Tillers of Prosperity: Land Ownership, Reallocation, and Structural Transformation

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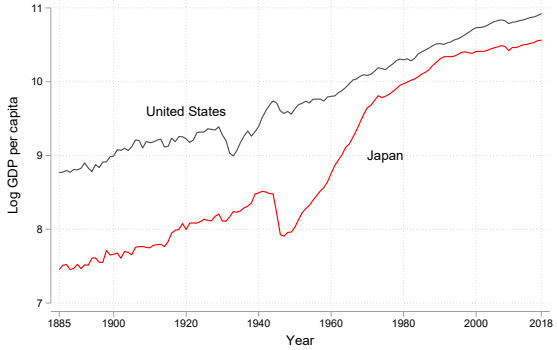
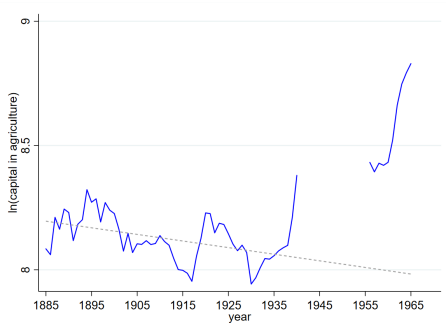
Rapid economic growth after WWII

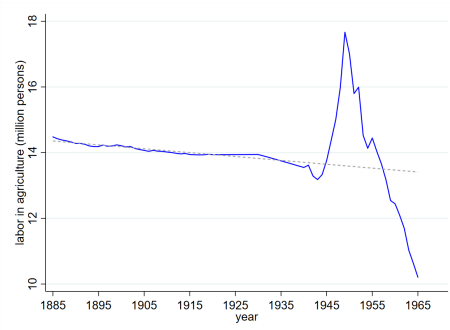


Source: Our World in Data.
Notes: International US dollars at 2011 prices.

- Between 1955-1973, the Japanese economy grew at an annual rate of above 9 percent (a.k.a. “Japanese economic miracle”)
- What happened to factor reallocation during this period?

Capital and labor in *agriculture*





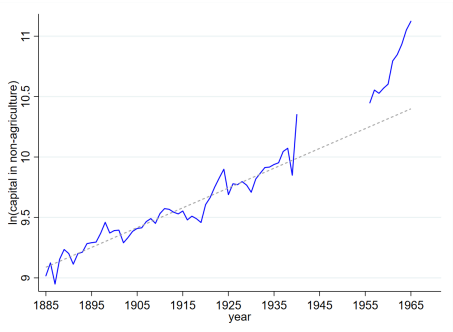
Notes: Real (1834-1836 prices); in units of non-agriculture

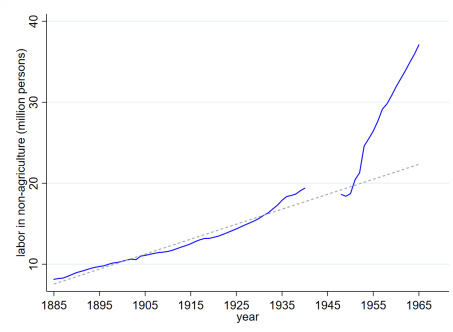
Left: Capital in agriculture was nearly constant/decreasing in the prewar period.
$\rightarrow$ Increased after WWII

Right: Employment in agriculture was nearly constant/decreasing in the prewar period.
$\rightarrow$ Decreased dramatically after WWII

- Temporal increase in the late 1940s due to the end of WWII

Capital and labor in *non-agriculture*





Left: Capital in non-agriculture increased more after WWII.

Right: Employment in non-agriculture increased more after WWII.

Research question

Prewar: Relatively abundant labor and scarce capital in agriculture

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During the period of rapid growth (late 1950s-early 70s), factor reallocation and capital-labor substitution in agriculture occurred. As a result:

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- Empirical studies on secure property rights/tenure (e.g., Besley 1995, Banerjee et al. 2002, Jakoby et al. 2002, Deininger and Jin 2006, Hornbeck 2010)

In this paper

I used the massive redistributive land reform in Japan, enforced by the Allies after WWII (1947-50), as a natural experiment to examine the role of cultivators, rather than non-cultivators, owning farmlands in economic development.

- During the land reform, the ownership of farmlands was redistributed from landlords (non-cultivators, who only earned land rent) to tenant farmers (who actually cultivated the soil) through compulsory purchase.

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I utilized the variation caused by this land reform to estimate the effects of land ownership on technology adoption (capital) and out-migration from rural areas (labor) during the rapid growth period (1950s-60s).

- The main estimation strategy employs the difference-in-differences (DID) method.
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I also evaluated the overall effect of factor reallocation on economic growth using a two-sector neo-classical growth model.

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During the rapid growth period, land ownership...

- Increased the adoption of low-cost agricultural machines (power tillers), and
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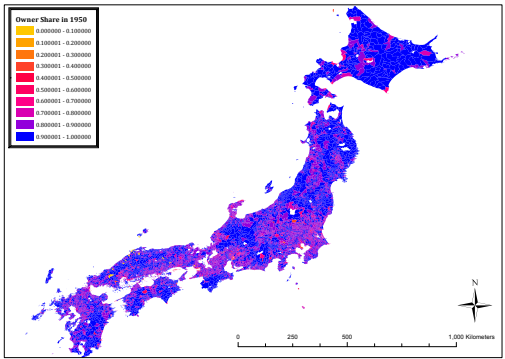
In the counterfactual simulation, I found that relaxing *production*-related wedges had a substantial impact on economic growth.

- In contrast, I found that other types of wedges had a limited impact.

Background, Data, and Empirical Strategy

Background: Land reform, 1947-50



Motivation: The Allies sought to democratize rural society by redistributing farmlands from landlords to tenants, disrupting the hierarchical relationship between them.

Procedure: Compulsory purchase on behalf of prefectural governors

- Relatively low prices. Payment completed within 1 or 2 years.
- Not a full confiscation; landlords were able to maintain some of their farmlands (will explain later).

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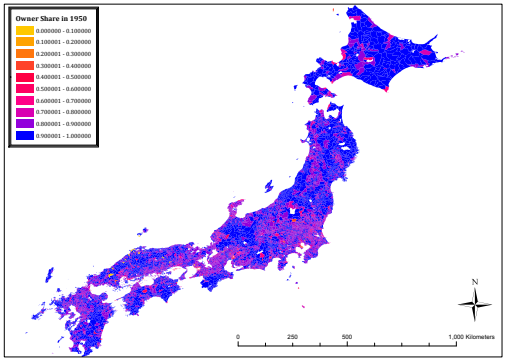
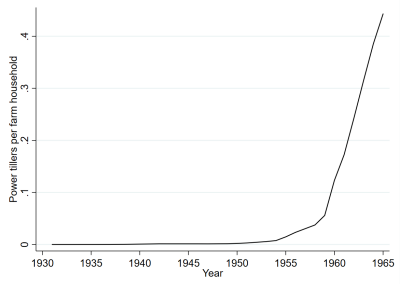


Results: The ownership of 2 million ha of farmlands was redistributed from landlords to tenants, affecting nearly all 6 million farm households. Many tenant farmers became owner farmers.

