A research on the effect of economic diversity on regional productivity using growth accounting data from R-JIP2017

Tokyo Institute of Technology, School of Environment and Society
Department of Civil and Environmental Engineering
○Masaki Shimizu
Tatsuro Sakano

The types of agglomeration economies

By Rosenthal (2004)

- Localization (specialization) economies
- Urbanization (diversity) economies

Both economies are understood as two types of **“external economies of scale.”**

What are localization economies?

Marshal I (1920)'s definition and Rosenthal & Strange (2004) interpretation

- Localization economies occur when the size of an industry in a city/region shows positive externalities to the productivity of each firm/company.

- Three sources of externalities:
  1) knowledge spillovers, 2)input sharing, 3)labor pooling

Nakamura(1985)
- A doubling of an industry's scale leads to 4.5% increase in productivity

What are urbanization economies?

Rosenthal & Strange (2004)'s definition

- Urbanization economies occur when the size of a city/region shows positive externalities in productivity of industrial activities crossing over the industries → **Economy of Scale**

- Diversity as a source of city/regional externalities
  1) Marshall's externalities work across over the industries
  2) As Jacobs (1969) argues if main source of crossover externalities reside in knowledge spillover, "diversity" of economic activities is the main source of innovation → **Economy of Diversity**

⇒ **Economy of Scale vs. Economy of Diversity** Which is influential ?

Conflicting Evidence about Scale vs. Diversity

- Hollar(2006) argues localization (scale) works better in **small district** while urbanization (diversity) does in **metropolitan region**.
- Tran(2011) showed localization brings about **higher growth rate in short terms** but urbanization does **stable growth in longer terms** from the states level comparison in the U.S.
- Van Oort(2004) argues the **network relationship among cities** is also important.

⇒ The existing research cannot explain sufficiently the complex patterns.

⇒ It is still important to accumulate empirical knowledge in exploratory.

⇒ Which economies work at Prefectural Level in Japan?

Research Questions

1. Are the agglomeration economies existed at prefectural level in Japan?

2. If they are, which economies Scale or Diversity contribute more to prefectural economy?

Labor Productivity and Its Growth Rate

Tokui (2018, p29-31)　(Industry i , Prefecture r , t year)

$$Y_{rt} = \frac{V_{rt}}{H_{rt}}$$

$$\Delta \log Y_{rt} = \Delta \log V_{rt} - \Delta \log H_{rt}$$

$$\Delta \log A_{rt} = \sum_{i=1}^{23} \frac{1}{2}\left(S_{irt}^{V} + S_{irt-1}^{V}\right)\Delta \log A_{irt}$$

$$\Delta \log V_{irt} = \Delta \log A_{irt} + \alpha \Delta \log K_{irt} + (1-\alpha)\Delta \log L_{irt}$$

V_{irt} : Real Added Value　V'_{irt} : nominal added value

Y_{irt} : Labor Productivity　A_{irt} : TFP　K_{irt} : Capital

L_{irt} : Labor　H_{irt} : man-hour　$S_{irt}^{V} = V'_{irt}/V'_{rt}$

Entropy as a measurement of diversity

v_{ir}:real added value of industry i in prefecture r

v_r:real added value of industry i in prefecture r

p_{ir}: relative proportion of industry i in prefecture r

$$-\sum_{i=1}^{23} p_{ir}\, log\, p_{ir} = -\sum_{i=1}^{23} \frac{v_{ir}}{v_r} log \frac{v_{ir}}{v_r}$$

closer to 0, the more dependent on a specific industry

closer to $log\, N$, the higher diversity

A comparison of three models

Dependent variable

Y_r : Labor Productivity of Prefecture r

Independent variables

S_r : Scale of Industrial Activities of Prefecture r

D_r : Diversity of Industrial Activities of Prefecture r

$$\text{Model 1: } Y_r = \alpha_1 S_r + \gamma_1 + \varepsilon_r$$
$$\text{Model 2: } Y_r = \beta_1 D_r + \gamma_2 + \varepsilon_r$$
$$\text{Model 3: } Y_r = \alpha_2 S_r + \beta_2 D_r + \gamma_3 + \varepsilon_r$$

Measurement of the variables

Y_r : average annual labor productivity

S_r : average annual real added value

D_r : entropy measured by proportion of industrial activities

Data

R-JIP 2017 Data Base

by Research institute of Economy, Trade and Industry

Panel Data from 1970 to 2012 for growth accounting:

(1)Real and nominal added value

(2)Capital input

(3)Labor input

for 23 industries by 47 prefecture

The effects on labor productivity(1970~2010)

1) α_1 α_2 β_1 β_2 are positive

2) Adjusted R2 of Model 3 is the highest, and that of Model 1 comes to second

3) $\alpha_1 > \alpha_2$ and $\beta_1 > \beta_2$

Labor productivity (1970~2010)

	Model 1		Model 2		Model 3	
	B	p-value	B	p-value	B	p-value
constant	-6.052	0.000	-0.284	0.733	-7.218	0.000
S_r	0.702	0.000	—	—	0.619	0.000
D_r	—	—	1.264	0.000	0.887	0.001
	R2	Adj R2	R2	Adj R2	R2	Adj R2
	0.494	0.482	0.245	0.228	0.608	0.590

The above results show that

1) Scale of industrial activities and diversity are positively correlated with each other

2) However, they have independent effects on labor productivity

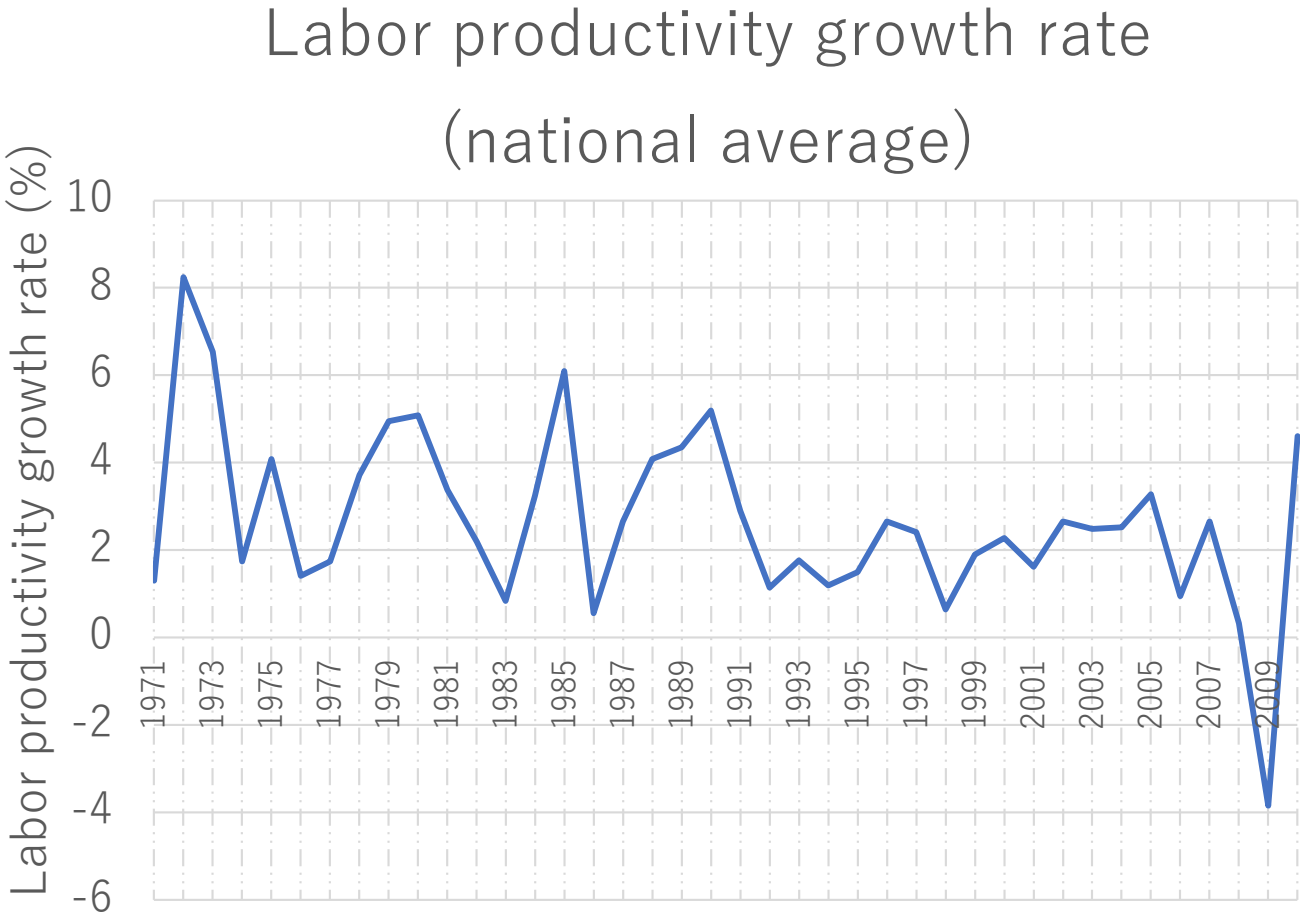
3) Implying that economy of scale and that of diversity, both operate at prefectural level, although the latter effect is weaker than the former.

