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The Left-Behind and Land Reforms in China**

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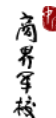
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*JEL Classification:* Q12, Q18, O11

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# Spatial Misallocation in Education: The Left-Behind and Land Reforms in China

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March 21, 2026

## Abstract

We study how land security shapes family migration and rural-origin children's human capital amid stark urban-rural education gaps. Exploiting China's staggered land reforms, we find that (i) strengthened land security reduces by 33% the likelihood migrants leave children behind; and (ii) each additional childhood year in urban areas raises university enrollment probability by 0.8 percentage point. A calibrated heterogeneous-agent model with incomplete markets, migration, and education implies that the reforms yielded a 2.1% consumption-equivalent welfare gain by reallocating talent and reducing precautionary distortions. General equilibrium adjustments in land markets are first-order for the reform's aggregate and distributional evaluations.

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# 1 Introduction

Inequality of opportunity can lead to misallocation of talent, lowering overall economic efficiency. For example, Chetty et al. [2016] and Chetty and Hendren [2018a,b] show that moving disadvantaged children to better neighborhoods improves their long-run outcomes in the United States. In China, there are historically large disparities in education between rural and urban children [Hannum, 1999, Connelly and Zheng, 2007]. Figure 1 shows that while these gaps hold even among individuals with similar innate ability, migration from rural to urban areas in relatively young age (as proxied by change from agricultural to non-agricultural hukou) might mitigate disadvantages associated with being born in rural areas. As these patterns are robust to controlling for demographics and revealed location preferences, it suggests a substantial misallocation of human talent due to geographic and institutional barriers.

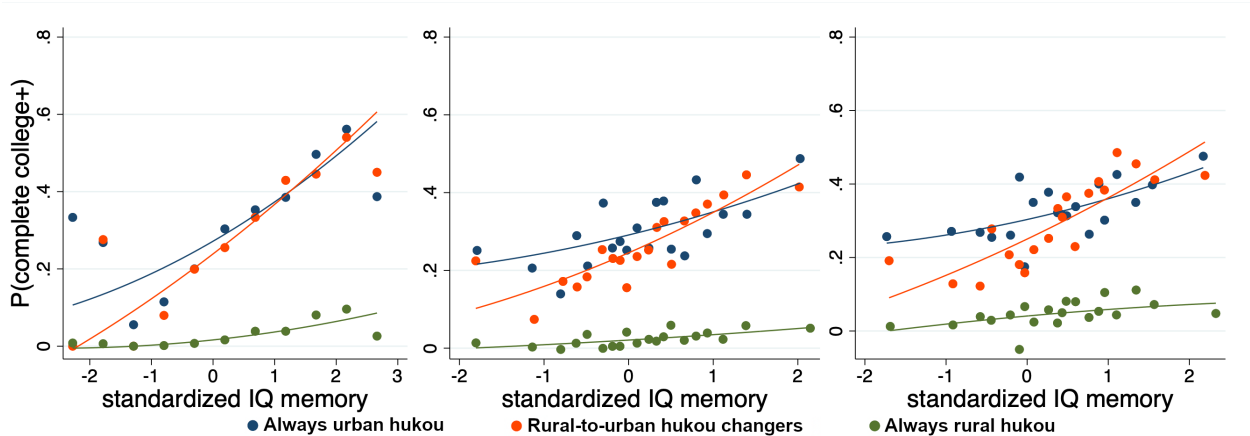


Figure 1: Higher education attainment vs ability in China

Notes: Data source: 2010 CFPS. Sample restricted to adults aged 25–50. IQ memory test’s score is designed to measure inborn, i.e. “fluid” (as opposed to “crystalized”), intelligence. Individuals are categorized as “Always urban hukou” if they were born with non-agricultural (urban) hukou; “Always rural hukou” if they were born with agricultural (rural) hukou and had it at the time of survey; and “Rural-to-urban hukou changers” if they were born with agricultural hukou and transferred to non-agricultural one by the age of 12 or the time of survey. Left panel is without controls. Middle panel controls for gender, age and age<sup>2</sup>. Right panel restricts the sample to those living in urban areas at the time of survey, and controls for age and gender.

In this paper, we ask whether *security of agricultural land property rights* contributes to the misallocation of human capital in China. Until early 2000s, agricultural land rights were communal with local village councils extending complete control over land allocations.

Focusing on recent land rights reforms, we examine the impact of assigning these property rights to individual households on the educational outcomes of rural migrants' children and the broader macroeconomy of China. Our central hypothesis is that insecure land tenure in rural China has been an important factor causing migrant workers to leave their children (and often spouses) behind in the home village. By strengthening land rights, the reforms may have encouraged migrants to bring their families to the city, thereby allowing their children to access better education.

To answer these questions, we combine empirical analysis with a quantitative model. First, we exploit two major waves of land rights reforms (enacted in the early 2000s and mid 2010s) that were implemented at different times across Chinese province-level administrative divisions. This staggered rollout provides quasi-experimental variation in land tenure security, which we use to identify the causal effects on family migration decisions and child outcomes. We analyze rich micro-data from multiple sources in order to shed light on short-run and long-run impacts of the reforms, and on the operating mechanism. Our event study analysis shows that after a province increases land tenure security, the share of rural-to-urban migrant workers leaving children behind drops by one-third. Moreover, using the timing of land reform as an instrumental variable (IV) for the length of urban tenure, we document that each additional year a rural child spends growing up in an urban area increases that child's probability of attending university by about 0.8 percentage points. Together with our further mechanism analysis, these results imply that improvements in the assignment of rural land rights can substantially improve educational outcomes for children of rural origin.

In the second part of the paper, we build a heterogeneous agent overlapping-generations (OLG) model with incomplete markets, migration, land security and human capital accumulation. We parametrize it by combining reduced-form empirical analysis and simulated method of moments (SMM). We externally calibrate the parameters of the intergenerational persistence of inborn ability, the human capital production function, location-specific level of education expenditures and land loss risk. Using SMM, we match moments such as the distribution of families over rural-urban areas, rural-urban earning gaps, relative share of land income for rural households and our event-study evidence on the impact of land reforms on the share of children left-behind. We conduct our quantitative analysis in two steps. The

partial equilibrium (PE) analysis where the amounts of land owned and rented are held constant at the pre-reform level shows that introducing a complete security of agricultural land rights induces a 4.4% consumption-equivalent welfare gain to the average society member. The reform is pro-urban as rural households enjoy only a 1.5% welfare gain, compared to 7.6% for urban households. Importantly, in this setting, the reform does not alter the share of families with children in rural areas.

However, once the fixed land supply constraint unleashes the general equilibrium (GE) effects reallocating land ownership and rentals, the share of children educated in rural areas drops by 7%. The average welfare gain becomes half of the PE one, and rural households actually experience welfare losses equivalent to a 3.8% reduction in their consumption on average. This happens as the reform secures all of the urban workers' land, and so reduces the amount of land owned by the remaining rural population. Nonetheless, the reform does reduce income inequality by 4%, the intergenerational elasticity of income (IGE) by 35% and boosts both the GDP and the stock of human capital by 1.5% and 2.1%, respectively.

**Literature review.** This study contributes to several strands of literature. First, it relates to research on the misallocation of talent and human capital due to place-based frictions. [Chetty et al. \[2016\]](#), [Chetty and Hendren \[2018a,b\]](#) provide seminal empirical evidence on neighbourhood effects in the US setting. [Hsieh et al. \[2019\]](#) quantify the macroeconomic loss from talent misallocation in the United States, while [Chyn and Daruich \[2025\]](#) evaluate how enabling disadvantaged families to move affects children's outcomes in an equilibrium framework. [Gao et al. \[2023\]](#) show empirically that China's rural migrants looking for urban work opportunities are more likely to leave behind their daughters than sons. Our work provides a novel case study of a directly measurable barriers to talent allocation and evaluates a reform alleviating those in the context of China's rural-to-urban migration.

Second, we build on the growing body of work analyzing migration restrictions in China on aggregate productivity and structural transformation [[Tombe and Zhu, 2019](#), [Hao et al., 2020](#), [Gai et al., 2025](#)].<sup>1</sup> A more closely related strand of this literature has shown that strengthening land property rights improved agricultural productivity and altered labor al-

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<sup>1</sup>See [Chan and Zhang \[1999\]](#) for early work describing the hukou system in China.

location [Ngai et al., 2019, Gottlieb and Grobovšek, 2019, Chari et al., 2021, Adamopoulos et al., 2024, Chen et al., 2025].<sup>2</sup> We extend this literature by investigating how the incompleteness of rural land rights affects similar macroeconomic outcomes due to the inequality in access to education between rural and urban areas of China.

Third, this paper relates to the long literature on economic consequences of agricultural land market frictions (Besley [1995], Goldstein and Udry [2008], Chen et al. [2022, 2023], Adamopoulos and Restuccia [2020], Adamopoulos et al. [2022], Manalis and Mazur [2025]). A smaller strand of this literature has focused on the interaction between these frictions and human capital accumulation. Galor et al. [2009], Albertus et al. [2020] argue that unequal distribution of landownership may inhibit introduction of public schooling and thereby impede the rate of structural transformation. Kim and Lee [2025] show that South Korean 1950 land rights reforms abolishing tenancy farming redistributed income towards local farmers, leading to increases in agricultural productivity and education attainment. We study how the interaction between unequal quality of education and incomplete land property rights may constitute a drag on intergenerational talent allocation.

**Structure of the paper.** Section 2 provides background on China’s land rights and education system, and the institutional reforms we study. Section 3 presents the empirical evidence: data sources, the effects of land reforms on left-behind children, the IV analysis of urban exposure on education, and a discussion of mechanisms. Section 4 outlines the quantitative model, its calibration and presents the structural analysis. Section 5 concludes.

## 2 Institutional Setting

In this section we describe how rural migrant families in China were balancing two major institutional constraints: (i) the risk of losing land rights if the entire family relocated, and (ii) limited access to urban public education for their children without local hukou. The land tenure reforms we study have not only directly alleviated the first constraint, but also – as we argue – have contributed to alleviating the second. Table A.3 in Appendix A summarizes

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<sup>2</sup>de Janvry et al. [2015] provides a similar empirical evidence from land certification in Mexico.

the provisions of land laws key to our study, which we discuss in more detail below.

## 2.1 Hukou System and Educational Barriers for Migrants

Instituted in 1958, China’s *hukou* system (household registration) imposes rules on internal migration. Upon birth, an individual obtains local county’s hukou of agricultural (if born in countryside) or non-agricultural type (if born in an urban area). This registration system imposes frictions on rural-to-urban migration from two angles. First, public schools in cities generally require local non-agricultural hukou for enrollment. Migrant children without local hukou often faced difficulties in enrolling into urban public schools and usually had to opt for private schools or informal schools for migrants, or return to their home province for schooling.

Second, the hukou system has also created frictions to migration on the rural end. In particular, agricultural hukou registration has traditionally been associated with a right to allocation of farmland for active cultivation, but without broader property rights implying that migration would normally trigger loss of these land lights. This system has gone through major reforms starting in early 2000s and ending in 2018. We discuss these issues in detail in the next subsection.

In 1997, many prefectures in China started gradually lifting the urban-side barriers to transferring agricultural hukou into non-agricultural one [Fan, 2019]. One concern with our main empirical findings below may be that they are confounded by jointly timed reforms of land rights and hukou restrictions. Combining the city-level hukou reform index for years 1997-2010 from Fan [2019] and the timing of the province-level 2003-wave of land reforms used in this paper, we show that this is not the case. In particular, Figure A.1 in Appendix A reports a city-level Callaway and Sant’Anna [2021] event-study of the effect of land reforms on the hukou restriction index. The coefficients on the leads show that, prior to the adoption of land reforms, cities in provinces that reformed earlier were not on different pre-trends in hukou policy relative to cities in later-reforming provinces, suggesting that land reforms were not strategically timed with hukou reforms. Likewise, the post-reform coefficients remain close to zero, indicating that the introduction of land reforms did not accelerate or slow down the implementation of hukou reforms.

Similarly, Table A.4 in Appendix A shows that the timing of both the 2003 and 2014 waves of reforms cannot be predicted by a vector of averages of the following province-level controls pre-2003 and pre-2014 (respectively): population size, number of high school students, GDP per capita, fiscal expenditures per capita and rural and urban income per capita.

## 2.2 Hukou System, Land Frictions and Recent Reforms

The Constitution of the People’s Republic of China regulates that the state or the village collectives are exclusive owners of farmland, and individuals only hold use rights. Over the past few decades, the government introduced a series of reforms to strengthen agricultural land rights. In 1998, the government extended farmers’ land-use contracts to 30-year terms. The first major wave of reform came with the 2002 *China Land Contract Law* (implemented in the early 2000s), which codified farmers’ land rights and allowed small-scale leasing of land parcels [Chari et al., 2021]. This reform was rolled out gradually across provinces between 2003 and 2013. However, these use rights were yet ambiguous and not well protected by the legal system whenever rural families migrated out of their villages, and especially so if they further converted their agricultural hukou to non-agricultural one. For example, the 2002 *China Land Contract Law* stipulated that if an entire family relocated to a city with districts and converted to non-agricultural hukou, the village could reclaim the land. Besides this, according to the *Protection of Basic Farmland Regulations* and the *Land Administration Law of the PRC*, the rural families should lose land if they abandoned or left fallow the land for two consecutive years under the name of agricultural land protection. In practice, migrant workers often could not find trustworthy informal tenants and feared that moving the entire family to the urban area, even without changing their hukou, would trigger a land reallocation. Therefore, the weak land rights protection and limited land rental market created a strong incentive to keep a family member (often a spouse with children) in the village to protect their claims to the farmland.

