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

Kazushige Matsuda* Karol Mazur† Chao Shen‡

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Abstract

At the beginning of 2000s, China has introduced a series of major agricultural land rights reforms. Using multiple datasets and a structural model, we show that strengthened land security reduced the likelihood of migrant workers leaving children and spouses behind in rural areas. By enabling more families to migrate together, the reforms increased human capital of the rural-origin children by allowing them to attend superior urban education institutions. The findings highlight how land insecurity acts as a barrier to educational equality and efficient talent allocation, with important implications for long-term productivity and welfare in China.

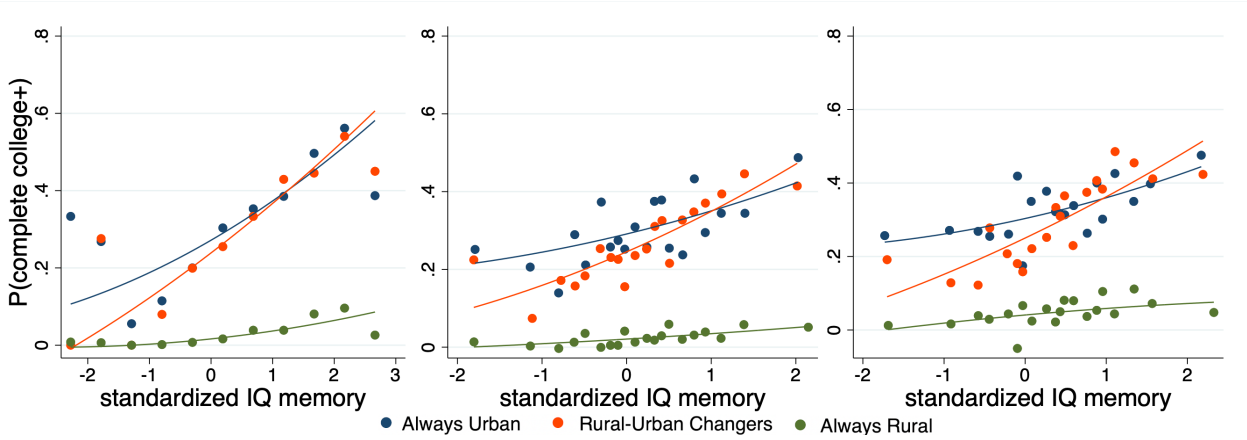
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*Keio University, contact: kazu.matsuda@keio.jp
†Peking University HSBC Business School, contact: kmazur@phbs.pku.edu.cn
‡Peking University HSBC Business School, contact: shenchao@phbs.pku.edu.cn

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 (as proxied by change from agricultural to non-agricultural hukou) from rural to urban areas 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.



Data: 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" if they were born with non-agricultural (urban) hukou; "Always Rural" if they were born with agricultural (rural) hukou and had it at the time of survey; and "Rural-Urban 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^2. Right panel restricts the sample to those living in urban areas at the time of survey, and controls for age and gender.

Figure 1: Higher education attainment vs ability in China

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 provinces. 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 an university by about 1-2 percentage points. Together with our further mechanism analysis, these results imply that improvements in the assignment of rural land rights areas 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 and importance of land income for rural households. Our quantitative analysis indicates that introducing a complete security of agricultural land rights induces large positive long-run changes in the China's economy: it increases by 40% the share of children educated in urban areas, boosting the aggregate stock human capital by 9% and the level of GDP by 17%. Similarly, the

reforms reduce income inequality, as proxied by earnings Gini, by 6% and improve intergenerational mobility, as proxied by intergenerational elasticity of income (IGE), by up to 8%. Overall, average society member enjoys a consumption-equivalent welfare gain of 15.6% in the long-run. Nonetheless, the reform induces significant redistribution as it secures all of the urban workers' land, and so reduces the land income of the remaining rural population.

The remainder of the paper is organized as follows. Section 2 discusses related literature. Section 3 provides background on China's land rights and education system, and the institutional reforms we study. Section 4 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 5 outlines the quantitative model, its calibration and presents the structural analysis. Section 6 concludes.

2 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. Hu et al. [2025] study the impact of uneven distribution of universities in China on spatial inequalities. Our work provides a novel case study of these issues in the context of rural-urban migration in China.

Second, we build on the growing body of work analyzing migration restrictions in China Chan and Zhang [1999] on aggregate productivity and structural transformation [Tombe and Zhu, 2019, Hao et al., 2020]. A more closely related strand of this literature has shown that strengthening land property rights improved agricultural productivity and altered labor allocation [Chari et al., 2021, Ngai et al., 2019, Adamopoulos et al., 2024, Chen et al., 2025].[1] We extend this literature by investigating how the incompleteness of rural land rights affects

[1] de Janvry et al. [2015] provides a similar empirical evidence from land certification in Mexico.

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. [2017, 2022, 2023], Gottlieb and Grobovšek [2019], 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.

