Trade-Induced Urbanization and the Making of Modern Agriculture

Yuan Tian[1], Junjie Xia[2], Rudai Yang[2]

[1]University of Nottingham, [2]Peking University

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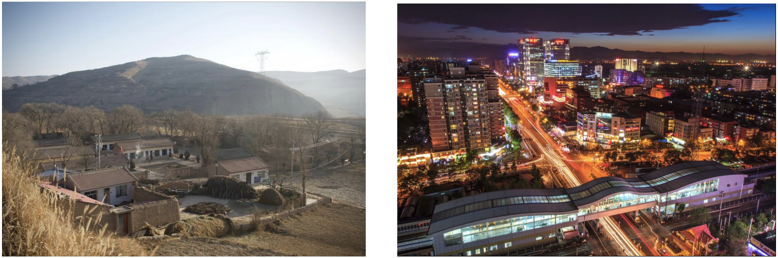
Trade-Induced Structural Transformation

- How does manufacturing growth lead to agricultural modernization?
  - Declines in agricultural labor;
  - Increase in land market activeness;
  - Adoption of agricultural machinery;
  - Increase in agricultural productivity.

Two Steps Towards A Modern Economy (I): Decline in Agricultural Population and Urbanization



Note: Panel (a) shows Gansu Province, Lumacha County, 2018. Panel (b) shows Beijing, Haidian District. The per capita GDP in Lumacha County was $6,176 in 2017, and the per capita GDP in Beijing was $20,356.

Two Steps Towards A Modern Economy (II): Modernization of Agricultural Production

Note: Panel (a) shows Gansu Province, Nianjianzhai Village in 2016. Panel (b) shows Gansu Province, Dingan Village in 2019.

Structural Transformation in Developing Countries

- Urbanization "is an irreversible process that every industrializing society undergoes once and only once" (Lucas 2004)
  - Step 1: Sectoral labor reallocation;
  - Step 2: The modernization of agriculture.
- Rural land markets are thin in developing countries, including China (Adamopoulos and Restuccia 2014, Adamopoulos et al. 2017).
  - Farm sizes are small;
  - Land transaction costs are high, and policies tend to discourage land consolidation;
  - Potentially substantial land misallocation. ◂ Land
- Out-migration opportunities can increase the value of outside options for farmers.
  - Increase land leasing market thickness;
  - Improve allocation efficiency if productive households operate larger farms;
  - Facilitate capital adoption.

This Paper: the Chinese Urbanization and Agricultural Modernization after the WTO Accession

- Challenges in identifying the impact of out-migration on agriculture productivity:
  - Reverse causality (Bustos et al. 2016);
  - Omitted variable bias (e.g. transportation network expansion).
- This paper looks at the ***agriculture modernization*** in China after the WTO accession:
  - Positive shocks in manufacturing pulled labor out of rural areas.
- Substantial changes in both the manufacturing sector and the agricultural sector:
  - Manufacturing exports increased 4 times from 2000 to 2010;
  - Internal migration doubled;
  - Agriculture land and labor productivity grew a lot.

How to Measure a Village's Exposure to Manufacturing Trade Shocks

- Industry-level shocks for the manufacturing sector come from reductions of tariffs on Chinese exports.

- A shift-share design:
  - Destination exposure: industrial composition $\times$ industry-level tariff.
  - Origin's exposure through migration connections: prefecture-to-prefecture migration network $\times$ destination exposure.

- Controlling for the agricultural trade shocks using the initial crop patterns interacted with crop-level trade shocks.

Trade Shocks in the Manufacturing Sector Benefited the Agricultural Sector

- A one-standard-deviation larger trade exposure through the migration network resulted in:
  - A 3-percentage-point larger increase in the share of non-agricultural labor;
  - A 26-percent larger increase in the stock of land leased;
  - An 8-percent larger increase in agricultural machinery;
  - A 30-percent larger increase in village-level TFP.

Mechanisms of the Village-Level TFP Effect

- Less productive farmers left agriculture;
  - Empirically, the correlation between agricultural productivity and non-agr productivity is small.
- More productive farmers operated larger farms.
- Capital adoption increased.

Contribution: Empirical Evidence on Trade-Induced Urbanization and Agricultural Modernization

- Structural transformation.(Caselli and Coleman 2001, Ngai and Pissarides 2007, Yang and Zhu 2013, Bustos et al. 2016)
  - This paper shows how the structural transformation is initiated by manufacturing growth and reinforced by the modernization of the agricultural sector.
- Land market institutions and misallocation. (de Janvry et al. 2015, Ngai et al. 2016, Adamopoulos et al. 2017, Chari et al. 2020)
  - This paper shows its complementarity with outside options.
- Impacts of out-migration. (Akram et al. 2017, Dinkelman et al. 2017, Bryan and Morten 2019, Johnson and Taylor 2019, Morten 2019)
  - This paper shows that quasi-permanent out-migration have large impacts on the factor market and agricultural efficiency.
- Economic impacts of WTO accession. (Khandelwal et al. 2013, Brandt et al. 2017, Handley and Limão 2017, Facchini et al. 2019, Tian 2020, Zi 2020, Erten and Leight 2021)
  - This paper focuses on the development process of agriculture.

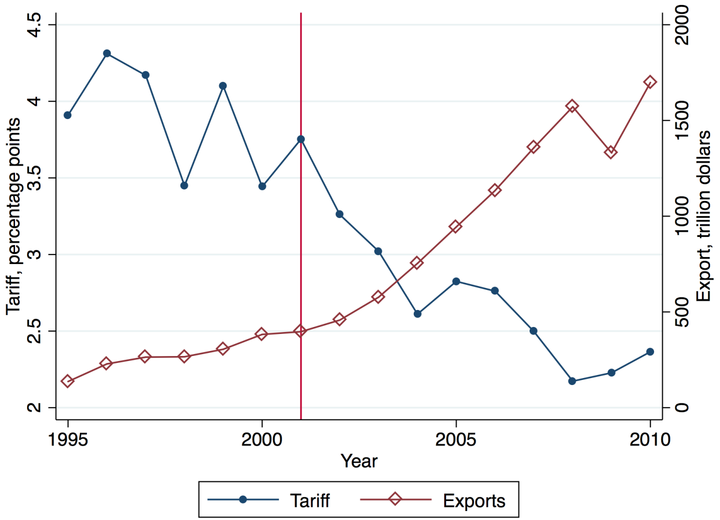
Roadmap

- **Measurement of trade shocks.**
- Measurement of agricultural outcomes.
- Empirical results.
- Conclusion.

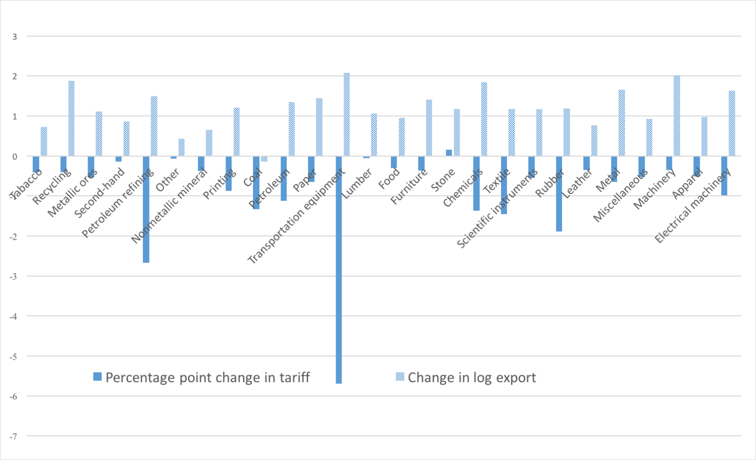
WTO Accession and Induced Tariff Reductions

- China's WTO accession in Nov. 2001:
  - The exact timing of accession was not anticipated;
  - Tariff and non-tariff trade barriers were lowered;
  - Most-favored-nation status generated exogenous tariff declines.
- Standard in trade literature to use tariff reductions to measure trade shocks:
  - Topalova (2010); Kovak (2013); McCaig and Pavcnik (2018); and Bombardini and Li (2020).

Decline of Average Tariffs on Chinese Manufacturing Exports, 1995–2010



Distribution of Tariff Declines across Industries, 2001–2010



Prefecture-Level Manufacturing Trade Exposure

- Tariff on manufacturing exports faced by prefecture i in year t:

$$\tau_{it} = \sum_k \beta_{ik} \log(1 + \tau_{kt})$$

$$\text{where} \qquad \beta_{ik} = \frac{\lambda_{ik} \frac{1}{\theta_{ik}}}{\sum_{k'} \lambda_{ik'} \frac{1}{\theta_{ik'}}},$$

  - τ_{kt}: the industry-year-specific tariff on exports. (WITS, SIC2 level)
  - $\lambda_{ik} = \frac{L_{ik}}{L_i}$: the fraction of regional labor allocated to industry k. (Industrial Enterprise Survey 2001)
  - $1 - \theta_{ik}$: the cost share of labor in industry k. (Industrial Enterprise Survey 2001)

Village-Level Trade Exposure

- Administrative units: village (v) $\rightarrow$ county $\rightarrow$ prefecture (i) $\rightarrow$ province. Number of units at different levels

- Village v's trade exposure using prefecture-to-prefecture migration network:

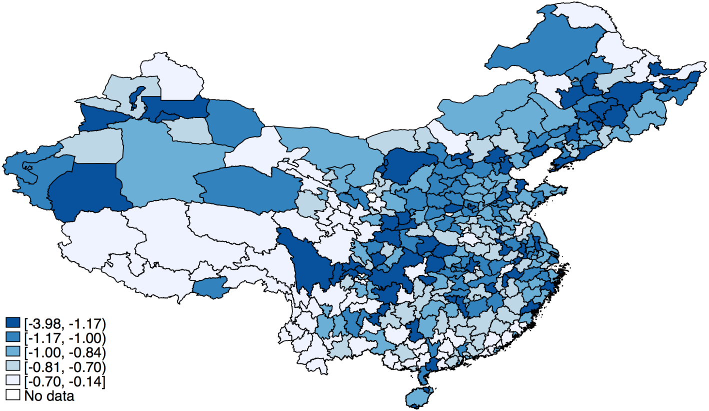
$$\tau_{v(i)t}^{other} = \sum_{j \neq i} \frac{m_{ij}}{\sum_{j' \neq i} m_{ij'}} \tau_{jt},$$

