Misallocation, Selection, and Productivity: A Quantitative Analysis with Panel Data from China

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Motivation

- Why is agricultural labor productivity so low in poor countries?
- Important because agriculture accounts for the bulk of income differences between rich and poor countries.
- Many useful perspectives.
- Our take is that resource misallocation is pervasive in agriculture.
- Misallocation particularly related to distortions in land markets.

Main Idea

land market frictions $\Rightarrow$ disproportionately affect more productive farmers

Reduce aggregate agricultural productivity by distorting two margins:

(1) Allocation of resources across farmers (misallocation)

(2) Type of farmers who operate in agriculture (selection)

Insight:

- Selection potentially amplifies the misallocation effect
- by affecting the productivity distribution and measured misallocation.

Study these channels using micro data from China.

Why China?

- Rapidly growing economy with substantial sectoral reallocation.
- Productivity in agriculture is low.
- Average farm size: 0.7 ha (BEL 16, NLD 17, USA 178 ha).
  ▸ Farm Size Distribution
- Lack of well-defined property rights over land.
  - Households are allocated use rights on egalitarian basis.
  - Thin rental markets ("use it or lose it").
- Unique panel data set of households with detailed information on farmer's output and inputs and non-agricultural wages.
  - Key: can identify selection across sectors and linkage to misallocation

What We Do

(1) Use panel data from China and a quantitative framework to:

- document extent of misallocation within, across villages and over time,
- assess static TFP gains from moving to efficient allocation,
- construct a summary measure of farm-level distortions.

(2) Develop and estimate a tractable two-sector general-equilibrium model with heterogeneous abilities across individuals and sectors.

- Use model structure to estimate population from observed moments.
- Key moments relate to dispersion and correlation of income across sectors.

(3) Assess the quantitative impact of measured distortions on the pattern of occupational choices, selection, and aggregate agricultural TFP.

What We Find

- Substantial misallocation of land and capital across farmers.
- Agricultural output (TFP) gains from eliminating misallocation are 84%.
  - not much variation over time
- Farm-level distortions systematically positively correlated with farm productivity: more productive farmers are "hit" harder.
- Eliminating farm-level distortions raises agricultural labor productivity 13.8-fold and agricultural TFP 4.3-fold when accounting for improved selection into agriculture.

Land Market Institutions in China I

- Households are allocated use rights over farmland.
- Ownership rights of farmland reside with the collective or village.
- Allocation of use rights is based on an individual's "registration" or "hukou," and is done on an egalitarian basis.
- HHs were supposed to enjoy use rights for a period of 15 years, but reallocations within villages were common to accommodate changing demographics (varied across villages).

Land Market Institutions in China II

- Land cannot be used as collateral for purposes of borrowing.
- HHs in principle have the right to rent or transfer their use rights to other households, but in practice these rights have been abridged with the rental market being thin over our study period (mainly to close relatives).
- Frequent claims of "use it or lose it rules" existing.

Framework for Measuring Misallocation

- Agricultural sector equilibrium framework.
- Production unit is a farm, there are M farm operators heterogeneous in farming ability s_i.
- Farmer with productivity s_i produces according to the decreasing returns to scale technology,

$$y_i = (A_a s_i)^{1-\gamma} \left[\ell_i^{\alpha} k_i^{1-\alpha}\right]^{\gamma},$$

where
  - $(y_i, \ell_i, k_i) =$ real farm output, land and capital inputs.
  - $\gamma =$ span-of-control parameter.

Micro Data from China

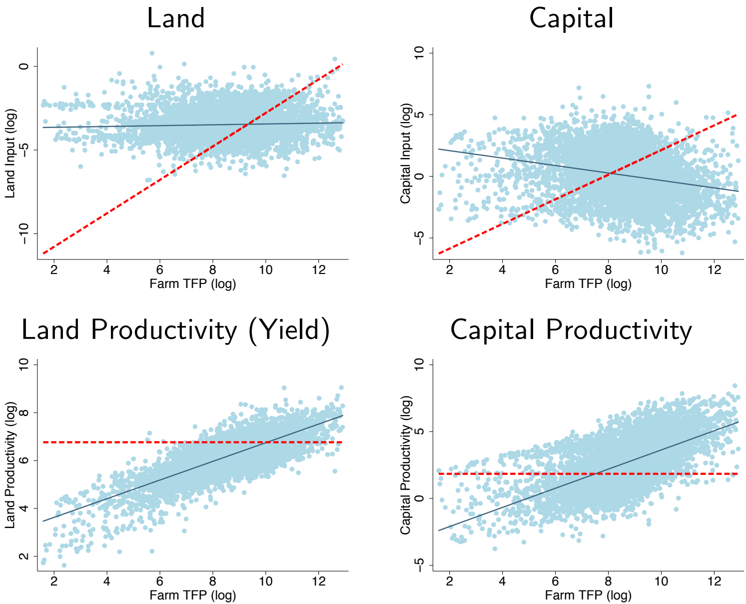
- HH survey panel data from Research Center for the Rural Economy, Ministry of Agriculture.
- HH data from 10 provinces, from 1993 to 2002.
- Unbalanced panel with $\sim$ 8000 HHs per year from 110 villages.
- Detailed information on income by sector.
- Agriculture: data on outputs, inputs, prices, at farm-level.

