

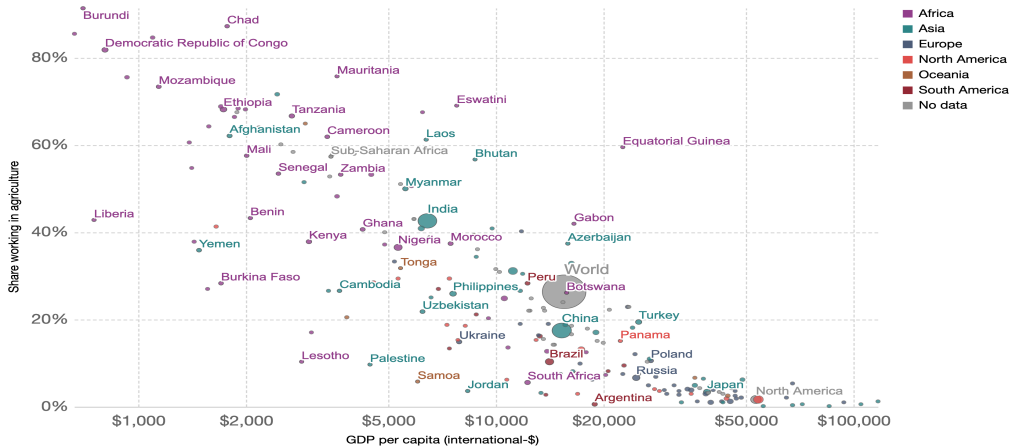
FROM MICRO TO MACRO: LAND INSTITUTIONS, AGRICULTURAL PRODUCTIVITY, AND STRUCTURAL TRANSFORMATION

Diego Restuccia
University of Toronto
and NBER

Structural Transformation and Economic Growth (STEG)
Special Lecture 2021
Virtual — December 02, 2021

Employment in agriculture vs GDP per capita, 2017

Share of persons of working age who were engaged in any activity to produce goods or provide services for pay or profit in the agriculture sector (agriculture, hunting, forestry and fishing).



Source: World Bank

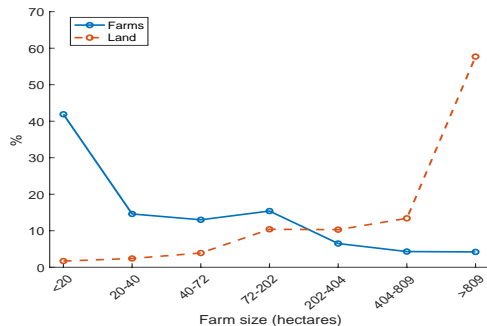
OurWorldInData.org/employment-in-agriculture • CC BY

MOTIVATION

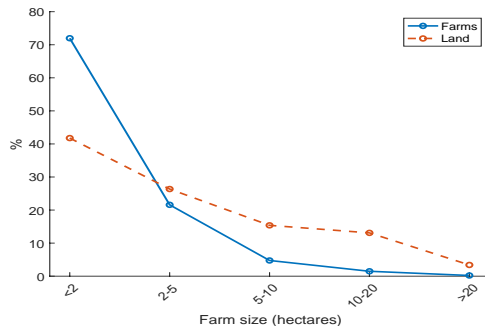
- Agriculture important in accounting for rich/poor income per capita disparity (Gollin, Parente, and Rogerson 2002; Restuccia, Yang, and Zhu 2008)
- Poor countries feature much lower real agricultural productivity (and relative to non-agriculture) compared to developed countries, and allocate much of their labor to agriculture
- What factors are key in holding back agricultural productivity in poor countries?
- Many relevant factors, I focus on factor misallocation across farms arising from restrictive land institutions

SIZE DISTRIBUTION OF FARMS AND LAND

(a) United States



(b) Poorest quintile



- Land distribution skewed towards small farms in poor countries, suggesting misallocation (Adamopoulos and Restuccia, 2014)

OUTLINE

- Land institutions in developing countries, evidence of land misallocation in agriculture
- Develop a two-sector general equilibrium model of structural transformation, featuring distorted land markets in agriculture
- Calibrate benchmark distorted economy to aggregate and micro data for Ethiopia
- Quantify the aggregate and distributional effects of a land rental-market reform

