Chukyo University Institute of Economics

Discussion Paper Series

March 2015

No. 1409

Estimation of the Effects of Industrial Concentration: The Case of Japan

Seiji YAMADA
Graduate School of Economics, Kobe University

Junya MASUDA
School of Economics, Chukyo University

Estimation of the Effects of Industrial Concentration: The Case of Japan[1]

Seiji Yamada
Graduate School of Economics, Kobe University

Junya Masuda[2]
School of Economics, Chukyo University

Abstract

This paper investigates the effects of industrial concentration by estimating each production function of prefectural in Japan. The effect of industrial concentration refers to the economic benefit which is generated from the concentration of firms in certain area. The estimation results show that there are not the effects of industrial concentration in Japan.

---

1 The authors are grateful to the Chukyo University for financial assistance with the research.
2 Address correspondence to: Junya Masuda, School of Economics, Chukyo University 101-2, Yagoto-Honmachi, Syowa-Ku, Nagoya 466-8666 Japan; e-mail: masuda@econometrics.jp.

1. Introduction

This paper investigates the effects of industrial concentration by estimating each production function of prefectural in Japan. The effect of industrial concentration refers to the economic benefit which is generated from the concentration of firms in certain area. For example, firms archive the cost-efficiency through industrial concentration in the sense that the concentration of firms reduce drastically transactions cost and transportation cost, since it is easy to access to input goods, information and infrastructure in localized area. Marshall (1890) indicated that industrial concentration brings about the innovation of machine and production process, the organizational improvement, the development of related industries, and the expanding employment opportunities, etc. The effect of industrial concentration also achieves sustained economic growth led by establishing the collaborative relationship among relevant companies which are located nearby, which is discussed in Porter (1990).

Most of the literature on the effects of industrial concentration has sought to estimate these effects. These literatures are characterized by the following two features. First, short term and long term are distinguished. In short term, it emphasized that the effects of industrial concentration realize the high productivity. In long term, it emphasized that the effect of industrial concentration also achieves sustained economic growth. Second, the viewpoint of demand and supply are distinguished. This means that the effects of industrial concentration are considered as the side of demand or the side of supply. Most of the literature has focused on the viewpoint of the supply side in short term and has taken the approach which considers industrial concentration and increasing returns to scale as external effects (Weber 1909 and Hoover 1937). Sveikauskas (1975) and Moomaw (1981) focused on the relation between the labor productivity of manufacturing industry and urban population in USA. Sveikauskas (1975) showed that the labor productivity of manufacturing industry increases by 6-7 percent, if the population of urban double. Moomaw (1981) also showed that the labor productivity of manufacturing industry increases by about 2 percent, if the population of urban double. Nakamura(1985) and Henderson(1986) considered both "localization economics" and "urban economics" for the labor productivity. These literatures examined whether external effects be actualized by an industrial scale or size of population by estimating the production function of manufacturing industry.

However, most of the literature on the effects of industrial concentration cannot distinguish the effect of industrial concentration from the effect of productivity, although these literatures can distinguish the size and the type of the industrial concentration effect. High productivity on location place bring about the incentive for building firm on such location place and as result, expand the economic scale on such location place, because these literature assume that the productivity of each firm depend on the economic scale. Therefore, it is not distinguishable whether high productivity in location place influence the effect of industrial concentration or whether the effect of industrial concentration influences high productivity in location place.

In this paper, we investigate whether high productivity in location place increases under the influence of industrial concentration by using time-series data. If the effect of industrial concentration changes and high productivity in location place changes, we think that there is the effect of industrial concentration. If the productivity changes, we think that high productivity firms collect in location place.