- Just a transfer of property rights without sizing. Tenant farmers obtained the same farmlands that they used to cultivate.

Map: Distribution of land ownership after the reform (1950)

Adoption of low-cost agricultural machines, late 1950s-



After the land reform, US-made low-cost power tillers were introduced. The technological innovation race among Japanese firms began.

- Notably, Honda's F150 (**top image**) was born in 1959. An epoch-making machine. Half the price of previous machines

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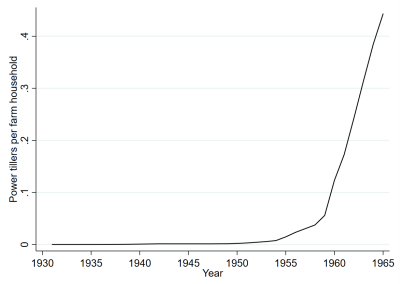

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Power tillers quickly spread out in the country (**bottom figure**).

- "With the introduction of power tillers it became possible for female or old-aged workers alone to keep on farming; this enabled young to middle-aged males in farm households to engage mainly in non-farm economic activities" (Hayami and Kawagoe 1989, p.227)

Mass migration of young people, late 1950s-

At the same time, mass migration of young people from rural areas to urban centers began.

Three metropolitan areas (Tokyo, Osaka, and Nagoya) received a large net immigration.

- In 1962, about 25% (166,000) of those who had just graduated from junior high schools—and about 20% (122,000) of those who had just graduated from high schools—in the countryside began to work in these metropolitan areas.

Picture: Young people wearing school uniforms arrived from the countryside, greeting their new employers in Tokyo

Data

Period: 1950, 55, 60, 65 (+ 1930)

Unit of observation: Municipality ($\approx$ county in the US) as of 1965

= Most aggregated unit in the study period

Data sources:

- Land reform data: *Nochi Kaikaku Siryo Shusei (The Collection of Agricultural Land Reform Materials)* (digitized)
- Other agricultural data: *Agricultural Census* (digitized), *Statistics of Agricultural Income* (digitized), *List of Agricultural Cooperatives* (digitized)
- Demographic data: *Census*, *Vital Statistics* (digitized)
- GIS data: *National Land Numerical Information*, *Shuttle Radar Topography Mission (SRTM3)*, *Global Agro-Ecological Zones (GAEZ)*

I also created the municipal boundary shapefiles to match municipalities across years.

- Municipalities in early years are spatially matched with those in 1965 using GIS software.

Empirical model

Difference-in-differences estimation

For municipality m in prefecture p in year t:

$$y_{mpt} = \sum_{j \in J} \beta_j OwnerShare_m \times \mu_j + \mathbf{x}_{mpt}\xi + \sigma_m + \mu_t + \epsilon_{mpt}, \quad (1)$$

$OwnerShare_m$:	Owner share when the land reform was complete (1950)
$\mathbf{x}_{mpt}$:	Pre-treatment control variables interacted with year dummies
σ_m, μ_t:	Fixed effects
ϵ_{mpt}:	Error term

Main outcomes (y_{mpt}): power tillers per farm household (technology adoption) and the share of the population aged 15-19 (out-migration)

- Similar results using migration data

Empirical strategy

To identify the causal effect, it is crucial that the treatment variable satisfies the DID assumptions such as the parallel trends assumption.

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Key to the identification is the formula-based cap (upper limits) that affected the post-reform owner share ($OwnerShare_m$).

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Upper limits: The Ministry of Agriculture and Forestry proposed upper limits for each *prefecture* p by using the following formula:

$$x_p = \left(\frac{U \sum_{k \in K} A_k}{\sum_{k \in K} a_k A_k} \right) \times a_p = (\text{Weight}) \times a_p, \tag{2}$$

where a_p: the average size of landlords' tenanted farmlands, A_k: the total area of tenanted farmlands, and U: the upper limit at the national level

- Example: If a landlord's tenanted farmlands is 1 ha and the upper limit is 0.6 ha, then the landlord has to sell 0.4 ha.

.... cont'd

After determining the prefectural upper limits, the upper limits at the *municipality* level were determined *using the same formula*, replacing the national upper limits (U) with the prefectural upper limits.

- Therefore, the upper limits at the municipality level are *constrained* by those at the prefecture level in the sense that the average of the municipal upper limits in a prefecture should be equal to the upper limit of that prefecture.
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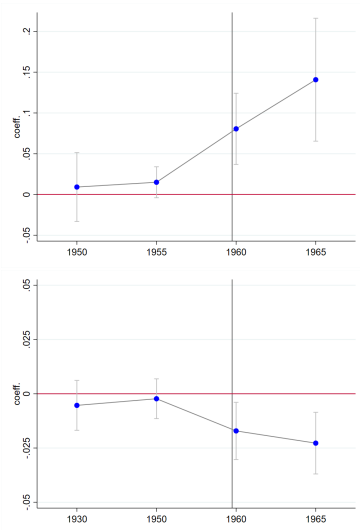
Based on the formula, I included the variables that potentially affect the post-reform owner share, i.e., average size of farmlands, the area of tenanted farmlands, and the share of the agricultural population, interacted with year dummies, as baseline pre-treatment controls. Balance Checks

- In later analyses, I also include other control variables as robustness checks.

Results

Main results



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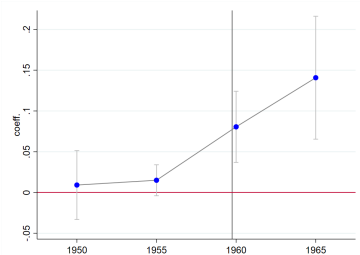

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In 1960, land ownership increased the adoption of power tillers (**top figure**), and decreased the share of young people in the population (**bottom figure**).

- The effects became even larger in 1965.

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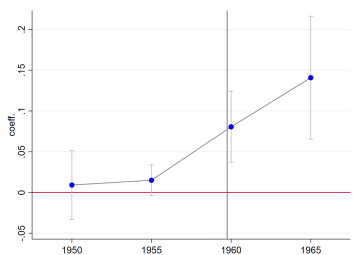

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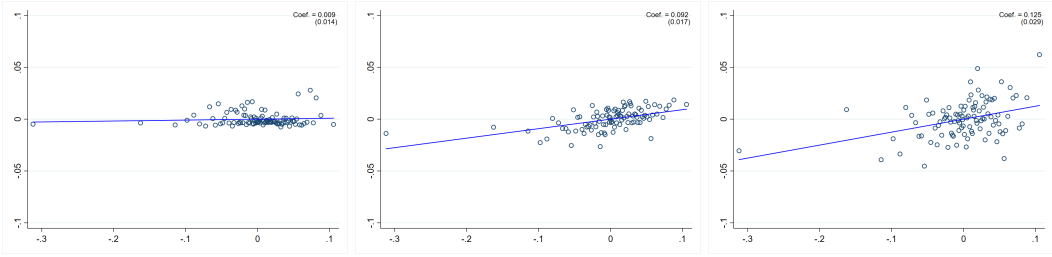
Magnitudes (1960 & 1965 averages): In average municipalities, 10 pp increase in owner share $\rightarrow$