WHAT I FIND

- Land rental-market reform reduces misallocation, improves selection into farming, and fosters structural transformation
 - Within a zone (county), 26% increase in agricultural TFP due to reallocation, 285% in agricultural labor productivity via improved selection and structural transformation
- Key are systematic component of implicit distortions, inability of productive farmers to expand, intensive margin of land rentals
- In the medium term, land reform can substantially reduce inequality (90-10 ratio cut by half) and poverty (a doubling in income in bottom decile)

WHY ETHIOPIA?

- Very poor country in Africa, GDP per capita about 3% of US
- Agriculture dominant sector, represents 70% of total employment
- Interesting land institution, reallocation only via rentals
- Detailed household-level micro data
 - LSMS-ISA data from the World Bank
 - Information on farm-level inputs and output in physical units
 - Useful in constructing measures of farm productivity and distortions

LAND INSTITUTION—ETHIOPIA

- Current institution shaped by historical events, prevailing characteristic state control over allocation and use of land
- Imperial period (mid 19th century to 1974):
 - Land ownership allocation to political supporters regardless of occupation or use in farming, resulted in powerful landlords
- Communist regime (1975 to 1991) “Land to the Tiller”
 - Land expropriated, **uniformly** redistributed, adjusting for soil quality and family size, among all rural households in the form of **use rights**
 - Redistributions frequent to achieve equitable allocation of use rights at the local level
 - Prohibited land sale transactions
- Recent governments largely maintained policies related to land
 - Land certification reform (early 2000s) to promote tenure security, farm investment
 - **Restrictive land rentals** only channel allowing reallocation of farms’ operational scale

EVIDENCE OF MISALLOCATION—FRAMEWORK

- Standard model of heterogeneous production units and input allocation (Lucas 1978; Hopenhayn 1992; Adamopoulos and Restuccia 2014)
- Single homogeneous good produced across heterogeneous farms that differ in TFP

$$y_i = A_i \ell_i^\gamma, \quad \gamma \in (0, 1)$$

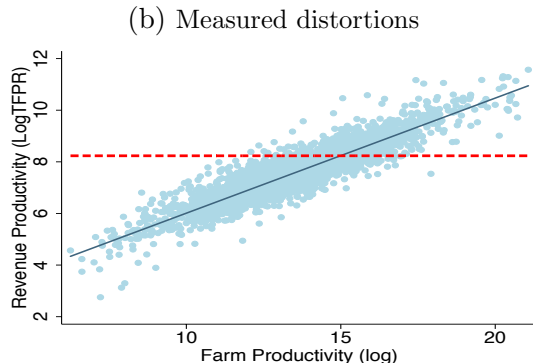
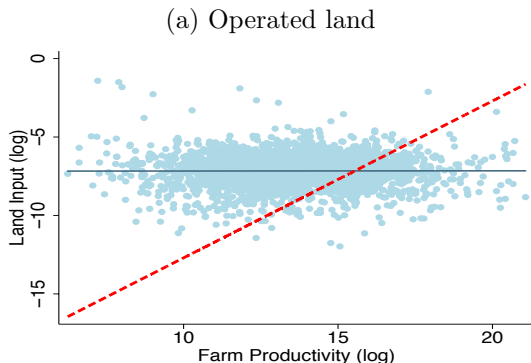
- Allocation with idiosyncratic distortions τ_i on land cost

$$\ell_i \propto \left(\frac{A_i}{1 + \tau_i} \right)^{\frac{1}{1-\gamma}}; \quad \frac{y_i}{\ell_i} \propto (1 + \tau_i)$$

EVIDENCE OF MISALLOCATION—ETHIOPIA

- Panel data from Chen, Restuccia, and Santaëulalia (2021)
- Focus on the **household farm** as unit of analysis
- Data on outputs (physical units), labor (days), capital, intermediate inputs, operated land, control for land quality and weather shocks
- Measure farm TFP as residual from farm production function
- Abstract from transitory variation by estimating **household-farm fixed effect** from panel data, focus on **within-zone** variation (following Adamopoulos, Brandt, Leight, and Restuccia 2021)

