Land Security and Mobility Frictions

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Academia Sinica
June 13, 2023

Big Picture

- Economic development is accompanied by a process of structural change and rural-urban migration
- Yet, in less developed countries this process has been slow.
- Despite the large gap in labor productivity and wages between agriculture and non-agriculture
  - ...even after accounting for human capital and other measurement differences (Gollin, Lagakos, and Waugh 2013)
- Why aren't more people moving out of agriculture and into cities in less developed countries?

Motivation

- Literature views labor mobility barriers as key constraint on rural-urban migration
- Instead, we focus on insecure land tenure as an implicit migration cost:
  - renting land out: costly with potential risk of losing land
  - having family members continue farming helps "secure" their landholdings
- Our research objective:
  - quantify migration cost arising from insecure land tenure versus "residual"

What We Do

- Focus on China: migration restrictions & insecure property rights
- Access to rich household and individual-level panel data from China (2004-2018)
- Build an equilibrium quantitative framework with *frictional sorting* of workers/households across occupations and locations
  - Individual occupational choice as in Roy '51
  - Nests family decision whether to farm and choice of farm operator $\rightarrow$ selection within the household
  - Insecure family land rights
  - Idiosyncratic barriers to labor mobility
- Disentangle the role of land security and labor mobility barriers and their evolution over time
- Quantify their impact on agricultural productivity and structural change

What We Find

- Mobility cost associated with land insecurity is substantial
  - in magnitude similar to all other labor mobility barriers
- With land security, more than half of incumbent farms stop farming and agricultural labor productivity increases by about 18 percent
- Over time overall mobility cost decreases
  - Mostly accounted by increase in land security
  - Other labor mobility barriers barely change

Related Literature

- Structural transformation and agriculture
  - Gollin-Parente-Rogerson '02 '05 '07, Restuccia-Yang-Zhu '08, Adamopoulos-Restuccia '14, Chen '17, Gottlieb-Grobovsek '19, Adamopoulos et al '21
- Structural transformation and migration
  - Gollin-Lagakos-Waugh '14, Bryan-Morten '19, Lagakos et al '20, Schoellman '20, Hamory et al '21
    - Land security and migration: de Janvry et al '15, Giles-Mu '17, Ngai-Pissarides-Wang '19
- Growth and development in China
  - Brandt-Zhu '10, Song et al '11, Brandt-Tombe-Zhu '13, Chari et al 20'

Institutional Environment in China

- Land rights:
  - Use rights over farmland on an egalitarian basis
  - Reallocations within villages were common
  - Limited rentals due to perceived "use it or lose it" practices
  - Land tenancy reforms in recent years
- Migration restrictions:
  - Household registration system (*hukou*)
  - Individuals assigned agricultural or non-agricultural hukou
  - Easing of restrictions over time, especially for smaller cities
  - Harder to obtain hukou to larger coastal cities; limited access to education; rising housing prices

Stylized Facts on China's Structural Transformation

Table: Employment in Agriculture

Variable	2004	2009	2014	2018
Nationwide agricultural employment share (%)	39.1	28.4	19.8	15.5
Share of all households living in rural area (%)	68.7	56.3	45.6	41.6
Share of labor days in agriculture among rural households (%)	56.9	50.4	43.2	37.8
Share of individuals in rural areas involved in agriculture (%)	70.3	62.8	56.2	48.4
Share of farm operators (%)	27.5	23.8	19.6	16.5
Share of full-time workers (%)	21.5	20.3	18.8	18.2
Share of part-time workers (%)	21.2	18.7	17.8	13.7
full-time non-agriculture (%)	29.7	37.2	43.8	51.6

Stylized Facts on China's Structural Transformation

Table: Average Farm Size and Land Rentals

Variable	2004	2009	2014	2018
Average farm size (ha)	0.59	0.62	0.73	0.87
Share of households renting-in land (%)	8.4	8.5	14.8	17.3
Share of land rented-in (%)	6.8	9.7	20.8	30.0

Stylized Facts on China's Structural Transformation

Table: Structural Transformation before 2004

Variable	1995	2002
Nationwide agricultural employment share (%)	48.0	42.2
Share of households living in rural area (%)	75.4	72.6
Share of labor days in agriculture among rural households (%)	63.6	58.2
Share of individuals in rural areas involved in agriculture (%)	73.6	67.5
Share of full-time workers (%)	53.6	48.8
Share of part-time workers (%)	19.9	18.8
Average farm size (ha)	0.57	0.59