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

3.1 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. Many cities in China started lifting these barriers in 2010s [Fan, 2019].

3.2 Hukou System, Land Frictions and Recent Reforms

In parallel, the hukou system has contributed to migration frictions due to agricultural hukou registration being associated with a right to allocation of farmland for active cultivation, but without broader property rights. This system has gone through major reforms starting in early 2000s and ending in 2018.

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 could lose land if they abandoned or left fallow the land for two consecutive year. 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. This weak land rights protection and limited land rental market created a strong incentive to keep a family member (often a spouse with children, or children with grandparents) in the village to protect their claims to the farmland.

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 use rights in rural areas. In order to address these concerns and encourage rural migrants to change their hukou, a second wave of reforms started with a policy directive in 2013 (and with first implementations in 2014). This round launched a national land certification to the household level, and encouraged the development of the land use rights rental market (including to commercial farms) 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. This reform has effectively lifted the rural-side barriers to migrants transferring their hukou, that allows for sending children to local public schools.

4 Empirical Evidence

4.1 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., 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).

2003 Land Reforms	
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
2014 Land Reforms	
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, www.rcre.agri.cn, www.gov.cn).

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

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, education outcomes, family relationships (allowing us to link children with parents), ability measures, economic variables, land ownership, 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. The years 2004 and 2007 of this dataset contain unique records on village-level land reallocations and perceptions of land security, which we utilize in our mechanism analysis.

CLDS. The China Labor Dynamics Survey is a nationally representative 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. For calibration of our model, we utilize the 2012 wave of the CLDS to compute average wage rates and income differentials between rural and urban workers, as well as between migrants with agricultural hukou and urban residents with non-agricultural hukou.

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

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

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 Santaeulalia-Llopis and Zheng [2018].

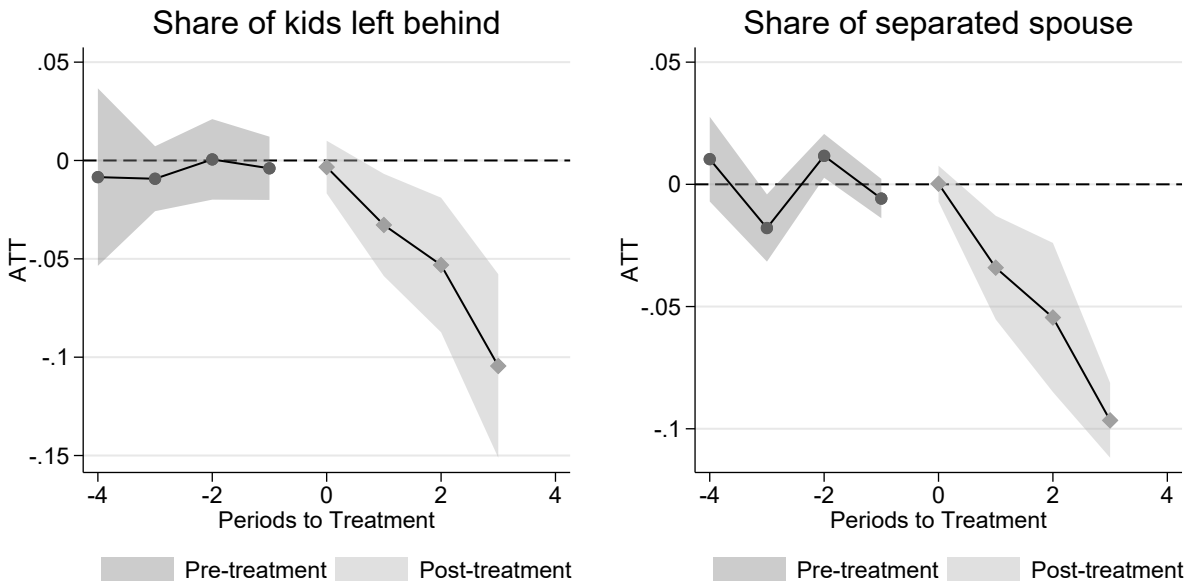
4.2 Land Reforms and Left-Behind: Event-Study Evidence

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:

$$Y_i = \alpha + \sum_{k \neq -1} \theta_k \, \mathbf{1}\{t - g(p) = k\} + X_i\gamma + \lambda_c + \lambda_t + \varepsilon_i \tag{1}$$

We define the "treatment" as a year when province implements the 2014-wave land rights reform. We look at migrant households originating from rural areas (as proxied by agricultural hukou of the migrant-respondent), and define the outcome Y_i as an indicator that child i is *left behind* (i.e., not living with the migrant parent) by a parent from province p (province of their agricultural hukou registration) and living currently in county c (of some province p') and as recorded in survey-year t. For married migrants, we also consider whether the spouse is left behind. We cluster errors ε_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



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.