EVIDENCE OF MISALLOCATION—ETHIOPIA



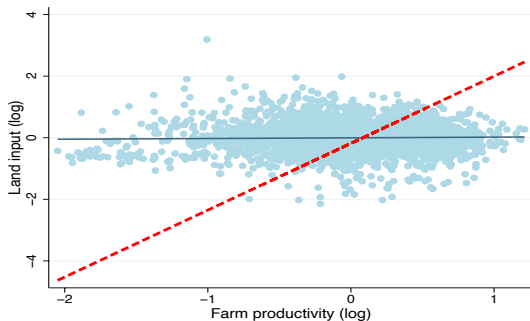
- Within-zones (counties): $\text{STD}(\log \text{ farm TFP})=0.65$, $\text{STD}(\log \text{ farm TFPR})=0.74$, $\text{CORR}(\log \text{TFP}, \log \text{TFPR})=0.90$
- Percentage of farms not renting land 68%

LAND MISALLOCATION IN OTHER CONTEXTS

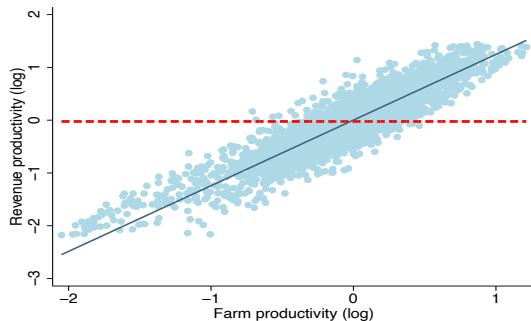
- Not unique to Africa, many restrictive land institutions in developing countries
 - Land holding ceiling (Adamopoulos and Restuccia 2020)
 - Untitled land across countries (Chen 2017)
 - “Ejido” communal land system in Mexico (de Janvry, Emerick, Gonzalez-Navarro, and Sadoulet 2015)
 - Extent of land rental markets across Indian states (Bolhuis, Rachapalli, and Restuccia 2021)
 - Land-use rights in China via “Hukou” system (Adamopoulos, Brandt, Leight, and Restuccia 2021)

EVIDENCE OF MISALLOCATION—CHINA

(a) Operated land



(b) Measured distortions



- Within-village: $\text{STD}(\log \text{ farm TFP})=0.35$, $\text{STD}(\log \text{ farm TFPR})=0.48$, $\text{CORR}(\log \text{TFP}, \log \text{TFPR})=0.91$

FURTHER EVIDENCE OF MISALLOCATION

- Evidence of changes in misallocation based on reform variation across time and space:
 - Privatization of Ejidos in Mexico (de Janvry, Emerick, Gonzalez-Navarro, and Sadoulet AER 2015)
 - Property rights reform in Pakistan (Beg JEEA 2021)
 - Land tenancy reform in China (Chari, Liu, Wang, and Wang REStud 2021) and mobility (Adamopoulos, Brandt, Chen, Restuccia, and Wei 2021)
 - Land certification reform in Ethiopia (Chen, Restuccia, and Santaaulalia-Llopis 2021)
- Differences in secure land property rights (Aragon, Restuccia, and Rud FoPol 2021; Manysheva 2021)

INTERPRETING EVIDENCE OF MISALLOCATION

- Efficient benchmark
 - Evidence of strong positive relationship between farm size and productivity in developed countries, both across farms and over time
- Mismeasurement
 - Gollin and Udry (2021) attribute a large role for mismeasurement using plot-level data
 - Distinction with previous evidence: farm vs plot-level analysis
 - At face value, correcting for mismeasurement does not change lack of positive relationship between land input and productivity (Aragon, Restuccia, and Rud 2021)
 - **Farm-level** mismeasurement not large using Bils, Klenow, and Ruane (2017) method exploiting panel data