- Increase power tillers by 17% of control mean (100 $\rightarrow$ 117 tillers)
- Decrease young population by 2% of control mean (2527 $\rightarrow$ 2476 individuals)

(Increase in owner share during the reform $\approx$ 30 pp)

Main table

Partial correlation: Power tillers

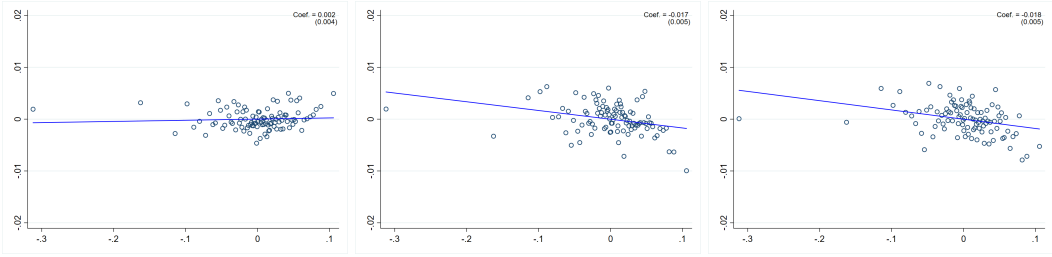


1950 Change (1960-50) Change (1965-50)

- x-axis: Owner share; y-axis: Power tillers per farm household

  Control variables: The average size of farmlands, the total area of tenanted farmlands, the share of the agricultural population, population, the number of births, the share of paddy fields, elevation, slope, agricultural suitability, the share of farm households using livestock, distance to the nearest metropolitan area, distance to the nearest transportation.

Partial correlation: Young people



1950 Change (1960-50) Change (1965-50)

- x-axis: Owner share; y-axis: Share of the population aged 15-19

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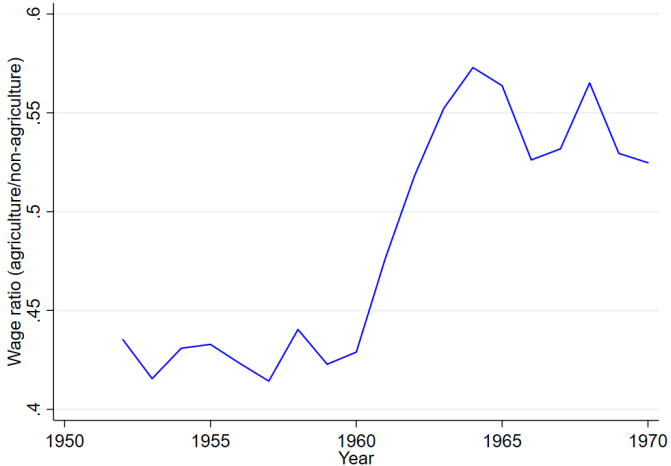
From technology adoption to migration

	Dep. variable: Pop. share aged 15-19		
	(1)	(2)	(3)
Owner share × Post	−0.018	−0.009	−0.009
	(0.006)***	(0.006)	(0.006)
Owner share × Post × Change in power tillers (1950-60)		−0.016	
		(0.007)**	
Owner share × 1960 × Change in power tillers (1950-60)			−0.009
			(0.008)
Owner share × 1965 × Change in power tillers (1950-60)			−0.024
			(0.008)***
Baseline controls	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.10
R^2	0.68	0.68	0.68
Adj. R^2	0.68	0.68	0.68
Observations	8312	8252	8252

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable is the share of the population aged 15-19. "Change in power tillers (1960-50)" indicates the difference in power tillers per farm household between 1950 and 1960. The value was normalized between 0 and 1.

- The share of young people decreased more in areas with more technology adoption.

Relative agricultural wage



- Agricultural wages relative to non-agricultural wages increased *after*, but not *before*, migration.

Comparing adjacent municipalities

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Idea: Upper limits at the municipality level are *constrained* by those at the prefecture level in the sense that the average of the municipal upper limits in a prefecture should be equal to the upper limit of that prefecture.

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→ Thus, very similar municipalities adjacent to each other across the prefectural border may have received different shocks simply because they belong to different prefectures.

The alternative estimation strategy compares the adjacent municipalities. After making pairs of municipalities along either side of the prefectural boundary. I ran the following regression: For municipality m in pair w in year t:

$$y_{mwt} = \alpha OwnerShare_m \times Post_t + \mathbf{x}_{mpt}\psi + \phi_w + \tau_t + \varepsilon_{mwt}. \tag{3}$$

Balance checks, adjacent municipalities

	Dependent variable:								
	Population	Births	Paddy fields	Elevation	Slope	Ag. suit.	Livestock	Dist. metro.	Dist. trans.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Owner share (1950)	38926.840	1226.783	58.849	−4.271	−0.004	0.123	0.036	3.581	0.748
	(28720.143)	(790.327)	(168.692)	(7.506)	(0.051)	(0.076)	(0.261)	(8.394)	(4.573)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Twin F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	24173.81	770.80	462.67	25.56	0.03	0.15	0.32	177.30	6.70
R^2	0.84	0.82	0.96	0.95	0.96	0.93	0.75	1.00	0.83
Observations	1745	1723	1745	1745	1745	1745	1745	1745	1745

Notes: Standard errors are clustered at the pair level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable is population (Column (1)), the number of births (Column (2)), the share of paddy fields (Column (3)), elevation (Column (4)), slope (Column (5)), agricultural suitability (Column (6)), the share of farm households using livestock (Column (7)), distance to the nearest metropolitan area (Column (8)), and distance to the nearest transportation (Column (9)). The baseline controls are the average size of farmlands, the total area of tenanted farmlands, and the share of the agricultural population.

The post-reform owner share is not statistically correlated with municipality characteristics.

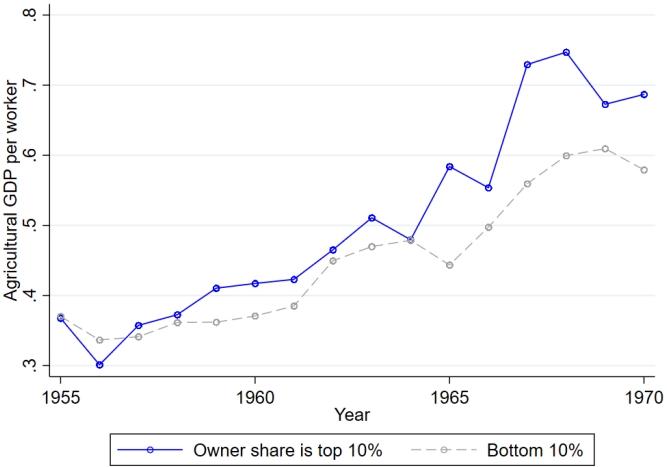
Results

	Dependent variable:			
	Population share aged 15-19		Power tillers per farm household	
	(1)	(2)	(3)	(4)
Owner share × Post	−0.037	−0.037	0.059	0.080
	(0.008)***	(0.009)***	(0.018)***	(0.018)***
Baseline controls	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Twin F.E.	Yes	No	Yes	No
Municipality F.E.	No	Yes	No	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.00	0.00
R^2	0.67	0.72	0.54	0.56
Observations	5169	5169	6882	6882

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable for Columns (1)-(2) is the share of the population aged 15-19, and that for Columns (3)-(4) uses power tillers per farm household.

