The Role of Structural Transformation in Regional Productivity Convergence in Japan: 1874 - 2008

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Hitotsubashi's New Per-capita GDP Series 1

Maddison's per-capita GDP series on Japan was mainly based on Hitotsubashi's Long-Term Economic Statistics (LTES) Series

- From 1885, based on Ohkawa and Shinohara (1979, Yale Univ. Press).
- Before 1885, based on informed "guesstimation."

Hitotsubashi's new per-capita GDP series

- New estimates on 1874 (mainly based on production data)
- Revision of value added ratio during the pre-WWII period
- New link between pre- and post-WWII data (Mizoguchi 2003)
- Prefecture-level estimation from 1874

Comparison of per capita GDP estimates: Maddison (2001) vs. Bassino, Fukao and Settsu (2016), (1990 international dollars)

	1874	1890	1909	1925	1935	1940	1955
Maddison (2001)	756	1,012	1,301	1,885	2,120	2,874	2,771
New estimates	1,013	1,166	1,467	2,147	2,406	3,071	2,771

Hitotsubashi's New Per-capita GDP Series 2

Revision of LTES (1874-2008)

Bassino, Jean-Pascal, Kyoji Fukao, and Tokihiko Settsu (2016) "Revisiting Meiji Japan's Economic Miracle: Changes in Regional Industrial Structure and Productivity (1874-1909)," a paper presented at Asian Historical Economics Conference 2016, Seoul National University, 2-3 September 2016.

Estimation of Edo Period (1600-1874)

Saito, Osamu and Masanori Takashima (2016) "Estimating the Shares of Secondary- and Tertiary-Sector Output in the Age of Early Modern Growth: the Case of Japan, 1600-1874," *European Review of Economic History*, Vol. 20 (3), pp. 368-386.

Super Long-Term Estimation (730-1874)

Bassino, Jean-Pascal, Stephen Broadberry, Kyoji Fukao, Bishnupriya Gupta, and Masanori Takashima (2017) "Japan and the Great Divergence, 730-1874," *University of Oxford Discussion Papers in Economic and Social History*, No. 156, Oxford: University of Oxford.

Prefecture-Level Per-capita GDP (1874-2008)

Fukao, Kyoji, Jean-Pascal Bassino, Tatsuji Makino, Ralph Paprzycki, Tokihiko Settsu, Masanori Takashima, Joji Tokui (2015) *Regional Inequality and Industrial Structure in Japan: 1874-2008*, Tokyo: Maruzen Publishing Co., Ltd..

Structural transformation and productivity convergence – existing literature 1

Structural transformation (Kuznets, 1955) is a key mechanism for growth and convergence in regional labor productivity (Caselli and Coleman II, 2001; Duarte and Restuccia, 2010; Hnatkovska and Lahiri, 2012).

In the presence of differences in the pace of structural transformation and sectoral productivity growth, a sectoral analysis could potentially explain the diverse process of regional convergence (Duarte and Restuccia, 2010).

Structural transformation and productivity convergence – existing literature 2

Contribution of structural transformation to productivity growth is typically measured using the shift-share framework (Fabricant, 1942; de Vries et al., 2013), which decomposes labor productivity growth into **structural transformation (between-sector effect)** and **sectoral productivity (within-sector effect)**.

10-Sector Database and EU KLEMS have been used for international comparison of labor productivity growth.

However,

To the best of our knowledge, there is no existing framework that quantitatively decomposes regional convergence into these two factors.

Structural transformation and productivity convergence – our approach 1

Use the notion of σ-convergence and measure it as changes in the Gini coefficient over time.

Build a novel convergence framework combining (1) Productivity decomposition (shift-share) and (2) ΔGini decomposition (Jenkins & van Kerm, 2006)

Show that the σ-convergence in aggregate productivity growth can be decomposed into σ-convergence in sectoral productivity growth and σ-convergence in structural transformation-led productivity growth.

Apply this framework to understand productivity growth convergence in Japan using novel historical datasets at the regional level spanning a period of 134 years (1874 to 2008).

Structural transformation (ST) and productivity convergence – findings

Empirical support to decomposition of σ-convergence in labor productivity growth across 47 prefectures.

[1] Pre-war (1874-1940) convergence: led by productivity growth in the secondary sector (manufacturing).

[2] Post-war (1955-2008) convergence: led by structural transformation (channel: large sectoral productivity gaps in the lagging regions).

→ We show that [1] contributed to [2]

Structural transformation (ST) and productivity convergence – contribution

Contribution to the literature

(1) Studies on structural transformation and regional convergence (Herrendorf et al., 2014)

(2) Studies on Inequality histories (Williamson, 1991)

The role of ST in productivity convergence – Data 1

Three datasets on productivity and employment shares (prefecture level)

1. Nine benchmarks years (1874, 1890, 1909, 1925, 1935, 1940, 1955, 1970, 1990 and 2008) and three broad sectors (primary, secondary and tertiary)
    - ✓ Real GDP figures are in constant 1934–36 prices for 1874–1940 and constant 2000 prices for 1955–2008.
    - ✓ Do not compare the figures on productivity growth between 1940 and 1955.
    - ✓ By-employment is considered while calculating sectoral employment shares in the pre-war periods (Saito and Settsu 2016).