  - m_{ij}: the number of migrants who are from prefecture i and reside in prefecture j in 2000, using the 2000 census data. Distribution

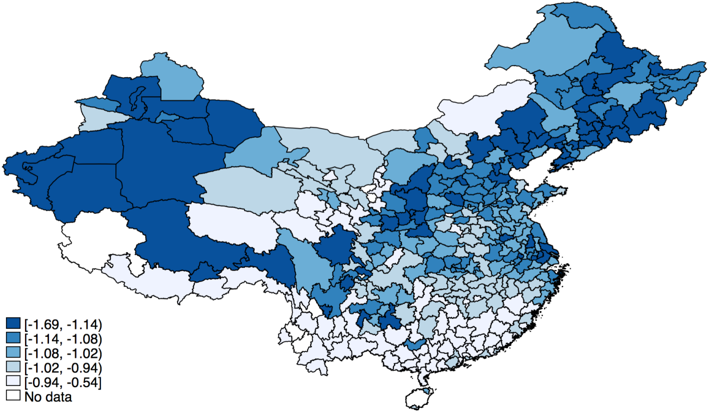
- Village v's trade exposure in its own prefecture:

$$\tau_{v(i)t}^{own} = \tau_{it}.$$

Geographic Distribution of the Trade Shocks, 2001–2010, Own Prefecture's Tariff



Geographic Distribution of the Trade Shocks, 2001–2010, Other Prefectures' Tariff



◂ Migr

Roadmap

- Measurement of trade shocks.
- **Measurement of agricultural outcomes.**
- Empirical results.
- Conclusion.

National Fixed Point Survey of Rural Households

- Conducted by the Research Center for the Rural Economy under the Ministry of Agriculture in China from 1986.
  - Multi-stage sampling for a nationally representative sample;
  - Around 300 villages, 20K households.

- We use the 1995 to 2010 sample. Sum Stats
  - 2001–2010 period as the main sample: 295 villages, 2,333 village-year observations, and 148K household-year observations.

- No evidence on differential attrition by the size of trade shocks. Attrition

Measurement of agricultural outcomes

- Non-agricultural laborer/ wage earner: ◂ Non-ag
  - Employed outside their own household for wages;
  - Empirically, not very likely to be employed within the village.
- Land market outcomes: amount of land leasing transactions within a year; total amount of leased land; land leasing income.
- Capital market outcomes: value of agricultural machinery.
- Agricultural productivity: ◂ TFP
  - Household-level productivity as Solow residuals from panel regressions with fixed effects (OLS, IV with lagged inputs, balanced panel, LP);
  - Village-level productivity as the output-weighted household-level productivity.

Roadmap

- Measurement of the trade shocks.
- Measurement of agricultural outcomes.
- **Empirical results.**
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No Differential Pre-Trends in Outcome Variables

- Evidence on exogeneity of trade shocks at the industry level and at the destination prefecture level. (Tian 2020)
- Evidence on exogeneity at the village level:

$$\tau^{o}_{v(i)t} = \gamma_o + \gamma_1 \tau^{o}_{v(i)2001} + \Pi Z_{v1995\text{–}2001} + I_p + \xi_v,$$

  - $o = own, other,\ t = 2002, ..., 2010;$
  - $Z_{v1995-2001}$: changes in the share of non-agriculture labor, land rental, agricultural capital, and TFP;
  - I_p are province fixed effects;

- We fail to reject the null hypothesis that $\Pi = 0$. Test

How Trade Exposures Affected the Non-Ag Labor Share

- Non-ag labor share on trade exposures:

$$y_{vt} = \beta_0 + \beta^{other}\tau^{other}_{v(i)t} + \beta^{own}\tau^{own}_{v(i)t} + \Gamma X_{vt} + I_{pt} + I_v + \epsilon_{vt}$$

  - Village panel of 2001–2010;
  - $\beta^{other} < 0$: the lower the tariff in destination prefectures, the larger labor outflows;
  - Controls: size of the village (the log total number of laborers, log number of households); log government transfers;
  - Fixed effects: village, province-year;
  - Standard errors clusters: province and year;
  - Potential heterogeneity by initial characteristics.

Trade Shocks in Other Regions Pulled Labor Out of Agriculture

Y: % non-agricultural laborer	(1)	(2)	(3)	(4)	(5)	(6)
Tariff exposure through migrant connections	-0.08***	-0.06***	-0.06**	-0.04*	-0.16***	-0.16***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
Tariff exposure through migr connect × % cross-pref. migr				-0.04		
				(0.04)		
Log(land/labor) 2001 × Other pref. tariff					0.05***	
					(0.01)	
2nd land/labor quintile 2001× Other pref. tariff						0.03
						(0.02)
3rd land/labor quintile 2001 × Other pref. tariff						0.03
						(0.02)
4th land/labor quintile 2001 × Other pref. tariff						0.07**
						(0.03)
5th land/labor quintile 2001 × Other pref. tariff						0.10**
						(0.03)
Own prefecture tariff		0.02*	0.02*	0.02	0.03***	0.03***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Village-Year Specific Controls	No	No	Yes	Yes	Yes	Yes
Observations	2,333	2,333	2,333	2,333	1,971	1,971
R-squared	0.85	0.85	0.85	0.85	0.85	0.85

Robust to Including Other Controls

Y: % non-agricultural laborer	(1)	(2)	(3)	(4)	(5)	(6)
Tariff exposure through migrant connections	-0.08***	-0.06***	-0.06**	-0.04*	-0.16***	-0.16***
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Larger Effects for Places with Smaller Land-to-Labor Ratios

Y: % non-agricultural laborer	(1)	(2)	(3)	(4)	(5)	(6)
Tariff exposure through migrant connections	-0.08***	-0.06***	-0.06**	-0.04*	-0.16***	-0.16***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)	(0.04)
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R-squared	0.85	0.85	0.85	0.85	0.85	0.85

Higher Land-Labor Ratios Correlated with More Fluid Land Markets (2001 Correlations)

	(1)	(2)	(3)
	% of land leased	Log(land leased+1)	
		Stock	Flow
Log(land/agr labor)	0.04**	1.06***	0.91***
	(0.01)	(0.25)	(0.24)
	(4)	(5)	(6)
	Ruggedness	% non-agr labor	Allocation efficiency
Log(land/agr labor)	-37.39**	0.04*	0.23***
	(16.66)	(0.02)	(0.07)

Higher Land-Labor Ratios Correlated with More Favorable Geo Conditions for Land Consolidation (2001 Correlations)

	(1)	(2)	(3)
	% of land leased	Log(land leased+1)	
		Stock	Flow
Log(land/agr labor)	0.04**	1.06***	0.91***
	(0.01)	(0.25)	(0.24)

	(4)	(5)	(6)
	$\boxed{\text{Ruggedness}}$	% non-agr labor	Allocation efficiency
Log(land/agr labor)	$\boxed{-37.39^{**}}$	0.04*	0.23***
	$\boxed{(16.66)}$	(0.02)	(0.07)

Higher Land-Labor Ratios Correlated with Higher Allocation Efficiency (2001 Correlations)

	(1)	(2)	(3)
	% of land leased	Log(land leased+1)	
		Stock	Flow
Log(land/agr labor)	0.04**	1.06***	0.91***
	(0.01)	(0.25)	(0.24)
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	Ruggedness	% non-agr labor	Allocation efficiency
Log(land/agr labor)	-37.39**	0.04*	0.23***
	(16.66)	(0.02)	(0.07)

Summary of the Effects on Occupation Choices

- Villages with migrant connections to prefectures facing larger tariff declines in export markets had larger flows of labor from agriculture to non-agriculture.

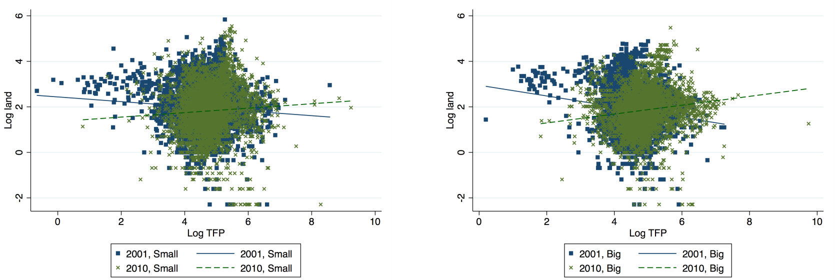
- The effect was stronger for villages that were in earlier stages of urbanization and had worse land allocation in the beginning of the period.

Larger Trade Shocks, More Active and Efficient Local Land Markets

- Villages with larger shocks had more active land rental markets. ◂ Land
- In villages with larger trade exposures, the allocation of land towards productive households were stronger.
  - The elasticity of land to TFP is 15% larger in villages with a one-standard-deviation larger trade exposure.

More Land Allocated Toward Initially Productive Households, Especially in Places with Larger Shocks

(a) Villages with small shocks, 2001 vs 2010 (b) Villages with big shocks, 2001 vs 2010



Note: The 2001 to 2010 trade shock is defined as the difference between a village's exposure to other prefectures' output tariff in 2001 and 2010, i.e., $(\tau_{2010}^{other} - \tau_{2001}^{other}) \times s$; the shocks above the median magnitude (in absolute values) are defined as large shocks, and the shocks below the median are defined as small shocks.

Larger Trade Shocks, More Agricultural Machinery Adopted

- Labor-capital substitution with increased labor cost (Manuelli and Seshadri 2014). ✓ Wage
- Increased farm sizes and scale-dependent returns to mechanization (Foster and Rosenzweig 2011; 2017). ✓ Size
- Reduction in land misallocation. ✓ Capital
- Migrant remittances and household credit constraints. X Remittance

Large Trade Shocks, Larger Village-Level TFP

- Village-level TFP increased more in villages with larger trade exposure.
  - Village-level results on the increase in TFP and allocation efficiency; TFP
  - Individual-level results on negative selection out of agriculture. Selection Correlation

Robustness Checks

- Migration outcomes using village-level surveys. ◂ Village
- Agricultural trade shocks. ◂ AgTrade
- Alternative measures of TFP. ◂ Alternative TFP
- Controlling for the share of migrants to the major destinations. ◂ Big Share
- Controlling for crop patterns. ◂ Main Crop
- Husbandry and cash crop choices. ◂ Husbandry

Roadmap

- Measurement of the trade shocks.
- Measurement of agricultural outcomes.
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Conclusion

- Trade-induced manufacturing growth generated strong pull forces for rural out-migration.
- The out-migration increased rural land market fluidity and improved land allocation efficiency.
- More agricultural machinery was adopted, and village-level TFP increased.
- Manufacturing growth had a more important role than land reforms in urbanization and agricultural modernization in China.
  - Theoretical model with quantitative exercises in the paper.

