Financial Development and Rural Transformation: Evidence from County-level Data in China

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Introduction

China has achieved a miracle in agricultural development over the past 40 years.

- Agricultural GDP grew at 5.4% a year, five times than population growth rate of 1% (NBS 2023).
- The rapid agricultural development led to poverty reduction and economic structural change.

Introduction

Grain yield in China

Rural per capita disposable income

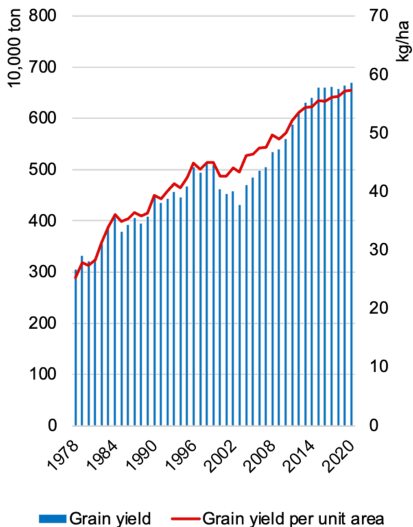Sources of farmers' income (%)

Introduction

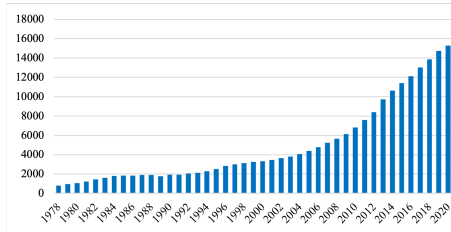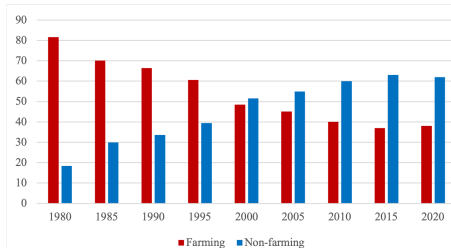China has achieved a miracle in agricultural development over the past 40 years.

- Agricultural GDP grew at 5.4% a year, five times than population growth rate of 1% (NBS 2023).
- The rapid agricultural development led to poverty reduction and economic structural change.

Institutional reforms on the land, labor and financial markets are essential to driving agricultural development.

- HRS reform in land market (Lin, 1992) and Hukou reform in labor market (Pu et al., 2018).
- Establishing rural financial markets is important for agricultural development (Levine and Zervos, 1998; Gatti and Love, 2008; Guirkinger and Boucher, 2008; Brown et al., 2012).

Little is known about the impact of financial reforms on agricultural sector.

Introduction

We examine the impact of financial market reforms in rural China on agricultural labor productivity (ALP), with the aim to:

- Examine the mechanism through which financial market reforms affect ALP growth: technology progress vs. capital accumulation.
- Distinguish the different roles of financial market reforms in affecting land consolidation and capital deepening.

We use a natural experiment, namely the Postal Saving Bank of China (PSBC) reform, to conduct the analysis.

- "Open branches across regions over time" (a continuous variable) plus "authorizing branches to provide banking loan business" (a dummy variable)
- A generalized staggered difference-in-difference approach is employed to identify the causality.

We construct the agricultural production account for

- 1,465 rural counties (out of total 2, 760 counties)
- the 1993-2016 period

Contribution

We explore the mechanism through which financial market reforms affect ALP, apart from assessing their productivity impact

- Use the Solow model at the county level
- Agricultural productivity vs. Capital accumulation

We measure financial market reforms by combining two different types of reforms and their interaction.

- Market penetration: "Open branches across regions over time" (Beck et al., 2010; Rice and Strahan, 2010)
- Bank de-centralization: "authorizing branches to provide banking loan business" (Wang et al., 2014; Shi, 2011)

We identify the potential adverse impact of financial market reforms on ALP through reducing the marginal returns to land consolidation.

- We split between capital deepening and land consolidation.
- A regression forestry approach is used to explore the changing marginal effects (Athey et al., 2019).