Figure 2: Impact of land reforms on family migration patterns

the reform (so that timing of migration is exogenous to the reform), and we include a vector of controls X_{ipct} 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 λ_t and parent's current county λ_c 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 migrants 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. We observe a similar pattern for spouses, confirming results 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.

In Appendix A we report a variety of robustness checks confirming this finding: the result holds under alternative specifications (with/without controls), when limiting the sample to inter-provincial migrants or to migrants of certain age groups, and when adding controls for the spouse's location or local hukou policy environment. In all cases, higher land security is associated with a substantially lower probability of children being left behind. Finally, Table A.5 in Appendix A shows that the timing of the 2014-wave of reforms cannot be predicted by a vector of the following province-level controls in 2013: population size, number of high school students, GDP per capita, fiscal expenditures per capita and rural and urban income per capita.

4.3 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 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 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:

$$\text{Years spent in urban}_i = \max\{0, \min\{16, 16 - \text{age at migration}_i\}\} \tag{2}$$

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 time. In particular, we define our instrument as:

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

which implies (i) no exposure Effective Reform Year$_i$ = 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.[2]

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

$$Y_i = \alpha + \beta \cdot \text{Years in urban}_i + \lambda_b + \lambda_c + \lambda_g + \lambda_p + \lambda_t + \varepsilon_i \tag{4}$$

where Y_i is indicator of whether individual i, 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.

[2]While Effective Reform Year$_i$ = 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).

	(1) Years in Urban	(2) Years in Urban
Effective Reform Year	1.04*** (0.05)	0.80*** (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 2: First stage of land reform implementation on years spent in urban as a child

The first-stage results in Table 2 confirm that the instrument strongly predicts urban exposure. In our preferred specification with all five fixed effects included, a one extra year of having more secure land rights during childhood increases the number of years in urban by 0.8.

The second-stage IV results, reported in Table 3, indicate that each additional year spent in an urban environment during childhood raises the likelihood of entering high school by 1.5–4.6 percentage points and that of entering university by 0.6–0.8 percentage points. In the latter case, with all 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 10.2 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	0.0155*** (0.0016)	0.0112*** (0.0011)	0.0045*** (0.0005)	0.0044*** (0.0004)	0.0464*** (0.0024)	0.0149*** (0.0041)	0.0082*** (0.0009)	0.0064*** (0.0021)
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	–	–	–	–	487.3	236.0	487.3	236.0
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 3: Impact of childhood years spent in urban on education attainment

This magnitude is meaningful given the low base rates of high school and university attendance among rural students (see Table 8 below). 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 Year$_i$ does not predict number of years spent in 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; or (ii) local born individuals who have not migrated across cities.[3] Results in 4 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.5 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.

4.4 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.

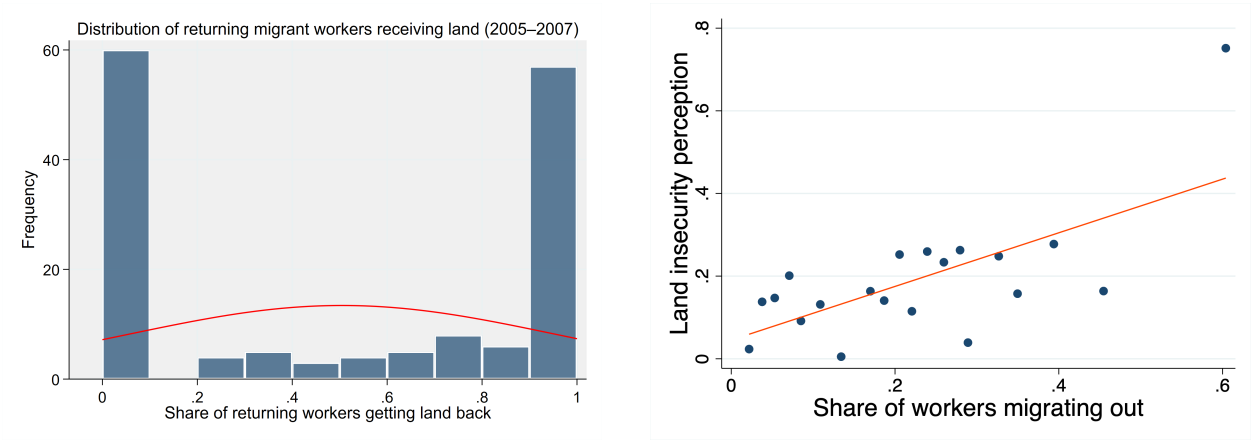
[3]In case of local born individuals not migratin (including those who migrated within their city) we assume that the number of years spent in new location is 0 (since they have not migrated to new urban location).