Many may believe that grandparents could farm the land and take care of the grandchildren. So the land rights and lack of rental market would not be major concerns for migration. However, this does not take into account China’s big baby boom after 1949. According to

the World Bank, the births per woman was around 6 in the 1960s, 3-6 in the 1970s, and 2.5 in the 1980s. With multiple kids who may move to the urban area, it is hard for the grandparents to take care of all the grandchildren and cultivate the farmland at the same time.

In the past two decades, China experienced a greater surge of internal migration with approximately 250 million (18.4% total population) domestic migrants in 2014, mostly are rural-urban migration. Those rural-urban migrants often expressed their concern over their land rights. In order to address these concerns and encourage rural migrants to change their hukou, a second wave of land reforms started in 2013 (and with first implementations in 2014). This round launched a national land certification program to the household level, and encouraged the development of the land rights rental market (including to commercial farms) in rural areas and permitted mortgaging land rights as collateral. Different provinces implemented these reforms in different years from 2014 through 2017. Table 1 in Appendix A contains the adoption years of the two waves of land reforms used in our empirical analysis.

Finally, in 2018 this nationwide reform program completed the formal titling and certification of rural land and removed the rule that migrants who obtain urban hukou must relinquish their farmland, and a rural land rental market was established so that migrants can rent out their land with formal land contracts. This reform has effectively lifted the rural-side barriers to migrants transferring their hukou, that allows for sending children to local public schools.

## 3 Empirical Evidence

### 3.1 Data and Sample

We combine several data sources for our empirical analysis, encompassing both nationwide surveys and region-specific panels.

**CMDS.** The China Migrants Dynamic Survey is an annual repeated cross-sectional survey of domestic migrants conducted by the National Health Commission of China. It covers people who have lived in a county other than their hukou county for over one month (i.e.,

<b>2003 Land Reforms</b>	
2003	Shanghai
2004	Shandong, Hunan
2005	Liaoning, Jilin, Shanxi, Anhui, Xinjiang, Fujian, Jiangsu, Tianjin
2006	Yunnan, Hainan, Guangxi, Gansu
2007	Jiangxi, Zhejiang, Shaanxi, Chongqing
2008	Sichuan
2009	Neimenggu
2013	Qinghai, Hubei, Hebei
Never	Beijing, Guangdong, Henan, Ningxia, Guizhou, Tibet, Heilongjiang
<b>2014 Land Reforms</b>	
2014	Shanghai, Sichuan, Shandong, Anhui
2015	Jilin, Ningxia, Jiangsu, Jiangxi, Henan, Hubei, Hunan, Gansu, Guizhou
2016	Yunnan, Neimeng, Shanxi, Guangdong, Hebei, Zhejiang, Hainan, Liaoning, Shanxi, Heilongjiang
2017	Beijing, Tianjin, Guangxi, Fujian, Chongqing, Qinghai
Never	Xinjiang, Tibet

The timing of the 2003-wave reforms comes from [Chari et al. \[2021\]](#), and the timing of the 2014-wave reforms is collected from documents on official government websites ([www.moa.gov.cn](http://www.moa.gov.cn), [www.rcrc.agri.cn](http://www.rcrc.agri.cn), [www.gov.cn](http://www.gov.cn)).

Table 1: Staggered implementation of the 2003 and 2014 waves of land reforms across provinces of China

Table 2: Summary statistics

<b>Variable</b>	<b>Mean</b>	<b>Std. Dev.</b>	<b>N</b>	<b>Data source</b>
Child left behind	.29	0.45	463,632	CMDS 2012-'17
Spouse left behind	.09	0.29	517,406	CMDS 2012-'17
Attended high school	0.52	0.5	34,957	CMDS 2012-'17
Attended university	0.07	0.25	34,957	CMDS 2012-'17
Years in urban	4.6	4.35	34,957	CMDS 2012-'17
Effective Reform Years	0.9	1.68	34,957	CMDS 2012-'17
Log Income	9.05	1.38	9,684	CFPS 2010
Land expropriation	0.05	0.22	58,861	CFPS 2010-'20
Land insecurity perception	0.19	0.39	3,588	GSCF 2004-'07

The number of observations (N) reported varies across different sets of analysis, as the underlying data sources do not overlap and differ in their temporal scopes.

migrant workers without local county hukou). Between 2012-2014, the survey covers migrants aged between 15 and 59, and after 2014, it covers migrants aged 15 and above. We use the 2012–2017 waves. The CMDS provides detailed information on migrants’ employment, migration history, and family arrangements (including whether their spouses and children are currently living together with the migrant or left behind in the home county).

**CFPS.** The China Family Panel Studies is a longitudinal survey collected between 2010–2020 in biennial waves (except an additional 2011 wave) covering nationwide representative urban and rural households, conducted by the Institute of Social Science Survey of the Peking University. We use the rich data from CFPS on individual demographics, income,<sup>3</sup> education outcomes, family relationships (allowing us to link children with parents), ability measures, economic variables, land ownership and land expropriations,<sup>4</sup> migration and changes in hukou status.

**2010 Population Census (1% sample).** This census sample was collected by the National Bureau of Statistics of China and is the most comprehensive dataset covering the Chinese demographics. We use it to derive the distribution of children across locations and family configurations, migration patterns, and educational distribution to help calibrate our model.

**GSCF.** The Gansu Survey of Children and Families is a longitudinal study of households and communities in rural villages of Gansu province collected in the years 2000, 2004, 2007, 2009 and 2015. We use the 2004 and 2007 data, which contains unique records on village-level land reallocations and perceptions of land insecurity,<sup>5</sup> which we utilize in our mechanism analysis.

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<sup>3</sup>*Income* refers to gross personal income from salaries, allowances, bonuses, business, second occupations and part time work, social security and value of gifts.

<sup>4</sup>*Land expropriation* refers to binary response to: *In the past 12 months, was your family land expropriated?*

<sup>5</sup>*Land insecurity perception* refers to binary answers to question *”According to your experience of previous land readjustment in the village, will the fact that some family members went out of the village to work affect the area of land the household could get?”*

**CHIPS.** The China Household Income Project is a series of surveys conducted by the Chinese Academy of Social Sciences (CASS). The 2007 wave of CHIPS includes a unique village leader questionnaire that provides us with evidence on the prevalence of land reallocation and the difficulties returning migrants face in reclaiming their farmland, helping us illustrate the land tenure insecurity problem.

**2011 Education Yearbook.** China Education Finance Statistical Yearbook is an annual statistical publication, compiled by the Ministry of Education and the National Bureau of Statistics. It provides comprehensive data on educational expenditures at all levels of schooling in China, including both fiscal appropriations and private educational spending per student, disaggregated by region and school level. We use these data to quantify the gaps in educational resources between urban and rural schools and to calibrate the education expenditure parameters in our structural model.

**CLDS.** The China Labor Dynamics Survey is a nationally representative biennial longitudinal survey conducted by Sun Yat-sen University. It focuses on the dynamics of the Chinese labor force, collecting detailed information on individuals' employment, income, education, migration history, and health. We utilize the 2012 wave of the CLDS to calculate the average wage rates and income difference between rural and urban workers with agricultural or non-agricultural hukou.

**CHNS.** The China Health and Nutrition Survey is an international collaborative project between the University of North Carolina and the Chinese Center for Disease Control and Prevention, designed to examine the effects of health and nutrition policies in China. We use the 2009 wave to calibrate the share of land income in total rural household income, with variables constructed following [Santaaulalia-Llopis and Zheng \[2018\]](#).

### **3.2 Land Reforms and Left-Behind: Event-Study Evidence**

We first examine whether improving land rights security led migrant parents to bring their children along to the city (as opposed to leaving them behind in the village). Our empirical

strategy exploits the staggered implementation of the *2014 land reform wave* across provinces (see Table 1). We implement the following event-study difference-in-differences analysis using the estimator of Callaway and Sant’Anna [2021] on the repeated cross-sectional data from CMDS restricted to parent-migrants with underage children:

$$Y_{i,t} = \alpha + \sum_{k \neq -1} \theta_k \mathbf{1}\{t - g(p) = k\} + X_{i,t}\gamma + \lambda_c + \lambda_p + \lambda_t + \varepsilon_{i,t} \quad (1)$$

Our unit of analysis is a migrant-respondent  $i$  living currently in county  $c$  (of some province  $p'$ ) and as recorded in survey-year  $t$ . We define the "treatment" for such migrant-respondent  $i$  as a year when  $i$ 's province-of-origin  $p$  implements the 2014-wave land rights reform. We look at migrant households originating from rural areas (as proxied by  $i$  having an agricultural hukou), and define the outcome  $Y_{i,t}$  as an indicator whether  $i$ 's child is *left behind*, i.e., not living with  $i$  in his or her current urban location. For married migrants, we also consider whether the spouse is left behind. We cluster errors  $\varepsilon_i$  at the migrant-parent's province of origin.

We compare the outcomes of families from treated provinces to those from not-yet-treated (or never treated) provinces over time, relative to the year of reform adoption. Specifically, we estimate average treatment effects for each relative time period (event time) around reform implementation. Identification relies on the assumption that, absent the reform, outcome trends for families from earlier- versus later-reforming provinces would have evolved similarly (conditional on the included controls). To improve plausibility, we restrict the sample to migrant parents-respondents who have migrated *before* their home province implemented the reform (so that timing of migration is exogenous to the reform), and we include a vector of controls  $X_{i,t}$  for individual characteristics (child's ethnicity, age and gender, parent's ethnicity, age, gender, education, total number of children and hukou type) as well as time  $\lambda_t$ , parent's current county  $\lambda_c$  and parent's province of origin  $\lambda_p$  fixed effects. We cluster errors at the reform-relevant level of parent's province of origin.

The event-study plots in Figure 2 presents the estimates of the reform's impact on the probability of having a left-behind spouse or child, with the reform adoption year as event time 0. We find no significant differences in pre-trends between members of migrant families

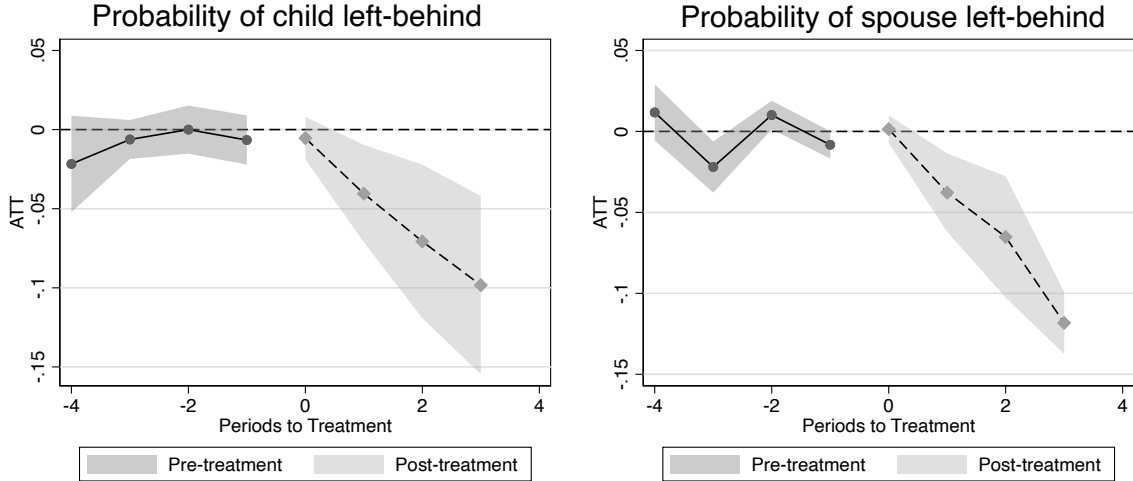


Figure 2: Impact of land reforms on family migration patterns

Figures present Callaway and Sant’Anna [2021] event studies on CMDS 2012-2017 repeated cross section of migrant workers and their families. Shaded areas indicate confidence intervals at 95%. Standard errors clustered at the province of parent’s origin.

from treated and control provinces. After the reform is implemented, there is a clear downward shift in the left-behind rates. On average, 3 years post-reform, the share of migrants leaving their children behind falls by roughly 10 percentage points, which corresponds to about a one-third reduction from the baseline level. The right panel of Figure 2 documents a similar pattern for spouses, confirming findings of Chen et al. [2025]. These results support the hypothesis that land tenure insecurity was a key reason migrants left family in the village. Once the reform assured them that moving their whole family would not jeopardize their land rights, many chose to reunite their households in the city.<sup>6</sup>

### 3.3 Urban Childhood Exposure and Education: IV Evidence

We have established that land reforms caused more children to migrate with their parents. We next examine the educational consequences for those children and argue that spending more years of one’s childhood in an urban environment improves the likelihood of university

<sup>6</sup>The event study evidence is robust to a variety of specifications: dropping controls, province of parent’s origin FE, when limiting sample to either male and female children or parents, to within-province or across-province migrants, when dropping children of parents with mixed agricultural and non-agricultural hukou, when replacing the county FE with county-by-post2014 FE (capturing the 2014-2016 wave of urban hukou reforms altering access of migrant children to local public goods), and when controlling for current location’s hukou index constructed by Zhang et al. [2019]. These results are available from us upon request.

enrollment.