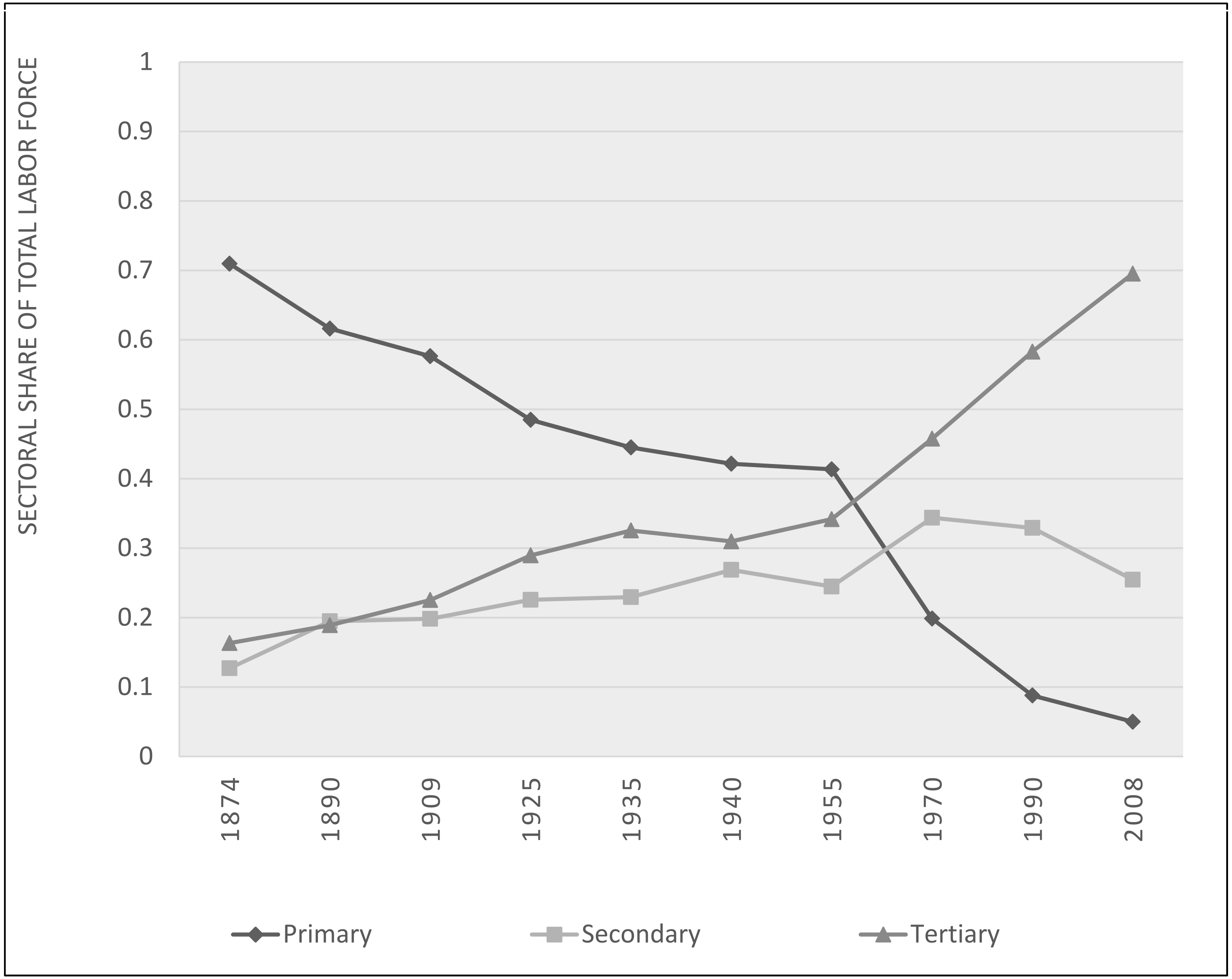
2. Seven benchmark years (1909, 1925, 1935, 1940, 1955, 1970, 1990 and 2008) and 12 sectors (agriculture, mining, food, textile, chemicals, ceramic, metal, machinery, miscellaneous manufacturing, construction including utilities, commerce including services and transport & communication).
    - ✓ Japan's Census of Manufacturers started from 1909.

The role of ST in productivity convergence – Data 2

3. Regional-Level Japan Industrial Productivity (R-JIP) Database : yearly data from 1955 to 2008 and 23 sectors (KLEMS Type Data from 1970 to 2008, agriculture, mining, food, textile, pulp, chemicals, petroleum, non-metallic mineral, primary metal, fabricated metal, machinery, electrical machinery, transport equipment, precision instruments, other manufacturing, construction, utility (electricity, gas and water supply), wholesale and retail trade, finance and insurance, real estate, transport and communication, private services and government services)

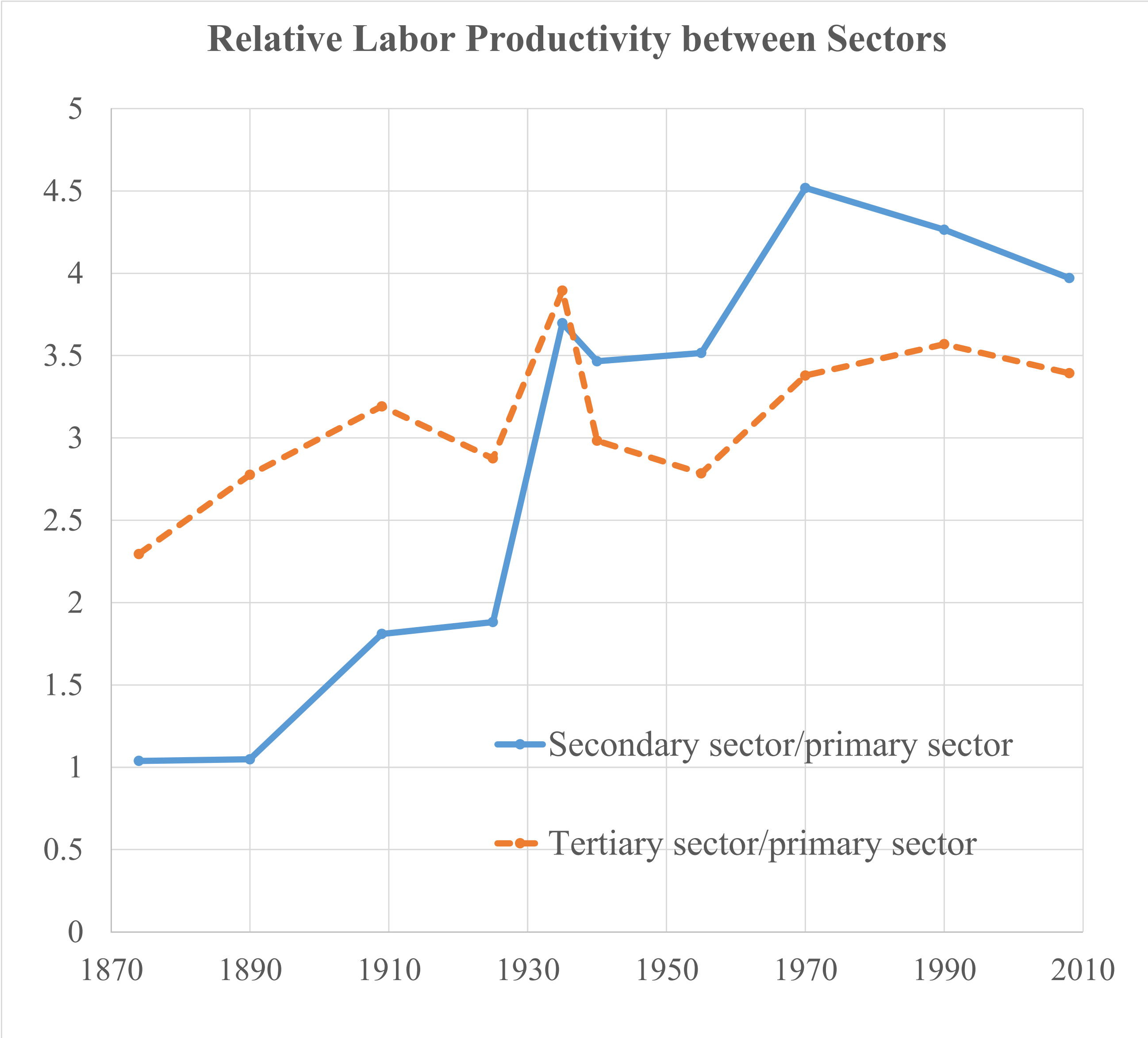
Source: Fukao et al. (2015)

Stylized facts 1: Why Japan?