Background: Agricultural output and input
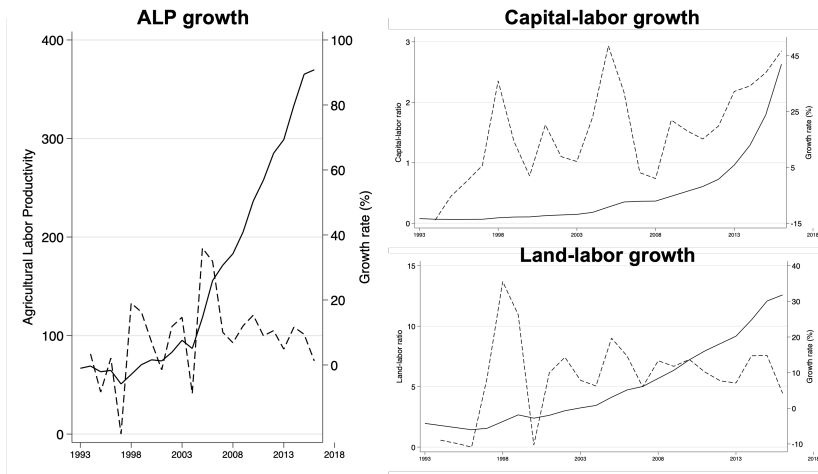
Note. The data comes from the agricultural production account we construct in this paper.

Background: Rural Financial Development

Timeline for the PSBC reform
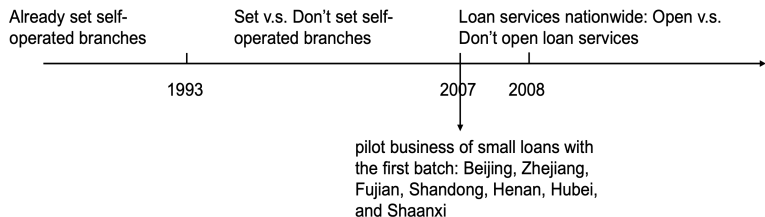
The PSBC reform is aligning with the entire rural financial reform.

- The reform of rural financial markets started the late 1990s, later than the land and labor reforms.
- The reform aims at transforming the state-owned banking system to the market-based system.

Background: Rural Financial Development

The number and proportion of PSBC branches across counties
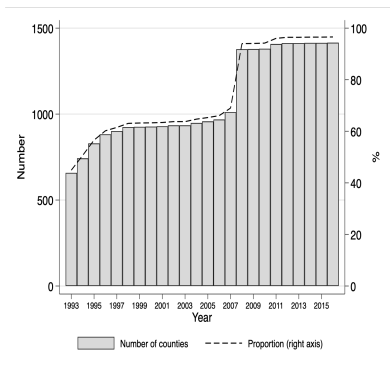
The number and proportion of PSBC branches providing loan service
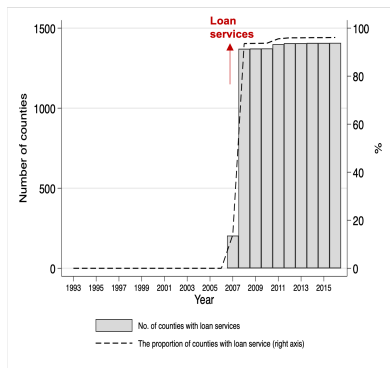
Note: The right figure show the results of PSBC branches conducting loan business. 634 rural counties have already had the self-operated PSBC branches before 1993 while the remaining 774 counties gradually set up the PSBC branches between 1993-2016. The other 57 counties acquired PSBC branches after 2016, mainly concentrated in the Tibet Autonomous Region, Qinghai Province and Yunnan Province. In 2007, the self-operated branches in 204 counties in 7 province are authorized to open the loan business.

Background: Financial Reform and Agricultural Development in Rural China

Internationally,

- Whether finance creates productivity has been discussed for a long time (Levine and Zervos, 1998; Andrews and Cingano, 2014; Bravo-Biosca et al., 2016).
- Most of them focus on the non-agricultural or broader economy (Brandt and Zhu, 2000, 2007; Song et al., 2011; Chava et al., 2013; Moll, 2014).

Domestically,

- Financial institutions in China encompass both policy-oriented and commercial entities, offering a range of financial services (Wang and He, 2019; Luo and Li, 2023).
- Reforms of rural financial institutions may positively affect the local economy (Ma et al., 2020; Song et al., 2023).