	(1) Years in New Urban Location	(2) Years in New Urban Location
Effective Reform Year	0.05 (0.04)	0.08 (0.04)
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 4: Placebo first stage of land reform implementation on years spent in new urban location as an urban-born child

Land Tenure Insecurity and Migration. Figure 3 present suggestive evidence of migration being associated with land insecurity from two surveys. First, the 2007 CHIPS data with answers from village leaders shows that in 60% of villages none of the returning migrants have received their land back. Second, we use the household-level answers in GSCF to question [whether 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.



(a) Evidence from 2007 CHIPS

(b) Evidence from 2004-07 GSCF

Figure 3: Migration and actual or perceived land security

Improved Land Security Through Reforms. The land rights reforms directly targeted this problem by strengthening tenure security and de-linking migration from land loss. We present evidence from both Gansu and national data. Table 5 with results from the GSCF panel data, the correlation between the share of migrant workers and the perception of land insecurity weakens significantly in the 2007 wave, consistent with the implementation of land reforms in Gansu in 2006 (see Table 1).

Likewise, using CFPS 2012–2018 data around the second wave of reforms, we find that urban residents reporting land ownership (and therefore likely of rural origin) became significantly less likely to experience land expropriation after the reforms. In particular, differences-in-differences estimates in Table 6 shows that reforms, the gap in reported land expropriation between migrants and rural residents shrank, consistent with reform improving security for those who had moved.

	Land insecurity perception	Land insecurity perception
Share of mig.out worker	.46***	.60***
Share of mig.out worker× 2007 dummy		-.27***
Observations	3,548	3,548
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 5: Evidence on the impact of reform in Gansu

	Land expropriation	Land expropriation
Post		-.009
Urban	.041**	.044***
PostReform × Urban	-.038*	-.028*
Observations	40,800	41,751
County×Year FE	Yes	No
Household FE	Yes	Yes
Year FE	No	Yes

Data source: CFPS 2010. Standard errors clustered at province level. Outcome variable: *In the past 12 months, was your family land expropriated?* * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. We interpret urban respondents reporting land ownership as rural migrants.

Table 6: Evidence on the impact of reforms in CFPS

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 7 confirm that urban schools both receive approx. 15-23% higher fiscal transfers from the government and charge approx. 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 7: Average annual education spending per student in 2010

On the other hand, Table 8 presents evidence from the 2010 1% on the highest education attainment of individuals aged 19-23 across different residence location and hukou status.[4] 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 institutional hurdles, they generally receive better education, leading to improved human capital outcomes.

[4]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
Rural	Agric. hukou	140,811(34.5%)	37,296(9.1%)	16,929(4.1%)	5,999(1.5%)
Urban	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%)
Total		214,722(52.6%)	89,977(22.0%)	60,681(14.8%)	43,252(10.6%)

[1] Data: 2010 1% population census. Data contains no information on hukou status change. Sample restricted to those aged 19–23.

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

Table 8: Education distribution in 2010

5 Quantitative Model

5.1 Overview and Location Choice

To further interpret our empirical findings and to quantify the long-run and general equilibrium implications, we develop an incomplete market OLG model of migration, education, and land rights. 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 abstract time subscripts from now on. Here 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 current child (turning adult) and of education for their children is 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).

5.2 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:

$$u(c) + \zeta_i + \xi_i \tag{5}$$

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 at the rate of β.

Furthermore, each location $i \in \{rr, ru, ua, un\}$ is associated with a common additive utility shifter ζ_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 ξ_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 any land income, against consumption, savings, and necessary expenditures:

$$c + a' + T_i \leq w_i \cdot h + (1 + r)\, a + (1 - \phi_i)\, r_{\text{land}} \bar{\ell} \tag{6}$$

The term $(1+r)a$ is the return on family assets brought from previous period and a' is assets saved for 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. If the parent is in rural, $w_i = w_r$; if in urban with agricultural hukou, $w_i = w_{ua}$ and $w_i = w_{un}$ with non-agricultural hukou.[5] The total labor income is given by $w \cdot h$, where h represents the human capital of the parent (which was accumulated in the previous period).

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:

$$h' = z^{\alpha_z} \cdot e_i^{\alpha_e} \tag{7}$$

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 3 exogenous levels of education investment e_r, e_{ua}, e_{un}. 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 two levels of lump-sum taxes for rural T_r and urban T_u, with each chosen as to ensure that the following government budgets are balanced:

$$\int_{i \in \{un,ua\}} e_i dG = T_u \tag{8}$$

$$\int_{i \in \{rr,ru\}} e_r dG = T_r \tag{9}$$

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

[5] This difference between the wage rates received by locals and migrants is well documented in Guo et al. [2025].

persistence and ε a mean-zero shock.