Our analysis focuses on rural-origin individuals who moved to an urban area as children. There is a strong self-selection in which families migrate and when, so we deploy an IV approach leveraging the staggered timing of the *2003 land rights reform wave* (see Table 1) as an instrument for the number of childhood years (up to 16 years old) an individual spent in the city. The idea is that in provinces where land rights became secure earlier, rural families had an earlier opportunity to move with a reduced fear of losing land, which should lead to children from those provinces, on average, experiencing more years of urban schooling (if their families chose to migrate) compared to children from provinces that reformed later. We combine this source of variation with the age of child at the time of reform, inducing additional variation at an individual level.

We use again the 2012-2017 CMDS data and restrict the sample to individuals of age 20-30 at the time of survey, who moved to their current city either (i) before their province implemented the 2003-wave of reforms or (ii) in the year of or the year immediately following their province’s reform implementation. The latter two restrictions provide a control group of not treated migrants and help ensure that the timing of migration is tightly linked to the reform. Since high school is not compulsory in China and usually begins at age 16, we further restrict the sample to individual who migrated to their destination before turning 17. In order to focus on rural-to-urban migrants, we also restrict the sample to individuals who were not born in the current urban area and either have (i) agricultural hukou; or (ii) parents with agricultural hukou at the time of survey. To reduce selectivity of our sample, we also keep individuals who were born in rural areas and never migrated.

Given this sample, our main endogenous dependent variable is:

$$\text{Years spent in urban}_i = \begin{cases} \max\{0, \min\{16, 16 - \text{age at migration}_i\}\}, & \text{if migrated}_i = 1, \\ 0, & \text{if migrated}_i = 0. \end{cases} \quad (2)$$

We address the endogeneity problem by constructing an instrument providing individual-level exogenous variation in the number of years spent in urban area by combining the province  $p$ ’s time of 2003-wave’s reform introduction and the age of individual  $i$  at that

	(1) Years in Urban	(2) Years in Urban
Effective Reform Years	0.86*** (0.05)	0.70*** (0.05)
Observations	34,957	34,957
Year FE	Yes	Yes
Province of origin FE	Yes	Yes
Migr. destination FE	No	Yes
Birth year FE	No	Yes
Gender FE	No	Yes

Data source: CMDS 2012-2017. Standard errors clustered at the level of respondents' province of origin.  
 $*p < 0.10$ ,  $**p < 0.05$ ,  $***p < 0.01$ .

Table 3: First stage of land reform implementation on years spent in urban as a child

time. In particular, we define our instrument as:

$$\text{Effective Reform Years}_i = \max\{0, \min\{16 + \text{birth year}_i - \text{year of land reform's introduction}_p\}\} \quad (3)$$

which implies (i) no exposure  $\text{Effective Reform Years}_i = 0$  for individuals of age 16 or above at the time of reform; and (ii) that the exposure to reform increases as individual happens to be younger than 16 at the time of reform.<sup>7</sup>

Equipped with this instrument, we run the following IV regression:

$$Y_{i,t} = \alpha + \beta \cdot \text{Years in urban}_i + \lambda_b + \lambda_c + \lambda_g + \lambda_p + \lambda_t + \varepsilon_{i,t} \quad (4)$$

where  $Y_{i,t}$  is indicator of whether individual  $i$  observed in year  $t$ , of gender  $g$  and birth year  $b$ , living currently in city  $c$ , coming from province  $p$ , and observed in survey-year  $t$  has enrolled into university or high school in the past. We cluster errors at the level of province of origin  $p$ .

The first-stage results in Table 3 confirm that the instrument strongly predicts urban exposure. In our preferred specification with all the five fixed effects included, a one extra year of having more secure land rights during childhood increases the number of years in urban by 0.7.

The second-stage IV results, reported in Table 4, indicate that each additional year spent

<sup>7</sup>While  $\text{Effective Reform Years}_i = 16$  for individuals born or not yet born at the time of reform, these are not part of our sample as we restrict the age of our sample to 20-30 at the time of survey (2012-2017).

in an urban environment during childhood raises the likelihood of entering high school by 1.7–5.6 percentage points and that of entering university by 0.7–1.0 percentage points. In the latter case, with all the fixed effects included, the estimates imply that a rural child who migrates to the city as a newborn, and spends all the 16 years of childhood in urban, would have a 16 percentage point higher probability of university enrollment than if they arrived to urban area at the age of 16 (right after completing middle school, and so having no prior education history in urban).

	P(High School)		P(University)		P(High School)		P(University)	
	(1)	(1')	(2)	(2')	(3)	(3')	(4)	(4')
Years in Urban	0.0170*** (0.0017)	0.0123*** (0.0012)	0.0048*** (0.0006)	0.0044*** (0.0005)	0.0557*** (0.0020)	0.0173*** (0.0047)	0.0098*** (0.0011)	0.0075*** (0.0024)
Model	OLS	OLS	OLS	OLS	IV	IV	IV	IV
Observations	34,957	34,957	34,957	34,957	34,957	34,957	34,957	34,957
KP-Wald F-stat	–	–	–	–	300.3	170.0	300.3	170.0
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Province of origin FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Migr. destination FE	No	Yes	No	Yes	No	Yes	No	Yes
Birth year FE	No	Yes	No	Yes	No	Yes	No	Yes
Gender FE	No	Yes	No	Yes	No	Yes	No	Yes

Data source: CMDS 2012-2017. Standard errors clustered at the level of respondents' province of origin; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$

Table 4: Impact of childhood years spent in urban on education attainment

This magnitude is meaningful given the low 2010 base rates of 29% high school and 11% university attendance among rural students. The IV estimates are significantly larger from OLS regressions, consistent with positive selection (families who migrate earlier may be relatively advantaged or determined, biasing OLS downward) or with the idea that the marginal impact of forced early migration is particularly high for those who would otherwise stay in poor rural schooling conditions. Overall, this evidence implies that policies enabling rural children to access urban education (through migrating with their parents) can substantially improve their academic opportunities, thereby reducing the rural-urban human capital gap.

We probe robustness of our IV design in two ways. First, we conduct a placebo test showing that our instrument Effective Reform Years<sub>*i*</sub> does not predict the number of years spent in the new urban location for urban-born children with urban parents who do not have farmland, and so should not be affected by the reforms. To proxy urban-born children, we restrict the CMDS sample to 20-30 years old individuals with (i) agricultural hukou or with parents having non-agricultural hukou who migrated into the current city before age 16;

	(1)	(2)
	Years in New Urban Location	Years in New Urban Location
Effective Reform Years	0.049 (0.042)	0.075 (0.047)
Observations	7,022	7,022
Year FE	Yes	Yes
Province of origin FE	Yes	Yes
Migr. destination FE	No	Yes
Birth year FE	No	Yes
Gender FE	No	Yes

Data source: CMDS 2012-2017. Standard errors clustered at the level of respondents' province of origin.

\* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

Table 5: Placebo first stage of land reform implementation on years spent in new urban location as an urban-born child

or (ii) local born individuals who have not migrated across cities.<sup>8</sup> Results in Table 5 show that, indeed, our instrument does not predict years in the new urban location for urban-born individuals, confirming our intuition and proving the validity of our instrumental variable approach.

Second, similarly as in the case of the 2014-wave reforms' timing, Table A.4 in Appendix A shows that the timing of the 2003-wave of reforms cannot be predicted by a vector of province-level controls recorded in 2002.

### 3.4 Mechanisms: Why Do Land Rights Matter for Education?

We have demonstrated empirically that increasing land security leads to fewer left-behind children, and that growing up in the city improves educational outcomes for those children. We now explore the underlying mechanisms in more detail.

**Land Tenure Insecurity and Migration.** Figure 3 presents suggestive evidence of migration being associated with land insecurity from two surveys. First, the 2007 CHIPS data with answers from village leaders show that in 60% of villages none of the returning migrants have received their land back.

Second, we use the household-level answers in the Gansu Survey to question [whether

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<sup>8</sup>In case of local born individuals not migrating (including those who migrated within their city) we assume that the number of years spent in new location is 0 (since they have not migrated to new urban location).

household-head believes that migrating out of village for work] ”will affect land allocation”. The right panel of Figure 3 shows that the village-average of this proxy for land insecurity correlates positively with the village’s share of total labor force migrating out.

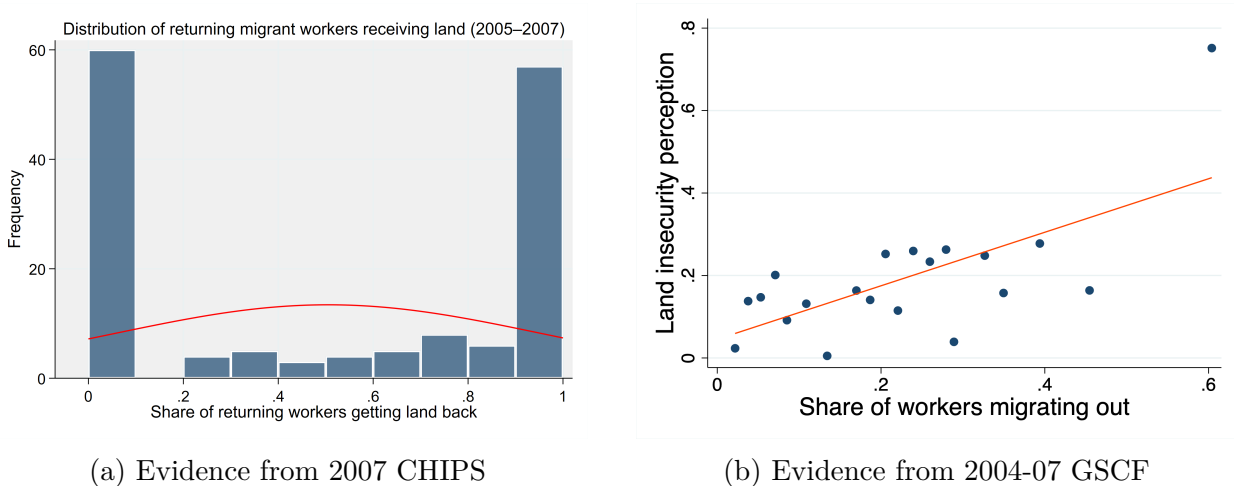


Figure 3: Migration and actual or perceived land security

**Improved Land Security Through Reforms.** The land rights reforms directly targeted the above frictions by strengthening tenure security and de-linking migration from land loss. We present evidence consistent with this explanation from both the GSCF on Gansu province and the CFPS data covering the whole country.

Table 6 contains results from the GSCF panel data. It shows that the correlation between the share of migrant workers and the perception of land insecurity weakens significantly in the 2007 wave. Given that Gansu province has implemented land reforms in 2006, this estimate is consistent with land reforms significantly improving land security of migrants.

Furthermore, we exploit the panel dimension of the CFPS 2012–2018 data sandwiching the second wave of land reforms to provide further evidence of reforms impact on land security. We conduct a standard respondent-level differences-in-differences analysis of the reform’s impact on the experience of land expropriation in past 12 months by respondent  $i$  living in rural or urban areas of county  $c$  in province  $p$  in year  $t$ .<sup>9</sup> The regression equation

<sup>9</sup>We keep only respondents who are present in the survey at least once before and after the reform implementation by their province.

	Land insecurity perception	Land insecurity perception
Share of mig.out worker	0.461*** (0.103)	0.596*** (0.117)
Share of mig.out worker $\times$ 2007 dummy		-0.271*** (0.100)
Observations	3,548	3,548
$R^2$	0.552	0.555
Household FE	Yes	Yes
Year FE	Yes	Yes

Data source: GSCF 2004–2007. Errors clustered at household level. \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 6: Impact of reform on perceptions of land insecurity in Gansu province

reads:

$$Land\ expropriation_{it} = \beta_1 PostReform_t + \beta_2 Urban_i + \beta_3 (PostReform_t \times Urban_i) + \alpha_i + \gamma_t + \varepsilon_{it}. \quad (5)$$

Given usual in China lack of private urban land ownership, we interpret urban respondents reporting land ownership as rural migrants. As such, results in Table 7 show that land reforms reduced the excess of land expropriation experienced among urban residents towards that of rural residents, consistent with reforms improving land security for rural out-migrants.

	Land expropriation	Land expropriation
Post Reform		-0.006 (0.011)
Urban	0.040*** (0.012)	0.044*** (0.013)
Post Reform $\times$ Urban	-0.035** (0.013)	-0.032*** (0.009)
Observations	55,410	56,744
$R^2$	0.39	0.35
Household FE	Yes	Yes
County $\times$ Year FE	Yes	No
Year FE	No	Yes

Data source: CFPS. Standard errors clustered at province level.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 7: Impact of land reforms on land expropriations

**Quality of Urban and Rural Education.** Bringing children to the city exposes them to typically better-resourced urban schools. Data from the 2010 China Education Yearbook in Table 8 confirm that urban schools both receive approximately 15-23% higher fiscal transfers from the government and charge approximately 20%-30% more in compulsory tuition fees than their rural counterparts.