Land Reforms or Non-Agricultural Productivity Growth?

- A complementary set of literature on the importance of land reforms (de Janvry et al. 2015; Chari et al. 2020):
  - Land right security increases $\Rightarrow$ Land market transaction costs decline;
  - Agricultural productivity and urbanization rates increase.
- We argue that the availability of outside options in the manufacturing sector is the key to agricultural modernization.
- Both land reforms and manufacturing growth happened in the 2001–2010 period in China.
  - We use a quantitative exercise to evaluate the relative importance of the two channels.

The Increase in Non-agricultural Productivity Mattered More

- Two-sector open-economy model with agricultural land transaction costs. (Adamopoulos et al. 2017) Model

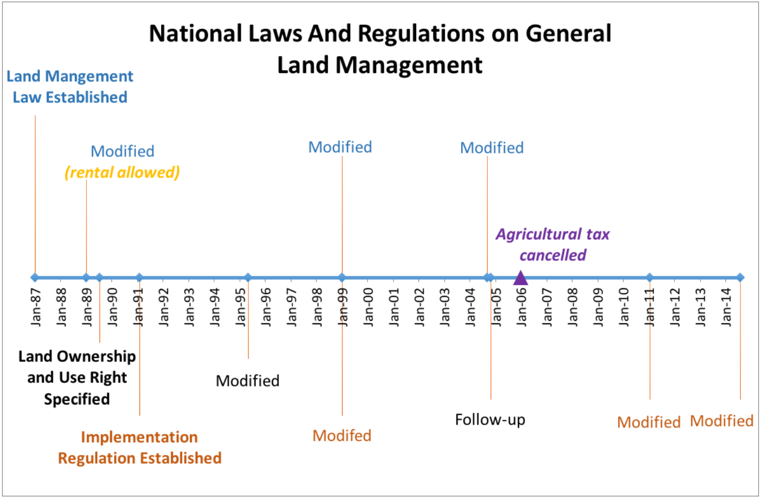
- The calibration of the model shows:
  - There was a small positive correlation between an individual's agricultural and non-agricultural ability;
  - The transaction cost in the rural land market declined from 2001 to 2010;
  - The growth in non-agricultural productivity was bigger than the growth in agricultural productivity.

- Counterfactual results:
  - The reduction in transaction costs and the increase in non-agr productivity both benefit agriculture;
  - The second effect is larger.

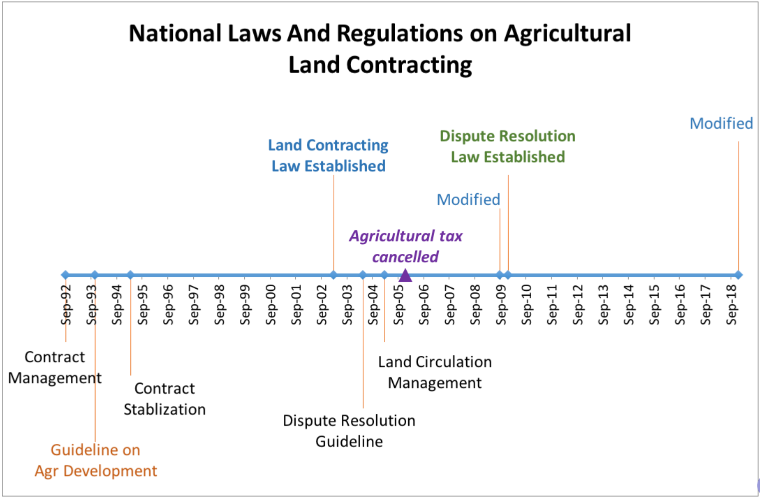
Rural Land Markets in China

- Household Contract Responsibility System (started 1978–1983).
  - The village commune owns the land collectively;
  - Households in the commune contract the land to operate;
  - Initial land distribution was proportional to household size;
  - Land leasing across households in the same commune are legally allowed. ◂ Land Regulations
- Land rights security is ambiguous.
  - First round contract length 15 yrs (1983–1998), second round 30 yrs (1998–2027);
  - However, land reallocation within a village is common. (Benjamin and Brandt 2002)
- Farm sizes are small: on average 0.52 hectare.
  - 16 and 17 ha. in Belgium and the Netherlands, 178 ha. in the U.S. (Adamopoulos et al. 2017) ◂ Trends ◂ R

Land Market Regulations: General



Land Market Regulations: Farm Land Contracting



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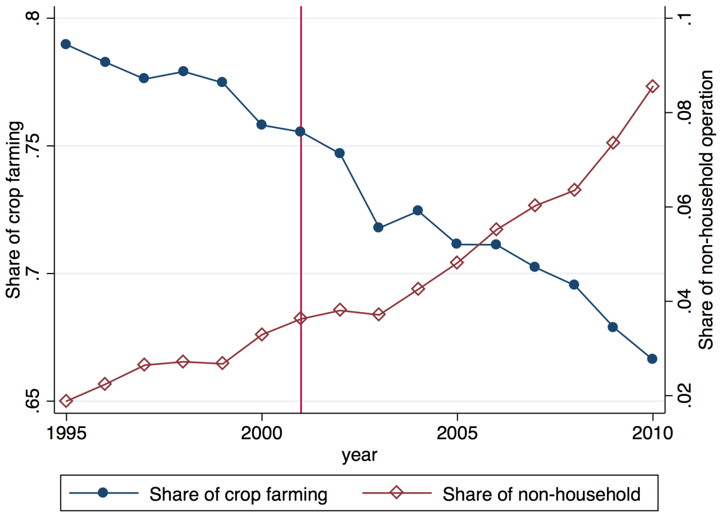
Trends (and Trend Breaks) in the Agriculture Sector

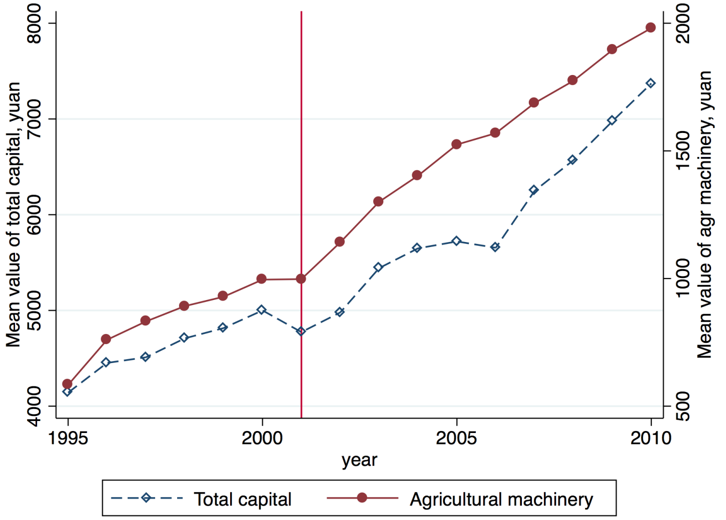
- Labor exiting the agricultural sector;
- Increased land activity;
- Capital adoption;
- Increased land and labor productivity.

Trend 1: Increased Labor Outflow from Agriculture

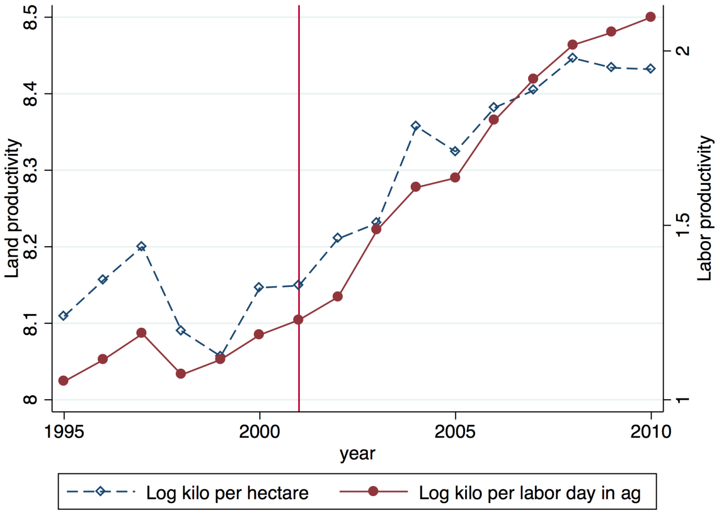


Trend 2: More Land Rental, Higher Rental Income

Trend 3: More Capital Adopted



Trend 4: Land and Labor Productivity Increased, Wheat as an Example



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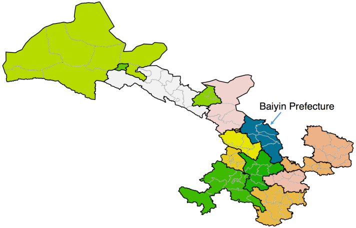
Example of Baiyin Prefecture in Gansu Province in China