A MODEL OF DISTORTED LAND MARKETS

- Two sector GE model of structural transformation of agriculture and non-agriculture (Gollin, Parente, and Rogerson 2002; Restuccia, Yang, and Zhu 2008)
- Production heterogeneity in agriculture, distorted land rental markets, land endowment (Adamopoulos and Restuccia 2014; Deininger and Nagarajan 2010; Bolhuis, Rachapalli, and Restuccia 2021)
- Ability heterogeneity across sectors (Lagakos and Waugh 2013; Adamopoulos, Brandt, Leight, and Restuccia 2021)

PREFERENCES AND ENDOWMENTS

- Closed **local** economy (county or village)
- Preferences over agricultural and non-agricultural goods

$$U_i = a \log(c_{ai} - \bar{a}) + (1 - a) \log(c_{ni})$$

where \bar{a} minimum subsistence consumption of agricultural good

- Heterogeneous abilities in agriculture and non-agriculture, (z_{ai}, z_{ni}) drawn from a bivariate distribution of skills with cdf $F(z_{ai}, z_{ni})$, variance-covariance matrix given by,

$$\Sigma = \begin{pmatrix} \sigma_a^2 & \sigma_{an} \\ \sigma_{an} & \sigma_n^2 \end{pmatrix}$$

- Individuals in agriculture are endowed with an equal amount of land $\bar{\ell}$

PRODUCTION IN NON-AGRICULTURE

- Constant returns technology in efficiency units of labor,

$$Y_n = A_n Z_n$$

where

- Y_n is real non-agricultural output
- A_n is productivity in non-agriculture
- $Z_n = \int_{i \in H_n} z_{n_i} dF i$ is effective labor input from workers in non-agriculture

PRODUCTION IN AGRICULTURE

- The production unit in the agricultural sector is a farm
- A farm is a technology that requires the inputs of a farm operator with ability z_a as well as land, which also defines the size of the farm
- The farm technology exhibits decreasing returns to scale,

$$y_{ai} = A_a z_{ai}^{1-\gamma} \ell_i^\gamma,$$

where y_a is farm output, ℓ is the land input, and A_a is an agriculture-specific TFP parameter, common across all farms

COMPETITIVE DISTORTED MARKETS

- Denote relative price of agriculture p_a and rental price of land q
- Endowed land ($\bar{\ell}$) cannot be sold, land reallocation through rentals
- Farmers can rent land to (l_i^{out}) or from (l_i^{in}) other farmers, but face farm-specific transaction costs τ_i^{in} and τ_i^{out}

COMPETITIVE DISTORTED MARKETS

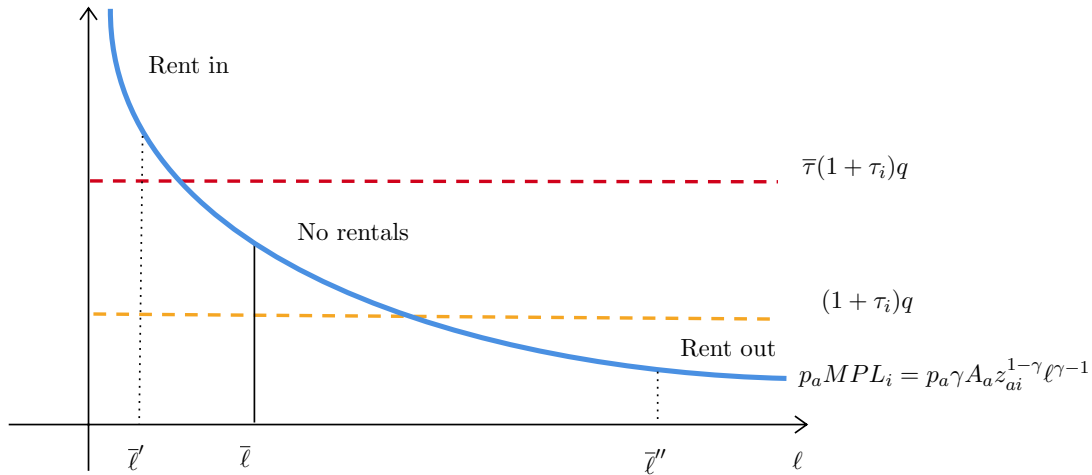
- Assume $(1 + \tau_i^{in}) = \bar{\tau}(1 + \tau_i^{out})$, where $\bar{\tau} \geq 1$ is a cost wedge between renting in and out, common across farmers
- $(1 + \tau_i^{out}) = (1 + \tau_i)$ farm-specific distortion
- $\log(1 + \tau_i) = \theta \log z_{ai} + \epsilon_i$, where $\epsilon_i \sim N(0, \sigma_\epsilon^2)$, *i.i.d.* across farms
- Land distortions characterized by $\bar{\tau}$, θ , and σ_ϵ