Although the samples were quite different from those used in the DID estimation, this alternative estimation method yielded estimates similar to those before.

Agricultural productivity



Real agricultural GDP per worker increased in areas with more owner farmers.

Other analyses

- Control for pre-reform owner share Link
- Control for owner share in neighboring municipalities Link
- Drop observations (some regions, top and bottom percentiles, industrial areas, randomly drop half municipalities in each prefecture) Link
- Effects by quantile Link
- Poisson pseudo-likelihood regression Link
- Bias-adjusted Beta (Oster 2019) Link
- Effects of other variables Link
- Effects by distance to industrial areas Link
- Effects on communal power tillers Link

Mechanism (work-in-progress)

There are several possible channels, which are not mutually exclusive. Compared to tenant farmers (fixed renters), owner farmers are more likely to buy agricultural machines because...

- Their farmlands are more secure (security effect).
- They can use their farmlands as collateral for loans (collateral effect)
- They are richer (income effect)

Security effect?

	Dependent variable:			
	Pop. share aged 15-19		Power till. per farm hh.	
	(1)	(2)	(3)	(4)
Owner share × Post	−0.017	0.096	−0.017	0.110
	(0.006)***	(0.022)***	(0.006)***	(0.023)***
Owner share × Permanent tenancy × Post	−0.009	0.082		
	(0.014)	(0.078)		
Permanent tenancy × Post	0.008	−0.080		
	(0.012)	(0.069)		
Owner share × Sharecropping × Post			−0.012	−0.152
			(0.017)	(0.085)*
Sharecropping × Post			0.012	0.136
			(0.016)	(0.076)*
Baseline controls	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.01	0.10	0.01
R^2	0.68	0.51	0.68	0.51
Adj. R^2	0.68	0.50	0.68	0.50
Observations	8312	11063	8081	10755

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The dependent variable for Columns (1)-(2) is the share of the population aged 15-19 and for Columns (3)-(4) is power tillers per farm household. "Permanent tenancy" is an indicator which takes a value of 1 if permanent tenancy existed in the municipality, and 0 otherwise. "Sharecropping" is an indicator which takes a value of 1 if sharecropping existed in the municipality, and 0 otherwise.

No strong support for the security effect

Income or collateral effect?

	Dependent variable:			
	Pop. share aged 15-19		Power till. per farm hh.	
	(1)	(2)	(3)	(4)
Owner share × D(Agri. income per farm hh. > median) × Post	−0.008		0.049	
	(0.011)		(0.050)	
Owner share × D(Agri. income per farm hh. ≤ median) × Post	−0.019		0.073	
	(0.006)***		(0.018)***	
D(Agri. income per farm hh. > median) × Post	−0.008		0.039	
	(0.011)		(0.044)	
Owner share × D(Share coop. membership > median) × Post		−0.024		0.118
		(0.008)***		(0.032)***
Owner share × D(Share coop. membership ≤ median) × Post		−0.009		0.046
		(0.007)		(0.028)
D(Share coop. membership > median) × Post		0.014		−0.056
		(0.009)		(0.030)*
Baseline controls	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes
Control mean (1950)	0.101	0.101	0.006	0.006
H0: b[Owner share × D(... > median) × Post] = b[Owner share × D(... ≤ median) × Post] (p-value)	0.359	0.145	0.613	0.046
R^2	0.69	0.69	0.51	0.51
Adj. R^2	0.68	0.68	0.51	0.50
Observations	8225	8207	10967	10943

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(2) is the share of the population aged 15-19 and for Columns (3)-(4) is power tillers per farm household. "D(Agri. income per farm hh. ¿ median)" is an indicator variable which takes a value of 1 if agricultural income per farm household is above the median value, and 0 otherwise, whereas "D(Agri. income per farm hh. ≤ median)" is 1 minus this variable. "D(Share coop. membership ¿ median)" is an indicator variable which takes a value of 1 if the share of the membership of the agricultural cooperatives is above the median value, and 0 otherwise, whereas "D(Share coop. membership ≤ median)" is 1 minus this variable.

No strong support for the income effect, but some support for the collateral effect

Quantifying Aggregate Impact: A brief sketch

I used a two-sector neo-classical growth model to evaluate the overall effect of factor reallocation. Link

Quantifying Aggregate Impact: A brief sketch

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First, I computed wedges in the prewar period, separately for the consumption, production, and mobility component (Cheremukhin et al., 2016).

$$\tau_K = \underbrace{\frac{U_{nt}}{U_{at}/p_t}}_{\text{consumption component}} \times \underbrace{\frac{MPK_{nt}/r_{nt}}{p_t MPK_{at}/r_{at}}}_{\text{production component}} \times \underbrace{\frac{r_{nt}}{r_{at}}}_{\text{mobility component}}, \tag{4}$$

and

$$\tau_L = \frac{U_{nt}}{U_{at}/p_t} \times \frac{MPL_{nt}/w_{nt}}{p_t MPL_{at}/w_{at}} \times \frac{w_{nt}}{w_{at}}, \tag{5}$$

where r_{jt} and w_{jt} for $j \in \{a, n\}$ are the rental and wage rate, respectively.

- Each component becomes 1 if there is no wedge.

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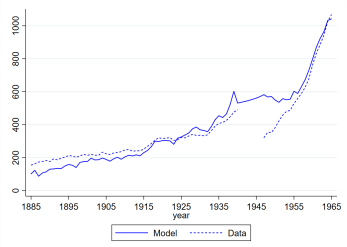
where r_{jt} and w_{jt} for $j \in \{a, n\}$ are the rental and wage rate, respectively.

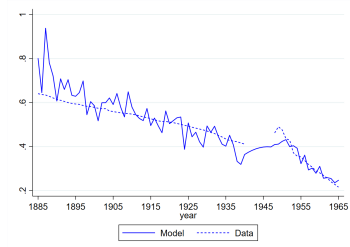
- Each component becomes 1 if there is no wedge.

I found that the production component is large, while the consumption and mobility components are negligible. Figures

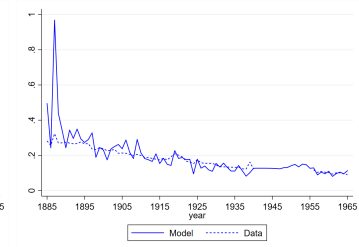
Model fit and simulation



GNP per worker



Share of agri. employment

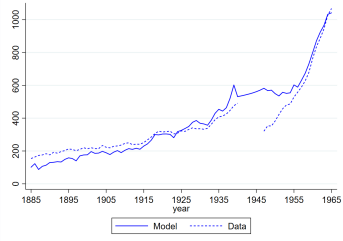


Share of agri. capital

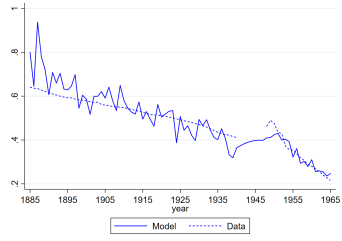
Overall, the model fits the data relatively well.

I ran a counterfactual simulation, by fixing the production component for the post-war period until 1965, and compared it with the actual values.