Farm-Level Measures

- Gross real output: aggregate farm output by crop using common prices across HHs.
- Real intermediate input expenditures: mainly fertilizer and pesticides valued at common prices.
- Real value added: gross real output − real intermediate input expenditures.
- Land: cultivated area.
- Capital: value of farm machinery and equipment, larger hand tools, and draft animals used in agriculture.

Factor Allocation by Farm TFP

Yield by Farm Size



Assessing Factor Misallocation — Results

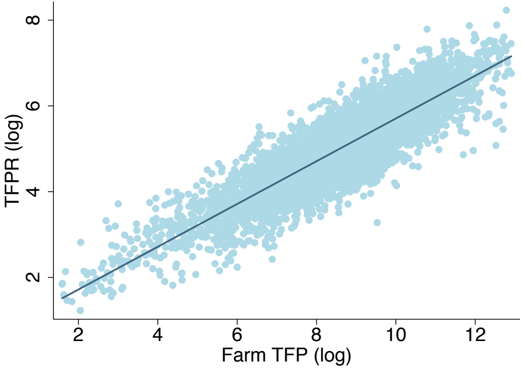
Efficiency gains from factor reallocation (2000):

	Output (TFP) Gain	
	Baseline	Across HHs s
Eliminating misallocation:		
nationwide	1.84	1.37
within villages	1.42	1.16

- 60% of gains due to reallocation within villages.
- About 1/2 of gains due to misallocation across HHs with different productivity.

▸ Mean Farm TFP ▸ By Crop

Farm-specific Distortions and Productivity in 2000



- Summary measure of distortions $TFPR_i = \frac{1}{1-\tau_i}$.
- $1 - \tau_i = \frac{1-\tau_i^y}{\left(1+\tau_i^\ell\right)^\alpha \left(1+\tau_i^k\right)^{1-\alpha}}$.
- SD(log(TFPR))=0.91, CORR(TFPR,TFP)=0.88.

A Model of Misallocation and Selection

- Standard two-sector GE model of agriculture and non-agriculture.
  - Non-homothetic preferences, minimum consumption requirement of agricultural good.
- Agriculture features production heterogeneity
- Individuals face a sectoral occupational choice (Roy model):
  - Farm operator in agriculture
  - Worker in non-agriculture
- Economy populated by a continuum of individuals of measure 1.
- Individuals indexed by i are heterogeneous with respect to:
  - Ability in agriculture s_{a_i}
  - Ability in non-agriculture s_{n_i}
  - Distortion in operating a farm τ_i
- Assume tri-variate log normal distribution of (s_a, s_n, τ) across individuals.

Calibration

- Strategy: Calibrate distortions, abilities, and sectoral selection in a Benchmark Economy (BE) to the panel household-level data from China.

- Proceed in two steps:
  (I) Infer population parameters on abilities and distortions from observed moments on sectoral incomes, farm TFP, and estimated wedges.
  (II) Given population moments, calibrate remaining parameters from general equilibrium equations of the sectoral economy to match data targets.

Counterfactuals: Effects of Eliminating Distortions

Statistic	BE	$\sigma_{a\varphi} = 0$	No Distortions
Aggregate Statistics			
Real Agricultural Productivity	1.00	11.10	13.83
Share of Employment in Agriculture	0.46	0.06	0.05
Real Non-Agricultural Productivity	1.00	0.69	0.69
Average Ability in Agriculture	1.00	6.53	7.78
Average Ability in Non-Agriculture	1.00	0.69	0.69
Real GDP per Worker	1.00	1.23	1.27
Micro-level Statistics			
STD (farm TFP)	0.68	0.46	0.38
STD (farm TFPR)	0.91	0.43	0
CORR(farm TFP, farm TFPR)	0.93	0.51	–
CORR(agr. income, nonagr. income)	0.05	0.51	0.51