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2 Background

3 Model and Method

4 Data Source

5 Empirical Results

6 Conclusions

Model and Method

Assume that agricultural production function takes the form of a Cobb-Douglas function:

$$Y = AK^b Z^c L^\theta$$

Take the first order condition leading to

$$lny = a + blnk + clnz$$

where ALP is decomposed into three components:

- Technology progress (TFP) affects (a)
- Physical capital accumulation affects (k)
- Land consolidation affects (z)

Let R represents the shocks caused by the PSBC reform:

$$lny = Rlny(1) + (1 - R)lny(0)$$

Empirical Specification

Baseline empirical model specification is:

Elasticity of capital (land) intensity before PSBC reform

Fixed effects

$$lny_{ct} = b_0 lnk_{ct} + c_0 lnz_{ct} + \alpha R_{ct} + \beta R_{ct} lnk_{ct} + \gamma R_{ct} lnz_{ct} + u_c + v_t + \varepsilon_{ct}$$

$$R_{ct} = BY_{ct} \times LS_{ct}$$

BY(continuous): the number of years since the first PSBC branch was established .
LS(dummy): whether the PSBC branch is allowed to providing the loan services

Main interests: technology progress, capital accumulation or land consolidation

- y - agricultural labor productivity
- k - capital-labor ratio
- z - land-labor ratio
- R - a continuous variables measuring the PSBC reform

Identification Problem

the PSBC reform might not be randomly assigned across counties:

- We use the Neighborhood Matching Technique (PS match).
- Covariates include Industrial GDP, Fiscal expenditure, and Fiscal income.
- The parallel trend tests are conducted (Imbens, 2015).

There are also potential omitted macroeconomic policies shocks and the potential reverse causality.

- TWFE model with the control of weather conditions, macroeconomic shocks etc.
- The general method of moment (GMM) estimation technique, following Arellano and Bond (1991); Blundell and Bond (1998); Wooldridge (2001).
- The endogeneity test has been conducted (Lars Peter, 1982).

Other Econometric Issues

The potential "negative weight" problem associated with the traditional TWFE model:

- Borusyak et al. (2021); De Chaisemartin and d'Haultfoeuille (2020); Goodman-Bacon (2021).
- We use the difference-in-difference estimation developed by Gardner (2022) with multiple time periods.

The heterogeneity effects in treatment across countries and over time.

- Cumulative impact over time/Cross-lagged summation.
- Eventual analyses.

High correlation between capital-labor and land-labor

A series of robustness checks:

- Other measurement of PSBC reform
- Sub-sample of poverty counties or bread-ban counties
- The counterfactual exercise using 2003 land reform.

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Data Source

We construct agricultural production account data

- 1,465 rural counties in China for the 1993-2016 period.

Agricultural input and output definition follows Ball et al. (2010):

- **Agricultural value-added output:** total agricultural output value minus total costs of intermediate inputs, deflated by the agricultural PPI.
- **Capital input:** capital services from capital stocks by using the PIM method, including non-residential building and structures, transportation vehicles and other machinery and equipment.
- **Land input:** land services, estimated by using the land rental in real term. A hedonic approach has been adopted.
- **Labour input:** hours worked, and quality adjustment has been made by using the wage of rural labors segregated by different sub-sectors.

Measures of the PSBC reform

- A dummy variable for branches to provide loans (Beck et al., 2010)
- A continuous variable for years since first branch is established (Wang et al., 2014)

Data Source

ALP and PSBC branch distribution: 1993 vs. 2016

ALP: 1993 vs. 2016
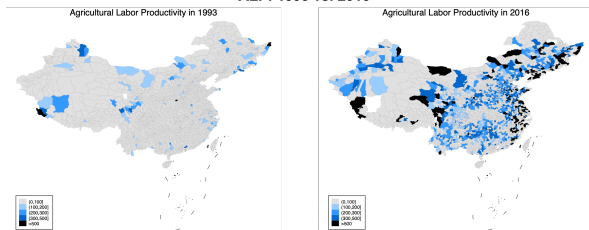
PSBC: 1993 vs. 2016
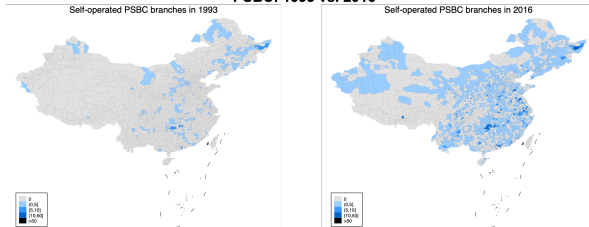
1 Introduction

