)	0.011 (0.057)	0.004 (0.057)	0.062 (0.136)	-0.042 (0.065)	-0.086 (0.065)	0.044 (0.060)
Population Size	-0.237 (0.162)	0.309 (0.220)	0.329 (0.221)	0.413* (0.186)	1.079** (0.393)	1.274** (0.387)	0.274 (0.254)
Rural Resident Average Income		-0.079* (0.034)	-0.087* (0.035)	-0.203 (0.228)	0.226** (0.086)	-0.089* (0.041)	-0.090** (0.034)
Manufacture Sector Share			-0.179 (0.166)	-0.314 (0.451)	0.200 (0.414)	-0.303 (0.278)	-0.178 (0.176)
Revenue Per Capita				0.022 (0.080)			
Rural Population with NRP				-0.006 (0.007)			
Rural Population with NRM				-0.039 (0.051)			
Number of Cellphone Users					0.032 (0.023)		
Number o of Internet Users					-0.018 (0.027)		
Connect to the National Highway						-0.173 (0.211)	
Rural Out-migrant Share							0.094 (0.063)
Observations	14501	5508	5470	938	1374	2978	5025

Notes: County Level Panel (2003–2020). Standard errors clustered at the county level in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A11: Impact of Reforms on Rural Individuals' Migration and Employment, by Gender and Age

Dependent Variables	Rural Individual Sample RFPS (2003–2017)			
	Migration (=1)	Migration days (Logged)	Migration Income (Logged)	Farming labor days (Logged)
Aged between 18 and 44				
	(1)	(2)	(3)	(4)
Land Reform Index	0.001 (0.005)	0.013 (0.027)	0.056 (0.049)	-0.004 (0.027)
Land Reform Index * Female	0.010*** (0.004)	0.048** (0.020)	0.184*** (0.041)	-0.016 (0.017)
Observations	228861	228861	228859	228861
Aged between 45 and 55				
	(5)	(6)	(7)	(8)
Land Reform Index	0.012** (0.005)	0.060** (0.026)	0.134*** (0.048)	-0.011 (0.033)
Land Reform Index * Female	-0.005 (0.005)	-0.029 (0.024)	-0.035 (0.046)	-0.018 (0.023)
Observations	120024	120024	120024	120024
Control Variables	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

Notes: Rural Fixed Point Survey 2003–2017. The dependent variables in columns 1 to 4 are: A dummy variable that equals one if the surveyed individual devoted any labor days to out-migration work during a year (the extensive margin); the logged total number of labor days spent on out-migration activities (the intensive margin); the logged income from out-migration activities; and the logged total labor days spent on farming. Control variables include age, a dummy variable indicating whether one is cohabiting with a partner, and education level. Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A12: Impact of Reforms on Rural Individuals' Migration by Education Level, Alternative Data

Dependent Variables	Rural Individual Sample								
	CFPS (2010–2020)			CHIP (1995–2018)					
	Migration (=1)			Migration (=1)			Migration days (Logged)		
	All	High School and Below	College and Above	All	High School and Below	College and Above	All	High School and Below	College and Above
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Land Reform Index	0.016** (0.007)	0.016** (0.007)	0.029 (0.020)	0.022 (0.027)	0.024 (0.028)	-0.139* (0.080)	0.307* (0.169)	0.352** (0.167)	-1.026** (0.521)
Land Reform Index * Female	0.009** (0.004)	0.009** (0.004)	0.012 (0.023)	0.017*** (0.004)	0.019*** (0.004)	-0.010 (0.013)	0.056** (0.025)	0.055** (0.026)	-0.066 (0.075)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Individual FE	Yes	Yes	Yes	No	No	No	No	No	No
County FE	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	114647	105962	7250	83546	78282	5237	83546	78282	5237

Notes: Columns (1) to (3) use CFPS Rural Sample (2010–2020), while (4) to (9) use CHIP Rural Sample (1995–2018). The dependent variable is a dummy variable indicating migration. Columns 1, 4, 7 use the full sample, while columns 2-3, 5-6, and 8-9 use sub-samples categorized by education level. Control variables include age, a dummy variable indicating whether one is cohabiting with a partner, and education level. Standard errors clustered at the county level in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.