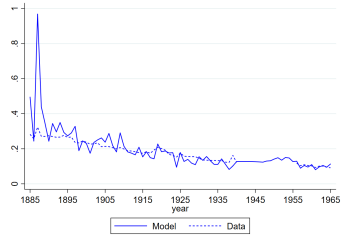
Model fit and simulation



GNP per worker



Share of agri. employment



Share of agri. capital

I found that relaxing the production-related wedges increased the real GNP per worker per annum by 16% on average between 1947-65.

- If the capital wedge in agricultural production is only considered, it is 1% (e.g., increased by 327 billion yen in 1965 only $\approx$ total government expenditure on the land reform).
- An even larger effect is expected by alleviating the labor wedge in non-agricultural production to absorb released labor.

Taking stock

This paper examines the effects of land ownership on economic development using massive land reform as a unique natural experiment.

I found that land ownership increased the adoption of agricultural machines, leading to the out-migration of young people to urban centers.

- The effect tends to be greater in areas with better access to credit.

Counterfactual simulations show a considerable impact of factor reallocation on the overall economy.

Thank you!

Any suggestions and comments are welcome:

kitamura@iser.osaka-u.ac.jp

Balance checks

	Dependent variable:								
	Population	Births	Paddy fields	Elevation	Slope	Ag. suit.	Livestock	Dist. metro.	Dist. trans.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Owner share (1950)	−34183.705	−590.890	165.663	5.695	−0.006	0.122	0.196	47.282	0.690
	(40396.151)	(847.285)	(165.219)	(6.606)	(0.103)	(0.092)	(0.109)*	(27.001)*	(8.533)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean	21945.58	711.39	280.02	19.17	0.03	0.22	0.26	241.75	6.53
R^2	0.45	0.46	0.52	0.43	0.34	0.39	0.43	0.97	0.23
Observations	2800	2772	2800	2800	2800	2800	2800	2800	2800

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable is population (Column (1)), the number of births (Column (2)), the share of paddy fields (Column (3)), elevation (Column (4)), slope (Column (5)), agricultural suitability (Column (6)), the share of farm households using livestock (Column (7)), distance to the nearest metropolitan area (Column (8)), and distance to the nearest transportation (Column (9)). The baseline controls are the average size of farmlands, the total area of tenanted farmlands, and the share of the agricultural population.

- Conditioning on baseline controls, the post-reform owner share is not correlated with most of these municipality characteristics.
- Yet, the weak positive correlations with the share of farm households using livestock and distance to the nearest metropolitan area are a source of concern.
  - → Show results with these covariates, as well as others, as additional controls.
  - → Show results using an alternative estimation method.

Back

Main table

	Dependent variable:									
	Population share aged 15-19					Power tillers per farm household				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Owner share × Post					−0.018					0.098
					(0.006)***					(0.023)***
Owner share × 1950				−0.002					0.009	
				(0.005)					(0.021)	
Owner share × 1955						0.008	0.005	0.006	0.015	
						(0.012)	(0.014)	(0.013)	(0.009)	
Owner share × 1960	−0.049	−0.020	−0.015	−0.017		0.082	0.077	0.071	0.081	
	(0.014)***	(0.008)**	(0.006)**	(0.007)**		(0.029)***	(0.023)***	(0.020)***	(0.022)***	
Owner share × 1965	−0.047	−0.024	−0.021	−0.023		0.146	0.139	0.132	0.141	
	(0.011)***	(0.008)***	(0.006)***	(0.007)***		(0.042)***	(0.036)***	(0.040)***	(0.037)***	
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes	No	Yes
Prefecture-by-year F.E.	No	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Baseline year	1950	1950	1950	1930	1950	1950	1950	1950	1930	1950
Dep. var. mean (1950)	0.10	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01	0.01
R^2	0.51	0.63	0.68	0.60	0.68	0.40	0.48	0.51	0.46	0.51
Observations	8396	8396	8312	11084	8312	11175	11175	11063	13835	11063

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(5) is the share of the population aged 15-19, and that for Columns (6)-(10) uses power tillers per farm household.

The estimates are relatively stable across the specifications. Combined Back

Effects in 1960 and 1965 are combined

	Dependent variable:							
	Population share aged 15-19				Power tillers per farm household			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Owner share × Post	−0.048	−0.022	−0.018	−0.020	0.111	0.105	0.098	0.111
	(0.012)***	(0.008)***	(0.006)***	(0.007)***	(0.026)***	(0.022)***	(0.023)***	(0.025)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	Yes	No	No	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Baseline year	1950	1950	1950	1930	1950	1950	1950	1930
Dep. var. mean (1950)	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
R^2	0.51	0.63	0.68	0.60	0.40	0.48	0.51	0.45
Observations	8396	8396	8312	11084	11175	11175	11063	13835

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$. The dependent variable for Columns (1)-(4) is the share of the population aged 15-19, and that for Columns (5)-(8) uses power tillers per farm household.

Back

Control for pre-reform owner share

	Dependent variable:							
	Pop. share aged 15-19				Power till. per farm hh.			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Owner share (1950) × Post	−0.022		−0.019	−0.019	0.105		0.128	0.074
	(0.008)***		(0.008)**	(0.006)***	(0.022)***		(0.025)***	(0.027)***
Owner share (1945) × Post		−0.008	−0.005	0.003		−0.017	−0.034	0.037
		(0.005)	(0.005)	(0.004)		(0.017)	(0.018)*	(0.014)**
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	No	Yes	No	No	No	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
R^2	0.63	0.63	0.63	0.68	0.48	0.48	0.48	0.51
Adj. R^2	0.63	0.62	0.63	0.68	0.47	0.47	0.47	0.50
Observations	8396	8402	8396	8312	11175	11183	11175	11063

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(4) is the share of the population aged 15-19 and for Columns (5)-(8) is power tillers per farm household. "Owner share (1950)" indicates the post-reform owner share, while "Owner share (1945)" means the pre-reform owner share.

Back

Control for owner share in neighboring municipalities

	Dependent variable:					
	Pop. share aged 15-19			Power till. per farm hh.		
	(1)	(2)	(3)	(4)	(5)	(6)
Owner share × Post	−0.022	−0.022	−0.019	0.105	0.097	0.090
	(0.008)***	(0.007)***	(0.006)***	(0.022)***	(0.022)***	(0.023)***
Owner share (nbr. avg.) × Post		−0.001	0.004		0.029	0.031
		(0.004)	(0.003)		(0.010)***	(0.009)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.10	0.01	0.01	0.01
R^2	0.63	0.63	0.68	0.48	0.48	0.51
Adj. R^2	0.63	0.63	0.68	0.47	0.47	0.50
Observations	8396	8396	8312	11175	11175	11063

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(3) is the share of the population aged 15-19 and for Columns (4)-(6) is power tillers per farm household. For those municipalities that do not have neighbors (e.g., islands) (147 observations for Column (3) and 192 observations for Column (6)), the missing values were replaced by zero to keep the same sample. The results were very similar without replacement.