Labor Productivity in Agriculture

$$\underbrace{\frac{Y_a}{N_a}}_{13.8} = \underbrace{A}_{1.66} \cdot \underbrace{\bar{Z}_a^{\,1-\gamma}}_{2.6} \cdot \underbrace{\left[\frac{L^{\alpha}K^{1-\alpha}}{N_a}\right]^{\gamma}}_{3.1},$$

In the model, eliminating distortions increases agricultural labor productivity via:

- An increase in agricultural TFP due to static misallocation by 1.66-fold
- An increase in agricultural TFP due to selection by 2.6-fold
- An increase in agricultural labor productivity due to reallocation of labor to non-agriculture by 3.1-fold

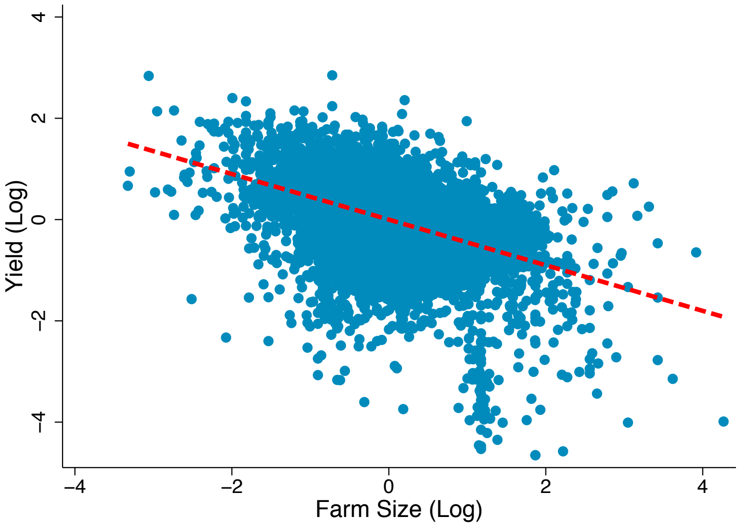
Removing Distortions vs. Exogenous 66% TFP Increases

Statistic	BE	No Distortions	66% increase in: A_a	(A_a, A_n)
Aggregate Statistics				
Real Agricultural Productivity	1.00	13.83	1.63	1.63
Share of Employment in Agriculture	0.46	0.05	0.29	0.29
Real Non-Agricultural Productivity	1.00	0.69	0.85	1.44
Average Ability in Agriculture	1.00	7.78	0.97	0.97
Average Ability in Non-Agriculture	1.00	0.69	0.85	0.85
Real GDP per Worker	1.00	1.27	1.11	1.75
Micro-level Statistics				
STD (farm TFP)	0.68	0.38	0.68	0.68
STD (farm TFPR)	0.91	0	0.90	0.90
CORR(farm TFP, farm TFPR)	0.93	–	0.94	0.94
CORR(agr. income, nonagr. income)	0.05	0.51	0.19	0.19

Take-away

- Substantial factor misallocation in Chinese agriculture from uniform land allocations and restricted land markets.
- Operational farm scales should be able to adjust to raise agricultural productivity, also keeping the "better" farmers in agriculture.
- These effects substantially contribute to structural change and growth.
- Implementing a system of secure property rights to facilitate a decentralized allocation of land would generate large aggregate productivity gains.

Yield by Farm Size



◂ Return

Farm Size Distribution in China

Land Farm Size	(%) 1995	2000
< 0.5 ha	69.2	71.6
$0.5 - 1$ ha	20.7	20.2
$1 - 1.5$ ha	6.1	5.8
> 1.5 ha	4.0	2.4
Average Farm Size	0.49	0.43

Return

Assessing Factor Misallocation — Results

Efficiency gains from factor reallocation:

	Output (TFP) Gain	
	Baseline	HHs Mean s
Eliminating misallocation:		
nationwide	1.84	1.67
within villages	1.42	1.33

- Exploiting the panel data, we estimate the fixed effect productivity for each HH to remove potential transitory effects.
- Reallocation gains are still substantial, about 85% of baseline gains.

Return

Assessing Factor Misallocation — By Crop

	Farms by Crops		
	All	Rice	Other
Fraction of Farms	1.00	0.42	0.58
Efficiency Gain	1.84	1.64	2.00
std(log(TFPR))	0.93	0.76	1.02

- Rice farms = greater than 40 percent of sown area in rice.
- Concentrated geographically in southern provinces.

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