(a) Gansu Province in China

(b) Baiyin Prefecture in Gansu Province

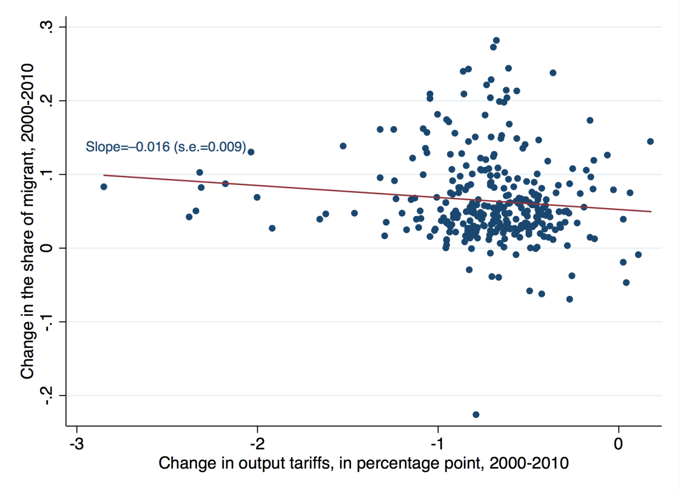


Levels of Government Administration, 2000

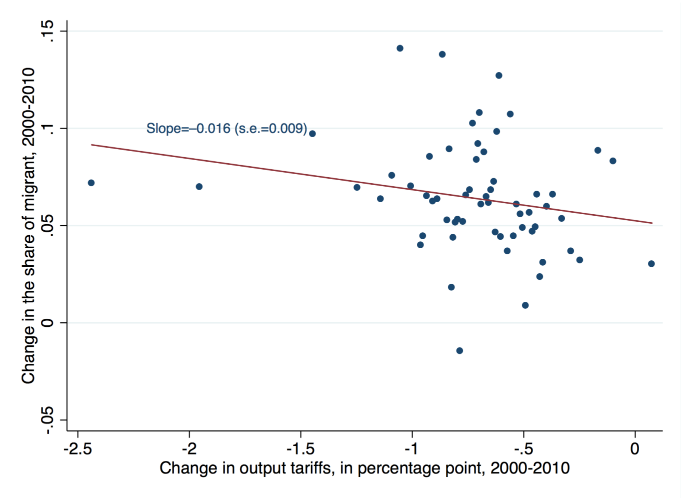
Level	Number
Province	31
Prefecture	333
County	2,074
Village (1996)	748,340

◂ R

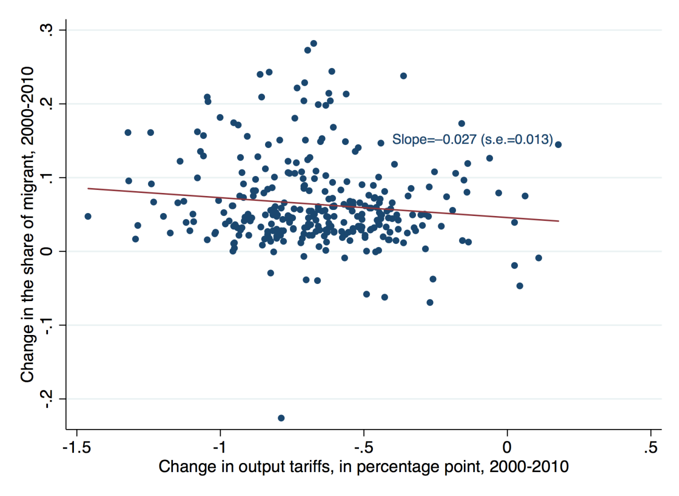
From Receiving Prefectures' Perspective: Larger Declines in Output Tariffs, Larger Increases in In-Migration, 2000–2010 Census Data



Larger Declines in Output Tariffs, Larger Increases in In-Migration, 2000–2010 Census Data, Binned Scatter



Larger Declines in Output Tariffs, Larger Increases in In-Migration, 2000–2010 Census Data, Dropping Outliers



◂ R

Measurement of Non-agr Labor and Migration

- Laborer:
  - Working on their own family farm or family business;
  - Employed by other households, firms, or small businesses for wages. (Non-agr laborer)
- Non-agriculture laborer can be employed by:
  - Other households in the same village; (not likely – hired labor only 2% of labor days in household operations)
  - Firms in the same village; (not likely – on average 212 days working outside the village) Industry
  - Firms outside the village within the same prefecture; (τ^{own})
  - Firms in different prefectures. (τ^{other}) R

Household TFP in Crop Farming

- Cobb-Douglas production function:

$$\log(y_{h(v)t}) = \alpha \log(d_{h(v)t}) + \beta \log(k_{h(v)t}) + \gamma \log(l_{h(v)t}) + \delta \log(m_{h(v)t}) + \phi_{h(v)t}.$$

  - $y_{h(v)t}$: output value in crop farming in household h, village v, and year t.
  - Labor days, capital, land, and intermediate inputs.
  - Intermediate inputs and output are deflated with province-level price indices.

- Decomposition of TFP:

$$\phi_{h(v)t} = \phi_{vt} + \phi_h + e_{h(v)t}.$$

- $\hat{\phi}_{h(v)t}$ is recovered as a residual.

- Village-level TFP is calculated as a weighted average of household TFP, with output value as weights. Estimation R

TFP Estimation

- Output-method TFP estimation:

$$\log(y_{hvt}) = \alpha \log(d_{hvt}) + \beta \log(k_{hvt}) + \gamma \log(l_{hvt}) + \delta \log(m_{hvt}) + I_h + I_{vt} + \epsilon_{hvt}.$$

- Value-added-method TFP estimation:

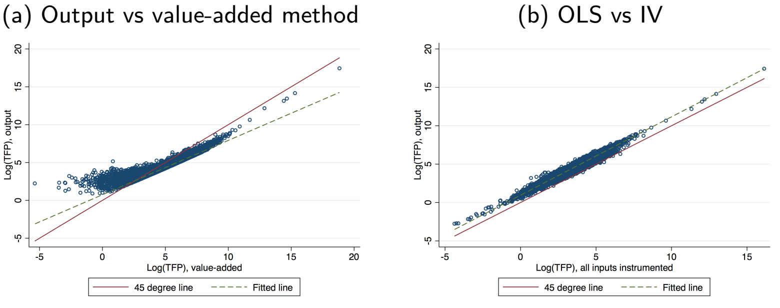
$$\log(V_{hvt}) = \alpha^V \log(d_{hvt}) + \beta^V \log(k_{hvt}) + \gamma^V \log(l_{hvt}) + I_h + I_{vt} + \epsilon^V_{hvt}.$$

- Can use lagged inputs to instrument for contemporary inputs.

Estimation Results

	(1)	(2)	(3)	(4)
	OLS		IV, log(output value)	
	Log(output value)	Log(value-added)	All inputs Lagged	Labor and intermediate lagged
Log(labor days in agriculture)	0.249***	0.343***	0.242***	0.261***
	(0.013)	(0.017)	(0.010)	(0.011)
Log(capital)	0.018***	0.024***	0.008***	0.010***
	(0.003)	(0.003)	(0.002)	(0.001)
Log(land)	0.346***	0.486***	0.248***	0.161***
	(0.014)	(0.017)	(0.010)	(0.007)
Log(intermediate input costs)	0.271***		0.466***	0.511***
	(0.014)		(0.012)	(0.012)
Observations	245,610	243,281	215,024	217,037
R-squared	0.892	0.846	0.385	0.371
Sum of the coefficients	.88	.85	.96	.94
CRS F-value	83.7	103.7	47.7	194.0
CRS p-value	0	0	0	0

Similar Estimated TFP with Different Methods



Village TFP and Allocation Efficiency

- Village TFP using household-output weights:

$$\hat{\Phi}_{vt} = \sum_h w_{h(v)t}\hat{\phi}_{h(v)t} = \sum_h \frac{y_{h(v)t}}{\sum_{h'} y_{h(v)t}}\hat{\phi}_{h(v)t}$$

- Decomposition of aggregate TFP:

$$\hat{\Phi}_{vt} = \overline{\phi}_{vt} + \sum_h (w_{h(v)t} - \overline{w}_{vt})(\hat{\phi}_{h(v)t} - \overline{\phi}_{vt})$$

  - $\overline{\phi}_{vt}$ and $\overline{w}_{vt}$ represent unweighted means.
  - The second term is the covariance between output weights and productivity.
  - We adopt the difference between the weighted and unweighted average of TFP as one measure of allocation efficiency. R

Summary of Statistics

Mean village	2001–2010
Households	64
Households inc	$3,829
Labor	173
Non-ag labor	33
Land	35 ha.
Land leased, stock	5 ha.
Land leased, flow	2.2 ha.
Capital	$12,979

◂ R

Tests on Selective Attrition

- We generate a dummy D_{hvt} that is equal to one if the household h is in a village(v)-year(t) sample, and zero otherwise, given that the village-year is in the sample, and the household is in at least one of the years between 2001 and 2010.

- Then we run the following regression:

$$D_{h(v)t} = \gamma_0 + \gamma_1 \tau_{v(i)t}^{other} + \gamma_2 \tau_{v(i)t}^{own} + I_{pt} + I_v + \epsilon_{hvt}.$$

- If we fail to reject, $H_0 : \gamma_1 = \gamma_2 = 0$, then there is no evidence on selective attrition.

No Selective Attrition

Table: No selective attrition

	(1)
	Dummy(=1 if the household is in the sample)
Other pref. tariff	-0.55
	(1.57)
Own pref. tariff	-0.36
	(1.16)
Constant	0.90***
	(0.08)
Observations	171,959
R-squared	0.18

R

Industry Where the Migrations Worked

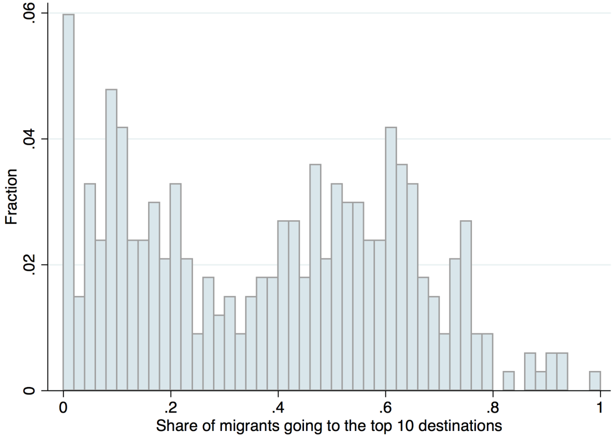
	(1)	(2)	(3)	(4)
	Agricultural labor		Non-ag laborer	
Industry	Freq	Percent	Freq	Percent
Agriculture	251,042	66%	2,732	3%
Industry	16,588	4%	38,397	39%
Construction	9,131	2%	15,119	15%
Transportation	9,923	3%	5,042	5%
Service	24,177	6%	17,833	18%
Other	66,831	18%	19,809	20%
Total	377,692		98,932	

◂ R

Summary of Statistics of the 2000 Migration Network

Variable	Value
Total number of migrants	51,850
Total number of network links	10,491
Per Destination Prefecture	
Median number of migrants	54
Median number of source prefectures	21
Per Source Prefecture	
Median number of migrants	117
Median number of destination prefectures	28

Distribution of the Share of Migrants Moving to the Top 10 Destinations



R

Note: The top 10 destination prefectures are Shenzhen, Dongguan, Guangzhou, Shanghai, Beijing, Foshan, Chongqing, Wenzhou, Wuhan, Quanzhou. These 10 prefectures absorbed 38% of total migrants in China in 2000.