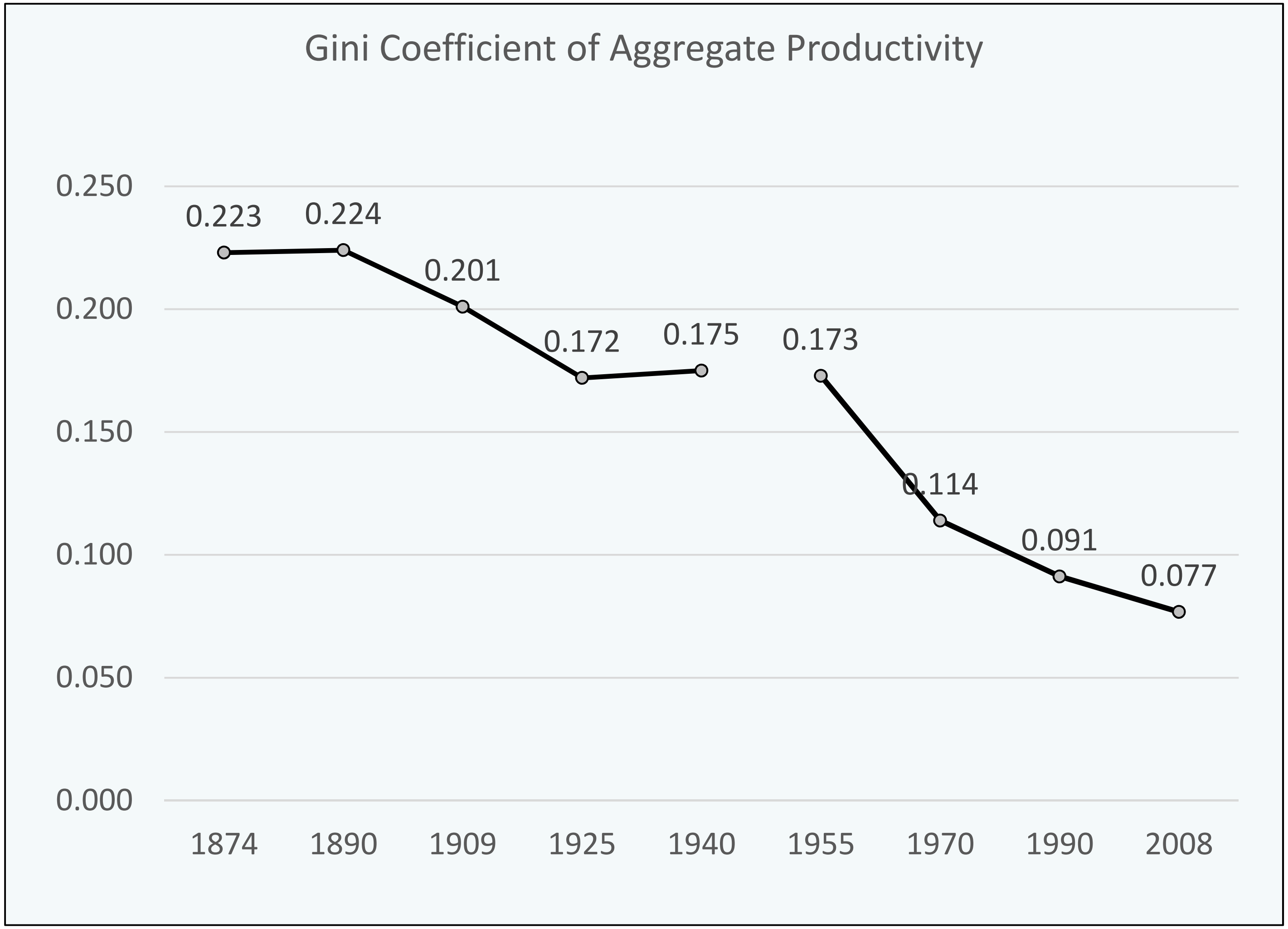


Structural Transformation in Japan

Stylized facts 2: Why Japan?