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Empirical Results

- Preliminary Tests
- Impact of PSBC reforms on agricultural labor productivity
- Regression forestry approach: Marginal Impact Analysis
- Robustness checks

Empirical Results: Preliminary Tests

Scatter and LOWESS smoothed regression between ALP and capital-labor ratio and land-labor ratio, segregated by the PSBC reform
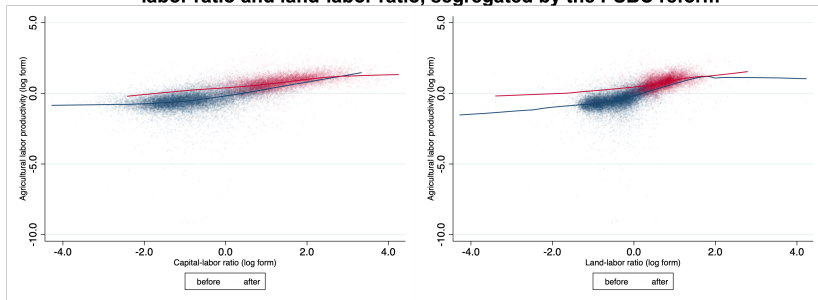
Note: The red line (dots) represents the relationship for the counties that have implemented the PSBC reforms while the the blue line (dots) represents the relationship for the counties that have not. We use the lowess smoothed regression to fit the dots.

Empirical Results: Preliminary Tests

Parallel trend test
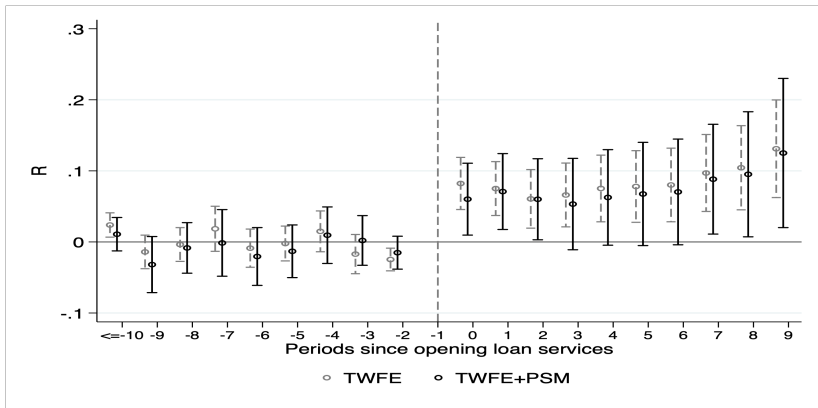
Note: we use 9 periods lags and 10 periods leads in this parallel trend test. The estimators can be obtained from the following regression:

$$\Delta lnyl_{ct} = \sum_{j=-10, j\neq-1}^{9} \alpha_j \Delta 1\{t - t_R^0 = j\} + b\Delta lnk_{ct} + c\Delta lnz_{ct} + \beta\Delta(R_{ct} \times lnk_{ct}) + \gamma\Delta(R_{ct} \times lnz_{ct}) + \Delta\nu_t + \Delta\epsilon_{ct}$$

Empirical Results: Preliminary Tests

Goodman-Bacon Test for "Negative Weights"