No Pretrends

Year	2010	2009	2008	2007	2006	2005	2004	2003	2002
p-value for $o = own$	0.61	0.33	0.73	0.36	0.47	0.30	0.07	0.64	0.30
p-value for $o = other$	0.27	0.47	0.21	0.24	0.16	0.34	0.47	0.13	0.51

R

How Trade Exposures Affected the Land Market Activities

- First, village-level results of intensity of land market transactions on trade exposures:

$$y_{vt} = \beta_0 + \beta^{other}\tau^{other}_{v(i)t} + \beta^{own}\tau^{own}_{v(i)t} + \Gamma X_{vt} + I_{pt} + I_v + \epsilon_{vt}$$

  - Village panel of 2001–2010;
  - Outcome variables: the stock of land leased, the land rental happened within a year, land rental income;
  - $\beta^{other} < 0$: the lower the tariff in destination prefectures, the more active the land market.

Larger Trade Shocks, More Land Leased, Accumulated

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(land leased+1)				Log(land lease income+1)	
	Stock		Flow			
Other pref. tariff	-0.60***	-0.10	-1.73***	-1.10**	-3.04**	-2.37**
	(0.15)	(0.32)	(0.46)	(0.41)	(1.03)	(0.92)
Other pref. tariff		-1.40**		-1.78**		-1.87
$\times$ % cross-pref. migr		(0.54)		(0.62)		(1.97)
Own pref. tariff	-0.09*	-0.14***	0.10***	0.04	-0.27	-0.34
	(0.05)	(0.04)	(0.02)	(0.05)	(0.50)	(0.49)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.83	0.84	0.69	0.70	0.67	0.67

Larger Trade Shocks, More Land Leased within the Year

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(land leased+1)				Log(land lease income+1)	
	Stock		Flow			
Other pref. tariff	-0.60***	-0.10	-1.73***	-1.10**	-3.04**	-2.37**
	(0.15)	(0.32)	(0.46)	(0.41)	(1.03)	(0.92)
Other pref. tariff		-1.40**		-1.78**		-1.87
× % cross-pref. migr		(0.54)		(0.62)		(1.97)
Own pref. tariff	-0.09*	-0.14***	0.10***	0.04	-0.27	-0.34
	(0.05)	(0.04)	(0.02)	(0.05)	(0.50)	(0.49)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.83	0.84	0.69	0.70	0.67	0.67

Larger Trade Shocks, Larger Land Rental Income

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(land leased+1)				Log(land lease income+1)	
	Stock		Flow			
Other pref. tariff	-0.60***	-0.10	-1.73***	-1.10**	-3.04**	-2.37**
	(0.15)	(0.32)	(0.46)	(0.41)	(1.03)	(0.92)
Other pref. tariff $\times$ % cross-pref. migr		-1.40**		-1.78**		-1.87
		(0.54)		(0.62)		(1.97)
Own pref. tariff	-0.09*	-0.14***	0.10***	0.04	-0.27	-0.34
	(0.05)	(0.04)	(0.02)	(0.05)	(0.50)	(0.49)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.83	0.84	0.69	0.70	0.67	0.67

How Trade Exposures Affected the Land Allocation Efficiency

- Second, household-level results of land sizes on trade exposures and initial productivity:

$$
\begin{aligned}
\log(\mathit{land})_{h(v)t} = {} & \alpha_0 + \alpha_1 \log(\mathit{TFP})_{h(v)2001} + \alpha_2 \tau^{other}_{v(i)t} + \alpha_3 \log(\mathit{TFP})_{h(v)2001} \times \tau^{other}_{v(i)t} \\
& + \alpha_4 \tau^{own}_{v(i)t} + I_{pt} + I_v + \epsilon_{h(v)t}.
\end{aligned}
$$

  - Household panel of 2001–2010;
  - $\log(\mathit{TFP})_{h(v)2001}$: the productivity of household h in village v and in 2001;
  - Controls: a village's own tariff, province-year fixed effects, and village fixed effects;
  - $\alpha_3 < 0$: the reallocation of land towards the productive farmers was stronger in places with larger shocks.

Land Allocated More towards Initially Productive Households, 2001–2010

Y: log(land) in year t	(1)	(2)	(3)	(4)
Initial TFP (log TFP in 2001)	0.281***		0.201***	
	(0.039)		(0.041)	
Other pref. tariff	0.185	0.155		
	(0.157)	(0.169)		
Other pref. tariff ×Initial TFP	-0.061***	-0.054***		
	(0.013)	(0.015)		
Other pref. tariff*%cross-pref. migr			0.097	0.422**
			(0.166)	(0.171)
Other pref. tariff*%cross-pref. migr			-0.079**	-0.152***
× Initial TFP			(0.028)	(0.038)
Own pref. tariff	-0.033	-0.032	-0.046	-0.044
	(0.043)	(0.040)	(0.042)	(0.040)
Observations	103,027	102,262	103,027	102,262
R-squared	0.631	0.871	0.631	0.871
Province-Year FE	Yes	Yes	Yes	Yes
Village FE	Yes		Yes	
HH FE		Yes		Yes

Alternative Specification with Household FEs

Y: log(land) in year t	(1)	(2)	(3)	(4)
Initial TFP (log TFP in 2001)	0.281***		0.201***	
	(0.039)		(0.041)	
Other pref. tariff	0.185	0.155		
	(0.157)	(0.169)		
Other pref. tariff $\times$Initial TFP	-0.061***	-0.054***		
	(0.013)	(0.015)		
Other pref. tariff*%cross-pref. migr			0.097	0.422**
			(0.166)	(0.171)
Other pref. tariff*%cross-pref. migr			-0.079**	-0.152***
$\times$ Initial TFP			(0.028)	(0.038)
Own pref. tariff	-0.033	-0.032	-0.046	-0.044
	(0.043)	(0.040)	(0.042)	(0.040)
Observations	103,027	102,262	103,027	102,262
R-squared	0.631	0.871	0.631	0.871
Province-Year FE	Yes	Yes	Yes	Yes
Village FE	Yes		Yes	
HH FE		Yes		Yes

Alternative Specification with Trade Exposures Taking Into Account Cross-Prefecture Migrant Shares

Y: log(land) in year t	(1)	(2)	(3)	(4)
Initial TFP (log TFP in 2001)	0.281***		0.201***	
	(0.039)		(0.041)	
Other pref. tariff	0.185	0.155		
	(0.157)	(0.169)		
Other pref. tariff $\times$Initial TFP	-0.061***	-0.054***		
	(0.013)	(0.015)		
Other pref. tariff*%cross-pref. migr			0.097	0.422**
			(0.166)	(0.171)
Other pref. tariff*%cross-pref. migr			-0.079**	-0.152***
$\times$ Initial TFP			(0.028)	(0.038)
Own pref. tariff	-0.033	-0.032	-0.046	-0.044
	(0.043)	(0.040)	(0.042)	(0.040)
Observations	103,027	102,262	103,027	102,262
R-squared	0.631	0.871	0.631	0.871
Province-Year FE	Yes	Yes	Yes	Yes
Village FE	Yes		Yes	
HH FE		Yes		Yes

◂ R

How Trade Exposures Facilitated Capital Adoption

- Same specification as previous village-level results:

$$y_{vt} = \beta_0 + \beta^{other}\tau^{other}_{v(i)t} + \beta^{own}\tau^{own}_{v(i)t} + \Gamma X_{vt} + I_{pt} + I_v + \epsilon_{vt}$$

  - $\beta^{other} < 0$: the lower the tariff in destination prefectures, the more capital adopted.

Larger Trade Shocks, More Agricultural Machinery Adopted

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(agr machine)		Log(# of hhs with positive ag machine & land larger than 1/3 hectare)			
Other pref. tariff	-0.07	0.34	-0.23	0.18	0.03	0.46
	(0.76)	(0.79)	(0.38)	(0.37)	(0.44)	(0.33)
Other pref. tariff × % cross-pref. migr		-1.15**		-1.23***		-1.39**
		(0.47)		(0.35)		(0.46)
Own pref. tariff	0.03	-0.01	-0.08	-0.12*	-0.05	-0.10*
	(0.06)	(0.08)	(0.05)	(0.07)	(0.04)	(0.05)
Log(# of hhs with ag machine>0 & land<1/3 ha)					0.07	0.07
					(0.06)	(0.06)
Observations	2,333	2,333	2,181	2,181	1,413	1,413
R-squared	0.87	0.87	0.88	0.88	0.91	0.91

Larger Trade Shocks, More Households with Large Land and Agricultural Machinery

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log(agr machine)		Log(# of hhs with positive ag machine & land larger than 1/3 hectare)			
Other pref. tariff	-0.07	0.34	-0.23	0.18	0.03	0.46
	(0.76)	(0.79)	(0.38)	(0.37)	(0.44)	(0.33)
Other pref. tariff × % cross-pref. migr		-1.15**		-1.23***		-1.39**
		(0.47)		(0.35)		(0.46)
Own pref. tariff	0.03	-0.01	-0.08	-0.12*	-0.05	-0.10*
	(0.06)	(0.08)	(0.05)	(0.07)	(0.04)	(0.05)
Log(# of hhs with ag machine>0 & land<1/3 ha)					0.07	0.07
					(0.06)	(0.06)
Observations	2,333	2,333	2,181	2,181	1,413	1,413
R-squared	0.87	0.87	0.88	0.88	0.91	0.91

Robust to Controlling the Number of Households with Small Land and Agricultural Machinery