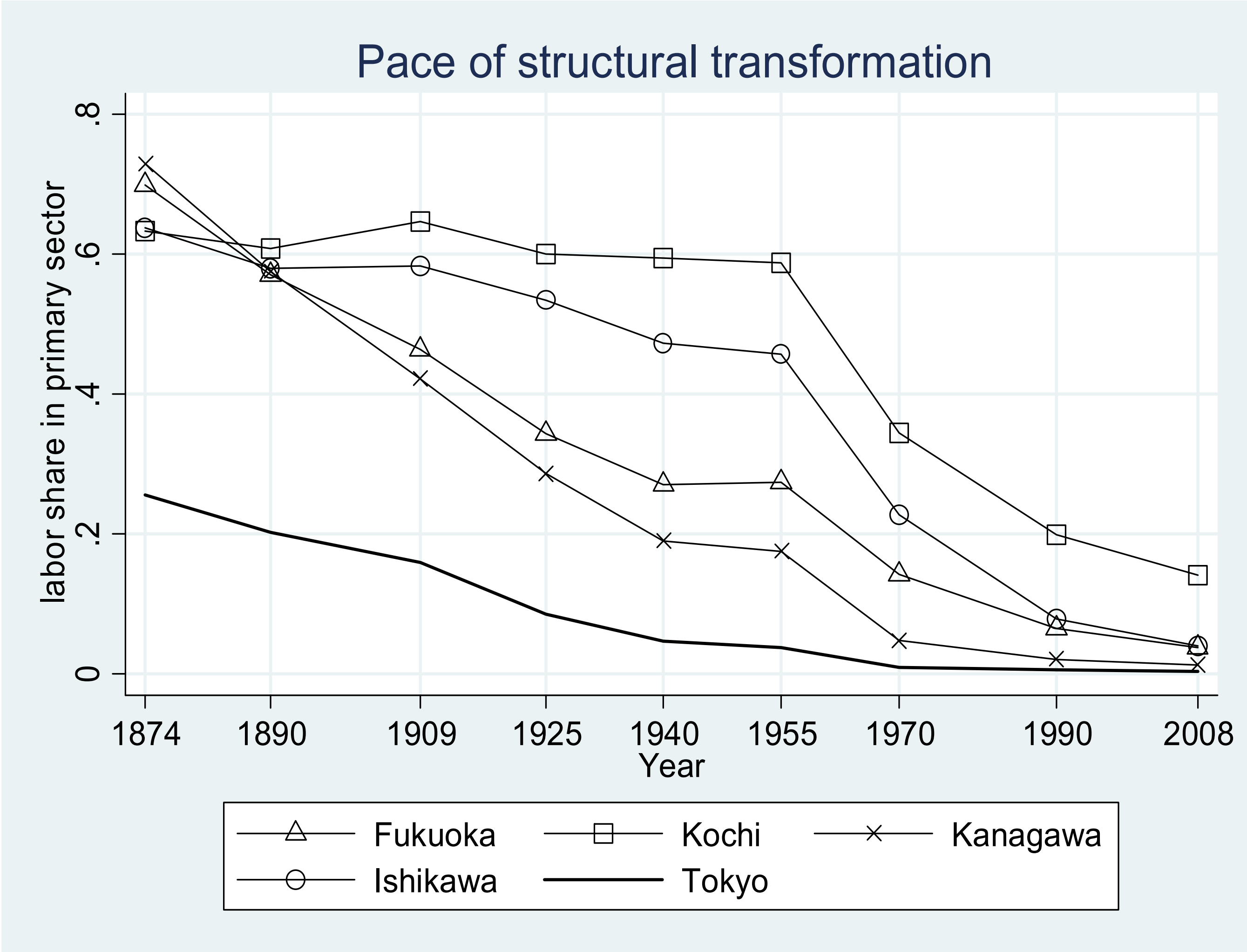


Stylized facts 3: Why Japan?



Regional disparity in aggregate labor productivity

Stylized facts 4: Why Japan?



Diverse trajectories of structural transformation

The role of ST in productivity convergence – framework 1

(1) $V_k{}^{t+1} - V_k{}^{t} = \sum_{i=P,S,T}(\theta_{ki}^{t})(\Delta V_{ki}) + \sum_{i=P,S,T}(\Delta\theta_{ki})(V_{ki}^{t}) + \sum_{i=P,S,T}(\Delta\theta_{ki})(\Delta V_{ki})$

$\Phi(\text{WS})_k$: Within sector effect $\Phi(\text{ST})_k$: Sectoral transformation effect

Equation (1), can be rewritten as

(2) $V_k{}^{t+1} - V_k{}^{t} = V_{WS,k}^{t+1} - V_k{}^{t} + V_{ST,k}^{t+1} - V_k{}^{t}$,

where $V_{WS,k}^{t+1} = V_k{}^{t} + \Phi(\text{WS})_k$ and $V_{ST,k}^{t+1} = V_k{}^{t} + \Phi(\text{ST})_k$

Three sectors of production: primary (*P*), secondary (*S*) and tertiary (*T*)

θ_{ki}^{t} denotes labor share of sector *i* in region *k* and period *t*

The role of ST in productivity convergence – framework 2

(3) $$G(V) = 1 - 2\int_{\alpha}^{\beta}[1 - F(V)]\frac{V}{\mu}f(V)dx$$

(4) $$\Delta G(V) = G^{t+1}(V^{t+1}) - G^{t}(V^{t})$$

μ is mean value of labor productivity (V)

α and β are the lower and upper bounds of V

F is the cumulative distribution of V

f is the density function of V

The role of ST in productivity convergence – framework 3

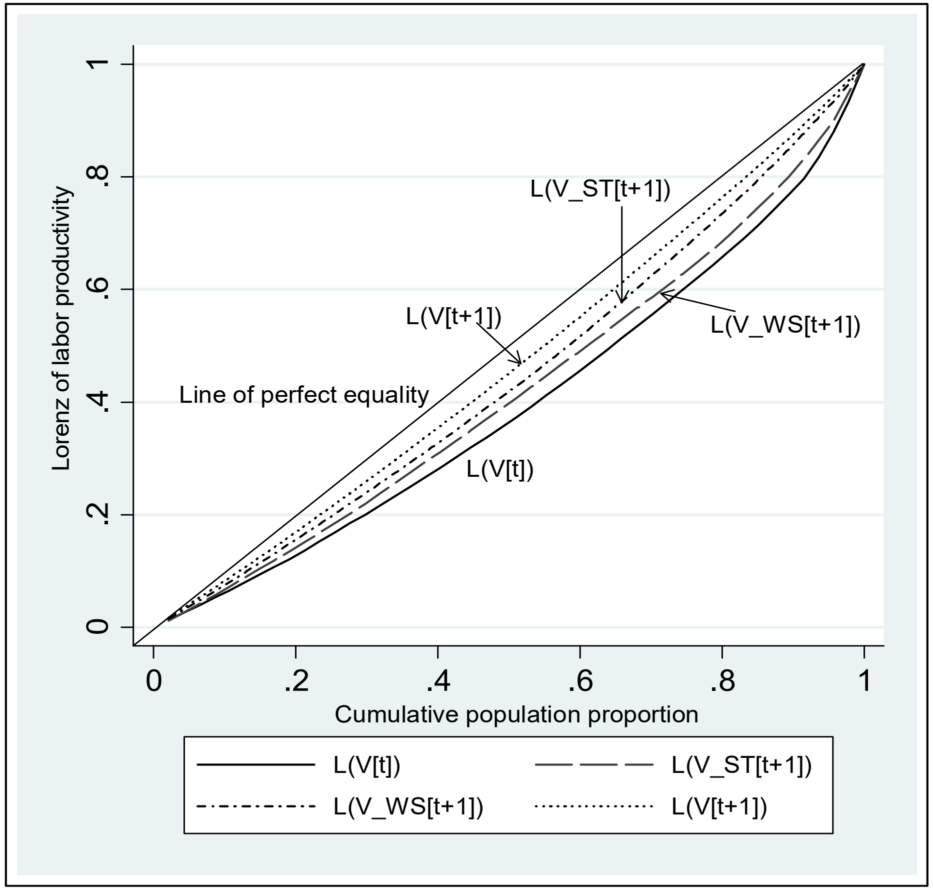
Based on the properties of the Gini coefficient of the sum of two or more random variables (Yitzhaki, 2003, see appendix 1 of our paper), we derive