Overall DD Estimate = .00817579
Within component = .12567337 (weight = .30853407)
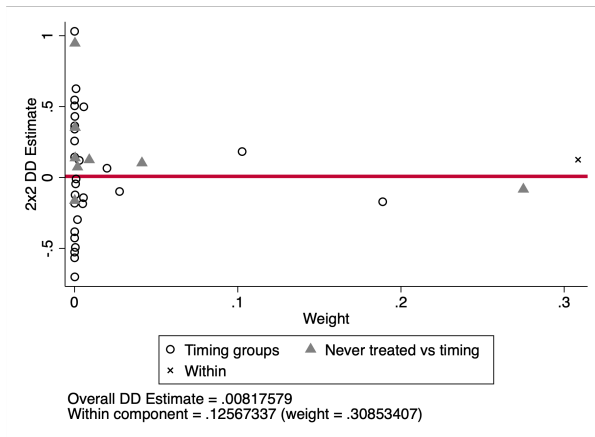
Note: the estimate contain a weighted sum of 12,333 ATTS, where 7013 receive a positive weight (57%) and 5320 receive a negative weights (43%).
The sum of the positive weights is 4.578, while the sum of the negative weights is -3.578.
The null hypothesis that the estimated coefficient is comparable with a DGP is rejected at 1%.

Empirical Results

- Preliminary Tests
- Impact of PSBC reforms on agricultural productivity
  - ALP impact: capital deepening vs. technology progress
  - Financial market reform and its impact on land consolidation
- Regression forestry approach: Marginal Impact Analysis
- Robustness checks

Empirical Results: Impact of PSBC reforms on ALP

	TWFE	TWFE	TWFE+PSM	SYS-GMM+PSM
	(1)	(2)	(3)	(4)
R	0.071***	0.071***	0.080***	0.116**
	(0.019)	(0.019)	(0.028)	(0.052)
Capital-labor ratio (log)	0.047***	0.048***	0.044**	0.064**
	(0.012)	(0.012)	(0.019)	(0.037)
Land-labor ratio (log)	0.333***	0.331***	0.320***	0.330**
	(0.028)	(0.029)	(0.041)	(0.079)
R×capital-labor (log)	0.031***	0.031***	0.022**	0.045***
	(0.008)	(0.008)	(0.011)	(0.019)
R×land-labor (log)	-0.042***	-0.042***	-0.043***	-0.079**
	(0.007)	(0.007)	(0.010)	(0.022)
Self-fiscal (log)	-	-0.016	0.002	0.135**
	-	(0.017)	(0.028)	(0.052)
GDP (log)	-	0.057	-0.048	0.105***
	-	(0.074)	(0.123)	(0.045)
Rainfall (log)	-	-0.009	-0.008	-0.034
	-	(0.015)	(0.025)	(0.045)
Constant	4.285***	3.698***	4.914***	3.588***
	(0.042)	(0.862)	(1.435)	(0.712)
County fixed effect	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y
R-squared	0.78	0.78	0.77	
Difference-in-Hansen test	-	-	-	0.000
Number of instruments	-	-	-	282
Observations	35160	35160	15384	14102

Empirical Results: Impact of PSBC reforms on ALP

	TWFE	TWFE	TWFE+PSM	SYS-GMM+PSM
	(1)	(2)	(3)	(4)
R	0.071***	0.071***	0.080***	0.116**
	(0.019)	(0.019)	(0.028)	(0.052)
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Number of instruments	-	-	-	282
Observations	35160	35160	15384	14102

→ Capital-labor raitio and land-labor ratio takes up nearly 40% .

Empirical Results: Impact of PSBC reforms on ALP

	TWFE	TWFE	TWFE+PSM	SYS-GMM+PSM	
	(1)	(2)	(3)	(4)	
R	0.071***	0.071***	0.080***	0.116**	→ Increasing agricultural productivity
	(0.019)	(0.019)	(0.028)	(0.052)	
Capital-labor ratio (log)	0.047***	0.048***	0.044**	0.064***	
	(0.012)	(0.012)	(0.019)	(0.037)	
Land-labor ratio (log)	0.333***	0.331***	0.320***	0.330**	
	(0.028)	(0.029)	(0.041)	(0.079)	
R×capital-labor (log)	0.031***	0.031***	0.022**	0.045***	→ Increasing returns to capital deepening
	(0.008)	(0.008)	(0.011)	(0.019)	
R×land-labor (log)	-0.042***	-0.042***	-0.043***	-0.079**	
	(0.007)	(0.007)	(0.010)	(0.022)	
Self-fiscal (log)	-	-0.016	0.002	0.135**	→ Decreasing returns to land consolidation
	-	(0.017)	(0.028)	(0.052)	
GDP (log)	-	0.057	-0.048	0.105***	
	-	(0.074)	(0.123)	(0.045)	
Rainfall (log)	-	-0.009	-0.008	-0.034	
	-	(0.015)	(0.025)	(0.045)	
Constant	4.285***	3.698***	4.914***	3.588***	
	(0.042)	(0.862)	(1.435)	(0.712)	
County fixed effect	Y	Y	Y	Y	
Year fixed effect	Y	Y	Y	Y	
R-squared	0.78	0.78	0.77		
Difference-in-Hansen test	-	-	-	0.000	
Number of instruments	-	-	-	282	
Observations	35160	35160	15384	14102	