School level	Area	Fiscal transfer	Private expenditure	Total
Primary school	Rural	3,876	222	4,098
	Urban	4,616	1,184	5,800
Middle school	Rural	5,061	354	5,415
	Urban	5,993	1,599	7,592
High school	Rural	3,821	2,459	6,280
	Urban	4,972	3,502	8,474
College	–	5,890	6,710	12,600
University	–	11,745	11,477	23,222

Data: China Educational Finance Statistical Yearbook 2011.

Expenditures cover both public and private schools. Private expenditures include tuition fees and costs of textbook, uniform, meals and school trip, and other related costs.

Table 8: Average annual education spending per student in 2010

On the other hand, Table 9 presents evidence from the 1% sample of the 2010 Population Census on the highest education attainment of individuals aged 19-23 across different residence location and hukou status.<sup>10</sup> The evidence points to patterns consistent with Figure 1: young adults of rural origin have a significantly lower education attainment compared to their urban peers. Moreover, this data again suggests that moving from rural to urban areas (proxied by the urban group with agricultural hukou) does help in finishing high school and enrolling into higher education.

**Summary.** The evidence presented points to a story in which land rights reforms alleviate a key constraint (land loss risk) that was keeping families apart. Once that constraint is lifted, more children move to urban areas at earlier ages, where despite some remaining

<sup>10</sup>We restrict the sample to the 19-23 age group to account for the common hukou changing after graduation from university and upon finding an employer able to sponsor local hukou (like government), usually happening at the age of 24 or later.

		Below high school	High school	College	Uni & above
<b>Rural</b>	Agric. hukou	140,811(34.5%)	37,296(9.1%)	16,929(4.1%)	5,999(1.5%)
<b>Urban</b>	Agric. hukou	64,079(15.7%)	33,872(8.3%)	19,169(4.7%)	10,637(2.6%)
	Non-agric. hukou	9,832(2.4%)	18,809(4.6%)	24,583(6.0%)	26,616(6.5%)
<b>Total</b>		214,722(52.6%)	89,977(22.0%)	60,681(14.8%)	43,252(10.6%)

<sup>1</sup> Data: 2010 1% population census. Data contains no information on hukou status change. Sample restricted to those aged 19–23.

<sup>2</sup> College, or junior college, (*daxuezhuanke*) includes graduates of vocational and professional schools. University (*daxuebenke*) includes enrollees into bachelor (or higher) degrees.

Table 9: Education distribution in 2010

institutional hurdles, they generally receive better education, leading to improved human capital outcomes.

Noteworthy, the empirical evidence comes from a selected sample of migrant-respondents living in urban areas and so does not allow us to analyze the sample of rural stayers. Similarly, the empirical evidence does not tell us about the long-run and general equilibrium implications of the land reforms, especially when the fixed supply nature of land is taken into account. To shed light on these issues, we proceed with developing and estimating a quantitative structural model.

## 4 Quantitative Model

### 4.1 Overview and Location Choice

We construct an incomplete market OLG model of migration, education, and land rights where each family consists of one parent (the income earner) and one child. Time is discrete, every person lives for 2 periods with each period corresponding to one generation, i.e. 30 years, spanning a parent’s prime working life and the child’s upbringing years. We focus on steady state and so abstract from time subscripts for clarity of notation. We assume that wages and interest rates are exogenous.

The key element of the model is the family’s *location* for both the parent and child. At the end of each period, i.e. when the child becomes adult, the location for next period’s place of work for the current child (turning adult) and of education for their children are

chosen. There are two locations (rural and urban) and the child can either stay in the rural home, with or without the parent, or live in the city with the parent. For urban residence, we consider two options of family having agricultural or non-agricultural hukou. It follows that there are four possible location/hukou states  $i$  for the family:

- $i = rr$ : Both parent and child are in rural area.
- $i = ru$ : Parent works in urban area; child stays in rural area (“left-behind child”).
- $i = ua$ : Both parent and child are in urban area with agricultural (rural) hukou.
- $i = un$ : Both parent and child are in urban area with non-agricultural (urban) hukou.

These choices involve various trade-offs. If both the parent and child stay rural ( $rr$ ), the family forgoes higher urban wages and their child attends local rural schools. The  $ru$  case corresponds to labor migration with the child remaining in the village. In the  $ua$  case, the family migrates together without changing hukou (common for many migrant families in reality), which means the child gains access to urban schooling, albeit possibly as a migrant student. In the  $un$  case, the family fully urbanizes, granting the child full access to public schooling and other benefits of urban citizenship, but potentially increasing the risk of losing their rural land rights (before 2018 reforms).

## 4.2 Model Setup

**Preferences.** Each family derives utility from consumption and potentially has locational preferences. We assume the parent’s per-period utility (inclusive that of their children) at location  $i$  is given by:

$$u(c) + \zeta_i + \xi_i \tag{6}$$

where  $c$  is consumption and  $u(c) = \frac{c^{1-\mu}}{1-\mu}$  is a standard CRRA utility function. Parents altruistically value the continuation value of their children with the weight of  $\beta$ .

Furthermore, each location  $i \in \{rr, ru, ua, un\}$  is associated with a common additive utility shifter  $\zeta_i$  capturing non-monetary preferences or costs for each location.

Since in reality not all high-skill individuals out-migrate from rural areas. To capture idiosyncratic reasons for remaining in rural areas, we also assume that in every period each family draws an additive i.i.d. preference shock  $\xi_i$  for each potential location  $i$ . As in standard random utility frameworks, these shocks are assumed to be Type I extreme value (Gumbel) distributed, yielding a logistic choice component.

**Budget constraint.** The budget constraint reflects income from work, returns on assets and land, against spending on consumption, savings and tax:

$$c + a' + T_i \leq w_i \cdot h + (1 + r)a + r_\ell \cdot [\omega_i^o(1 - \phi_i)\ell^o + \omega_i^r\ell^r] \quad (7)$$

The term  $(1 + r)a$  is the return on family assets brought from the previous period and  $a'$  is assets saved for the next period (the child's generation). We assume a no-borrowing constraint, i.e.  $a' \geq 0$ . The location-specific lump sum tax  $T_i$  represents the net resource cost of educating the child in location  $i$ .

We denote by  $w_i$  the wage rate of the parent in location  $i \in \{rr, ru, ua, an\}$ . We assume that parents in  $ru$  families earn the same wage rates as urban families with agricultural hukou  $ua$  ( $w_{ru} = w_{ua}$ ), but different than those urban with non-agricultural hukou  $un$ .<sup>11</sup> The total labor income is given by  $w_i \cdot h$ , where  $h$  represents the human capital of the parent (which was accumulated in the previous period).

The land income is a product of the per-unit risk-less exogenous land return rate  $r_\ell$  and effective amount of land. The latter is made of risk-adjusted own land  $(1 - \phi_i)\ell^o$  and rented-in land  $\ell^r$  land. The exact amount of income depends on location-specific parameters of renting-out, renting-in and land loss risk  $\omega_i^o, \omega_i^r, \phi_i \in [0, 1]$ . We describe the details of the land market below.

**Human capital.** The child's human capital evolution is a crucial part of the model. Their level of human capital as an adult is given by the following law of motion:

$$h' = z^{\alpha_z} \cdot e_i^{\alpha_e} \quad (8)$$

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<sup>11</sup>This difference between the urban wage rates received by locals and migrants is well documented in Guo et al. [2025]. Furthermore, Gai et al. [2025] show that rural-to-urban migration in China does generate significant income gains.

where  $z$  denotes child's inborn ability and  $e_i$  denotes the education investment level at location  $i$ . The education choice is publicly determined and financed. As such, family's choice of location  $i$  has direct consequences for the child's education. In particular, we assume exogenous levels of education investment  $e_{rr}, e_{ru}, e_{ua}, e_{un}$ . Although we will assume that  $e_r \equiv e_{rr} = e_{ru}$ , we explicitly allow for differential quality of education in urban areas depending on local hukou status in order to capture common problems with access to public schools for migrants without local hukou registration.

In terms of education financing, we assume that each level of education  $i \in \{rr, ru, ua, un\}$  is financed via lump-sum taxes  $T_i$  ensuring that the government budget is balanced:

$$T_i = e_i \quad \forall i \in \{rr, ru, ua, un\} \quad (9)$$

We introduce risk into our model through intergenerational persistence of human capital by modeling child's ability as being correlated with the parent's ability. Specifically, we assume the following AR(1) process:  $\log z' = \rho_z \log z + \varepsilon$ , with  $0 < \rho_z < 1$  capturing persistence and  $\varepsilon$  a mean-zero shock.

**Land markets and reforms.** Each family has a claim to ownership of  $\ell^o$  units of land. However, the effective amount of land owned depends on the regime of land rights, which governs the amount of land lost  $\phi_i$  due to imperfect property rights. Furthermore, we assume the existence of the land rental market. Rural households rent land in from households with parents in urban areas, and receive share of associated revenue from operating it. Households with parents in urban areas rent out their land to rural households operating it in exchange for the share of revenue paid as a rental fee. The amount of land being rented is an equilibrium object depending on the urban-rural distribution of households and the property rights system.

If the whole family is in the city, they lose a fraction  $\phi_i$  of own land  $\ell^o$ . In case of urban family with agricultural hukou ( $i = ua$ ), we assume land loss risk of  $\phi_{ua}$ ; and for urban family with non-agricultural hukou ( $i = un$ ), a fraction  $\phi_{un} > \phi_{ua}$  is lost, capturing the fact that historically families giving up agricultural hukou had to surrender their land. Furthermore, we assume that urban families are unable to cultivate the land themselves, and

therefore they rent it out to rural families in exchange for share  $\omega_i^o = \omega \in (0, 1)$ ,  $i \in \{ua, un\}$  of the total land revenue generated by operators. Similarly, they do not rent-in any land ( $\omega_i^r = 0$ ,  $i \in \{ua, un\}$ ).

If the family has been in the rural area at least in the last and current period ( $rr$  or  $ru$ ), they face no risk of losing own land  $\ell^o$ :  $\phi_i = 0$ ,  $i \in \{rr, ru\}$ . Furthermore, fully rural families ( $rr$ ) rent in  $\ell^r$  units of land and receive share  $\omega_{rr}^r = 1 - \omega$  of the output. Families with left-behind children ( $ru$ ) do not rent-in land  $\omega_{ru}^r = 0$  and rent-out their land receiving the share of output  $\omega_{ru}^o = \omega$ .

Positive land loss  $\phi_{ua}, \phi_{un} > 0$  in the pre-reform allocation reflects static consequences of incomplete land rights associated with migration. Motivated by evidence in Figure 3a, we further assume in the pre-reform allocation that migrants from fully urban ( $ua, un$ ) to rural setups ( $rr, ru$ ) cannot receive immediately all of their land back and must remain rural for one period before being allowed to fully participate in the local land market. In particular, returnees to fully rural setup (we denote this group by  $rrr$ ) are assumed to not rent-in any land, i.e.  $\omega_{rrr}^r = 0$ , and face land loss risk of urban migrants with agricultural hukou, i.e.  $\phi_{rrr} = \phi_{ua}$ . Group  $rur$  of returnees to the rural child-urban parent setup, similarly as  $ru$ , rent-in no land, i.e.  $\omega_{rur}^r = 0$ , and rent-out their land receiving share  $\omega_{rur}^o = \omega$  with additional land loss risk of  $\phi_{rur} = \phi_{ua}$ . The land reform studied below will eliminate the above static and dynamic consequences of land insecurity, i.e. it will set  $\phi_i = 0 \forall i$  and remove restrictions in participating in the rental market for fully rural returnees  $rrr$ .<sup>12</sup>

Finally, we normalize the aggregate amount of land to 1. Given this, the per family amount of own land  $\ell^o$  satisfies the following equilibrium relationship:

$$\ell^o \cdot \int \mathbf{1}_{i \in \{ua, un, rr, rrr, ru, rur\}} (1 - \phi_i) dG = 1 \quad (10)$$

where  $G$  denotes the stationary measure of households in allocations considered.

Similarly, the amount of land rented-in per tenant  $\ell^r$  satisfies:

$$\ell^o \cdot \int \mathbf{1}_{i \in \{ru, rur, ua, un\}} (1 - \phi_i) dG = \frac{\ell^r}{\int \mathbf{1}_{i=rr} dG}. \quad (11)$$

---

<sup>12</sup>In terms of equilibrium location-groups, the post-reform allocation will effectively not have any households in  $rrr, rur$  categories.