(5) $G^{t+1}(V^{t+1}) - G^{t}(V^{t}) = \{G^{t+1}\left(V_{WS}^{t+1}\right) - G^{t}(V^{t})\} + \{\left(G^{t+1}\left(V_{ST}^{t+1}\right) - G^{t}(V^{t})\right\} + \varphi^{t}$

σ-convergence in aggregate LP growth ≅ σ-convergence in sectoral LP growth + σ-convergence in structural transformation-led LP growth

The role of ST in productivity convergence – framework 4

A graphical representation

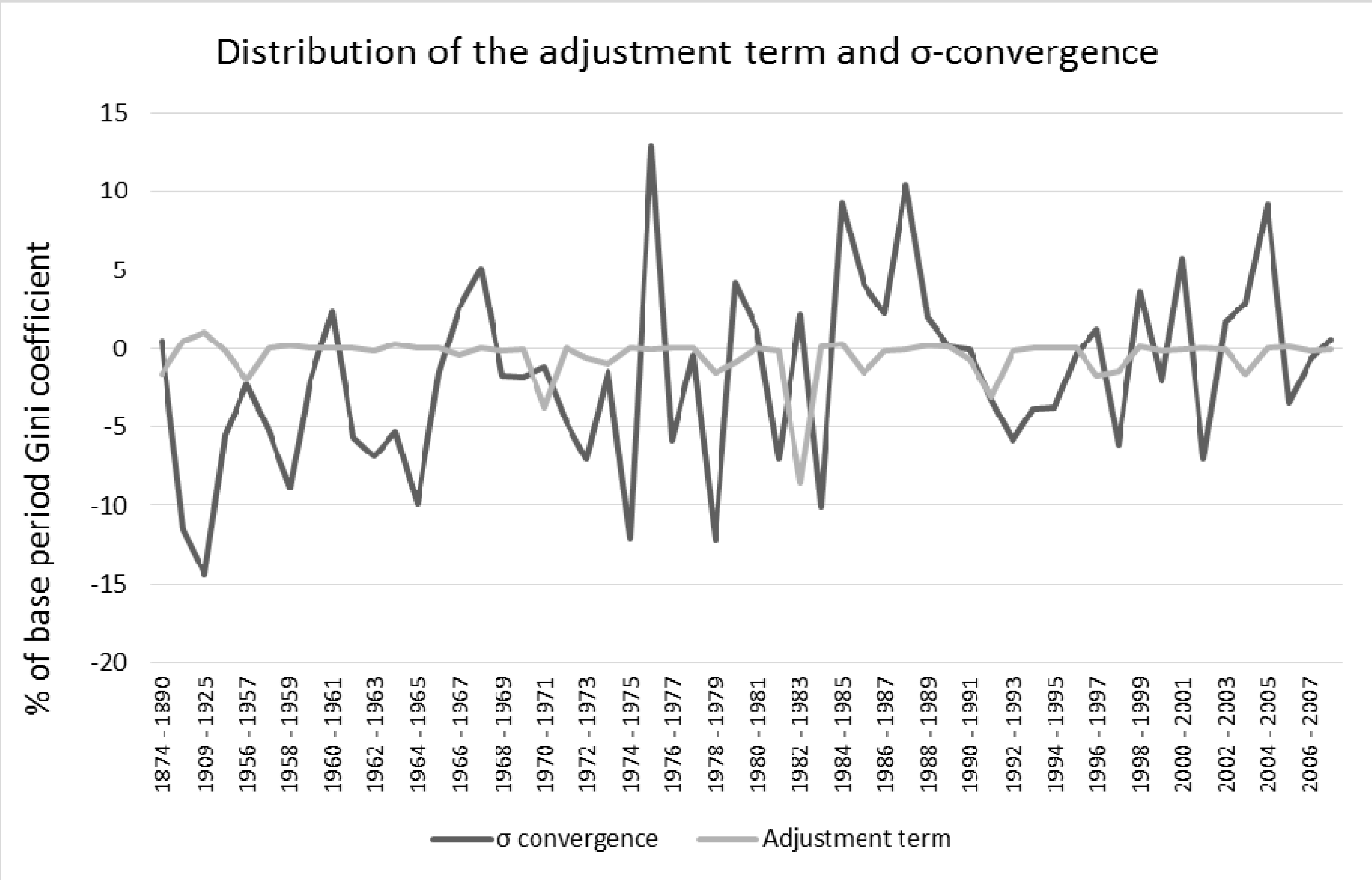


σ-convergence in labor productivity is represented by the area between L(V[t+1]) and L(V[t]).

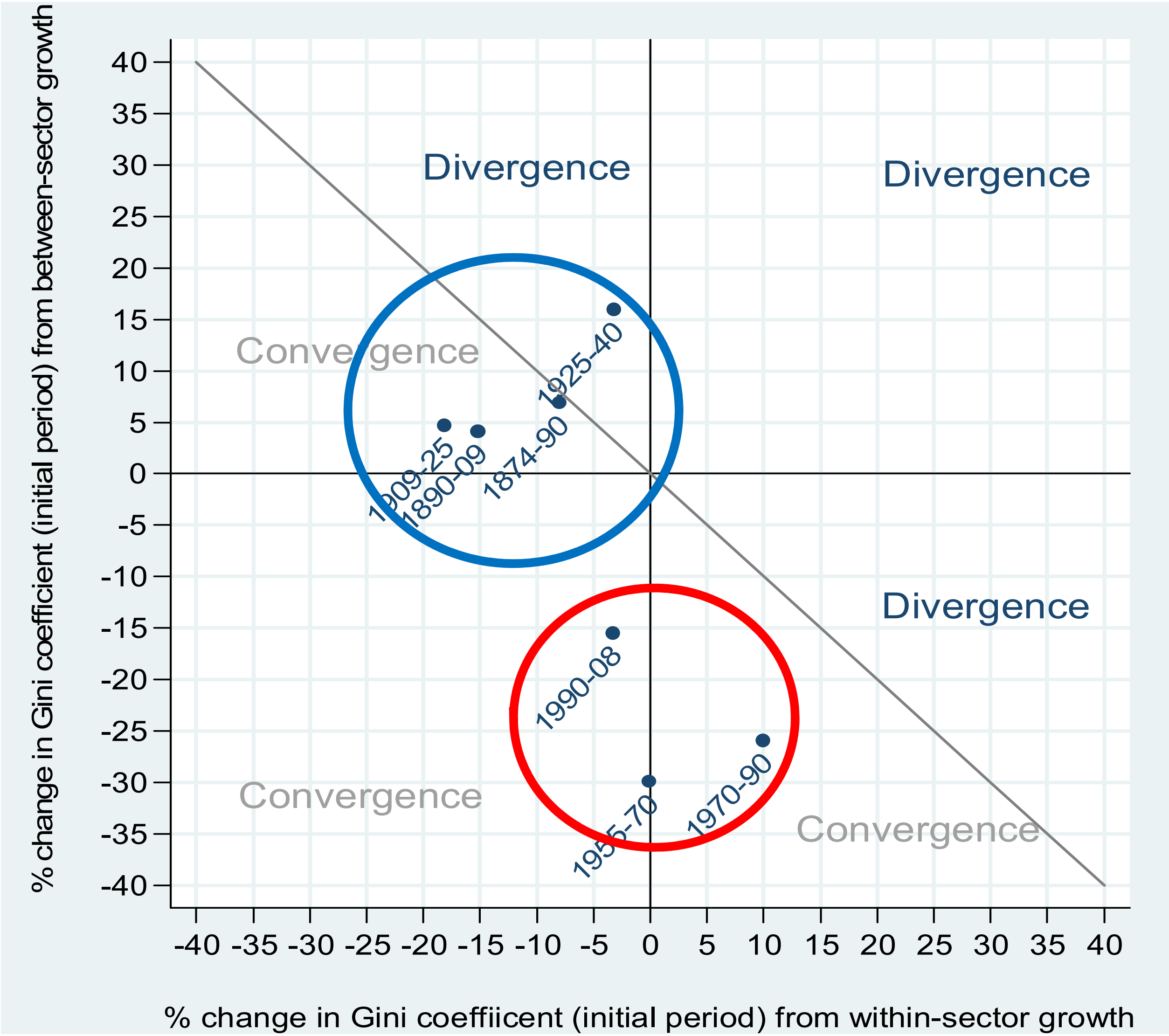
σ-convergence in sectoral productivity growth is the area a between L(V_WS[t+1]) and L(V[t]).