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(agr machine)		Log(# of hhs with positive ag machine & land larger than 1/3 hectare)			
Other pref. tariff	-0.07	0.34	-0.23	0.18	0.03	0.46
	(0.76)	(0.79)	(0.38)	(0.37)	(0.44)	(0.33)
Other pref. tariff × % cross-pref. migr		-1.15**		-1.23***		-1.39**
		(0.47)		(0.35)		(0.46)
Own pref. tariff	0.03	-0.01	-0.08	-0.12*	-0.05	-0.10*
	(0.06)	(0.08)	(0.05)	(0.07)	(0.04)	(0.05)
Log(# of hhs with ag machine>0 & land<1/3 ha)					0.07	0.07
					(0.06)	(0.06)
Observations	2,333	2,333	2,181	2,181	1,413	1,413
R-squared	0.87	0.87	0.88	0.88	0.91	0.91

◂ R

Larger Trade Shocks, Higher Wage of Hired Labor

	(1)	(2)	(3)	(4)
	Log(hired labor days)		Log(wage of hired labor)	
Other pref. tariff	-1.56	-1.99	0.16	0.37
	(1.49)	(1.55)	(0.35)	(0.38)
Other pref. tariff × % cross-pref. migr		1.27*		-0.64
		(0.59)		(0.39)
Own pref. tariff	-0.12	-0.09	0.00	-0.01
	(0.22)	(0.22)	(0.06)	(0.06)
Observations	1,879	1,879	1,742	1,742
R-squared	0.68	0.68	0.67	0.68

R

Larger Trade Shocks, More Households with Large Land

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(land)		Log(land per worker)		Log(# of hhs>1/3 ha)	
Other pref. tariff	0.12	0.18	-0.02	-0.01	0.15	0.42*
	(0.13)	(0.17)	(0.16)	(0.18)	(0.16)	(0.22)
Other pref. tariff × % cross-pref. migr		-0.16		-0.02		-0.73**
		(0.18)		(0.15)		(0.25)
Own pref. tariff	-0.04	-0.05	-0.03	-0.03	0.01	-0.02
	(0.03)	(0.03)	(0.02)	(0.02)	(0.04)	(0.04)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.96	0.96	0.93	0.93	0.95	0.95

R

People Do Not Reinvest Wage Income Back in Ag Production

	(1) Wage	(2) Farm	(3) Land rent	(4) Interest	(5) Government
Panel A: Y = Log(investment+1)					
Share of income from...	-0.41***	0.29***	0.17	0.20	0.75***
	(0.04)	(0.04)	(0.10)	(0.29)	(0.22)
Panel B: Y= I(investment>0)*100					
Share of income from...	-4.80***	3.44***	1.85	1.72	9.12***
	(0.64)	(0.63)	(1.50)	(3.12)	(2.96)
Mean (sd) share of income from...	0.22 (0.28)	0.62 (0.33)	0.01 (0.05)	0.005(0.003)	0.02 (0.05)

R

How Trade Exposures Led to Increases in Village-Level TFP

- Same specification as previous village-level results.
- Recall the decomposition of village-level TFP:

$$\hat{\Phi}_{vt} = \overline{\phi}_{vt} + \sum_{h} (w_{h(v)t} - \overline{w}_{vt})(\hat{\phi}_{h(v)t} - \overline{\phi}_{vt})$$

- Three outcomes: output-weighted, unweighted, and the allocation efficiency measure.

Larger Trade Shocks, Larger Increases in Output-Weighted Village TFP

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(village TFP)				Allocation efficiency	
	output weighted		unweighted			
Other pref. tariff	-0.69***	-0.45**	0.04	0.09	-0.74***	-0.54**
	(0.05)	(0.14)	(0.22)	(0.23)	(0.06)	(0.17)
Other pref. tariff × % cross-pref. migr		-0.69		-0.13		-0.55
		(0.59)		(0.08)		(0.55)
Own pref. tariff	0.01	-0.02	0.00	-0.00	0.00	-0.01
	(0.09)	(0.08)	(0.03)	(0.03)	(0.06)	(0.06)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.65	0.65	0.84	0.84	0.58	0.58

Insignificant Effects on Unweighted Village TFP

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(village TFP)				Allocation efficiency	
	output weighted		unweighted			
Other pref. tariff	-0.69***	-0.45**	0.04	0.09	-0.74***	-0.54**
	(0.05)	(0.14)	(0.22)	(0.23)	(0.06)	(0.17)
Other pref. tariff × % cross-pref. migr		-0.69		-0.13		-0.55
		(0.59)		(0.08)		(0.55)
Own pref. tariff	0.01	-0.02	0.00	-0.00	0.00	-0.01
	(0.09)	(0.08)	(0.03)	(0.03)	(0.06)	(0.06)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.65	0.65	0.84	0.84	0.58	0.58

Larger Trade Shocks, Larger Increases in Allocation Efficiency

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log(village TFP)				Allocation efficiency	
	output weighted		unweighted			
Other pref. tariff	-0.69***	-0.45**	0.04	0.09	-0.74***	-0.54**
	(0.05)	(0.14)	(0.22)	(0.23)	(0.06)	(0.17)
Other pref. tariff × % cross-pref. migr		-0.69		-0.13		-0.55
		(0.59)		(0.08)		(0.55)
Own pref. tariff	0.01	-0.02	0.00	-0.00	0.00	-0.01
	(0.09)	(0.08)	(0.03)	(0.03)	(0.06)	(0.06)
Observations	2,333	2,333	2,333	2,333	2,333	2,333
R-squared	0.65	0.65	0.84	0.84	0.58	0.58

◂ R

Selection: Unproductive Farmers More Likely to Leave Agriculture

Y: Number of non-agricultural laborers	(1)	(2)	(3)	(4)
Log(TFP), 2001	-0.043***	0.048**	-0.044***	0.051**
	(0.006)	(0.024)	(0.006)	(0.024)
Log(TFP), 2001, squared		-0.011***		-0.011***
		(0.003)		(0.003)
Number of laborers	0.251***	0.251***	0.255***	0.256***
	(0.005)	(0.005)	(0.005)	(0.005)
Constant	0.019	-0.174***	0.010	-0.191***
	(0.030)	(0.056)	(0.030)	(0.056)
Observations	110,244	110,244	110,243	110,243
R-squared	0.344	0.344	0.382	0.382
Year FE	Yes	Yes		
Village-Year FE			Yes	Yes
Village FE	Yes	Yes		

Selection: Unproductive Farmers More Responsive to Trade Shocks

	(1)	(2)	(3)	(4)
	TFP in 2001			
Y: Number of non-agricultural laborers	<Median	≥Median	<Median	≥Median
Other pref. tariff × % cross-pref migr	-0.40**	-0.28	-0.38**	-0.23
	(0.13)	(0.17)	(0.13)	(0.18)
Own pref. tariff	0.02	0.05	0.02	0.06
	(0.04)	(0.05)	(0.04)	(0.05)
Number of laborers	0.23***	0.23***	0.25***	0.25***
	(0.02)	(0.02)	(0.02)	(0.02)
Observations	55,715	53,904	56,050	54,192
R-squared	0.65	0.63	0.37	0.35
HH FE	Yes	Yes		
Village FE			Yes	Yes

R

No Strong Positive Correlation between Ag and Non-Ag Ability

	(1)	(2)	(3)	(4)	(5)	(6)
	Log(TFP) in agriculture			Log (income) from working outside village		
Education	0.035***	0.005***		0.056***	0.039***	
	(0.005)	(0.001)		(0.004)	(0.002)	
Non-agricultural training (=1)	-0.080***	-0.016		0.390***	0.303***	
	(0.026)	(0.013)		(0.020)	(0.016)	
Agricultural training (=1)	0.160***	0.011		-0.155***	-0.044*	
	(0.048)	(0.017)		(0.034)	(0.024)	
Age	0.002**	-0.000**		-0.001	-0.003***	
	(0.001)	(0.000)		(0.001)	(0.001)	
Log (TFP), 2001			0.177***			-0.008
			(0.013)			(0.018)
Village FE	No	Yes	Yes	No	Yes	Yes
Observations	127,029	127,029	165,515	85,104	85,104	63,000
R-squared	0.034	0.556	0.567	0.108	0.310	0.279

R

Village-Level Out-Migration Results

	(1)	(2)	(3)	(4)	(5)
	% in agriculture		% out of village		% excess labor
		Any	% within province	% between province	
Other pref. tariff	0.17***	-0.10*	-0.12**	0.02	0.03
	(0.04)	(0.05)	(0.04)	(0.04)	(0.04)
Own pref. tariff	0.01	-0.01**	-0.02*	0.00	0.01
	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)
Observations	2,255	2,257	2,256	2,257	2,253
R-squared	0.86	0.80	0.78	0.88	0.70
Mean (sd) Y	0.50 (0.31)	0.27 (0.18)	0.17 (0.14)	0.10 (0.13)	0.08 (0.11)

R

No Significant Impact of Agricultural Trade

	(1)	(2)	(3)	(4)	(5)	(6)
Y: % non-ag laborer		Agricultural tariff		Agricultural Market Access		Uncertainty
		Cereal	All	Cereal	All	
Other pref. tariff	-0.09***	-0.09**	-0.09***	-0.09***	-0.09***	-0.06**
	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)	(0.02)
Own pref. tariff	0.02**	0.02**	0.02*	0.02**	0.02**	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Agricultural export shock		-0.07	-0.11	0.06	-0.02	
		(0.16)	(0.19)	(0.10)	(0.03)	
Agricultural import shock		-0.09	-0.02	0.00	-0.00	
		(0.05)	(0.03)	(0.01)	(0.00)	
Uncertainty, own pref.						-0.11***
						(0.03)
Uncertainty, other pref.						0.15
						(0.13)
Observations	1,964	1,964	1,964	1,964	1,964	2,333
R-squared	0.85	0.85	0.85	0.85	0.85	0.85

R

Village-Level Value-Added TFP Results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(village TFP)				Allocation efficiency	
	output weighted		unweighted			
Other pref. tariff	-0.68***	-0.39	0.03	0.11	-0.70***	-0.49
	(0.16)	(0.21)	(0.34)	(0.35)	(0.14)	(0.27)
Other pref. tariff $\times$ % cross-pref. migr		-0.81		-0.23		-0.59
		(0.71)		(0.13)		(0.66)
Own pref. tariff	0.04	0.02	0.02	0.01	0.02	0.00
	(0.12)	(0.11)	(0.04)	(0.04)	(0.09)	(0.08)
Observations	2,332	2,332	2,332	2,332	2,332	2,332
R-squared	0.67	0.67	0.85	0.85	0.59	0.59

R

Labor Productivity

- An alternative measure of agriculture productivity is the labor productivity (Lagakos and Waugh 2013) as
$$\hat{\phi}^L_{h(v)t} \equiv \log(y_{h(v)t}) - \log(d_{h(v)t}),$$
- where $\log(y_{h(v)t})$ is the log of the value of agriculture output in household h, village v, and time period t, and $\log(d_{h(v)t})$ is the labor days in agriculture.
- Village level TFP, unweighted TFP, and allocation efficiency are calculated accordingly by replacing $\hat{\phi}_{h(v)t}$ with $\hat{\phi}^L_{h(v)t}$.