**Recursive formulation.** The current generation's state vector is given by  $(i, a, h, z)$ : the parent's childhood location  $i$ , assets inherited from parents  $a$ , parent human capital  $h$ , and child ability  $z$ . Given this, the value function  $V(i, a, h, z)$  satisfies:

$$V(i, a, h, z) = \max_{c, a'} u(c) + \beta \mathbb{E}_{\xi_{i'}} \max_{i'} \{ \mathbb{E}_{z'} V(i', a', h', z') + \zeta_{i'} + \xi_{i'} \} \quad (12)$$

subject to the following constraints:

$$\begin{aligned} c + a' + T_i &\leq w_i h + (1 + r) a + r_\ell \cdot [\omega_i^o (1 - \phi_i) \ell^o + \omega_i^r \ell^r], \\ c, a' &\geq 0, \quad h' = z^{\alpha_z} e_i^{\alpha_e}, \quad \log z' = \rho_z \log z + \varepsilon. \end{aligned}$$

Upon arriving into the period with state vector  $(i, a, h, z)$ , the family-head earns labor income  $w_i h$ , decides how much to consume  $c$  vs. save  $a'$  and chooses (or their child that becomes adult at the end of period) the next period's location  $i'$ , which determines where their children will work as adults and the next-generation child's education. The expectation is taken over the next-generation child's (or current family-head's grandchild's) ability  $z'$  draw and current location-taste shocks  $\{\xi_i\}_{i \in \{rr, ru, ua, un\}}$ .

### 4.3 Calibration

This section describes how we empirically discipline our model. Our strategy is to choose parameters such that the economy matches key properties of the China's economy in the year 2010, before introduction of the 2014-wave of land reforms. In the first step, we exogenously set values of 13 parameters based on the literature and our reduced-form evidence.

Next, we employ the simulated method of moments (SMM) for the other 8 parameters governing the time and location preferences, wage rates and land income. The algorithm chooses jointly values for these parameters as to minimize the average Euclidean percentage deviation of the 8 model-generated moments. Although the equilibrium of the model is complex and in some cases one parameter may affect multiple targeted moments, we explicitly associate the most informative moments for respective groups of parameters in our method of moments strategy.

parameter	interpretation	value	target/source
externally determined			
$\mu$	coefficient of relative risk aversion	2	modelling choice, CRRA=2
$r$	annual interest rate	2.1%	<a href="#">World Bank</a>
$w_{rr}$	rural wage rate	1	normalization
$\zeta_{un}$	$un$ location preference shifter	0	normalization
$\rho_z$	persistence of ability process	0.20	empirical persistence in Table 11
$(\alpha_z, \alpha_e)$	elasticities of human capital prod. f-n	(0.08, 0.59)	elasticities in Table 12
$(e_r, e_{ua}, e_{un})$	education expenditures (1,000s RMB)	(52.4, 83.6, 122.5)	expenditures in Table 13
$(\phi_{ua}, \phi_{un})$	land loss risk for $ua$ and $un$	(37.4%, 90.4%)	land ownership rates in Table 14
$\omega$	share of land rental income for $ru, ua, un$	25%	<a href="#">Jin and Deininger [2009]</a>
internally determined (jointly using SMM)			
$\beta$	intergen. altruism/time preference	0.45	$K/Y = 3.5$ , Penn World Tables
$w_{ua}$	urban wage rate w/ agric. hukou	2.85	$\frac{\int_{i' \in \{ru, ua\}} w_u \cdot h}{\int_{i' = rr} w_r \cdot h} = 3.67$ , CLDS
$w_{un}$	urban wage rate w/ non-agric. hukou	3.80	$\frac{\int_{i' = un} w_u \cdot h}{\int_{i' = rr} w_r \cdot h} = 4.98$ , CLDS
$r_\ell$	land income per unit of land	0.08	Avg $\frac{r_\ell \cdot \ell}{w_u h + r_\ell \cdot \ell} = 0.53$ , CHNS
$(\zeta_{rr}, \zeta_{ru}, \zeta_{ua})$	location preference shifters	(-1.77, -0.40, -0.86)	population shares in Table 15
$\sigma_g$	Gumbel distribution scale parameter	0.27	33% drop in $ru$ , Figure 2

Table 10: Calibration summary

*Note:* Education expenditures for  $ru$  and  $rr$  are assumed to be equal ( $e_r \equiv e_{rr} = e_{ru}$ ) and those for returnees in the baseline are assumed equal to stayers ( $e_{rrr} = e_{rur} = e_r$ ). We assume no land loss risk of  $rr$  and  $ru$  ( $\phi_{rr} = \phi_{ru} = 0$ ) and that returnees in the baseline allocation face land loss risk at the level of  $ua$  ( $\phi_{rrr} = \phi_{rur} = \phi_{ua}$ ). The wage rate of  $ru$  is assumed equal to that of  $ua$  ( $w_{ru} = w_{ua}$ ) and the wage rates of returnees in the baseline are assumed equal to that of stayers ( $w_{rrr} = w_{rr}$ ,  $w_{rur} = w_{ru}$ ). The fixed location preference parameters of returnee  $rrr$  and  $rur$  groups in the baseline are assumed equal to those of  $rr$  and  $ru$ , i.e.  $\zeta_{rrr} = \zeta_{rr}$  and  $\zeta_{rur} = \zeta_{ru}$ .

We normalize prices such that the average annual before-tax income of workers is \$4,629 (or approximately 30,333 RMB), as in 2010 China.<sup>13</sup> Table 10 summarizes the parameter values chosen and Table 17 presents the fit of our model.

### 4.3.1 Parameters Chosen Externally

**Utility function and risk aversion.** We set the utility function to  $u(c) = \frac{c^{1-\mu}}{1-\mu}$  with a coefficient of relative risk aversion  $\mu = 2$ , a standard value in the literature.

**Inborn Ability.** We assume that inborn ability follows a standard AR(1) process:

$$\log(z') = \rho_z \log(z) + \epsilon \quad (13)$$

<sup>13</sup>Source: <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD?locations=CN>.

with  $\epsilon$  following  $N(0, 1 - \rho_z^2)$  s.t.  $z'$  effectively follows  $LogNormal(0, 1)$ .

We estimate the intergenerational persistence of ability using the linked parent-child data in 2010 CFPS. Using father’s and child’s IQ memory test scores constructed by CFPS to measure ”fluid” intelligence (as opposed to ”crystalized” intelligence) allows us to treat them as proxies for inborn ability. We standardize the test scores so that the empirical and theoretical measures of ability correspond to each other. Results of estimating equation (13) in Table 11 suggest an intergenerational correlation of 0.2.<sup>14</sup>

	std child’s IQ memory	std child’s IQ memory
std father’s IQ memory	0.21*** (0.02)	0.20*** (0.02)
Observations	7,907	7,907
Year FE	Yes	Yes
County FE	Yes	Yes
Age FEs	Yes	Yes
Gender FE	No	Yes
Education FEs	No	Yes

<sup>1</sup> Source: 2012-16-20 CFPS data. Age and education FEs are for both the child and the father. IQ test scores are standardized. Errors clustered at child’s current county level; \*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table 11: Intergenerational persistence of ability

**Human capital production function.** We estimate elasticities of the function (8)  $h' = z^{\alpha_z} e^{\alpha_e}$  from micro-data by regressing adult income on (i) the IQ memory test results; and (ii) the education expenditures imputed using records from CFPS on respondents’ highest degree obtained and location of education, combined with the annual total expenditures at each level-location pair from Table 8. In particular, we estimate the following regression for each individual  $j$  of a given age, gender, observed in given year, working in a given county-urban

<sup>14</sup>Computationally, we discretize this AR(1) using the Rouwenhorst’s method.

or -rural location and being rural- or urban-educated as a child:

$$\begin{aligned} \log(\text{Income}_j) = & \beta_0 + \beta_1 \text{std IQ memory}_j + \beta_2 \log(\text{edu expenditure}_j) \\ & + \gamma_{age} + \gamma_{gender} + \gamma_{year} + \gamma_{county \times \text{urban}} + \gamma_{\text{rural-} \text{educated}} + \epsilon_j \end{aligned} \quad (14)$$

where *std IQ memory*<sub>*j*</sub> is a standardized score of the IQ-memory test, and the *county-by-urban*-FE absorbs the location-specific wage rate entering  $\text{Income} = w \cdot h$  on the LHS of regression (14), allowing us to directly associate theoretical elasticities with the empirical ones. Results in Table 12 suggest that, holding education expenditures constant, a one standard deviation increase in ability raises eventual earnings by about 9%, and holding ability constant, a doubling of education expenditures raises earnings by about 59%. In the model, we also assume that the inborn ability follows a standard normal distribution. As such, we assume  $\alpha_z = 0.08$  and  $\alpha_e = 0.59$ .

	ln(Income)
std IQ memory	.08***
ln(Edu expenditure)	.59***
Observations	8,988

Source: cross-section of 25-55 year old earners in 2010 CFPS. Fixed effects included: age, gender, year, county-by-urban, rural-educated. Income is winsorized at (2.5,97.5) levels. Standard errors clustered at the (current) county level.

Table 12: Estimation of human capital production function

**Education expenditures.** We derive values for the level of monetary education inputs in each location from the 2011 China Educational Finance Yearbook with records on average public spending per student at different education levels. We estimate that over the course of K-12 education, total spending per student in rural areas amounts to  $e_r = 52,000$  RMB, for an urban student with rural hukou (i.e., a migrant child likely in private or less-funded schools) amounts to  $e_{ua} = 83,000$  RMB, and for an urban student with urban hukou amounts to  $e_{un} = 120,000$  RMB. These figures reflect that migrant children tend to incur higher costs (often private schooling) yet might not receive as much benefit as true urban hukou children

who have access to the best public schools; however, overall urban educational investment is higher than rural.

	Rural	Urban	
		Agric. hukou	Non-agric. hukou
Public Expenditure	44,769	59,665	79,852
Private Expenditure	7,675	23,973	42,611
Total Expenditure	52,444	83,638	122,463

Table 13: Location-hukou specific levels of education expenditures

The table provides estimates of effective location-hukou-specific education expenditures by combining average total education expenditures per student for each location-hukou status combination in Table 8 with the average number of education years completed for each location-hukou status combination in Table 9.

**Output sharing in rental market.** In line with the evidence from early 2000s China in Jin and Deininger [2009], we externally set the share of output accruing to land owners who rent-out their land at  $\omega = 0.25$ . The land return rate  $r_\ell$  is calibrated internally and discussed below.

**Land loss risk.** We use the 2010 CFPS microdata on land ownership by migration status to pin down  $\phi_{ua}$  and  $\phi_{un}$ . Table 14 compiles further evidence consistent with the main premise of this paper, i.e. that migrating out of rural area has historically been associated with significant land loss risk.<sup>15</sup> In particular, while 87.1% of rural residents had land, only about 54.5% of rural-hukou individuals living in urban areas still had land, and only around 8.3% of those who had converted to urban hukou kept any land. Assuming that every rural resident may have some land if they wished and so that the 14.2% of rural residents do not own land due to working outside of agriculture, we infer  $\phi_{ua} = 1 - \frac{51.7\%}{85.8\%} = 39.7\%$  - equal to the fraction losing land due to urban migrant, but keeping agricultural hukou. Similarly, we infer  $\phi_{un} = 1 - \frac{7.4\%}{85.8\%} = 91.3\%$  for those who switch hukou to non-agricultural. As a period in our model equals 30 years, we can also derive annual probabilities of land loss equal to

<sup>15</sup>Table A.1 in Appendix A documents consistent evidence in 2013 China Household Finance Survey (CHFS).

	Urban	Rural
Agricultural hukou	51.7%(N=2230)	85.8% (N=5470)
Agr.→non-agr. hukou changer	7.4%(N=1319)	\
Non-agric. hukou	0.4%(N=1673)	\

<sup>1</sup> Source: 2010 CFPS.

<sup>2</sup> We use the household head data to estimate the land ownership by different hukou satus.

Table 14: Land ownership by location and hukou status

$\phi_{ua}^{annual} = 1 - \frac{0.517^{1/30}}{0.858} = 1.7\%$  and  $\phi_{un}^{annual} = 1 - \frac{0.074^{1/30}}{0.858} = 7.8\%$ . These numbers sandwich estimates of a 5% annual land loss risk in Adamopoulos et al. [2024].

### 4.3.2 Parameters Chosen Internally

All internally calibrated parameters are jointly determined to match the full set of target moments. In what follows, we describe each internally calibrated parameter and the moment(s) most closely associated with it.

**Time preferences.** The discount factor  $\beta$  is chosen such that the model’s implied asset-to-output ratio matches the empirical ratio for China of 3.5 from the Penn World Tables 10.01.

**Fixed location preferences.** The utility shifters  $(\zeta_{rr}, \zeta_{ru}, \zeta_{ua}, \zeta_{un})$  are calibrated to match the distribution of children across locations from the 2010 Census 1% sample, as reported in Table 15. With 12.6% of left-behind children, our estimates imply a total of 35.1 million children being left-behind in 2010 China.<sup>16</sup> We normalize  $\zeta_{un} = 0$  and calibrate the other 3 shifters by targeting the shares of children in  $rr, ru$  and  $ua$  locations. The calibrated values reflect entry barriers and differential values of amenities (e.g. due to hukou system), and other cultural or practical reasons for leaving children in rural.

**Wage rates.** We normalize  $w_{rr} = 1$  and calibrate  $w_{ua}(= w_{ru})$  and  $w_{un}$  internally by targeting relative non-agricultural income differences in 2011 between locations and hukou

<sup>16</sup>Our estimate is close to the 2015 estimate of 40 million left-behind in rural areas of China in UNICEF [2017].