Possibility of Structural Change

- Tokui(2018)and Mizohata(2018) pointed out Japanese Economy experienced structural change

  1) Catch up Economy 1970~1990
  2) Frontier Economy 2000~2010

- Labor Productivity growth rate
  Catch up period ⇒high average
  high volatility
  Frontier period ⇒low average
  low volatility



- **necessary to check if there any structural change**

The effects on labor productivity (period)

- In both periods, scale and diversity shows similar effects

↓

The mechanism of agglomeration economy operates in the same way even after the economy becomes matured.

Labor productivity (Model 3)

	1970~2010		1970~1990		2000~2010	
	B	p-value	B	p-value	B	p-value
constant	-7.218	0.000	-5.679	0.000	-8.917	0.000
S_r	0.619	0.000	0.507	0.000	0.803	0.000
D_r	0.887	0.001	0.579	0.021	1.042	0.008
	R2	Adj R2	R2	Adj R2	R2	Adj R2
	0.608	0.590	0.520	0.498	0.471	0.447

The effects on labor productivity growth rate

- R2 is lower than the models of labor productivity
- In Catch up period, scale and diversity show similar effects.
- In Frontier Period, explanatory power becomes zero,

Labor productivity growth rate

	1970~2010		1970~1990		2000~2010	
	B	p-value	B	p-value	B	p-value
constant	-0.594	0.762	-6.024	0.023	5.698	0.144
S_r	0.090	0.556	0.358	0.113	-0.299	0.273
D_r	0.845	0.035	2.037	0.000	-0.048	0.945
	R2	Adj R2	R2	Adj R2	R2	Adj R2
	0.120	0.080	0.380	0.352	0.027	-0.017

The effects on TFP growth rate

- R2 is relatively higher than labor productivity growth rate but lower than that of labor productivity.
- In Catch up period, scale and diversity show similar effects.
- In Frontier Period, explanatory power becomes zero,

TFP growth rate

	1970~2010		1970~1990		2000~2010	
	B	p-value	B	p-value	B	p-value
constant	-5.630	0.007	-12.354	0.000	4.589	0.242
S_r	0.371	0.021	0.738	0.002	-0.309	0.262
D_r	0.745	0.065	1.872	0.001	0.010	0.988
	R2	Adj R2	R2	Adj R2	R2	Adj R2
	0.217	0.181	0.472	0.448	0.028	-0.016

Conclusion

- It is confirmed that scale and diversity have independent effects on labor productivity at prefectural economy
- These effects have been stable during Catch-up period and Frontier period
- However, their effects on labor productivity growth rate and TFP growth rate disappears in Frontier period

- This is probably because growth rates are influenced more by business cycles
- As against the expectation that TFP would be the driving force of economic growth in Frontier period, TFP growth rates of all prefectures remains low.
  It is considered that there should be some factors to suppress innovation in Japanese economy, and that if they are removed, the agglomeration economy may be set in motion in Frontier period.

Reference

- Hollar, M. 2006, Industrial Diversity and Agglomeration Economies,
- Jacobs, Jane. 1969, The Economy of Cities, Random House.
- Marshall, Alfred. 1920, Principles of Economics, London: Macmillan
- Nakamura, Ryohei. 1985, Agglomeration economies in urban manufacturing industries: A case of Japanese cities
- Rosenthal S S and Strange W C 2004 Evidence on the Nature and Sources of Agglomeration Economies
- Tran, H.P.D. 2011, Industrial Diversity and Economic Performance: A Spatial Analysis,
- van Oort, F.G. 2004, Urban Growth and Innovation, Routridge, N.Y.
- 徳井丞次，2018 日本の地域別生産性と格差 R-JIPデータベースによる産業別分析
- 溝端幹雄，2018 日本の労働生産性に関する地域的接近　医療・福祉への資源偏在と大規模事業所の地域間生産性格差に課題
- RIETI R-JIPデータベース2017　https://www.rieti.go.jp/jp/database/R-JIP2017/index.html