Village-Level Labor Productivity Results

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)
	Log(village TFP)				Allocation efficiency	
	output weighted		unweighted			
Other pref. tariff	-0.68***	-0.39	0.03	0.11	-0.70***	-0.49
	(0.16)	(0.21)	(0.34)	(0.35)	(0.14)	(0.27)
Other pref. tariff × % cross-pref. migr		-0.81		-0.23		-0.59
		(0.71)		(0.13)		(0.66)
Own pref. tariff	0.04	0.02	0.02	0.01	0.02	0.00
	(0.12)	(0.11)	(0.04)	(0.04)	(0.09)	(0.08)
Observations	2,332	2,332	2,332	2,332	2,332	2,332
R-squared	0.67	0.67	0.85	0.85	0.59	0.59

◂ R

No Significant Impacts on Husbandry

VARIABLES	(1) Log (husb. output)	(2)	(3) Log (# of HHs in husb.)	(4)	(5) Log(labordays in husb.)	(6)
Other pref. tariff	0.21	0.20	0.25	0.42	-0.00	0.13
	(0.26)	(0.23)	(0.32)	(0.35)	(0.48)	(0.58)
Other pref. tariff ×		0.05		-0.46		-0.37
% cross-pref. migr		(0.47)		(0.31)		(0.51)
Own pref. tariff	0.12	0.12	0.07	0.06	0.10	0.09
	(0.07)	(0.08)	(0.04)	(0.04)	(0.09)	(0.08)
Observations	2,263	2,263	2,263	2,263	2,241	2,241
R-squared	0.79	0.79	0.87	0.87	0.82	0.82

No Significant Impact on Cash Crops

	(1)	(2)	(3)	(4)	(5)	(6)
	Cash crop revenue /crop revenue		# HHs with cash crops /HH with crops		Log(# of HHs) with cash crops	
Other pref. tariff	-0.04	-0.05	0.11***	0.11**	0.20*	0.13
	(0.08)	(0.07)	(0.03)	(0.03)	(0.11)	(0.17)
Other pref. tariff ×		0.02		0.02		0.20
% cross-pref. migr		(0.08)		(0.09)		(0.42)
Own pref. tariff	-0.02	-0.01	0.01	0.01	-0.00	0.01
	(0.01)	(0.01)	(0.02)	(0.02)	(0.08)	(0.09)
Observations	2,333	2,333	2,333	2,333	2,221	2,221
R-squared	0.92	0.92	0.89	0.89	0.87	0.87
Province-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes	Yes	Yes

No Significant Impact on Vegetables

	(1)	(2)	(3)	(4)	(5)	(6)
	Vegetable revenue /crop revenue		# HHs with vegetable /HH with crops		Log(# of HHs) with vege production	
Other pref. tariff	0.01	-0.02	0.16*	0.14	1.12***	0.87***
	(0.06)	(0.07)	(0.07)	(0.09)	(0.13)	(0.20)
Other pref. tariff X % cross-pref. migr		0.06		0.05		0.72
		(0.06)		(0.13)		(0.57)
Own pref. tariff	-0.00	-0.00	0.01	0.01	-0.02	0.00
	(0.01)	(0.01)	(0.02)	(0.02)	(0.08)	(0.09)
Observations	2,333	2,333	2,333	2,333	1,993	1,993
R-squared	0.92	0.92	0.90	0.90	0.87	0.87

◂ R

Differential Initial Share of Migrants Going to Top 10 Destinations Didn't Affect the Impact of Trade Shocks

	(1)	(2)	(3)	(4)	(5)
VARIABLES	% non-ag laborer	Log(land leased+1)	Log(agr machine)		Village TFP
Other pref. tariff	-0.06**	-0.65***	-0.12	0.27	-0.79***
	(0.02)	(0.15)	(0.79)	(0.82)	(0.14)
Other pref. tariff × % cross-pref. migr				-1.04*	
				(0.52)	
Own pref. tariff	0.02*	-0.09*	0.02	-0.01	0.00
	(0.01)	(0.05)	(0.07)	(0.08)	(0.08)
Share to top ten × year trend	0.01	0.12	0.12	0.08	0.22*
	(0.01)	(0.11)	(0.07)	(0.08)	(0.11)
Constant	0.49***	-0.52	2.05	2.56	4.88***
	(0.09)	(1.95)	(2.69)	(2.69)	(0.65)
Observations	2,333	2,333	2,333	2,333	2,333
R-squared	0.85	0.83	0.87	0.87	0.65
Province-Year FE	Yes	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes	Yes

◂ R

Results on Occupation Choices Robust to Controlling for Concurrent Crop Patterns

Y=% non-ag laborer	(1) Wheat	(2) Rice	(3) Corn	(4) Soybean
Other pref. tariff	-0.06**	-0.06**	-0.06**	-0.06**
	(0.02)	(0.02)	(0.02)	(0.02)
Own pref. tariff	0.02*	0.02	0.02	0.02*
	(0.01)	(0.01)	(0.01)	(0.01)
Share of output value coming from crop X	0.13*	0.03	0.01	0.02
	(0.06)	(0.05)	(0.04)	(0.06)
Observations	2,333	2,333	2,333	2,333
R-squared	0.85	0.85	0.85	0.85
Province-Year FE	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes

Results on Occupation Choices Robust to Controlling for Initial Crop Patterns

	(1)	(2)	(3)	(4)
Y=% non-ag laborer	Wheat	Rice	Corn	Soybean
Other pref. tariff	-0.09***	-0.10***	-0.09***	-0.09***
	(0.02)	(0.02)	(0.02)	(0.02)
Own pref. tariff	0.02**	0.02**	0.02***	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)
2001 crop share × Year FE	Yes	Yes	Yes	Yes
Observations	1,971	1,971	1,971	1,971
R-squared	0.85	0.85	0.85	0.85
Province-Year FE	Yes	Yes	Yes	Yes
Village FE	Yes	Yes	Yes	Yes

◂ R

Competing Factors in Agricultural Modernization

- Two competing channels for the increase in agriculture efficiency:
  - Reduction in agricultural land market transaction cost;
  - The selection of unproductive farmers out of agriculture when the manufacturing sector grows.

- The quantitative importance of these two channels depends on:
  - The size of the transaction costs;
  - The correlation between a worker's agr and non-agr abilities;
  - The growth in non-agr productivity and agr productivity.

A Quantitative Exercise with Land Market Transaction Costs and Occupation Choices

- We follow Adamopoulos et al. (2017) to build a simple two-sector economy model with land misallocation.

- The main deviations:
  - Open economy instead of closed economy (to abstract from demand side forces);
  - Micro foundation for the source of misallocation in the form of transaction costs;
  - Calibration using data from different years to document changes.

Model Environment

- Two sector economy: agriculture (a) and non-agriculture (n).
  - The relative price of agricultural good p_a is set at the international market.
- A continuum of individuals with measure one.
  - Endowed with a pair of abilities (s_{ai}, s_{ni}), land $\bar{l}$, and one unit of inelastically supplied labor.
- An individual chooses the sector with higher income:
  - $I_i = \max\{I_{ai}, I_{ni}\}$.
- The set of individuals who choose agriculture is $H_a = \{i : I_{ai} \geq I_{ni}\}$, and the set of non-ag workers is $H_n = \{i : I_{ai} < I_{ni}\}$.

Agricultural Production

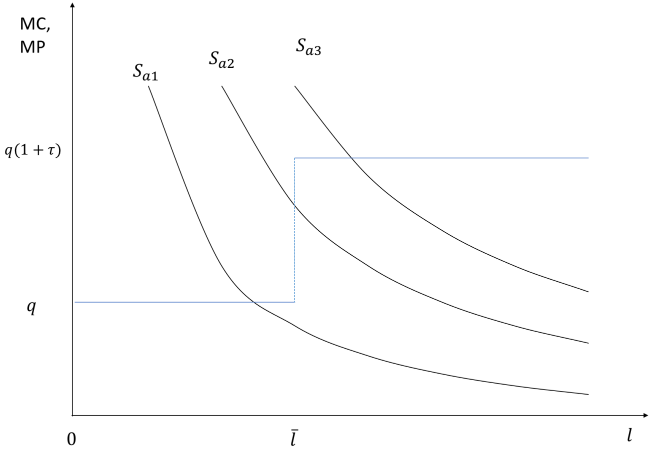
- Individual farms with decreasing returns to scale w.r.t. capital (k_i) and land (l_i).
- $$y_{ai} = (A_a s_{ai})^{1-\gamma}(l_i^{\alpha} k_i^{1-\alpha})^{\gamma}.$$
  - A_a is the agricultural productivity that is common to all individuals.
- Price of capital determined exogenously on the international market.
- Land rental market with transaction costs (τ):

$$C(l_i) = \begin{cases} q l_i & \text{if } l_i \leq \bar{l}, \\ q\bar{l} + q(1+\tau)(l_i - \bar{l}) = q(1+\tau)l_i - q\tau\bar{l} & \text{if } l_i > \bar{l}. \end{cases}$$

  - where $C(l_i)$ is the cost of land, q is the rental rate of land, and $\bar{l}$ is the individual land endowment.

Three Types of Farmers Depending on the Demand for Land

Figure: Three types of farmers in land markets with transaction costs



Non-Agricultural Production

- The output is linear in effective labor (Z_n):

$$Y_n = A_n Z_n,$$

$$\text{where } Z_n = \int_{i \in H_n} s_{ni} \, di,$$

- The total number of workers in the non-agricultural sector is

$$N_n = \int_{i \in H_n} di.$$

- A_n is the non-agricultural productivity that is common to all individuals.