Land income and security. Each family also has a claim on $\bar{\ell}$ units of land. As we normalize the aggregate amount of land to 1, $\bar{\ell}$ satisfies the following equation:

$$\int (1-\varphi_i)\bar{\ell} dG = 1 \tag{10}$$

If the family stays, at least partially, in rural (rr or ru), they retain full output from that land of $r_{\text{land}}\bar{\ell}$. If the family is in the city, there is a risk of losing some of this land income. We model this via $(1-\phi_i)$ factor: for location choice ua (urban with agricultural hukou), a fraction ϕ_a of the land's yield is lost (e.g., due to land being partially reallocated or idle); for location choice un (urban with non-agricultural hukou), a larger fraction ϕ_n is lost ($\phi_n > \phi_a$), representing the fact that fully urbanized families historically had to surrender their land. In the context of the reforms, ϕ_a and ϕ_n would decline as land rights become more secure.

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:

$$V(i,a,h,z) = \max_{c,\, a'} \;\; u(c) + \beta\, \mathbb{E}_{\xi_{i'}} \max_{i'} \{\mathbb{E}_{z'} V(i', a', h', z') + \zeta_{i'} + \xi_{i'}\} \tag{11}$$

subject to the following constraints:

$$\begin{aligned} c + a' + T_i &\leq w_i\, h + (1+r)\, a + (1-\phi_i)\, r_{\text{land}}\bar{\ell}, \\ c,\; a' \geq 0, \qquad h' &= z^{\alpha_z}\, e_i^{\alpha_e}, \qquad \log z' = \rho_z \log z + \varepsilon. \end{aligned}$$

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.

parameter	interpretation	value	target/source
	externally determined		
μ	coefficient of relative risk aversion	2	modelling choice, CRRA=2
r	annual interest rate	2.1%	World Bank
w_r	rural wage rate	1	normalization
ζ_{un}	*un* location preference shifter	0	normalization
ρ_z	persistence of ability process	0.16	empirical persistence in Table 11
(α_z, α_e)	elasticities of human capital prod. f-n	$(0.09, 0.59)$	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
(ϕ_a, ϕ_n)	land loss risk for *ua* and *un*	$(37.4\%, 90.4\%)$	land ownership rates in Table 15
	internally determined (jointly using SMM)		
β	intergen. altruism/time preference	0.48	$K/Y = 3.5$, Penn World Tables
w_{ua}	urban wage rate w/ agric. hukou	1.58	$\frac{\int_{i' \in \{ru,ua\}} w_u \cdot h}{\int_{i'=rr} w_r \cdot h} = 1.64$, CLDS
w_{un}	urban wage rate w/ non-agric. hukou	1.93	$\frac{\int_{i'=un} w_u \cdot h}{\int_{i'=rr} w_r \cdot h} = 2.17$, CLDS
r_{land}	land income per unit of land	0.03	$\frac{r_{land} \cdot \bar{\ell}}{\int_{i'=rr} w_u h + r_{land} \cdot \bar{\ell}} = 0.43$, CHNS
$(\zeta_{rr}, \zeta_{ru}, \zeta_{ua})$	location preference shifters	$(-4.83, 3.14, -0.06)$	population shares in Table 10
σ_g	Gumbel distribution scale parameter	1.83	27% rural in top 25% of income

Table 9: Calibration summary

5.3 Calibration

We calibrate the model to match key features of the Chinese economy and the outcomes of interest around the year 2010 (prior to the second wave of land reforms). Table 9 in the Appendix summarizes the parameter values. As shown in Table 16, the calibrated model replicates key targeted moments very well. In what follows, we explain in detail the estimation strategy.

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

The utility shifters $(\zeta_{\text{rr}}, \zeta_{\text{ru}}, \zeta_{\text{ua}}, \zeta_{\text{un}})$ are calibrated to match the distribution of children across locations from the 2010 Census 1% sample, as reported in Table 10. With 12.6% of left-behind children, our estimates imply a total of 35.1 million children being left-behind in 2010 China.[6] We normalize $\zeta_{un} = 0$ and calibrate the other 3 shifters by targeting the

[6]Our estimate is close to the 2015 estimate of 40 million left-behind in rural areas of China in UNICEF

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.

Moreover, we set the location parameter of Gumbel taste shocks $\mu_g = 0$ and calibrate the scale parameter $\sigma_g = 1.15$ so that the model matches the 27% share of rural workers in the top 25% of overall income distribution recorded in 2010 CFPS data.

	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%)

[1] Source: 2010 China 1% population census.
[2] 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.

Table 10: Population shares from the perspective of children

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

$$\log(z') = \rho_z \log(z) + \epsilon \tag{12}$$

with ϵ following $N(0, 1-\rho_z^2)$ s.t. z' effectively follows $LogNormal(0,1)$ (which is what we assume in the model).

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. Estimating equation (12), we find an intergenerational correlation of approximately 0.16. Computationally, we discretize this AR(1) using the Rouwenhorst's method.

Human capital production function: We estimate elasticities of the function (7)

[2017].