Table 15: Population shares from the perspective of children

	Rural children		Urban children
	Left-behind	Not Left-behind	
Non-agric. hukou	\	\	108,650(17.8%)
Agric. hukou	76,794(12.6%)	287,474(47.2%)	136,595(22.4%)

<sup>1</sup> Source: 2010 China 1% population census.

<sup>2</sup> We restrict the sample to children that (i) have the same hukou county as parents; (ii) are below 18 years old; (iii) are not in families with parents divorced and passed away. The "left-behind" children are defined as those with (i) parents' information recorded, and one or two of the parents not living within the same county as the children and the parent being out of the hukou county for more than 6 months; or (ii) missing information regarding one or two of the parents, implying parental absence.

statuses documented in Table 16. The data is derived from the 2012 CLDS data asking respondents about the annual income from primary occupation, which we interpret as a full-time job performed for 40 hours a week. We find that 39% of the rural sample was primarily engaged in non-agricultural work at an average wage rate of 9.6 RMB per hour. Given this, we compute weighted average urban-rural non-agricultural income ratios for urban workers with agricultural hukou of  $\frac{13.8}{0.39 \cdot 9.6} = 3.67$  and for those with non-agricultural hukou of  $\frac{18.7}{0.39 \cdot 9.6} = 4.98$ . We calibrate the wage rates per unit of human capital  $w_{ua}, w_{un}$  by targeting the moments of  $\frac{\int_{i \in \{ru, rur, ua\}} w_{ua} \cdot h}{\int_{i \in \{rr, rrr\}} w_r \cdot h} = 3.67$  and  $\frac{\int_{i=un} w_{un} \cdot h}{\int_{i \in \{rr, rrr\}} w_r \cdot h} = 4.98$ .

	Urban	Rural
Agric. hukou agri work	\	6.3(38.1%)
Agric. hukou non-agri work	13.8(10.4%)	9.6(24.3%)
Non-agric. hukou non-agri work	18.7(27.2%)	\

<sup>1</sup> Data: 2012 China Labor Dynamic Survey. Sample restricted to ages 25–64 with full-time jobs. Wage data winsorized at the (2.5/97.5) level.

<sup>2</sup> Rural figures restricted to agricultural hukou only. Relative shares of each group reported in parantheses.

Table 16: Labor income per hour of work across locations

**Land income.** We calibrate the land return rate  $r_\ell$  s.t. the model simulations imply a realistic share of income among rural households ( $rr, rrr, ru, rur$ ). For this purpose, we use the 2006 and 2009 waves of the China Health and Nutrition Survey (CHNS) with in-

come variables constructed following [Santaeulalia-Llopis and Zheng \[2018\]](#). Discarding urban households and households with annual total income below 1000 RMB, we find that the average share of agricultural income in total household income was 53%, which is what we target for the simulated counterpart moment of  $\int_{i \in \{rr, rrr, ru, rur\}} \frac{r_\ell \cdot [\omega_i^\sigma (1 - \phi_i) \ell^\sigma + \omega_i^r \ell^r]}{w \cdot h + r_\ell \cdot [\omega_i^\sigma (1 - \phi_i) \ell^\sigma + \omega_i^r \ell^r]}$ , with  $w = w_{rr}$  for  $rr, rrr$  and  $w = w_{ua}$  for  $ru, rur$ .<sup>17</sup>

**Unobserved heterogeneity in migration choices.** We normalize the location parameter of Gumbel taste shocks  $\mu_g = 0$  and calibrate the scale parameter  $\sigma_g = 0.27$  so that the model matches the relative magnitude of the left-behind response to the reform in [Figure 2](#). With the point estimate of a 10 p.p. reduction and an average of 30% share of urban migrants in the CMDS sample before implementation of reforms, we target a 33% reduction in the  $ru$  status.

While  $\sigma_e$  governs the responsiveness of discrete location choices to changes in the value of location choices, the model-implied decline in left-behind children following the reform is not mechanically pinned down by  $\sigma_e$  alone. First, it also depends on the level of  $r_\ell$  determining the level of risk-free income attainable by remaining in rural land. The latter feature also interacts with the institutional friction governing access to land after urban migration introduced via our returnee statuses  $rrr, rur$ , which affect the option value of staying in  $ru$  versus moving fully urban. Finally, households' intertemporal trade-offs are disciplined by  $\beta$ , which not only govern asset accumulation choices but also the willingness of households to invest into risky risky urban migration with a higher quality of education at the cost of lower safe land income attainable by returning to rural in case of a low realization of ability  $z$  in the future.

#### 4.4 Calibration Validation: Impact of Education on Income

In order to validate our model, we compare its predictions to our IV evidence in [Table 4](#) showing that a one extra year in urban education increases probability of a rural child enrolling into university by 0.8-1.0 p.p. With the maximum of 16 years of potential exposure

<sup>17</sup>The CLDS income data in [Table 16](#) present a similar evidence of a  $\frac{38.1 \cdot 6.3}{24.3 \cdot 9.6 + 38.1 \cdot 6.3} = 51\%$  share of rural income coming from agriculture.

Moment	Model	Data
Assets-to-GDP ratio	3.6	3.5
$rr$ share	43.4%	47.2%
$ru$ share	11.7%	12.6%
$ua$ share	21.7%	22.4%
Impact of land reform on $ru$ share	-33%	-33%
Land income share for $rr$	54%	53%
Wage income of $ua$ & $ru$ relative to $rr$	3.62	3.67
Wage income of $un$ relative to $rr$	4.93	4.98

Table 17: Moments matched and model fit

to the reform, this implies a total effect of an up to 16 p.p. increase in the probability of a rural-born child completing college education.

In our model, we do this by computing probability of average rural child making it into the top 10% of income distribution upon counterfactually assuming that they receive education expenditures at the level of population-weighted average urban expenditures  $\bar{e}_u$ . We interpret this category as the share of university-educated people, which amounted to 10.5% in 2010 China (as shown in Table 9). Our model predicts that in such a case this probability increases from 0% to 19.7%, close to the empirical upper bound of 16 p.p.

## 4.5 Interpreting the Effects of Reforms in the Model

We use the calibrated model to perform quantitative experiments that shed light on the macroeconomic importance of land rights, and to interpret our empirical findings in a general equilibrium context.

We evaluate a reform proxying the end of land reforms in China in 2021 allowing the rural-to-urban migrants to convert their hukou into non-agricultural without risking losing their land. Thus, in our main counterfactual exercise we change the baseline values of  $\phi_{ua} = 37.4\%$  and  $\phi_{un} = 90.4\%$  to  $\phi_{ua} = \phi_{un} = 0\%$ .

A key modeling distinction is that we report effects under two steady-state counterfactuals. The first one, which we use for calibrating the reform's impact on  $ru$ , is a GE allocation where own and rented-in land quantities  $\ell^0, \ell^r$  adjust according to equations (11) and (10). In the second, we fix these land quantities at the level of baseline allocation. These two

Statistic	Post Reform GE	Post Reform PE
	$\phi_a = \phi_n = 0$	$\phi_a = \phi_n = 0$
Cons.-equivalent welfare	+2.1%	+4.4%
Cons.-equivalent welfare: <i>rural</i>	-3.8%	+1.5%
Cons.-equivalent welfare: <i>urban</i>	+3.4%	+7.6%
GDP	+1.5%	+2.1%
Aggregate human capital	+2.5%	+0.1%
Own land per capita $\ell^o$	-33.7%	+0%
Rented-in land per capita $\ell^r$	+118.2%	+0%
Average asset holdings	+10.6%	-11.1%
Earnings Gini (baseline: 35.7)	-4.2%	+0.2%
Intergen. elasticity of income (baseline: 0.58)	-35.0%	-33.1%

*Notes:* PE holds  $\ell^o$  and  $\ell^r$  fixed at baseline levels; GE adjusts them according to (11) and (10). Consumption-equivalent welfare reports the average change in consumption required to make households indifferent between the pre- and post-reform allocations, evaluated at the respective stationary distributions.

Table 18: Key welfare statistics and the impact of land reforms

allocations are meant to elicit the importance of the fixed supply nature of land and the distributional impacts of the reform that would be hard to capture using pure micro-data analysis.

**Aggregate impact.** Table 18 shows that the reform generates a positive aggregate welfare effects: consumption-equivalent welfare rises by +2.1% in the GE allocation and by +4.4% in the PE allocation. The larger welfare gain in PE arises as when land quantities are held fixed at the baseline level, the reform primarily acts by increasing safe land income whenever household resides in urban areas, which pre-reform is associated with positive land loss risks. This relaxes precautionary distortions to migration and education choices, so the welfare gains accrue directly through improved allocation of children across schooling environments. In contrast, in GE, the reform also triggers a reorganization of land ownership due to fixed supply of land and of effective land use through the rental market. This redistributes resources and can generate losses for some groups even though aggregate output rises.

Consistent with this interpretation, rural households in GE allocation experience welfare losses of 3.8% on average, while urban households gain 3.4%. In the PE counterfactual where land is not subject to the fixed supply constraint, allowing everyone to at least keep

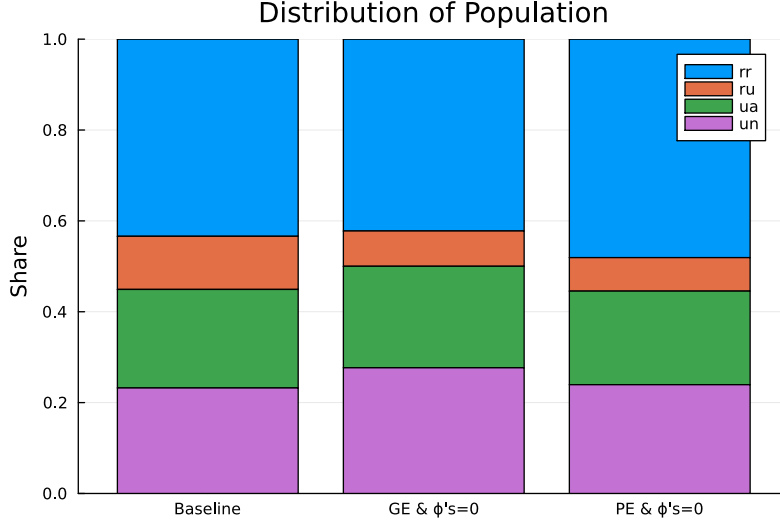


Figure 4: Impact of reforms on population distribution across locations

*Notes:* Location groups  $rr, ru$  in Baseline include also groups  $rrr, rur$ .

the same amount of land income as pre-reform, both groups gain significantly more. This highlights that an important part macro-effects of land reforms GE comes from equilibrium adjustments, rather than from the direct channel of removing the land-loss risk alone.

In terms of key aggregates, while GDP rises in both allocations (+1.5% in GE and +2.1% in PE), the reform significantly increases the stock of aggregate human capital by 2.5% only in GE. In PE, the increase is essentially zero. The latter effect reflects changes in location shares presented in Figure 4, which shows that in PE the overall ( $rr + ru$ ) share of children educated in rural areas does not decrease on impact of the reform. This happens due to the estimated high fixed preference level for living fully rural  $\zeta_{rr}$  combined with reduced riskiness of the economy, allowing households to spend a higher share of their income as suggested by an 11% drop in average asset holdings. In GE, however, rural households lose 33.7% of own land due to secure property rights of urban residents. As this is not fully compensated by higher income from rentals, average level of safe income in rural areas drops in GE, incentivizing more migration to cities. As a result, the share of rural educated children drops by around 12%. These results render complementary light on understanding our event study evidence in Figure 2.