Empirical Results: Impact of PSBC reforms on ALP

**Estimated impact of the PSBC reform for "negative weights": TWFE vs. Gardner**

Panel A.	R×age	Std. err	t/z	Num. of Obs.
TWFE	0.071	0.019	3.81	
G2021	-0.002	0.031	-0.06	
Panel B.	R×age×capital-labor	**Std. err**	**t/z**	35160
TWFE	0.031	0.008	4.17	
G2021	0.017	0.008	2.22	
Panel C.	R×age×land-labor	**Std. err**	**t/z**	
TWFE	-0.042	0.007	-5.95	
G2021	-0.026	0.013	-1.95	

Note: TWFE refers to the traditional two-way fixed effect approach. G2021 estimator is developed by Gardner (2022). Both control the factors that may affect agricultural TFP.

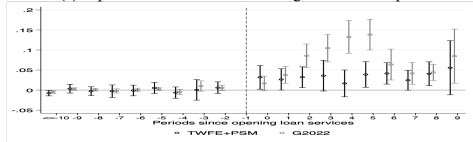# Empirical Results: Impact of PSBC reforms on ALP
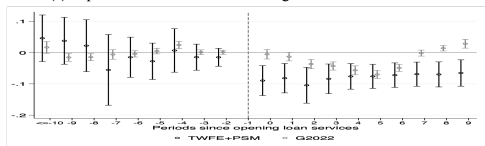
Event analysis of PSBC reform impact

(a) Impact of the PSBC reform on ALP
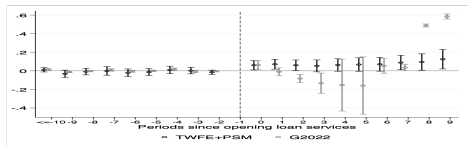
(b) Impact of the PSBC reform on marginal return to capital-labor ratio

(c) Impact of the PSBC reform on marginal return to land-labor ratio

Empirical Results

- Preliminary Tests
- Impact of PSBC reforms on agricultural productivity
- Regression forestry approach: Marginal Impact Analysis
- Robustness checks

Empirical Results: GRF for marginal impact analysis

Generalized Random Forest (GRF) method proposed by Athey et al. (2019) is a non-parametric estimation method designed to assess the heterogeneity of treatment effects.

We use GRF to analyze and compare the marginal impact of the reform by quantiles.

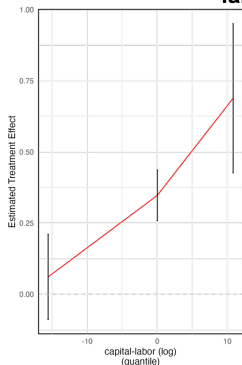- Physical capital-labor ratio
- Land-labor ratio

Following the goal of the tree-like structure of the grouping set, we maximize the heterogeneity of target parameters.

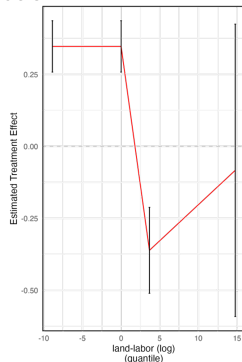$$max[\Delta(C_1, C_2) : n_{C_1}, n_{C_2}/n_P^2(\hat{\theta}_{C_1}(J) - \hat{\theta}_{C_2}(J))^2]$$

Referring to the interpretations in Carter et al. (2019), we can quantify the impact patterns of heterogeneity across capital-labor and land-labor dimensions.