	Child's IQ memory	Child's IQ memory
Father's IQ memory	.16***	.16***
Observations	8,740	3,770
Parents≤50	No	Yes
Parents Age; Edu FEs	Yes	Yes
Gender; Age; Edu FEs	Yes	Yes
Year; Urban; Current County FEs	Yes	Yes

[1] Source: 2010 CFPS data. Errors clustered at current county level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 11: Intergenerational persistence of ability

$h' = z^{\alpha_z} e^{\alpha_e}$ from micro-data by regressing adult income on (i) the IQ memory test results; and (ii) the education expenditures imputed using information on highest degree obtained and location of education in CFPS, combined with per-student expenditures in Table 7. 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 or -rural location and being rural- or urban-educated as a child:

$$\log(Income_j) = \beta_0 + \beta_1 std\ IQ\ memory_j + \beta_2 \log(edu\ expenditure_j) + \gamma_{age} + \gamma_{gender} + \gamma_{year} + \gamma_{countyXurban} + \gamma_{rural-educated} + \epsilon_j \quad (13)$$

where $std\ IQ\ memory_j$ is a standardized score of the IQ-memory test, and the $countyXurban$-FE absorbs the location-specific wage rate entering $Income = w \cdot h$ on the LHS of regression (13), 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 $\alpha_z = 0.09$ and $\alpha_e = 0.59$.

Education expenditures. We need values for the education input corresponding to each arrangement. We derive these from external data on education expenditure per stu-

	ln(Income)
std IQ memory	.09***
ln(Edu expenditure)	.59***
Observations	8,988

Source: repeated cross-section of 25-55 year old earners in 2012-16-20 CFPS. Fixed effects included: age, gender, year, countyXurban, rural-educated. Standard errors clustered at the county level.

Table 12: Estimation of human capital production function

dent. The China Educational Finance Yearbook (2010) provides average public spending per student at different education levels, and we combine this with survey data on private spending. Roughly, we estimate that over the course of K-12 education, total spending per student in rural areas is around 52,000 yuan, for an urban student with rural hukou (i.e., a migrant child likely in private or less-funded schools) around 83,000 yuan, and for an urban student with urban hukou around 120,000 yuan. We set e_r, e_{ua}, e_{un} in proportion to these amounts. 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

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 7 with the average number of education years completed for each location-hukou status combination in Table 8.

Table 13: Location-hukou specific levels of education expenditures

Wage rates. We pin down w_r and w_u by targeting relative income differences between locations and hukou statuses documented in Table 14 based on the 2012 CLDS data. Using it,

we compute weighted average urban-rural income ratios for urban workers with agricultural hukou of 1.64 and for those with non-agricultural hukou of 2.17. In our SMM strategy, we calibrate the wage rates per unit of human capital w_r, w_u by targeting the wage differentials of $\frac{\int_{i' \in \{ru,ua\}} w_u \cdot h}{\int_{i'=rr} w_r \cdot h} = 1.64$ and $\frac{\int_{i'=un} w_u \cdot h}{\int_{i'=rr} w_r \cdot h} = 2.17$.

	Urban		**Rural**	
	College+	**No College**	**College+**	**No College**
Agric. hukou	26.2(1.2%)	12.7(11.2%)	17.5(1.0%)	8.6(52.0%)
Non-agric. hukou	24.0(14.3%)	14.4(20.3%)	—	

[1] Data: 2012 China Labor Dynamic Survey. Sample restricted to ages 25–64 with full-time jobs. Wages winsorized at the (2.5/97.5) level.
[2] Rural figures restricted to agricultural hukou only. Relative shares of each group reported in parantheses.

Table 14: Labor income per hour of work across locations and education groups

Land income: We calibrate the land income r_{land} per unit of land $\bar{\ell}$ s.t. land income constitutes a realistic share of rural household income. The 2009 wave of the China Health and Nutrition Survey (CHNS) shows that the value of self-produced farm output evaluated at *consumer price* was 43% of average rural household income, which is what we target in our SMM strategy. We purposefully use the value of self-produced food at consumption prices to correctly capture the shadow value of food in light of any potential gaps between producer and consumer prices for food.

Land loss risk: We use the 2010 CFPS microdata on land ownership by migration status to pin down ϕ_a and ϕ_n. Table 15 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.[7] 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 $\phi_a = 1 - \frac{51.7\%}{85.8\%} = 39.7\%$ - equal to the fraction losing land due to urban migrant, but keeping agricultural hukou. Similarly, we

[7] 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)	\

[1] Source: 2010 CFPS.
[2] We use the household head data to estimate the land ownership by different hukou satus.

Table 15: Land ownership by location and hukou status

Moment	Model	Data
Assets-to-GDP ratio	3.52	3.53
rr share	44.1%	47.2%
ru share	12.1%	12.6%
ua share	22.7%	22.4%
Share of rural in top 25% of income	19.6%	26.6%
Land income share for *rr*	47%	43%
Wage income of *ua* & *ru* relative to *rr*	1.61	1.64
Wage income of *un* relative to *rr*	2.08	2.17

Table 16: Moments matched and model fit

infer $\phi_n = 1 - \frac{7.4\%}{85.8\%} = 91.3\%$ 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 $\phi_a^{annual} = 1 - \frac{0.517}{0.858}^{1/30} = 1.7\%$ and $\phi_n^{annual} = 1 - \frac{0.074}{0.858}^{1/30} = 7.8\%$. These numbers sandwich estimates of a 5% annual land loss risk in Adamopoulos et al. [2024].