σ-convergence in ST-led productivity growth is the area between L(V_ST[t+1]) and L(V[t]).

The role of ST in productivity convergence – findings 2



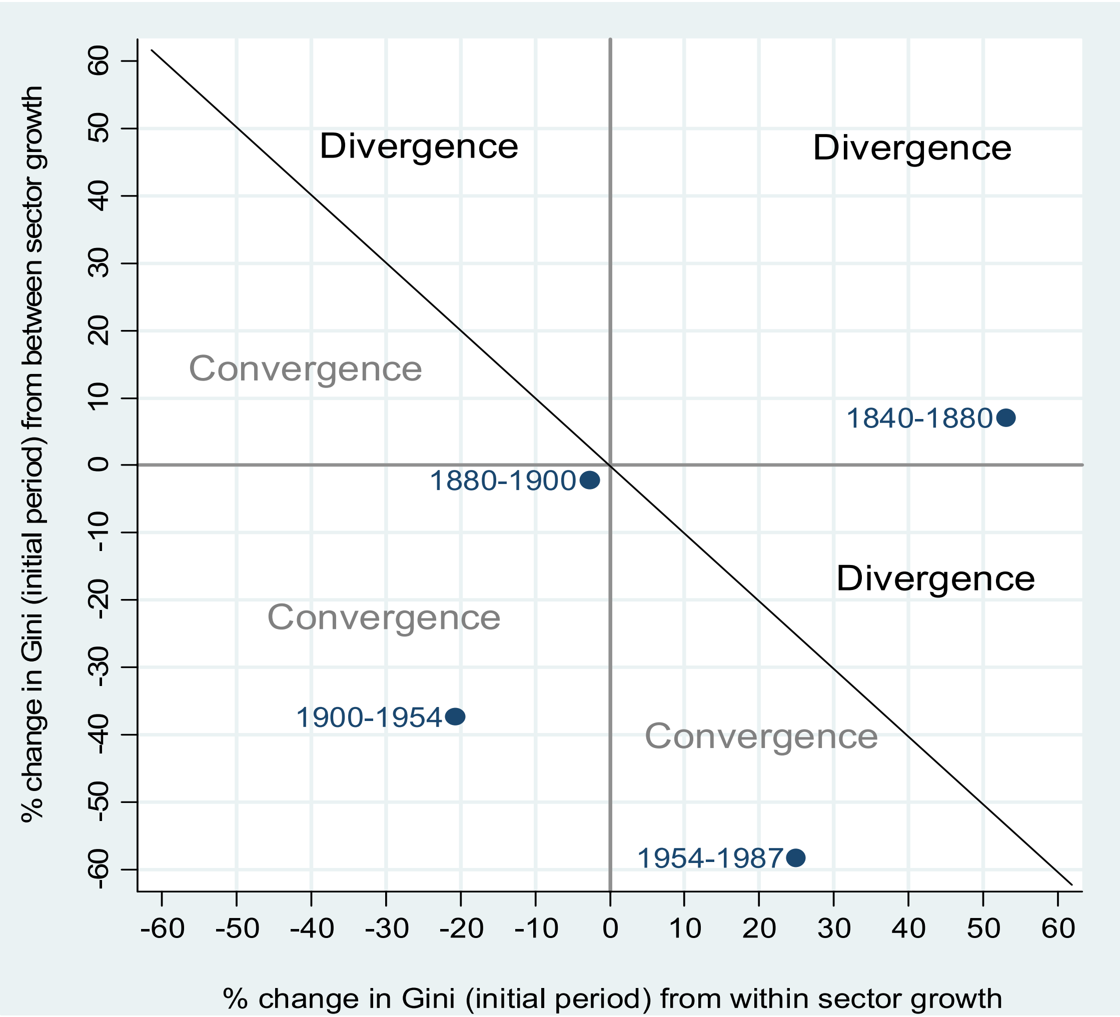
The role of ST in productivity convergence – findings 1



	Change in Gini index
Between-sector (Structural transformation)	
1874–1890	6.9
1890–1909	4.1
1909–1925	4.7
1925–1940	16.0
1955–1970	-29.9
1970–1990	-25.9
1990–2008	-15.5
Within-sector (Productivity growth)	
1874–1890	-8.0
1890–1909	-15.2
1909–1925	-18.1
1925–1940	-3.2
1955–1970	-0.1
1970–1990	10.0
1990–2008	-3.3

The role of ST in productivity convergence – findings 3

Contribution of structural transformation to regional convergence in labor productivity in the US, 1880–1987 (based on two-sector data of Kim 1998)