Finally, Table 18 shows further evidence that land reforms have potential to reduce

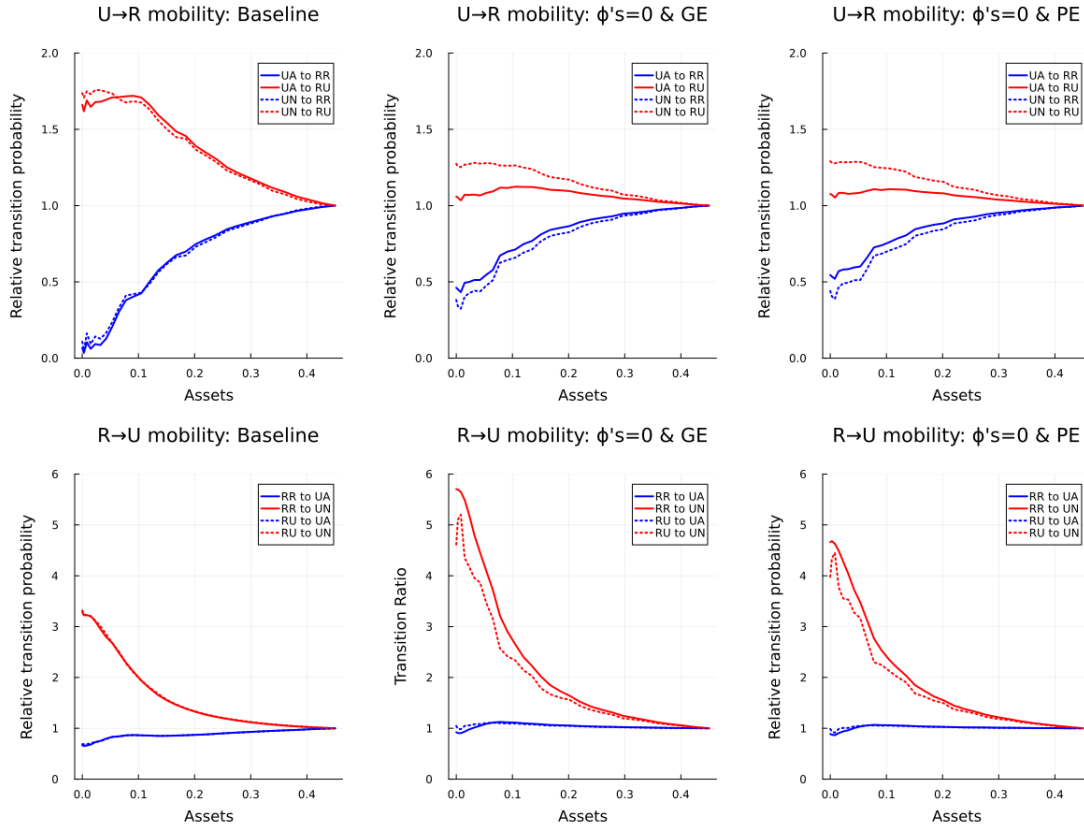


Figure 5: Impact of reforms on mobility across locations and assets

*Notes:* Figure presents probability of moving between rural and urban locations for average level of human capital  $h$ , child's ability  $z$  across all possible asset positions. The probabilities of moving are expressed in relative terms to probabilities for average household in the corresponding group in the highest asset position.

income inequality and the role of risk constraints in determining family locations. While the earnings inequality decreases modestly by 4.2% in GE (and remains unchanged in PE), the intergenerational persistence of income (IGE) falls sharply in both GE and PE allocations by approximately 34%. The strong reduction in IGE confirms that relaxing land-based mobility frictions allows for reallocating children toward higher-quality education environments when efficient, weakening the mapping from parental resources and residence into adult outcomes.

**Behavioral changes due to the reform.** We now discuss which groups adjust their mobility most on impact of land reforms. Figure 5 plots rural–urban transition probabilities for an average household across the asset grid (normalized to the highest-asset household within each origin group). In the baseline economy, conditional on being in the city, poorer

households exhibit much stronger “fallback-to-rural” behavior—consistent with the existence of a precautionary motive in which rural attachment (and the ability to re-access safe land income) is most valuable when savings are small. In both post-reform counterfactuals (GE and PE), these sharp gradients become much flatter, proving that improved land security reduces the need staying in rural areas for keeping their safe rural income.

On the rural-to-urban margins in the bottom panels of Figure 5, we observe that the poorest rural households are much more likely—relative to high-asset households—to switch into *un*. This is because of highest wage income potential in *un*, that allows for building up their asset positions. After the reform, these gradients become even more pronounced as the removal of land-loss risks increases the option value of going to the city, especially for low-asset households for whom migration is otherwise most risky.

These results are further complemented by Figure 6 comparing transition probabilities of the lowest- and highest-asset households along their state of the child’s ability state  $z$ . While the results point to selection on child ability, we find again that the selection is concentrated among households with limited assets.

Figure 7 shows mean asset holdings by location and child ability in the baseline, together with relative (to baseline) changes in assets under GE and PE reforms. The baseline panel indicates substantial heterogeneity in wealth by location (including “returnee” categories), showing that households deciding for returning to *rr* status in spite of imperfect land rights are positively selected in terms of asset buffers. The post-reform changes differ sharply between GE and PE in ways that line up with changes in aggregate asset levels in Table 18. Dissaving in PE is particularly visible for urban groups, consistent with the reform directly improving the safety of being away from the village (removing the need to self-insure via wealth). In GE, by contrast, average asset holdings rise as in this allocation some groups face adverse shifts in safe land income and respond by rebuilding their buffers.

**Distributional welfare effects.** Figure 8 tracks consumption-equivalent welfare changes across the grids of asset and child ability, separately for urban and rural groups, and for GE versus PE. The PE welfare surfaces show that welfare gains are positive for both rural and urban households, and they are largest for low-asset households, consistent with the reform’s

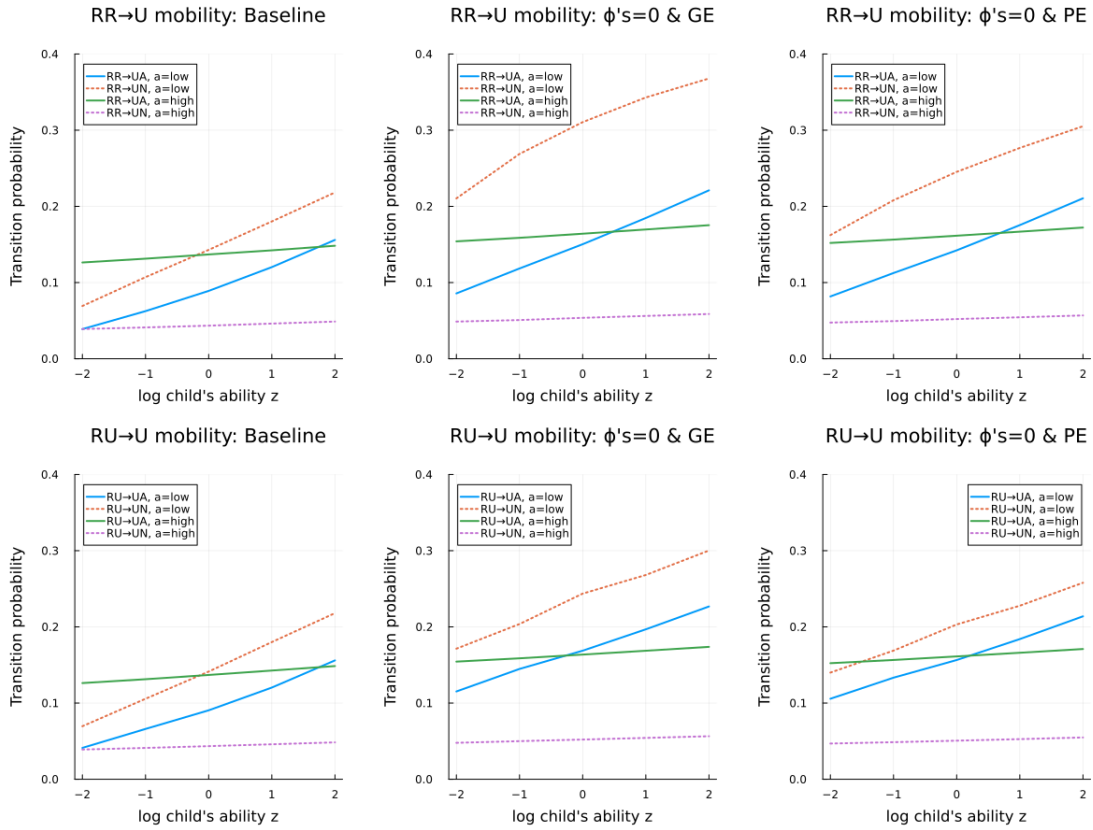


Figure 6: Impact of reforms on urban-mobility of rural population across child's ability

Notes: Figure presents probability of moving between rural and urban locations for average level of human capital  $h$  across all possible levels of child's ability, for households with lowest and highest asset positions.

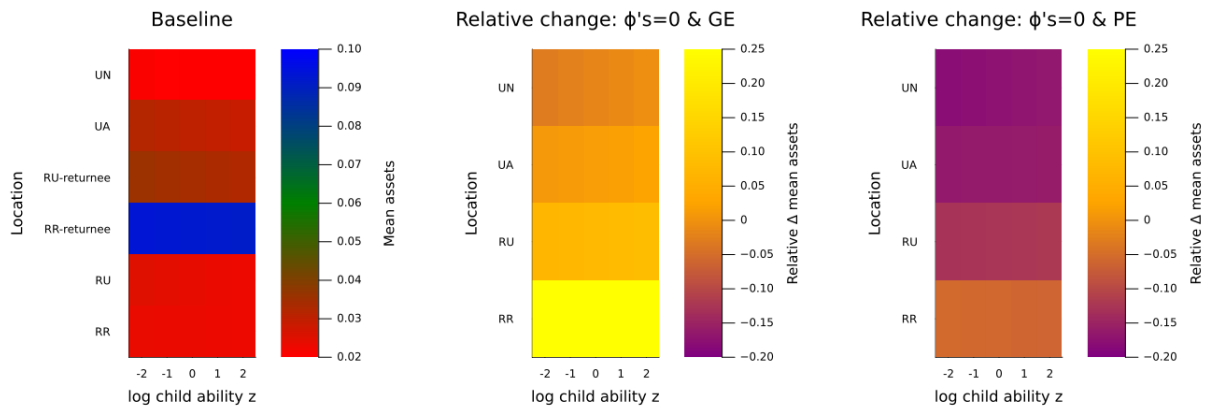


Figure 7: Impact of reforms on asset holdings across locations and child's ability

Notes: The left figure presents average asset positions across locations and child's ability in the baseline allocation. The center and right figures present relative (to baseline) changes in asset positions.

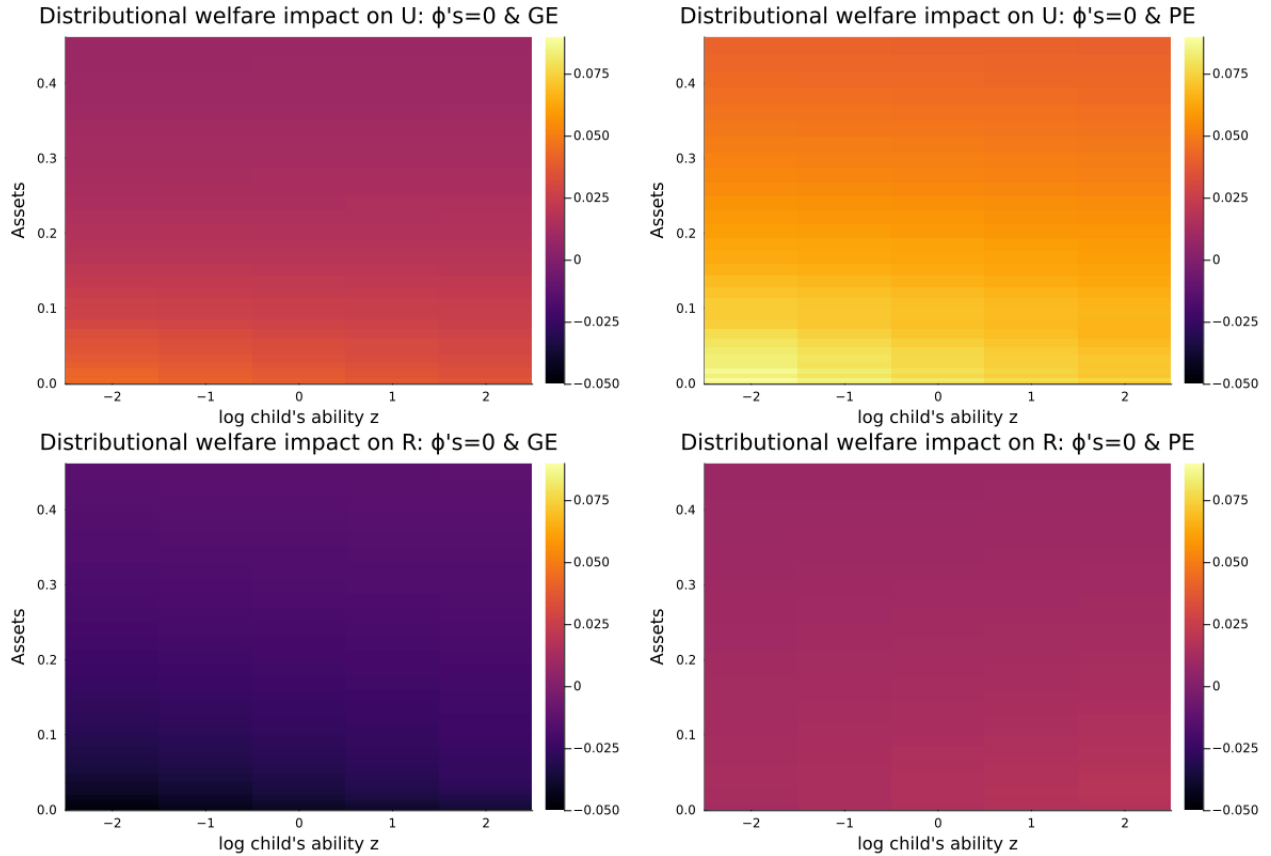


Figure 8: Welfare impact of the reform across locations and child’s ability

*Notes:* The left figure presents consumption-equivalent welfare variations for average household in rural ( $rr, rrr, ru, rur$ ) or urban ( $ua, un$ ) for average level of human capital  $h$  and a given combination of the asset and child’s ability state levels.

highest value in reducing downside risk when buffers are scarce.

In GE, Figure 8 paints a quite different picture: urban households generally gain, while rural households experience losses that are particularly severe at low asset levels. This shows that GE forces—especially the reallocation of land ownership and the implied change in safe rural income—generate a redistribution away from rural residents even when aggregate output rises.