Back

Drop some regions

	Dependent variable:					
	Population share aged 15-19			Power tillers per farm household		
	(1)	(2)	(3)	(4)	(5)	(6)
Owner share × Post	−0.018	−0.020	−0.022	0.098	0.075	0.089
	(0.006)***	(0.006)***	(0.007)***	(0.023)***	(0.023)***	(0.022)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Dropped	None	Hokkaido	Hokkaido & Tohoku	None	Hokkaido	Hokkaido & Tohoku
Control mean (1950)	0.10	0.10	0.10	0.01	0.01	0.01
R^2	0.68	0.69	0.66	0.51	0.51	0.49
Observations	8312	7862	6776	11063	10463	9015

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable for Columns (1)-(3) is the share of the population aged 15-19, and that for Columns (4)-(6) uses power tillers per farm household.

Drop top and bottom percentiles

	Dependent variable:							
	Population share aged 15-19				Power tillers per farm household			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Owner share × Post	−0.018	−0.024	−0.021	−0.027	0.098	0.109	0.120	0.141
	(0.006)***	(0.008)***	(0.010)**	(0.012)**	(0.023)***	(0.036)***	(0.035)***	(0.038)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dropped percentiles	None	1 & 99	5 & 95	10 & 90	None	1 & 99	5 & 95	10 & 90
Control mean (1950)	0.10	0.10	0.10	0.10	0.01	0.01	0.00	0.00
R^2	0.68	0.68	0.70	0.71	0.51	0.51	0.52	0.53
Observations	8312	8141	7492	6670	11063	10836	9971	8877

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,** $p < 0.05$,*** $p < 0.01$. The dependent variable for Columns (1)-(4) is the share of the population aged 15-19, and that for Columns (5)-(8) uses power tillers per farm household.

Drop industrial areas

	Dependent variable:			
	Pop. share aged 15-19		Power till. per farm hh.	
	(1)	(2)	(3)	(4)
Owner share × Post	−0.019	−0.016	0.109	0.097
	$(0.008)^{**}$	$(0.006)^{**}$	$(0.024)^{***}$	$(0.024)^{***}$
Baseline controls	Yes	Yes	Yes	Yes
Additional controls	No	Yes	No	Yes
Year F.E.	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.01	0.01
R^2	0.65	0.71	0.48	0.51
Adj. R^2	0.65	0.71	0.47	0.50
Observations	8120	8039	10807	10699

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable for Columns (1)-(2) is the share of the population aged 15-19 and for Columns (3)-(4) is power tillers per farm household. Columns (1) and (2) exclude top ten industrial municipalities in each of eleven prefectures in metropolitan areas. Municipalities were ranked based on the share of non-agricultural employment. A prefecture in metropolitan areas contains 41-87 municipalities.

Back

Randomly drop half of municipalities in each prefecture

	Dependent variable:					
	Pop. share aged 15-19			Power till. per farm hh.		
	(1)	(2)	(3)	(4)	(5)	(6)
Owner share × Post	−0.022	−0.024	−0.024	0.105	0.113	0.108
	$(0.008)^{***}$	$(0.011)^{**}$	$(0.008)^{***}$	$(0.022)^{***}$	$(0.028)^{***}$	$(0.028)^{***}$
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	No	Yes	No	No	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.10	0.01	0.01	0.01
R^2	0.63	0.64	0.69	0.48	0.49	0.52
Adj. R^2	0.63	0.63	0.68	0.47	0.48	0.50
Observations	8396	4149	4107	11175	5524	5468

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable for Columns (1)-(3) is the share of the population aged 15-19 and for Columns (4)-(6) is power tillers per farm household. Columns (2), (3), (5), and (6) randomly draw half of the sample municipalities within each prefecture. The sample was drawn without replacement using STATA's `randomtag` command.

Back

Estimates by quantile

	Dependent variable:			
	Population share aged 15-19		Power tillers per farm household	
	(1)	(2)	(3)	(4)
Owner Share (Q2) × Post	0.001	0.001	0.007	0.006
	(0.001)*	(0.001)*	(0.003)**	(0.003)*
Owner Share (Q3) × Post	−0.001	−0.001	0.011	0.007
	(0.001)	(0.001)	(0.004)***	(0.004)*
Owner Share (Q4) × Post	−0.003	−0.003	0.017	0.012
	(0.001)***	(0.001)***	(0.004)***	(0.004)***
Baseline controls	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes
Dropped	None	Hokkaido	None	Hokkaido
Control mean (1950)	0.10	0.10	0.01	0.01
R^2	0.68	0.69	0.51	0.51
Observations	8312	7862	11063	10463

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(2) is the share of the population aged 15-19, and that for Columns (3)-(4) uses power tillers per farm household.

Back

Poisson pseudo-likelihood regression

	Dependent variable:					
	Population share aged 15-19			Power tillers per farm household		
	(1)	(2)	(3)	(4)	(5)	(6)
Owner share × Post	−0.303	−0.271	−0.271	2.396	1.859	1.859
	(0.115)***	(0.074)***	(0.074)***	(0.602)***	(0.485)***	(0.485)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	No	Yes	Yes	No	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	No	No	Yes	No	No	Yes
Dep. var. mean (1950)	0.10	0.10	0.10	0.01	0.01	0.01
Pseudo R^2	0.00	0.01	0.01	0.17	0.20	0.20
Observations	8396	8312	8312	11175	11063	11063

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1, ^{**}p < 0.05, ^{***}p < 0.01$. The dependent variable for Columns (1)-(3) is the share of the population aged 15-19, and that for Columns (4)-(6) uses power tillers per farm household.

Back

Bias-adjusted Beta (Oster 2019)

	Dependent variable:	
	Pop. share aged 15-19	Power till. per farm hh.
	(1)	(2)
Owner share × Post	−0.018	0.098
	(0.006)***	(0.023)***
	[−0.023]	[0.070]
Baseline controls	Yes	Yes
Additional controls	Yes	Yes
Year F.E.	Yes	Yes
Municipality F.E.	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes
Dep. var. mean (1950)	0.10	0.01
R^2	0.68	0.51
Adj. R^2	0.68	0.50
Observations	8312	11063

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Column (1) is the share of the population aged 15-19 and for Column (2) is power tillers per farm household. The numbers in brackets are bias-adjusted beta according to Oster (2019) with parameters: $\delta = 1$ and $R^2_{max} = 1.3\bar{R}^2$, where $\bar{R}^2$ is the R-squared from the regression with all controls. The baseline control variables are included as unrelated controls. Since there were multiple solutions for the beta, the ones closest to the original estimates were reported. The bias-adjusted beta was computed using STATA's `psacalc` command.