Introduction

Model

Estimation

Quantitative Analysis

Framework Overview

- General equilibrium model of occupational, spatial, and sectoral selection.
- Individual heterogeneity with respect to ability and idiosyncratic distortions.
- Key novelties:
  1. Families choose which member operates the farm (if any)
  2. Insecure land rights perceived by families

Environment

- Two goods (agriculture and non-agriculture, numeraire) in two sectors
- Spatially the economy consists of the rural (villages) and urban areas:
  - villages $\rightarrow$ agriculture (a)
  - urban $\rightarrow$ non-agriculture (n)
- Urban households work in the non-agricultural sector (passive)
- Village families consist of heterogenous individuals that make occupational and locational choices (focus of model):
  - operate a farm in the village
  - work in agriculture in the village
  - migrate and work in non-agriculture in the urban area

Preferences

- Non-homothetic preferences over the agricultural and non-agricultural good

$$u(c_a, c_n) = \phi \log(c_a - \bar{a}) + (1 - \phi) \log(c_n)$$

- Generates structural transformation from agriculture to non-agriculture

The Non-Agricultural Sector

- A representative firm in non-agriculture produces by

$$Y_n = A_n H_n$$

- Hires labor input from
  - urban families
  - some rural family members who work in urban non-agricultural sector

Village Families

- Village families indexed by i
- Each family has J individual members, indexed by $j = 1, ..., J$
- Family-level perceived chance of reallocation/expropriation: η
- Individual-level labor mobility frictions to working in non-agriculture ξ_{ij}
- Individual-level farm distortions τ_{ij}: residual misallocation across farmers

Village Families

- Each family member is endowed with:
  - a farm operating ability s_{ij}
  - a non-agricultural earning ability h_{ij}
- This individual can choose from following occupations:
  - full-time operator of family farm: $\pi_{ij}(s_{ij}, \tau_{ij})$
  - full-time agriculture worker: $i_{ij}^{FA} = w$
  - full-time non-agricultural worker: $i_{ij}^{FN} = w_n h_{ij}(1 - \xi_{ij})$
  - part-time worker:

$$i_{ij}^{PT} = \underbrace{h_{ij} w_{ij}^{n}(1 - \xi_{ij})(1 - c - n_{ij})}_{\text{Non-Agr Income}} + \underbrace{w n_{ij}^{\nu}}_{\text{Agr Income}}$$

Agricultural Production

- Heterogeneous farms operated by village families
- Family farm's productivity determined by operator's ability s_{ij}
- A farm produces according to a DRS technology

$$y_{ij} = A s_{ij} \left(\ell_{ij}^{\theta} n_{ij}^{1-\theta} \right)^{\gamma}$$

- Family and hired labor are perfect substitutes

Land Rights

- Each family is allocated use rights over land $\bar{\ell}$ (egalitarian allocation)
- A farmer can adjust the size of their farm operation by renting-in ($\ell_{ij}^{rent} > 0$) or renting-out ($\ell_{ij}^{\text{rent}} < 0$) land
- After agricultural production, a land reallocation/expropriation may occur with probability η
  - Rent-out: punishment $\varphi_i \ell_{ij}^{\text{rent}}$ (loss of rented out land)
  - Land confiscated rebated to all rural households
- Profits $\pi(s_{ij}, \tau_{ij})$ given by

$$\max_{n_{ij}, \ell_{ij}^{\text{rent}}} \left\{ \tau_{ij} p A s_{ij} \left[\left(\bar{\ell} + \ell_{ij}^{\text{rent}} \right)^{\theta} n_{ij}^{1-\theta} \right]^{\gamma} - q \left(\ell_{ij}^{\text{rent}} \right) - w n_{ij} + \eta \varphi_i \ell_{ij}^{\text{rent}} \mathbb{1}[\ell_{ij}^{\text{rent}} < 0]) \right\},$$

Family Decisions

- Who (if any) should be the farm operator?
- If individual j is the farm operator, then household income is

$$I_i(\text{operator} = j) = \pi_{ij} + \sum_{k \neq j} i_{ik} = \pi_{ij} + \sum_{k \neq j} \max\{i_{ij}^{FN}, i_{ij}^{FA}, i_{ij}^{PT}\}$$

- Family chooses operator j that maximizes household income:

$$I_i = \max_{j \in J}\{I_i(\text{operator} = j)\}$$

- Family may choose not to operate a farm
- Household income if not operating a farm:

$$I_i^n = \sum_j \max\{i_{ij}^{FN}, i_{ij}^{FA}, i_{ij}^{PT}\} + q\bar{\ell} - \eta\varphi_i\bar{\ell}$$