Empirical Results: GRF for marginal impact analysis

Generalized Random Forest Results: capital-labor vs. land-labor ratio

(a) Capital-labor ratio   (b) Land-labor ratio

Note: The black line show the 95% confidence interval and the red point represents the estimated treatment effect. For the figure (a), the black lines represent the effect holding the capital-land labor at 0%, 25% (50%, 75%), and 100% quantile respectively. For the figure (b), the black line represent the effect holding the land-labor ratio at 0%, 25% (50%), 75% and 100% quantile respectively.

Empirical Results

- Preliminary Tests
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- Robustness checks

Empirical Results: Robustness Checks

Using other two measurement of PSBC reforms:

- The dummy variables for whether the branch in the county is authorized the loan business.
- The dummy variables for the openness of new branches before the reform.

Avoiding the correlation between physical capital-labor ratio and land-labor ratio.

- The correlation is 0.67.
- Construct the ratio between land and physical capital to replace the land-labor ratio.

Restrict the sample to only include the bread-ban counties and the counties categorized into the poverty counties.

Others will be done:

- The counterfactual exercise (e.g., 2003 land reform).
- Restrict sample to counties with more arable land, rural population, etc.

Empirical Results: Robustness Checks

Robustness Check Results

	Open a new branch		Authorize loan business		Loan business with continuous measure		poverty county	Bread-ban county
	TWFE	TWFE+PSM	TWFE	TWFE+PSM	TWFE	TWFE+PSM	TWFE+PSM	TWFE+PSM
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
R	-0.082	-0.089	0.201***	0.182**	0.071***	0.080***	0.072*	0.062*
	(0.074)	(0.075)	(0.053)	(0.090)	(0.019)	(0.028)	(0.039)	(0.035)
Capital-labor ratio (log)	0.089***	0.092***	0.045***	0.044**	0.048***	0.044**	0.047*	0.046**
	(0.017)	(0.017)	(0.012)	(0.019)	(0.012)	(0.019)	(0.027)	(0.022)
Land-labor ratio (log)	0.234***	0.234***	0.329***	0.325***	0.331***	0.320***	0.322***	0.296***
	(0.038)	(0.038)	(0.028)	(0.040)	(0.029)	(0.041)	(0.057)	(0.050)
R×capital-labor (log)	-0.044**	-0.046**	0.095***	0.058*	0.032***	0.023*	0.013	0.012
	(0.018)	(0.018)	(0.022)	(0.033)	(0.009)	(0.013)	(0.013)	(0.017)
R×land-labor (log)	0.024	0.027	-0.109***	-0.115***	-0.042***	-0.043***	-0.045***	-0.035***
	(0.037)	(0.037)	(0.019)	(0.030)	(0.007)	(0.010)	(0.016)	(0.012)
Constant	2.326***	2.345***	3.703***	4.919***	3.698***	4.914***	4.097***	2.756***
	(0.822)	(0.825)	(0.861)	(1.441)	(0.862)	(1.435)	(0.868)	(0.679)
Controls	Y	Y	Y	Y	Y	Y	Y	Y
County fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
Year fixed effect	Y	Y	Y	Y	Y	Y	Y	Y
R-squared	0.64	0.64	0.78	0.77	0.78	0.77	0.76	0.82
Observations	20510	20216	35160	15384	35160	15384	6480	5520

Conclusions

Our study shows that the PSBC reform has generated a positive direct impact on agricultural labor productivity through improving agricultural technology progress.

- A 1% increase in the PSBC reform is likely to generate around 11.6% increase in agricultural productivity, along with 2.7% in capital accumulation.

The PSBC reform is more likely to improve agricultural labor productivity through affecting the marginal returns to capital deepening, compared to improving technology progress .

- The PSBC reform is likely to increase agricultural labor productivity by strengthening the role of physical capital deepening but not through intensifying land consolidation. .

The findings underscore the positive role of financial institutions, particularly the impact of their loan services, in fostering agricultural labor productivity through the promotion of local investments.

Questions and Comments