5.4 Calibration Validation

In Table 17, we report performance of our model's baseline calibration against non-targeted empirical moments.

First, setting $\phi_a = \phi_n = 0$, as for the 2014 wave of land reforms, reduces the share of children left-behind (ru) by 31%, very close to 33% documented in Figure 2 with the event study evidence.

Second, we compare the predictions of our model to our IV evidence in Table 3 showing that one extra year in urban education increases probability of a rural child enrolling into university by 0.9-1.8 p.p. In our model, we do this by computing probability of average rural

Moment	Model	Data
Impact of land reform on share left-behind	-31%	-33%
P(top 10% income) for rural w/ urban edu	11%	10%
Intergenerational elasticity of income	0.423	0.39-0.442

Table 17: Non-targeted moments in the model and data

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 8). Our model predicts that in such a case this probability equals 17%, which is in the middle of empirical estimates from Table 3 of 11-22% (assuming 12 years of education).

Third, the IGE coefficient in our baseline allocation equals 0.403. This is well within the range of estimates reported in Fan et al. [2021] of 0.390 for the 1970–1980 birth cohort and 0.442 for the 1981–1988 birth cohort.

5.5 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 start with an evaluation of the 2014 land reforms culminating in 2018 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 $\phi_a = 37.4\%$ and $\phi_n = 90.4\%$ to $\phi_a = \phi_n = 0\%$. Results in Table 18 report the long-run impact of this reform.

We find that introducing complete security of land rights generates consumption-equivalent welfare gain of 16% on average. This happens as more rural households are able to migrate to urban areas with better education opportunities, leading to an increase in the aggregate stock of human capital by 9% and of GDP by 17%. The inequality is also reduced as suggested by 6-8% reductions in the earnings Gini and IGE.

Statistic	China 2010 Baseline	Post Reform $\phi_a = \phi_n = 0$
Cons.-equivalent welfare	–	+17.8%
GDP	–	+16.6%
Aggregate human capital	–	+8.1%
Land per capita $\bar{\ell}$	–	−27.0%
Earnings gini	21.6	−4.6%
Intergen. elasticity of income	0.423	−8.5%
Average value of being born in urban	-11%	+7%

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

While the reform generates large gains on average, it also induces large redistribution. As all urban workers also keep their land, the amount of land per capita drops by 27%. This implies that the rural residents with either strong rural-location preferences or insufficient ability for migration may experience significant welfare losses due to the reform.

Figure 4 shows the impact of reforms on population distribution along locations. The reform increases by 36% the share of children educated in urban areas ($ua+un$), with a 60% increase in the share of children educated in urban schools of highest quality (un).

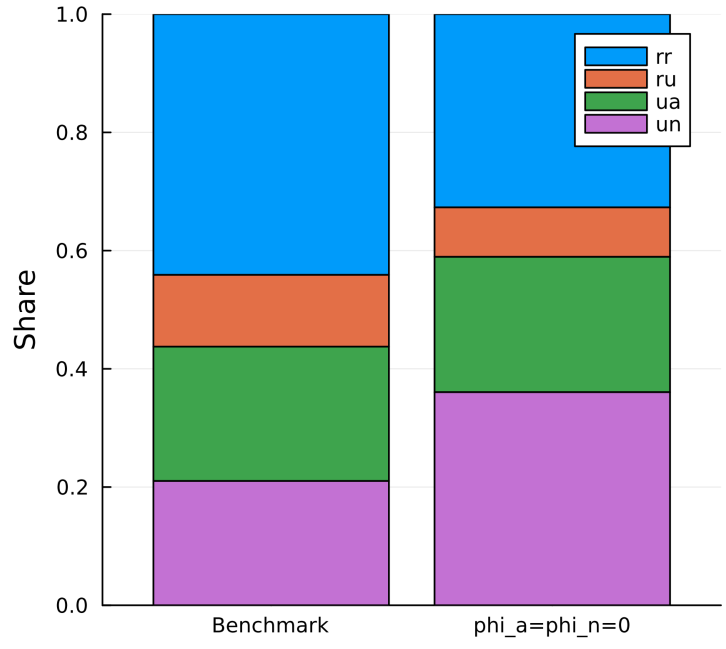


Figure 4: Impact of reforms on population distribution across locations

Finally, we life-time consequences of the place of birth and education. TBC

6 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

	Urban	**Rural**
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)	\

[1] Source: 2013 CHIF.
[2] We use the household head data to estimate the land ownership by different hukou satus.