- Family operates a farm if $I_i \geqslant I_i^n$

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Parameterization I

- Ability distributions (log normal)

$$\log(h_{ij}) = \log(h_i^H) + \log(h_{ij}^I), \quad \log(s_{ij}) = \log(s_i^H) + \log(s_{ij}^I) + \lambda \log(h_{ij})$$

  - Family components (s_i^H and h_i^H); individual components (s_{ij}^I and h_{ij}^I)
    - $\{s_i^H, h_i^H, s_i^I, h_i^I\}$: mean-zero log-normal with s.d. of $\{\sigma_s, \sigma_h, \gamma\sigma_s, \gamma\sigma_h\}$
    - γ: relative importance of individual components versus family components.
  - λ: correlation between two dimensions of abilities

- Labor mobility barriers:

$$\xi_{ij} = \frac{\exp(\varepsilon_{ij}^{\xi})}{1 + \exp(\varepsilon_{ij}^{\xi})},$$

  - Barriers bounded between zero and one
  - $\varepsilon_{ij}^{\xi} \sim \log \mathcal{N}(\mu_{\xi}, \sigma_{\xi})$

Parameterization II

- Idiosyncratic farming wedges:

$$\log(\tau_{ij}) = \underbrace{\zeta \log(s_{ij})}_{\text{correlated distortions}} + \underbrace{\varepsilon_{ij}^{\tau}}_{\text{uncorrelated}}, \text{ where } \varepsilon_{ij}^{\tau} \sim \log \mathcal{N}(0, \sigma_{\tau})$$

- Land security (punishment):

$$\varphi_i = \mu_{\varphi} + \varepsilon_i^{\varphi}, \quad \varepsilon_i^{\varphi} \sim \log \mathcal{N}(0, \sigma_{\varphi})$$

Data

- Unique household and individual panel data (RCRE's Fixed Point Survey)
- Panel data, use 2004 to 2018 waves
- Farm inputs and outputs; used to estimate farm productivity and wedges
- Individual labor supply to agriculture, rural/urban non-agriculture and wage
- Supplementary survey on land redistribution or land taking risks
- Macro data from various sources to determine non-agricultural moments
- Calibrate a benchmark economy to 2004 data moments using SMM

Baseline Estimation

- We have 23 parameters to be determined
- 9 parameters determined based on a priori information and normalizations
- Remaining 14 parameters estimated jointly to match empirical moments
- While jointly determined certain moments more relevant for identifying key parameters

Targeted Moments: Data and Model

Moments	Data	Model
Employment share among village individuals:		
Full-time non-agriculture	0.297	0.293
Part-time	0.212	0.207
Median fraction of part-time hours in agriculture	0.274	0.275
Rank correlation of wages and part-time hours in nonagr.	0.398	0.398
Share of village households with farm operators	0.737	0.732
Sectoral gap: nonagr. wage versus farming profit	0.081	0.081
Family wage differentials:		
Average nonagr wage, with/without operators	−0.281	−0.283
Wage dispersion among full-time non-agr. workers:		
Standard deviation	0.610	0.608
Within-family correlation	0.557	0.555
Correlation of non-agricultural wage income and farm profit	0.083	0.080
Agricultural production:		
Standard deviation of farm TFP	0.657	0.659
Standard deviation of farm TFPR	0.633	0.630
Rank correlation of farm TFP and TFPR	0.963	0.975
Nominal agr. to non-agr. labor productivity ratio	0.388	0.387

Key Identification: Land Insecurity vs. Mobility Barriers

- Land loss risk: the mean of η is 0.051 from our supplementary survey
- Separately identify land loss punishment (μ_φ) vs. labor mobility barriers (μ_ξ)
  - both generates sectoral wage gaps of individuals
  - land insecurity matters more the fraction of households operating farms

Key Identification: Land Insecurity vs. Mobility Barriers

- Sensitivity of parameters:
  - increase a single parameter by 1% keeping all other parameters unchanged
  - assess the changes in model moments

Moments	μ_φ	μ_ξ
Village households with farm operators (%)	+0.28	+0.09
Sectoral wage gap	+0.25	+0.29

Key Identification: Land Insecurity vs. Mobility Barriers

- Estimated $\varphi_i \bar{\ell}$ is on average five times of rural household annual income
- This value is empirically plausible:
  - farming accounts for roughly 1/3 to half of total family income in 2004
  - land share 0.4
  - subjective discount rates ranging from 3% to 5%
  - present value of land is roughly $0.4 \cdot \frac{\frac{1}{3} \sim \frac{1}{2}}{3\% \sim 5\%} = 2.7$ to 6.7-fold annual income