Back

Effects of other variables

	Dependent variable:							
	Pop. share aged 15-19				Power till. per farm hh.			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Owner share × Post	−0.022	−0.022	−0.023	−0.016	0.097	0.099	0.106	0.118
	(0.008)***	(0.008)***	(0.007)***	(0.006)**	(0.022)***	(0.023)***	(0.023)***	(0.023)***
Population × Post	−0.004				−0.016			
	(0.002)**				(0.007)**			
Birth × Post	0.002				−0.011			
	(0.001)				(0.005)**			
Slope × Post		−0.001				−0.020		
		(0.001)				(0.004)***		
Elevation × Post		−0.003				0.005		
		(0.001)**				(0.004)		
Ag. suitability × Post			0.000				0.035	
			(0.004)				(0.026)	
Paddy fields × Post			0.007				0.011	
			(0.000)***				(0.003)***	
Livestock × Post			−0.000				−0.001	
			(0.000)				(0.002)	
Dist. to metro. area × Post				−0.005				−0.009
				(0.002)**				(0.006)
Dist. to trans. × Post				−0.004				−0.007
				(0.000)***				(0.002)***
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.10	0.10	0.10	0.01	0.01	0.01	0.01
R^2	0.63	0.65	0.67	0.66	0.49	0.50	0.49	0.49
Adj. R^2	0.63	0.65	0.67	0.65	0.49	0.49	0.48	0.48
Observations	8312	8396	8396	8396	11063	11175	11175	11175

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for Columns (1)-(4) is the share of the population aged 15-19 and for Column (5)-(8) is power tillers per farm household.

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Effects by distance to industrial areas

	Dependent variable:					
	Metro.		Top 10		$\geq$ 99th percentile	
	Pop.	Tech.	Pop.	Tech.	Pop.	Tech.
	(1)	(2)	(3)	(4)	(5)	(6)
Owner share × Post	−0.014	0.105	−0.019	0.098	−0.017	0.097
	(0.007)**	(0.029)***	(0.007)***	(0.030)***	(0.007)**	(0.029)***
Dist. to indust. area: decile=2 × Owner share × Post	0.000	−0.003	−0.003	−0.000	0.001	−0.005
	(0.003)	(0.010)	(0.003)	(0.009)	(0.003)	(0.008)
Dist. to indust. area: decile=3 × Owner share × Post	−0.005	0.007	−0.004	−0.002	−0.002	−0.008
	(0.003)	(0.013)	(0.003)	(0.014)	(0.003)	(0.013)
Dist. to indust. area: decile=4 × Owner share × Post	−0.004	0.008	−0.003	−0.014	−0.001	−0.000
	(0.003)	(0.016)	(0.004)	(0.016)	(0.003)	(0.014)
Dist. to indust. area: decile=5 × Owner share × Post	−0.005	0.002	−0.007	−0.009	0.001	0.005
	(0.004)	(0.017)	(0.004)	(0.018)	(0.003)	(0.018)
Dist. to indust. area: decile=6 × Owner share × Post	−0.009	−0.005	0.001	−0.002	0.001	0.006
	(0.004)**	(0.017)	(0.006)	(0.022)	(0.003)	(0.018)
Dist. to indust. area: decile=7 × Owner share × Post	−0.008	−0.008	0.002	−0.008	0.000	0.010
	(0.005)	(0.017)	(0.005)	(0.022)	(0.003)	(0.020)
Dist. to indust. area: decile=8 × Owner share × Post	−0.010	−0.007	0.005	−0.014	−0.001	0.014
	(0.006)*	(0.019)	(0.005)	(0.024)	(0.003)	(0.021)
Dist. to indust. area: decile=9 × Owner share × Post	−0.007	−0.030	0.008	0.032	−0.001	0.009
	(0.006)	(0.021)	(0.006)	(0.031)	(0.004)	(0.016)
Dist. to indust. area: decile=10 × Owner share × Post	−0.004	−0.024	0.007	0.022	−0.003	−0.023
	(0.006)	(0.021)	(0.007)	(0.030)	(0.004)	(0.015)
Baseline controls	Yes	Yes	Yes	Yes	Yes	Yes
Additional controls	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Municipality F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Prefecture-by-year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.10	0.01	0.10	0.01	0.10	0.01
R^2	0.68	0.51	0.69	0.51	0.68	0.51
Adj. R^2	0.68	0.50	0.68	0.50	0.68	0.50
Observations	8312	11063	8312	11063	8281	11019

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable for odd-numbered columns is the share of the population aged 15-19 and for even-numbered columns is power tillers per farm household. Columns (1)-(2) use the distance to the nearest metropolitan areas, Columns (3)-(4) use the distance to the top 10 municipalities with a high share of non-agricultural employment, and Columns (5)-(6) use the distance to the top 1% municipalities (29 municipalities) with a higher share of non-agricultural employment. The omitted category is the first decile. The distance to the nearest metropolitan areas is excluded from additional controls in Columns (1)-(2).

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Effects on communal power tillers

	Dependent variable: Power tillers per farm hh.			
	1960		1965	
	Private	Communal	Private	Communal
	(1)	(2)	(3)	(4)
Owner share (1950)	0.071	0.009	0.129	0.011
	$(0.018)^{***}$	(0.006)	$(0.034)^{***}$	$(0.006)^{*}$
Municipality controls	Yes	Yes	Yes	Yes
Prefecture F.E.	Yes	Yes	Yes	Yes
Dep. var. mean (1950)	0.03	0.01	0.07	0.01
R^2	0.32	0.44	0.26	0.41
Observations	2752	2752	2771	2771

Notes: Standard errors are clustered at the prefecture level. $^{*}p < 0.1$,$^{**}p < 0.05$,$^{***}p < 0.01$. The dependent variable is power tillers per farm household. Odd columns use power tillers owned privately, whereas even columns use power tillers owned communally.

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The model: Household

- Population N_t.

- Preference of the representative household:

$$\sum_{t=0}^{\infty} \beta^t \frac{U(c_{at}, c_{nt})^{1-\rho} - 1}{1-\rho}, \tag{6}$$

Where c_{at}, c_{nt} are the consumption of agricultural and non-agricultural goods, $\beta \in (0,1)$ is a discount factor, $\rho \geqslant 0$ is the intertemporal elasticity of substitution, and

$$U(c_{at}, c_{nt}) := \left[\psi^{\frac{1}{\sigma}} (c_{at} - \bar{c}_a)^{\frac{\sigma-1}{\sigma}} + (1-\psi)^{\frac{1}{\sigma}} (c_{nt})^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}}, \tag{7}$$

Where $\psi \geqslant 0$ is the consumption share of agricultural goods and $\sigma > 0$ is the elasticity of substitution between the two consumption goods.

- Non-homotheticity ($\bar{c}_a > 0$) is assumed.

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Where $\psi \geqslant 0$ is the consumption share of agricultural goods and $\sigma > 0$ is the elasticity of substitution between the two consumption goods.

  - Non-homotheticity ($\bar{c}_a > 0$) is assumed.

- The household is endowed with one unit of time and an initial capital stock, $K_0 > 0$.

Firms

- Technology of the representative firm in each sector:

$$Y_{jt} = A_{jt} K_{jt}^{\theta_{Kj}} L_{jt}^{\theta_{Lj}}, \qquad j \in \{a, n\}, \tag{8}$$

Where A_{jt} is TFP, K_{jt} is capital, L_{jt} is labor, and θ_{Kj} and θ_{Lj} are the capital and labor shares in sector j, respectively.

  - The capital and labor shares satisfy $\theta_{Kj} + \theta_{Lj} \leqslant 1$. Land is fixed and its share in production is $1 - \theta_{Kj} - \theta_{Lj}$.

Closing the model

- The capital and labor markets clear in equilibrium:

$$K_t = K_{at} + K_{nt} \qquad \text{and} \qquad L_t = L_{at} + L_{nt}. \tag{9}$$

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- The law of motion for the aggregated capital stock takes the form

$$K_{t+1} = (1 - \delta)K_t + I_t, \tag{10}$$

Where $\delta \in (0, 1)$ is the depreciation rate and I_t is investment.