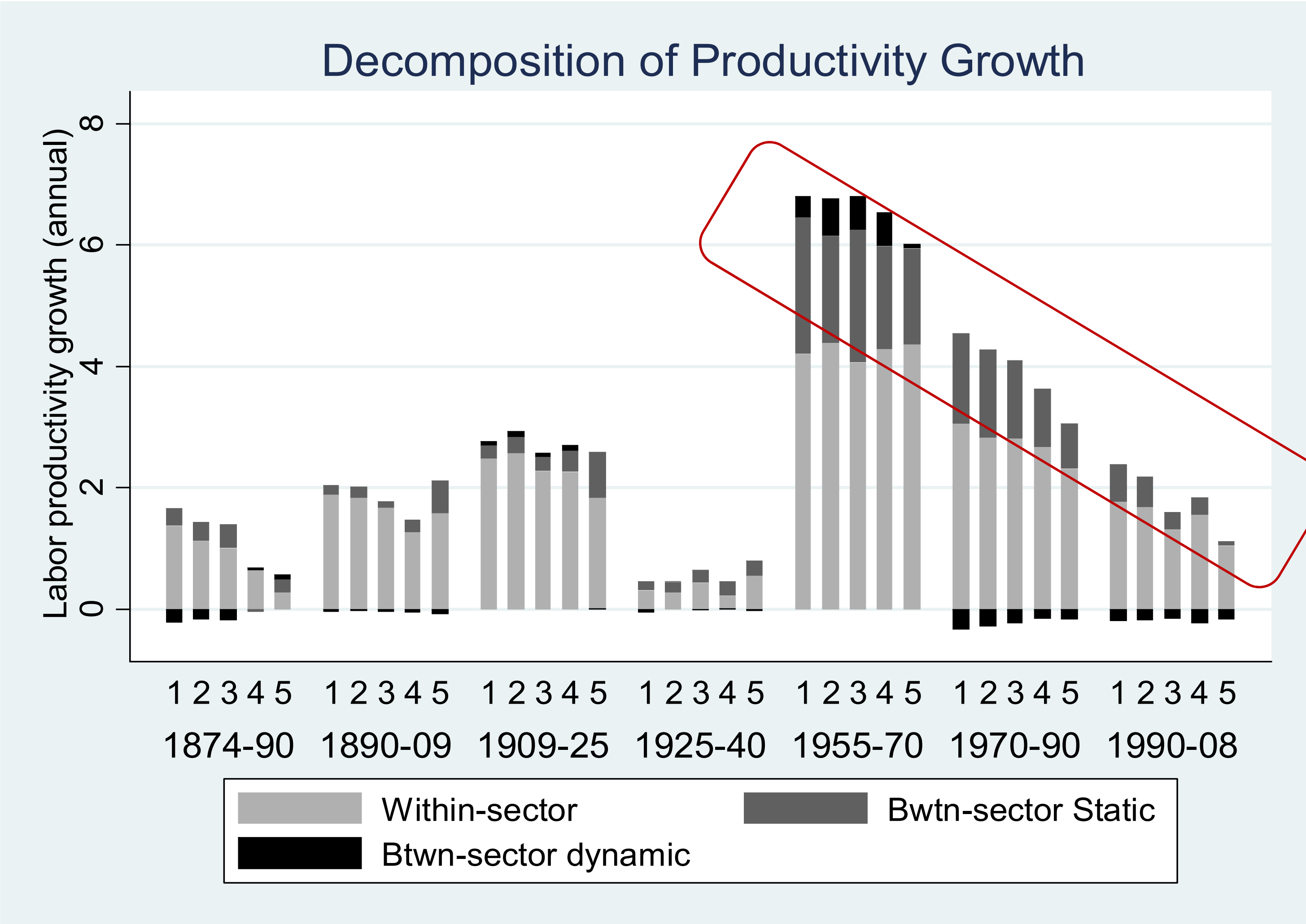
The Gini index as a measure of inequality in regional productivity in the US was 0.16 in 1840, 0.22, in 1880, 0.20 in 1900, 0.08 in 1954, and 0.06 in 1987.

Average annual labor productivity growth was 0.80 in 1840–80, 0.70 in 1880–1900, 3.9 in 1900–54, and 6.1 in 1954–87.

The contribution of structural transformation to labor productivity growth was 19% in 1840–80, 43% in 1880–1900, 16% in 1900–54, and 10% in 1954–87.

The role of ST in productivity convergence – based on another measure

Aggregate productivity catch-up



Decomposition of labor productivity growth (by productivity quintiles)

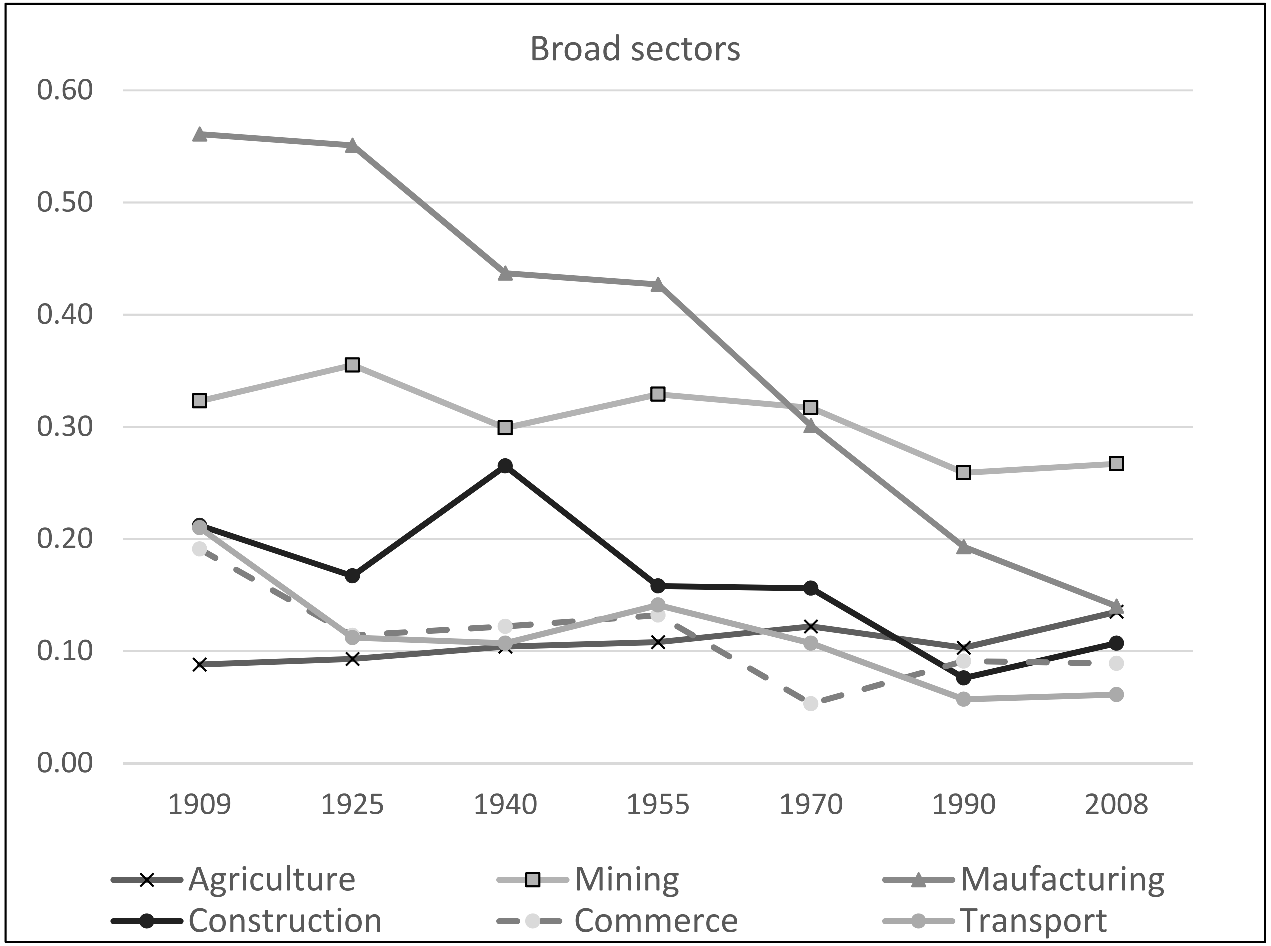
The role of ST in productivity convergence – channel 1