Importantly, the dependence of welfare impact on child ability is comparatively modest relative to the dependence on assets, suggesting that —within our model— the reform’s welfare incidence is shaped more by households’ financial vulnerability than by  $z$  directly, even though  $z$  matters strongly for selection patterns, as shown in Figure 6.

## 5 Conclusion

This paper studies how strengthening rural land property rights in China affects the human capital development of the next generation. Using a combination of quasi-experimental evidence and structural modeling, we show that land tenure reforms encouraged migrant workers to bring their families to the city, which in turn improved educational outcomes for their children. Our empirical findings imply that reducing frictions that keep families apart (such as fear of land loss) can mitigate the misallocation of talent between rural and urban areas. Children who might otherwise be left in under-resourced rural schools can instead access better opportunities in cities, closing some of the rural-urban gap in education.

China provides a unique case study as at the same time there is a large number of left-behind children residing in rural areas with worse education opportunities, the government has implemented effective land reforms, and rich, nationally representative data are available for analysis. The challenge of left-behind children, however, is far from unique to China. [Fellmeth et al. \[2018\]](#) estimate that 27% of children in the Philippines, 36% in Ecuador, and 40% in South Africa are left behind. [Nguyen \[2016\]](#) reports comparable figures of 15% in Ethiopia, 18% in India, 25% in Peru, and 16% in Vietnam. In many of these contexts, land rights remain incomplete, continuing to shape migration and education decisions of many households.

Beyond applying our methodology to other empirical settings, future research could extend our framework by incorporating other decisions such as college enrollment or multi-dimensional skill acquisition, and by studying further GE impacts accounting for price changes. Another avenue is to explore the role of financial frictions—e.g., whether credit constraints limit the ability of some households to take advantage of migration even when institutional barriers fall. Nonetheless, the evidence presented here underscores that removing institutional frictions can unlock human potential that would otherwise be left behind.

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# Appendices

## A Additional Figures and Tables

	<b>Urban</b>	<b>Rural</b>
Agricultural hukou	58.8%(N=4835)	81.3%(N=6319)
Agr.→non-agr. hukou changer	14.0%(N=2576)	\
Non-agric. hukou	2.4%(N=6406)	\

<sup>1</sup> Source: 2013 CHIF.

<sup>2</sup> We use the household head data to estimate the land ownership by different hukou satus.

Table A.1: 2013 CHIF Land ownership by location and hukou status

<b>Source of Reform Year</b>	<b>Provinces</b>
<b>2014 Government Document</b>	Shanghai
<b>2015 Agricultural Minister Talk</b>	Shandong, Sichuan, Anhui, Jiangsu, Jiangxi, Hubei, Hunan, Gansu, Ningxia, Jilin, Guizhou, Henan
<b>2016 Agricultural Deputy Minister Talk</b>	Hebei, Shanxi, Inner Mongolia, Liaoning, Heilongjiang, Zhejiang, Guangdong, Hainan, Yunnan, Shaanxi
<b>2017 Agricultural Minister Talk</b>	Beijing, Tianjin, Chongqing, Fujian, Guangxi, Qinghai

Table A.2: Staggered Reforms Across Provinces

Law / Regulation	Year Introduced	Key Provisions
Protection of Basic Farmland Regulations	1998	<i>For units or individuals contracted to manage basic farmland who abandon cultivation for two consecutive years, the original contracting entity shall terminate the contract and reclaim the contracted basic farmland...</i>
Land Administration Law of the PRC	2004	<i>If the land remains unused for two consecutive years, upon approval by the original approving authority, the people's government at or above the county level shall reclaim the land use rights of the land-using unit without compensation. If the land was originally collectively owned by farmers, it shall be handed over to the original rural collective economic organization to resume cultivation...</i>
	2002/2009	<i>If, during the contract period, the entire family of the contractor relocates to a city with districts and changes to a non-agricultural household registration, they shall return the contracted arable land and grassland to the contracting authority...</i>
China Land Contract Law	2018 (revision)	<i>The state protects the land contracting and operating rights of rural households that move into urban areas. The relinquishment of land contracting and operating rights shall not be used as a condition for rural households settling in urban areas... If, during the contract period, contracting rural households settle in urban areas, they shall be guided and supported to transfer their land contracting and operating rights within their collective economic organization in accordance with the principle of voluntary compensation, or to return the contracted land to the contracting authority. They may also be encouraged to circulate their land operating rights... Grantees shall have the following rights: (2) The right to exchange or transfer a conventional usufruct on rural land for agricultural operations in accordance with the law; (3) The right to circulate land operating rights in accordance with the law...</i>
	2015	<i>The following real estate rights shall be registered in accordance with the provisions of this Regulation: (1) Collective land ownership; (3) Ownership of forests and woods; (4) Right to the contracted management of land such as farmland, forest land and grassland; (6) Right to use homestead land; (8) Easement; (9) Mortgage right...</i>

Table A.3: Summary of Key Chinese Land Laws and Regulations

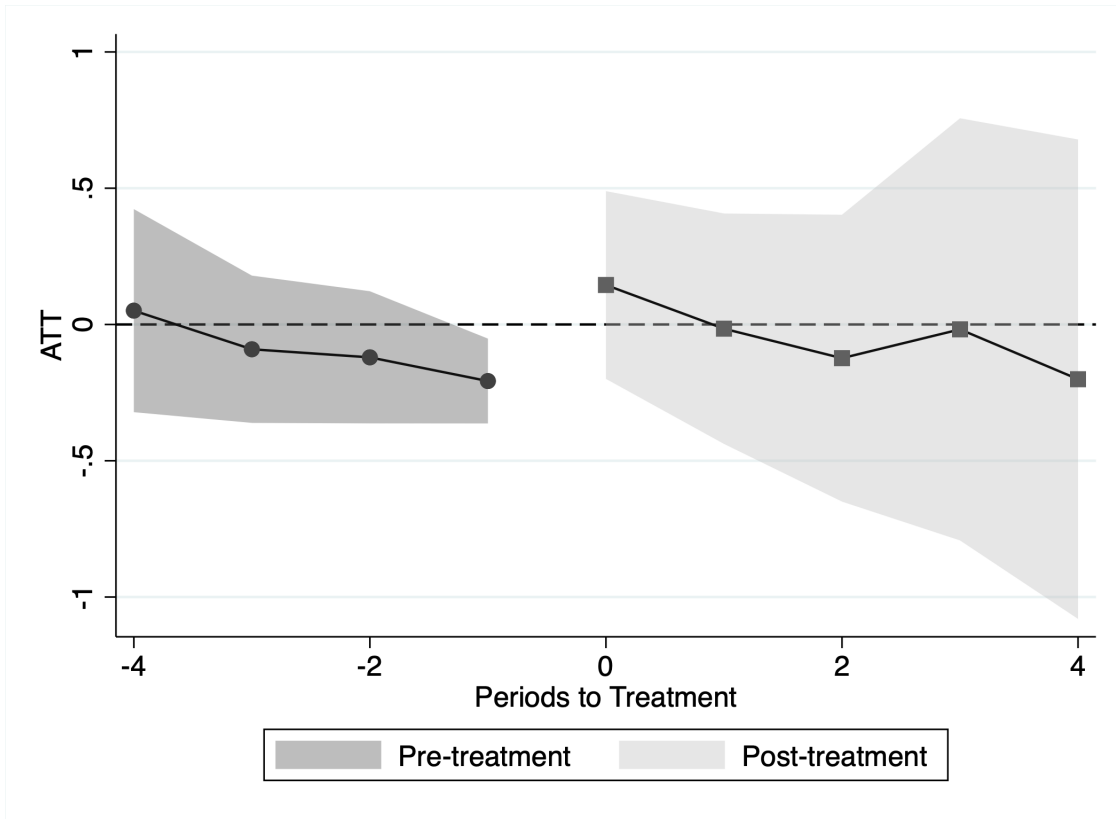
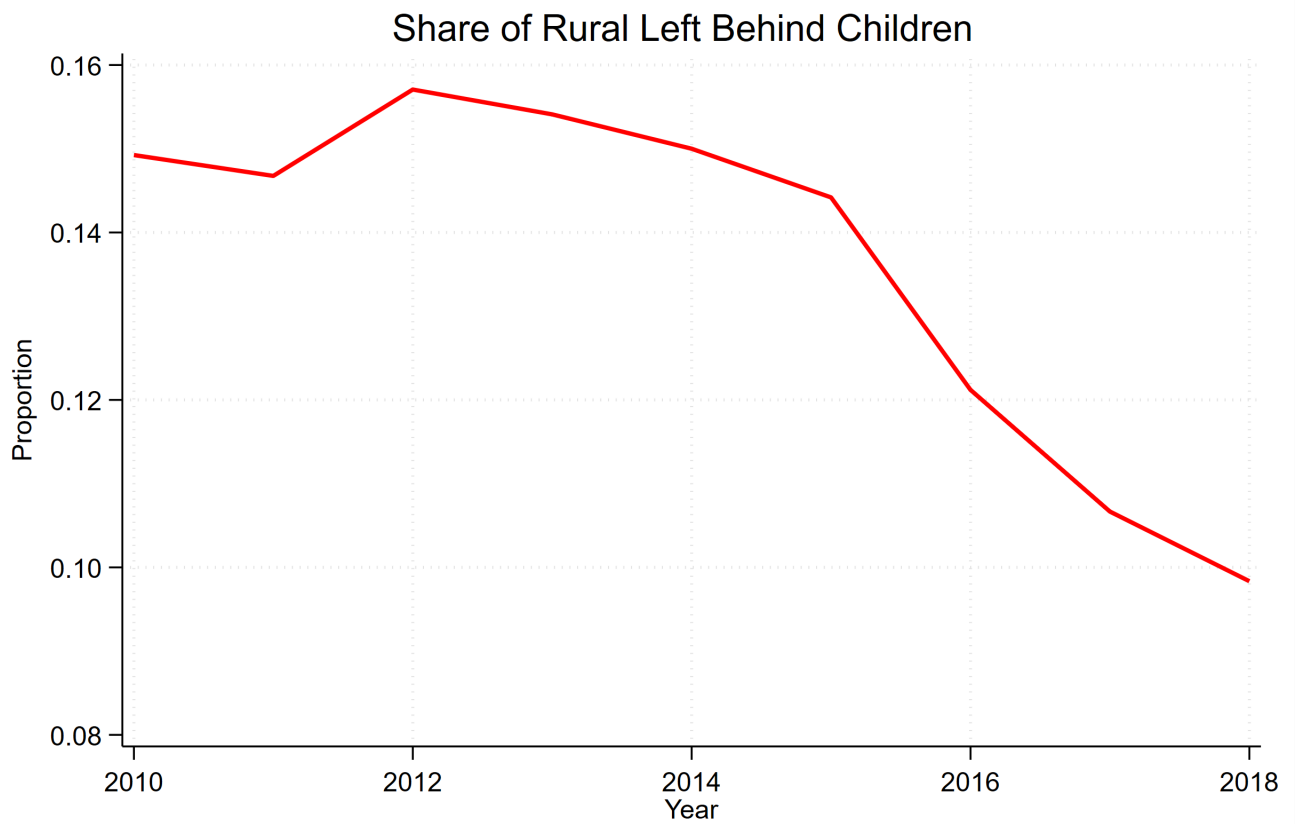


Figure A.1: Impact of land reforms on hukou-migration restrictions

Figure presents a city-level Callaway and Sant'Anna [2021] event study of the impact of the 2003-wave land reforms (with timing of introduction as listed in Table 1) on the index of hukou-migration restrictions from Fan [2019]. The regression reads:  $HukouIndex_{i,t} = \alpha + \sum_{k \neq -1} \theta_k \mathbf{1}\{t - g(p) = k\} + \lambda_i + \lambda_t + \varepsilon_{i,t}$ , with the Hukou Restriction Index being recorded at annual basis between 1998–2010 and taking values between 0–6 (higher being less restrictive). Shaded areas indicate 95% confidence intervals. Standard errors clustered at the province level.



Source: China Education Department  
Notes: 'Rural Left-behind children' are defined by the China Education Department as rural compulsory school kids whose one parent or both have migrated out for work for more than three consecutive.

Figure A.2: Share of Rural Left-Behind Children

	2003-wave Year of reform introduction	2014-wave Year of reform introduction
log(population)	5.190 (5.035)	0.0282 (1.945)
log(number of high school students)	-3.237 (4.848)	0.148 (2.043)
log(GDP pc)	-10.08 (7.910)	0.474 (2.588)
log(fiscal expenditures pc)	9.701* (5.589)	2.703 (2.012)
log(rural income pc)	8.012 (10.34)	0.0552 (3.178)
log(urban income pc)	-3.435 (10.32)	-2.959 (3.868)
Observations	31	31
$R^2$	0.26	0.35

Data source: outcome variable from Table 1 and controls from the National Bureau of Statistics. For provinces not treated in either wave of reforms, we assume either the year of implementation in the next wave or 2021 (end of all reforms). Per capita variables are derived by dividing the relevant variables by the total population of a province. Standard errors in parentheses. \* $p < 0.10$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$ .

Table A.4: Predictors of the reforms' timing