FARM PROBLEM

- Given z_{ai} , $\bar{\ell}$, prices and wedges, a farm chooses operated land ℓ_i , to maximize profits:

$$\max_{\{\ell_i, \ell_i^{out}, \ell_i^{in} \geq 0\}} \pi_i \equiv p_a A_a z_{ai}^{1-\gamma} \ell_i^\gamma - q(1 + \tau_i) (\bar{\tau} \ell_i^{in} - \ell_i^{out}),$$

subject to $\ell_i = \bar{\ell} + \ell_i^{in} - \ell_i^{out}$



OCCUPATIONAL CHOICE

- Income in agriculture is determined by profits from farm operation,
 $I_{ai} = \pi_{ai}(z_{ai}, \tau_i, \bar{\ell})$
- Income in non-agriculture is $I_{ni} = w_n z_{ni}$
- Individual i 's income is given by $I_i = \max \{I_{ai}, I_{ni}\}$
- Denote the occupational choice by an indicator function $o(z_{ai}, \tau_i, z_{ni})$ which equals 1 if $I_{ai} \geq I_{ni}$ and 0 otherwise

COMPETITIVE EQUILIBRIUM

A competitive equilibrium is a set of prices $\{p_a, q\}$, allocations for farm operators $\{\ell_i, y_{ai}\}$, profits π_i , allocations for non-agricultural firm $\{Y_n, N_n\}$, occupational choice $\{o(z_{ai}, \tau_i, z_{ni})\}$, consumption allocations $\{c_{ai}, c_{ni}\}$ for each i , such that:

- (A) consumption allocation $\{c_{ai}, c_{ni}\}$ maximizes utility subject to budget constraint, given prices, abilities, and distortions;
- (B) farm production allocation $\{\ell_i, y_{ai}\}$ maximizes profits given prices, agricultural ability, and distortions;
- (C) non-agricultural production allocation $\{Y_n, N_n\}$ maximizes the profits given prices;
- (D) occupational choice $\{o(z_{ai}, \tau_i, z_{ni})\}$ maximizes income given prices, abilities, distortions; and
- (E) markets for land, agricultural goods, and non-agricultural goods clear

- Calibrate benchmark distorted economy to Ethiopia
- Parameters selected without solving the model: $a = 0.01$, $A_a = A_n = 1$ (normalization), decreasing returns in farm production $\gamma = 0.54$, correlation of sectoral abilities $\rho_{an} = 0.35$
- Common land endowment in agriculture $\bar{\ell}$ set to match average farm size (1.3 ha)
- Land per capita L/N is average farm size times the target for the share of employment in agriculture

CALIBRATION

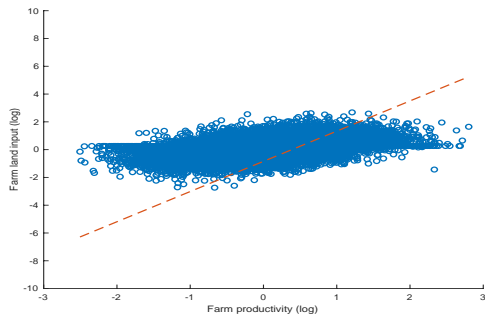
- Parameters selected to match targeted moments
- Select \bar{a} to match share of employment in agriculture $N_a = 0.70$
- Calibrate ability distribution (σ_a, σ_n) to dispersion in log sectoral incomes
- Distortions θ , σ_ϵ , and $\bar{\tau}$ to match: correlation log distortions (TFPR) and log TFP across farms, dispersion of distortions, and share of farms not renting