The pace of structural transformation and the sectoral productivity gaps

The dots represent regions in the bottom 20% and triangles represent regions in the top 20% based on the labor productivity in the initial year in each period.

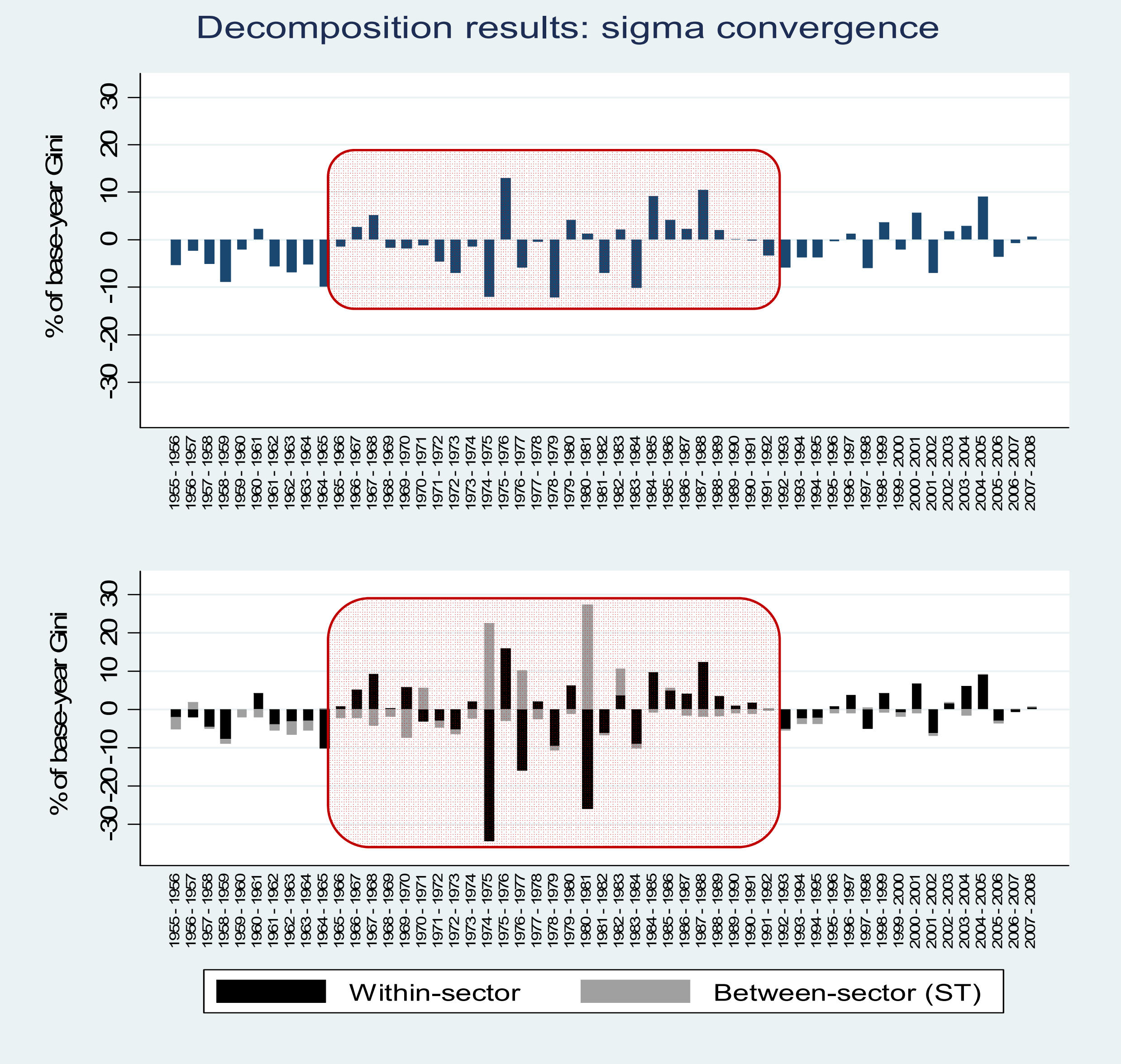
The role of ST in productivity convergence – based on Dataset 2

Gini index of productivity by sector



The role of ST in productivity convergence – based on Dataset 3

The counter-balancing effects of growth components on regional convergence



The pace of regional convergence gradually slowed down.

Since the early 1970s the σ-convergence of structural transformation has been frequently offset by the σ-divergence of within-sector productivity growth and vice versa.

The role of ST in productivity convergence - concluding remarks / way forward

Main implications

The framework is easy to implement and can be extended to any country where regional data on sectoral labor shares and value added are available.

Why σ-convergence of within-sector occurred before WWII?

- Introduction of motors at small factories in rural Japan (Minami 1976).
- Transfer of management skills through M&A (Braguinsky et al. 2015)

Why σ-convergence of sectoral transformation had large impact after WWII?

- σ-convergence of within-sector in the pre-war period contributed
- Amendment of civil law (Hayashi and Prescott 2007)
- Relocation of factories caused by labor shortage and regulations at big cities.

Way Forward

Factor movements across regions (migration, capital flows)

Effects of capital accumulation and TFP changes

Price Gaps