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Where $\delta \in (0, 1)$ is the depreciation rate and I_t is investment.

- Assuming that investment is made by the non-agricultural sector, feasibility conditions in the two sectors are written by

$$N_t c_{at} + E_{at} = Y_{at} \qquad \text{and} \qquad N_t c_{nt} + I_t + G_t + E_{nt} = Y_{nt}, \tag{11}$$

Where G_t is the government expenditure and E_{jt} for $j \in \{a, n\}$ is the net exports of goods j.

Calculating wedges

- Using the optimality conditions, wedges are calculated as

$$\tau_K = \frac{MPK_{nt}}{p_t MPK_{at}} \tag{12}$$

$$= \frac{U_{nt}}{U_{at}} \frac{MPK_{nt}}{MPK_{at}} \tag{13}$$

and

$$\tau_L = \frac{MPL_{nt}}{p_t MPL_{at}} \tag{14}$$

$$= \frac{U_{nt}}{U_{at}} \frac{MPL_{nt}}{MPL_{at}}, \tag{15}$$

Where τ_K and τ_L are the intersectoral capital and labor wedge, respectively.

- p_t is the price for the agricultural goods relative to the non-agricultural goods, MPK_{jt} and MPL_{jt} are the marginal product of capital and labor for sector j, respectively, and U_{jt} is the marginal utility of consuming goods j.

... cont'd

- The wedges are further decomposed as

$$\tau_K = \underbrace{\frac{U_{nt}}{U_{at}/p_t}}_{\text{consumption component}} \times \underbrace{\frac{MPK_{nt}/r_{nt}}{p_t MPK_{at}/r_{at}}}_{\text{production component}} \times \underbrace{\frac{r_{nt}}{r_{at}}}_{\text{mobility component}}, \tag{16}$$

and

$$\tau_L = \frac{U_{nt}}{U_{at}/p_t} \times \frac{MPL_{nt}/w_{nt}}{p_t MPL_{at}/w_{at}} \times \frac{w_{nt}}{w_{at}}, \tag{17}$$

Where r_{jt} and w_{jt} for $j \in \{a, n\}$ are the rental and wage rate, respectively.

... cont'd

- The wedges are further decomposed as

$$\tau_K = \underbrace{\frac{U_{nt}}{U_{at}/p_t}}_{\text{consumption component}} \times \underbrace{\frac{MPK_{nt}/r_{nt}}{p_t MPK_{at}/r_{at}}}_{\text{production component}} \times \underbrace{\frac{r_{nt}}{r_{at}}}_{\text{mobility component}}, \tag{16}$$

and

$$\tau_L = \frac{U_{nt}}{U_{at}/p_t} \times \frac{MPL_{nt}/w_{nt}}{p_t MPL_{at}/w_{at}} \times \frac{w_{nt}}{w_{at}}, \tag{17}$$

Where r_{jt} and w_{jt} for $j \in \{a, n\}$ are the rental and wage rate, respectively.

- Each component becomes 1 if there is no wedge.

... cont'd

- The wedges are further decomposed as

$$\tau_K = \underbrace{\frac{U_{nt}}{U_{at}/p_t}}_{\text{consumption component}} \times \underbrace{\frac{MPK_{nt}/r_{nt}}{p_t MPK_{at}/r_{at}}}_{\text{production component}} \times \underbrace{\frac{r_{nt}}{r_{at}}}_{\text{mobility component}}, \tag{16}$$

and

$$\tau_L = \frac{U_{nt}}{U_{at}/p_t} \times \frac{MPL_{nt}/w_{nt}}{p_t MPL_{at}/w_{at}} \times \frac{w_{nt}}{w_{at}}, \tag{17}$$

Where r_{jt} and w_{jt} for $j \in \{a, n\}$ are the rental and wage rate, respectively.

- Each component becomes 1 if there is no wedge.

- Rewrite these expressions using the following notations:

$$\tau_K = \tau_C \times \tau_{PK} \times \tau_R \quad \text{and} \quad \tau_L = \tau_C \times \tau_{PL} \times \tau_W. \tag{18}$$

Data

Period: 1885-1965

Data sources:

- Hayashi and Prescott (2008). Extended using Ohkawa et al. (1982, 1978), Yamazawa and Yamamoto (1979), Ohkawa and Shinohara (1979), and Norinsho (1969, 1971)

Parametrization

Parameter	Description	Value
θ_{Ka}	Capital share (agriculture)	0.144
θ_{Kn}	Capital share (non-agriculture)	0.333
θ_{La}	Labor share (agriculture)	0.545
θ_{Ln}	Labor share (non-agriculture)	0.667
β	Discount factor	0.9
σ	Elasticity of substitution	1
ρ	Intertemporal elasticity	0
ψ	Asymptotic share of agriculture	0.23
$\bar{c}_a$	Subsistence level	40.675
δ	Depreciation rate	0.051

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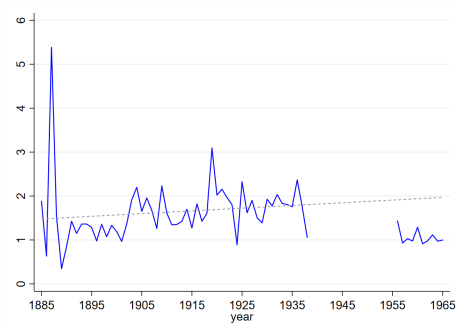
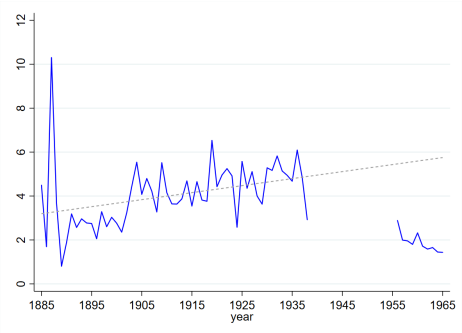
Wedges τ_K and τ_L



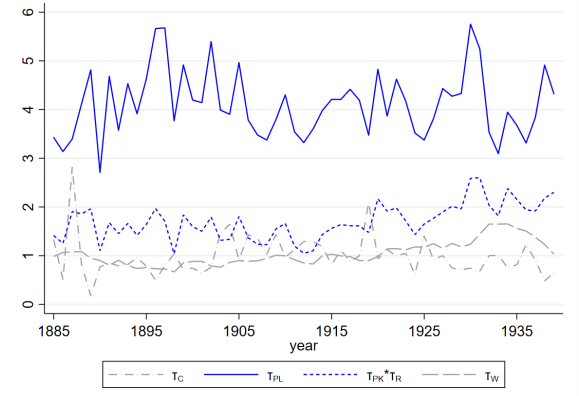
Capital wedge (τ_K)



Labor wedge (τ_L)

Although both τ_K and τ_L had slightly increasing trends in the prewar period, they decreased in the postwar period.

Further decomposition of the prewar wedges



The consumption and mobility components of wedges were negligible.

The production components of the wedges were relatively high, implying that it was the production side which caused the misallocation in the prewar period.