CALIBRATED PARAMETERS AND MOMENTS

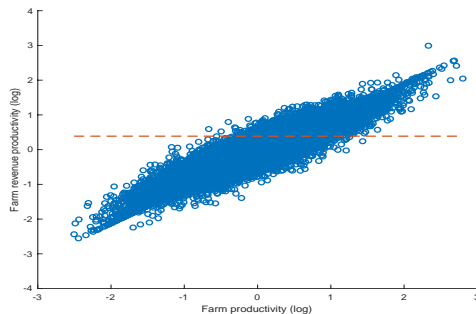
Parameter	Value	Moment	Data	Model
\bar{a}	1.06	Share of employment in agriculture (N_a)	0.70	0.70
$\bar{\ell}$	1.30	Average farm size (AFS)	1.30	1.30
L/N	0.91	AFS $\times N_a$	0.91	0.91
ρ_{an}	0.35	Baseline value	0.35	0.35
σ_n	1.30	STD of log non-agricultural income	0.88	0.88
σ_a	1.42	STD of log agricultural TFP (TFP_a)	0.65	0.65
σ_ϵ	0.60	STD log TFPR	0.74	0.74
θ	0.80	CORR(log TFP_a , log TFPR)	0.90	0.90
$\bar{\tau}$	2.15	Share of farms not renting	0.68	0.68

LAND ALLOCATION AND DISTORTIONS ACROSS FARMS

(a) Operational land



(b) Measured distortions



- Parsimonious parameterization of distortions captures well patterns of operational farm scales and measured distortions

QUANTITATIVE EXPERIMENT

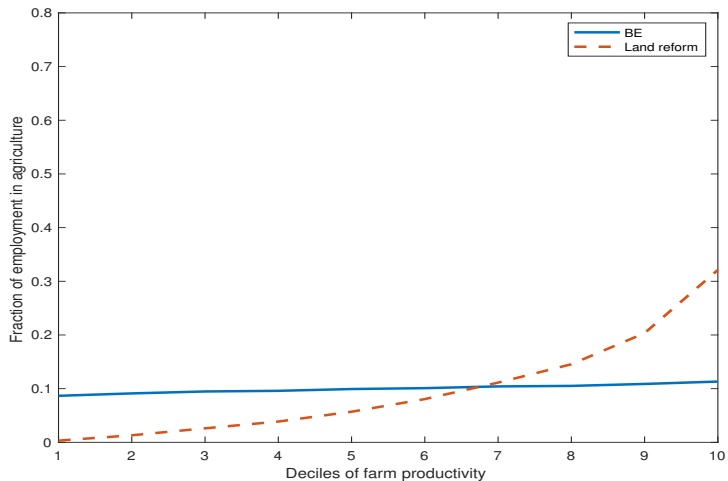
- Land rental-market reform
- Maintain land endowment, allowing perfectly competitive rental markets
- Set $\bar{\tau} = 1$ and $\tau_i = 0$ for all i (i.e., $\theta = \sigma_\epsilon = 0$)
- Farm operational scales and occupational choices independent of the land endowment
- Reform delinks land rights from land use via rental markets

EFFECTS OF LAND RENTAL-MARKET REFORM

Statistic	Benchmark (BE)	Land Reform
Aggregate statistics		
Agricultural labor productivity (Y_a/N_a)	1.00	3.85
Fraction of employment in agriculture (N_a)	0.70	0.19
TFP in agriculture (TFP_a)	1.00	1.88
TFP in agriculture, BE farms	1.00	1.26
Average ability in agriculture (Z_a/N_a)	1.00	2.41
Average ability in non-agriculture (Z_n/N_n)	1.00	0.48
Real GDP per capita (Y/N)	1.00	1.19
Conditional micro-level statistics		
STD of log-farm TFP	0.65	0.54
STD of log-farm TFPR	0.74	0.00
CORR of log-(farm TFP, farm TFPR)	0.90	0.00