Key Identification: Land Insecurity vs. Mobility Barriers

- Consider an otherwise identical model but no land insecurity ($\eta = 0$)
- Re-calibrate it to match same moments except for those governing land insecurity
- We can match the same sectoral wage gap, BUT a much higher level of labor mobility barriers is needed
  - ξ_{ij} is now on average 80%, compared to 55% in the baseline calibration
- MOREOVER, this re-calibrated model predicts much fewer rural households operate farms
  - 43% in the re-calibrated model as opposed to 74% in the data (and baseline calibration)

Implications on Land Rental Markets

- The model is consistent with the data that most farms neither rent in nor rent out
  - 87% in the data and 72% in the model despite not targeted
  - Renting out land is associated with a risk which effectively reduces the rent-out price
  - Our modelling of land insecurity provides a micro foundation of the wedge between rent-in and rent-out prices used in literature to generate inaction

Implications on Land Rental Markets

- Who rent in land?
  - In a frictionless environment, the most productive farms rent in land
  - In the data, however, the correlation between farm productivity and a rent-in dummy is weak at only 0.02
  - Our baseline calibration also implies a low correlation (0.27)

Implications on Land Rental Markets

- Rental implications are also consistent in the intensive margin
  - average amount of rentals among those who rent in land:
    - 0.97-fold of average farm size in the model vs. 0.89-fold in the data
  - weak correlation between farm productivity and amount of rentals among those who rent in land
    - 0.20 in the model and 0.31 in the data

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Experiment 1: Land Security and Labor Mobility

- Disentangle the importance of land security Vs. residual labor mobility barriers
  - eliminate risk of reallocation/expropriation ($\eta = 0$)
  - eliminate labor mobility barriers ($\xi_{ij} = 0$)

Experiment 1: Land Security and Labor Mobility

	Baseline	Land Security	No Labor Barriers
Village families operating farms (%)	73.2	28.6	48.3
Ag. emp. share among villagers (%)	56.6	46.0	46.3
Δ Agricultural labor productivity (%)	–	+24.3	+16.2
Δ Real GDP per capita (%)	–	+3.4	+2.7
Within-household selection in farming:			
% of farm operators with highest s_{ij}	61.4	69.3	62.9
Nominal agricultural productivity gap	2.58	2.22	1.38

- Land security has a substantial impact on the percentage of village families operating farms
  - Data: prevalence of (subsistence) farms that do not sell to the market
  - Land insecurity encourages farm operation to secure the land
- Residual labor mobility barriers have weaker effects on agr. productivity
- Real agricultural labor productivity is not necessarily related to the nominal labor productivity gaps between sectors within a country

Experiment 2: Evolution of Frictions over Time

- We recalibrate the model to match empirical moments for 2018
- Use estimated values of land security and labor mobility barriers as follows:
  - Change η to 0.016 and μ_φ to match the average $\varphi_i \bar{\ell}/l_i$ to 3.2-fold in 2018
  - Change distribution of ξ_{ij} to 2018 estimates
- From baseline, quantify changes to 2018 in land security and labor mobility barriers

Experiment 2: Evolution of Frictions over Time

	Baseline	2018 Land Security	2018 Labor Barriers
Village households operating farms (%)	73.2	56.4	77.0
Ag. emp. share among villagers (%)	56.6	53.2	59.4
Δ Agricultural labor productivity (%)	–	+6.8	−2.9
Δ Real GDP per capita (%)	–	+2.0	−0.2

- Overall migration cost falls over time
  - mostly from improvement in land security—consistent with land reform
  - "residual" labor mobility barriers barely change

Extensions

1. Rural and Urban Non-agricultural Sectors
   - Motivation: About half leaving agriculture work in rural non-agriculture
   - Findings: Land insecurity hurts equally non-agricultural employment in rural and urban
2. Age Cohorts
   - Motivation: Old (45+) substantially more engaged as farm operators
   - Findings: Land insecurity contributes about 40% to age gap in farm operators
3. Regional Heterogeneity
   - Motivation: Peri-urban villages have better access to off-farm opportunities
   - Findings: Land insecurity less severe in peri-urban than remote villages