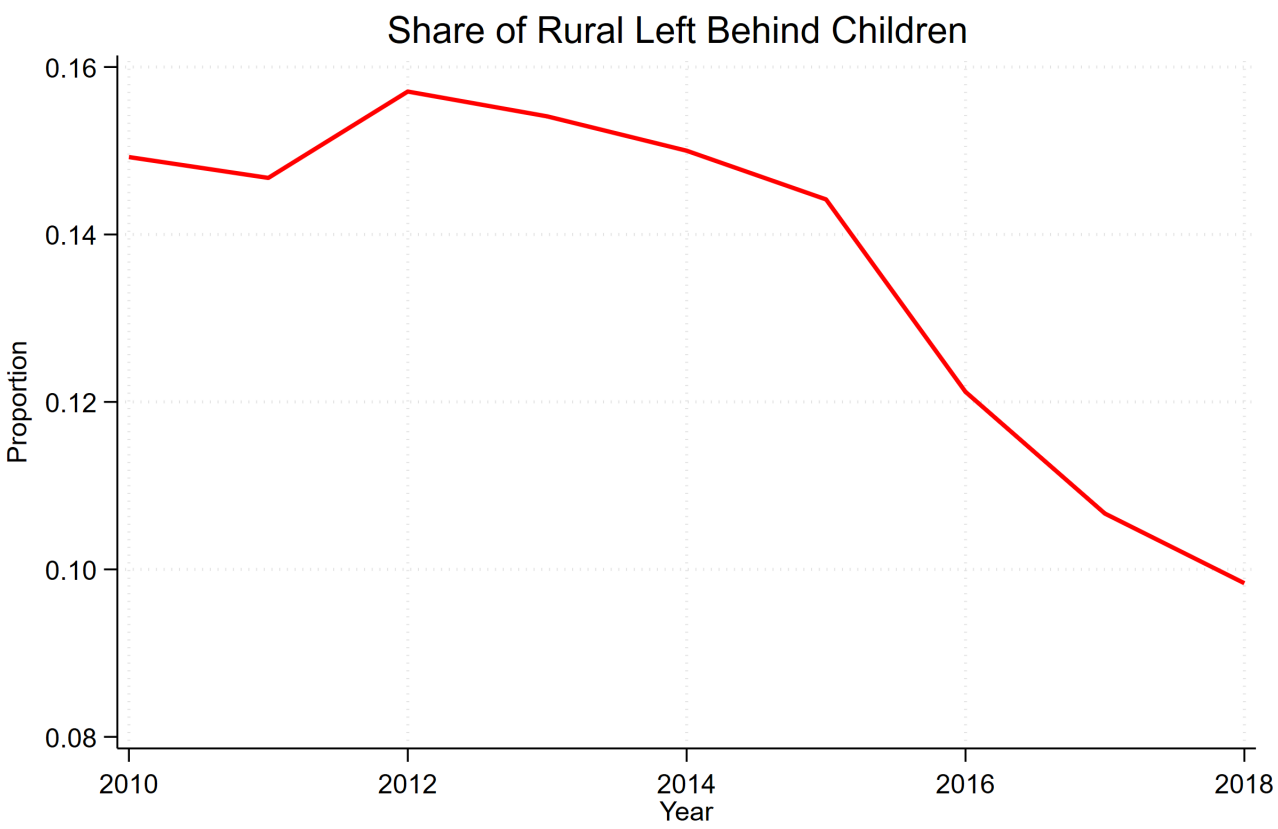
Table A.1: 2013 CHIF Land ownership by location and hukou status

Source of Reform Year	Provinces
2014 Government Document	Shanghai
2015 Agricultural Minister Talk	Shandong, Sichuan, Anhui, Jiangsu, Jiangxi, Hubei, Hunan, Gansu, Ningxia, Jilin, Guizhou, Henan
2016 Agricultural Deputy Minister Talk	Hebei, Shanxi, Inner Mongolia, Liaoning, Heilongjiang, Zhejiang, Guangdong, Hainan, Yunnan, Shaanxi
2017 Agricultural Minister Talk	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	*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...*
Land Administration Law of the PRC	2004	*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...*
China Land Contract Law	2002/2009	*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...*
	2018 (revision)	*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...*
The Interim Regulation on Real Estate Registration	2015	*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...*

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



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.1: Share of Rural Left-Behind Children

	P(High School)	P(College)
Educated in city primary school	.10**	.07**
Observations	3,228	3,228
$20 \leq$ Age ≤ 40	Yes	Yes
Parents Hukou; Edu FEs	Yes	Yes
Gender; Age; Hukou FEs	Yes	Yes
Urban; Birth and Current City FEs	Yes	Yes

[1] Data Source: 2012 CLDS data. Errors clustered at current county level; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Impacts of primary school location on education

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

Data source: outcome variable from Table 1 and controls from XXX. 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.5: Predictors of the reforms' timing