- A 26% increase in agricultural TFP due to reduced misallocation translates into a 285% increase in agricultural labor productivity

OCCUPATIONAL SELECTION IN AGRICULTURE



EXTENT OF RENTAL MARKETS

- Delinking land rights and land use requires **active rental markets**

	BE	Reform
% farms not renting	68%	0%
% land rented in	7%	77%

- ...and **operated land concentration** among most productive farms

	BE	Reform
% land operated by top 10%		
most productive farms	11.6%	43.6%

OTHER RESULTS

- Importance of systematic component of land distortions ($\approx 80\%$ of agricultural productivity) and intensive margin of land rental markets

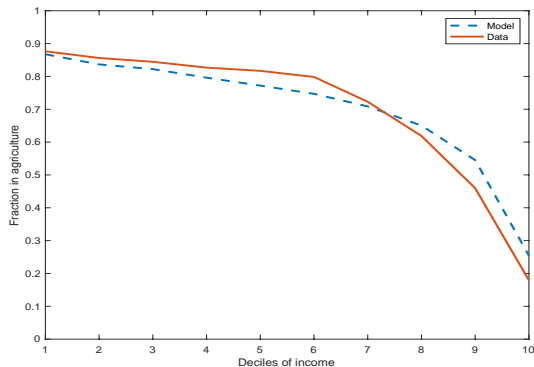
Statistic	BE	Land Reform	$\bar{\tau} = 1$ $\theta = 0$	$\theta = 0$
Ag. labor productivity (Y_a/N_a)	1.00	3.85	3.04	2.41
Fraction emp. in agriculture (N_a)	0.70	0.19	0.23	0.29
Fraction farms not renting	0.68	0.00	0.00	0.44
Fraction land rented in	0.07	0.77	0.75	0.61

DISCUSSION OF RESULTS

- Reform increases agricultural labor productivity substantially (3.85-fold), but large productivity gap with developed countries remains
- Reform increases average farm size from 1.3 ha to 4.8 ha, below developed countries with similar land endowment ≈ 16 ha
- Abstracted from potential complementary factors:
 - Separation of land rights from land use on reallocation across space (Adamopoulos, Brandt, Chen, Restuccia, and Wei 2021)
 - Increased farm size on crop choice, mechanization, technology adoption in agriculture (e.g., Chen 2020)
 - Complementary institutions, frictions (e.g., financial frictions Manyasheva 2021, rule of law, other spatial/sectoral frictions,...)

DISTRIBUTIONAL IMPLICATIONS

Agriculture and income



- Despite uniform distribution of land input, substantial dispersion in income in BE: p90/p10 income ratio 6.8-fold

REFORM WITH RENTAL INCOME

- **Medium term** effect on income: same N_a but efficient rental markets to disassociate land rights from land use
- Counterfactual income: CF $I_a = p_a y_a(\ell^e) + q^e(\bar{\ell} - \ell^e)$, compare with BE I_a

	p90	p10	Ratio
CF I_a	4.99	1.78	2.80
BE I_a	4.59	0.88	5.22
Ratio	1.09	2.04	0.54

- Rental markets more effective in equalizing incomes, substantial reduction in poverty

REFORM WITH RENTAL INCOME

- Long term effect on income inequality:

p90/p10	BE	Reform
Total income	6.8	7.7
Rural income	5.2	5.9

- Dispersion in income increases, but mostly from larger dispersion in non-agriculture
- Incomes increase, opportunity to implement other more effective redistribution programs

CONCLUSIONS

- Restrictive land markets substantially depress agricultural productivity
- Egalitarian distribution of ownership rights consistent with efficient distribution of farm operational scales via rental markets, dissipating distributional concerns
- Productivity gains from reform can unravel substantial process of structural transformation and growth (modernization of agriculture)
- Separating land use from land rights facilitate flow of resources across sectors and space (de Janvry et al. 2015; Adamopoulos, Brandt, Chen, Restuccia, and Wei 2021)
- Challenge is developing and fostering decentralized arrangements (markets) that improve resource allocation and facilitate productivity growth