Conclusions

- Land insecurity as implicit reallocation barrier, prevalent in developing countries
- Build a framework:
  - nesting individual's occupational choice with family decision on farming
  - highlights the importance of within-family selection
- Estimate model using rich individual- and household-level panel data
- Land insecurity quantitatively as important as all other mobility barriers
  - contributes to accounting for prevalence of small/unproductive/subsistence farms
- Overall mobility barriers fall over time
  - mostly from improvement in land security associated with land reforms
  - other mobility barriers barely change

The Extended Model: Setup

- We allow for two non-agricultural sector: rural (r) and urban (u)
  - technologies: $Y_r = A_r N_r$, $Y_u = A_u N_u$
  - labor mobility barriers differ: ξ_{ij}^r and ξ_{ij}^u
  - Different costs of part-time working c_r and c_u
  - goods are perfect substitutes
- We also allow for cohort differences: young and old
  - each individual j in family i can be either young or old with probability p_o
  - differences in the levels of ability distribution and labor mobility barriers
    - drifts of labor mobility barriers of the old: μ_o^r and μ_o^u
    - drifts of abilities of the young: μ_y^s and μ_y^h

The Extended Model: Calibration

- Empirical moments: we treat an individual above 45 as "old"
- 7 more parameters to calibrate:
  - 7 more moments regarding the employment share and wage gaps for young and old separately and for rural and urban non-agricultural sectors separately

The Extended Model: Implications of Calibrated Economy

- The young have higher average abilities but comparative advantage in non-agriculture
  - $\mu_y^s = 0.14$ and $\mu_o^s = 0.20$
- The old face substantially higher labor mobility barriers especially to urban non-agriculture
  - $\mu_o^r = 0.36$ and $\mu_o^u = 0.90$

The Extended Model: Quantitative Results

	Baseline	Land Security	No Labor Barriers
Village families operating farms (%)	72.1	30.5	53.4
Ag. emp. share among villagers (%)	57.7	51.0	49.3
Δ Agricultural labor productivity (%)	–	+11.7	+9.7
Δ Real GDP per capita (%)	–	+2.2	+5.8
Within-household selection in farming:			
% of farm operators with highest s_{ij}	54.4	61.0	53.9
Nominal agricultural productivity gap	2.50	2.14	1.28

- Implications on farming choice and agricultural productivity remain largely unchanged
- Land insecurity helps explain "left-behind elderly"
  - With land security, the percentage of operators who are old reduces from 51% to 48%

Regional Heterogeneity

- Important heterogeneity across regions in China
- We divide villages into two groups: (a) Peri-urban and (b) Remote
- For each group, re-calibrate model using micro moments calculated from observations in each region only
- Implement "Land Security" and "No Labor Mobility Barriers" counterfactuals

Regional Heterogeneity

(a) Peri-urban Area	Baseline Calibration	Land Security	No Labor Barriers
Village households operating farms (%)	53.9	33.5	35.9
Agrricultural employment share of villagers (%)	44.4	40.6	35.9
Δ Agricultural labor productivity (%)	–	+8.7	+14.2
Δ Non-agricultural output (%)	–	+1.5	+6.3
Δ Real GDP per capita (%)	–	+1.2	+3.9

(b) Remote Area	Baseline Calibration	Land Security	No Labor Barriers
Village households operating farms (%)	75.9	46.1	58.8
Agricultural employment share of villagers (%)	61.9	55.6	53.5
Δ Agricultural labor productivity (%)	–	+11.5	+8.7
Δ Non-agricultural output (%)	–	+2.6	+7.1
Δ Real GDP per capita (%)	–	+2.2	+3.8

Regional Heterogeneity

- Results:
  - Land insecurity less severe in Peri-urban than Remote
  - Labor mobility barriers:
    - ξ_{ij}^{r} substantially lower in Peri-urban than in Remote
    - ξ_{ij}^{u} slightly higher for Peri-urban villages
- Possible explanations:
  - More off-farm opportunities for Peri-urban villagers from local non-agriculture
  - Agriculture less important for Peri-urban and hence less pressure to reallocate land

Summary of Frequency of Reallocations and Takings

(a) Land Reallocations

Period	Number	Number per year	Probability
Survey, 2004:			
1991–1999	140	15.6	13.0%
2000–2003	15	3.8	3.1%
1991–2003	155	11.9	9.9%
Survey, 2018:			
2003–2017	16	1.1	0.9%

(b) Land Takings

Period	Number	Number per year	Probability	Land (Ha)	Households
Survey, 2004:					
1991–2003	123	9.5	7.9%	581.6	11,076
Survey, 2018:					
2003–2017	123	8.2	7.3%	1,433.0	12,881