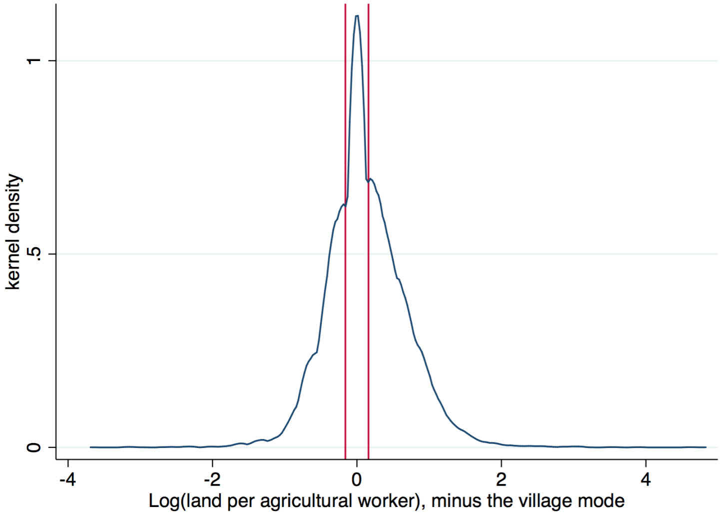
Occupation Choice

- An individual chooses the sector with higher income.
  - Factor payment $q\bar{l}$ is received no matter which sector one works in;
  - The rest of income in the agricultural sector is the profit of running the farm (π_i);
  - The rest income in the non-agricultural sector is the wage ($w_n s_{ni}$). R

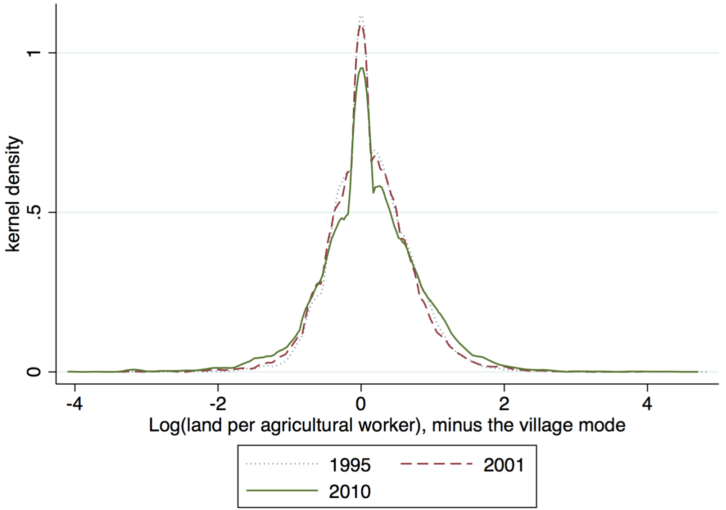
Model Calibration

- Assume that the ability (s_{ai}, s_{ni}) follows a bi-variate log-normal distribution.
  - Mean $(0, 0)$ and variance Σ, fixed over time;
  - Further assume that $\sigma_a^2 = \sigma_n^2$.
- The model implies that at any cross-section, there are three types of farmers.
  - Type I with land less than the endowment, Type II at the endowment, and Type III larger than the endowment.
- Empirically, we define the village mode to be the endowment point. R

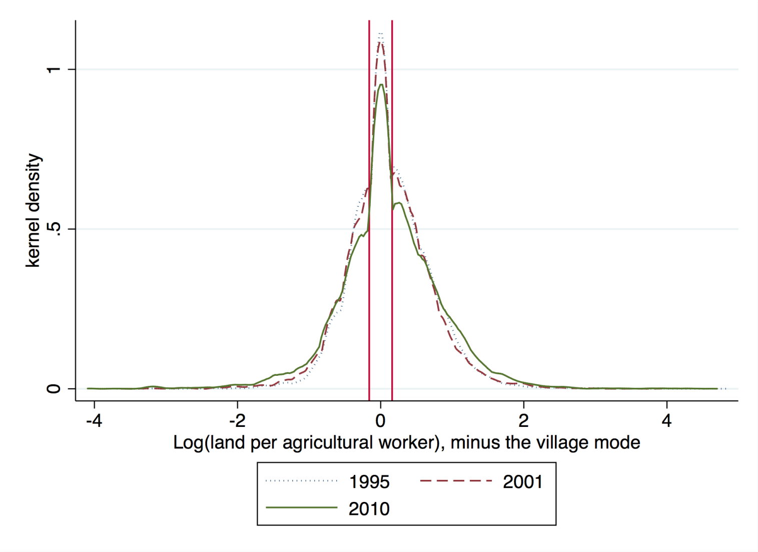
Empirical Distribution of Land per Worker in 1995



Changes in Distributions from 1995 to 2010



Fuzziness in the Definition of the Land Endowment across Years



Calibration of the Productivity Distribution and Transaction Costs

- Key objects to be calibrated:
  - Productivity distribution (A_a, A_n) and Σ;
  - Land market transaction cost τ.

- Information used:
  - The probabilities of being Type I, Type II, and Type III farmers;
  - The probability of choosing agriculture over non-agriculture;
  - The variances of land for Type I and Type III farmers;
  - The mean income of workers who switched from agriculture to non-agriculture;
  - The mean value of agricultural output. Details

Calibrated Parameters: Covariance Matrix

Year	2001	2010
Variance of sector-specific productivity, σ_a^2	0.7172	
Covariance between productivity in different sectors, σ_{an}	0.1243	
Land market transaction cost, τ	1.6	1.2
Agricultural productivity, $(1-\gamma)\log A_a$	6.8	7.2
Non-agricultural productivity, $\log A_n$	8.1	9.6

Calibrated Parameters: Transaction Costs

Year	2001	2010
Variance of sector-specific productivity, σ_a^2	0.7172	
Covariance between productivity in different sectors, σ_{an}	0.1243	
$\boxed{\text{Land market transaction cost, } \tau}$	$\boxed{1.6}$	$\boxed{1.2}$
Agricultural productivity, $(1-\gamma)\log A_a$	6.8	7.2
Non-agricultural productivity, $\log A_n$	8.1	9.6

Calibrated Parameters: Productivity Growth

Year	2001	2010
Variance of sector-specific productivity, σ_a^2	0.7172	
Covariance between productivity in different sectors, σ_{an}	0.1243	
Land market transaction cost, τ	1.6	1.2
Agricultural productivity, $(1-\gamma)\log A_a$	6.8	7.2
Non-agricultural productivity, $\log A_n$	8.1	9.6

Takeaways from the Calibration

- The correlation of the sectoral ability was 0.17.
- The land market transaction costs were 1.6 in 2001 and 1.2 in 2010.
  - These costs are substantial and decline over the years, which is in line with the land reforms documented in Chari et al. [2017].
- Strong forces for sectoral labor reallocation:
  - The growth of agricultural productivity was smaller than the growth in the non-agricultural productivity. R

Counterfactual Analysis

- Experiments:
  - What if the land transaction cost is smaller: let $\tau^{2010} = 0$.
  - What if the non-agricultural sector does not grow: let $A_n^{2010} = A_n^{2001}$.
- Outcomes of interests:
  - Agricultural productivity (output per person, average productivity in ag);
  - Share of employment in agriculture;
  - GDP per worker;
  - Capital to labor ratio in agriculture.

The Impact on the Agricultural Sector

Aggregate statistics	Benchmark Economy	C1 $\tau = 0$	C2 $A_n^{2010} = A_n^{2001}$
Real agricultural productivity (output per person)	1	1.09	0.69
Share of employment in agriculture	0.49	0.48	0.90
TFP in agriculture	1	1.06	0.91
Real non-agricultural productivity (output per person)	1	0.93	0.36
Average ability in agriculture (in log)	1	1.48	0.34
Average ability in non-agriculture (in log)	1	0.79	1.84
GDP per worker	1	1.02	0.83
Total agricultural capital per agricultural employment	1	1.09	0.69

The Impact on the Overall Economy

Aggregate statistics	Benchmark Economy	C1 $\tau = 0$	C2 $A_n^{2010} = A_n^{2001}$
Real agricultural productivity (output per person)	1	1.09	0.69
Share of employment in agriculture	0.49	0.48	0.90
TFP in agriculture	1	1.06	0.91
Real non-agricultural productivity (output per person)	1	0.93	0.36
Average ability in agriculture (in log)	1	1.48	0.34
Average ability in non-agriculture (in log)	1	0.79	1.84
GDP per worker	1	1.02	0.83
Total agricultural capital per agricultural employment	1	1.09	0.69

The Increase in Non-agricultural Productivity Mattered More

- Reducing land-market transaction costs had:
  - Relatively small impacts on per capita GDP and the share of employment in the agricultural sector;
  - Moderate impacts on capital adoption and agricultural TFP.

- Increase in non-agricultural productivity had:
  - Large impacts on the sectoral employment patterns and agricultural productivity.

- Overall, the pull factors dominated the push factors of out-migration in facilitating both urbanization and agriculture modernization. ◂ R

Calibration Details: Data Used

Year	1995	2001	2010
Probability of choosing agriculture	.75	.71	.49
Total number of farmers	21,521	19,564	15,158
Number of Type I farmers	5,963	5,769	4,560
Number of Type II farmers	6,242	5,673	3,966
Number of Type III farmers	9,316	8,122	6,632
Prob of Type I farmers, conditioning on being a farmer	.28	.29	.30
Prob of Type II farmers, conditioning on being a farmer	.29	.29	.26
Prob of Type III farmers, conditioning on being a farmer	.43	.42	.44
Variance of log land, Type I	.097	.136	.237
Variance of log land, Type III	.158	.161	.232

Calibration Idea

- We need to determine the cut-off of the agricultural productivity to determine the type of the farmer (I, II, or III).
- The land market transaction cost will affect occupation choice of individuals.
- The variance of land conditioning on type is informative about the variance-covariance matrix.
- The switchers into non-agriculture gives information on non-agricultural wage.
- The relative productivity of the two sectors determine the occupation choice.
- Factor prices can be solved using input shares.

◂ R

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