The paper is organized as follows. Section 2 shows the effects of industry concentration and the Econometric Models to estimation the effects. Section 3 shows the estimation result in Japan. Finally, Section 4 discusses the results derived from the analysis conducted in the paper

2. Econometric Model

In this paper, in order to verify the effects of industry concentration, we estimate product function. In previous study, generally the Cobb-Douglas production function or the transcendental logarithmic product function which is formed from the Cobb-Douglas production function and quadratic terms is used. In this study, in similar previous study, we estimate the Cobb-Douglas production function[3] as follows that

$$Y_{it} = A_{it}(K_{it})^{\alpha_{it}}(L_{it})^{\beta_{it}}(IC_{it})^{\tau_{it}} \qquad (1),$$

where i indicates the region, and t indicates the period. A_{it}, α_{it}, β_{it} and τ_{it} are parameters. These parameters depend on regions and periods. Y_{it}, K_{it} and L_{it} are each the output, the capital and the labor at the t-period in the i-region. IC_{it}[4] shows that a certain level of industry concentration at nearby i-region's as follows that

$$IC_{it} = \sum_{i \neq j} f(K_{jt}, L_{jt}, l_{ij}),$$

[3] The transcendental logarithmic product function is more general than the the Cobb-Douglas production function. However, number of parameter of the transcendental logarithmic product function is large. Thus, we estimate the the Cobb-Douglas production function.

[4] In Spatial Econometrics, IC_{it} is called the spatial distributed rag term.

where

$$\frac{\partial f(K_{jt}, L_{jt}, l_{ij})}{\partial K_{jt}} > 0,$$

$$\frac{\partial f(K_{jt}, L_{jt}, l_{ij})}{\partial L_{jt}} > 0 \text{ and}$$

$$\frac{\partial f(K_{jt}, L_{jt}, l_{ij})}{\partial l_{ij}} < 0.$$

And l_{ij} indicates the distance from i-region to j-region. Thus, the variable IC_{it} depends on the other region's capital and labor. Particularly, if nearby region's capital and labor is high, IC_{it} is high. Thus if IC_{it} is high, the nearby region has high capital and labor. When the parameters are different at each region and each period, we are not able to estimate the model, because the number of sample is smaller than the number of parameters. Thus, in order to estimate the model we suppose two restrictions. The first restriction is follows that

$$A_{it} = A_t, \alpha_{it} = \alpha_t, \beta_{it} = \beta_t \; and \; \tau_{it} = \tau_t.$$

This restriction is called Model1. The parameters of this restriction are same at each period and different at each region. Thus, we estimate cross-section models at the number of period times. When we expect the parameter change at the period, this model is effective.

The model2 has the restriction as follows that

$$A_{it} = A_i, \alpha_{it} = \alpha_i, \beta_{it} = \beta_i \; and \; \tau_{it} = \tau_i$$

The parameters of this restriction are same at each region and different at each period. Thus, we estimate time- series models at the number of region times. When we expect that the parameter differ from each region, this model is effective.

We verify whether satisfy both conditions as follows that

$$\alpha_{it} + \beta_{it} > 1 \text{ and } \tau_{it} > 0.$$

When these conditions are satisfied, the effects of industry concentration are exist. When $\tau_{it} > 0$[5], the influence of the effects to i-region from nearby i-region increase productivity on i-region. When $\alpha_{it} + \beta_{it} > 1$, the product function is increasing returns

[5] When $\tau_{it} > 0$, generally spillover effects exist.

to scale. If the effects of industry concentration exist, a product function of each firm has a positive externality and a product function of the region is increasing returns to scale. Thus, if the estimation result of product function is increasing returns to scale, the effects of industry concentration at i-region exist. In addition, when $\gamma_{it} = \alpha_{it} + \beta_{it} - 1$, in the case of γ_{it} >0 the effects of industry concentration exist.

We estimate the effects of industry concentration exist using log linearized the (1) equation as follows that

$$lnY_{it} = lnA_{it} + \alpha_{it} lnK_{it} + \beta_{it} lnL_{it} + \tau_{it} lnIA_{it} + u_{it} \qquad (2)$$

At Model1 we estimate the equation (2) by OLS using cross section data on each region. At Model2 we estimate the equation (2) by OLS using time series data on each period.

3.Data and Results

We estimate the models from 1993 to 2010 by the prefectural level (the state level) data. The output, the capital and the labor are derived from the Census of Manufactures. The capital and the labor are Gross Value Added by Industry, Size of Capital and Number of Persons Employed of the prefectural level data. The data of IC_{it} is calculate by

$$lnIC_{it} = \sum_{j \neq i} \frac{\ln K_j}{l(i,j)}$$[6],

where $l(i,j)$ indicates the distance from i-region to j-region. The distance data is calculated by National Integrated Transport Analysis System (NITAS) provided by Ministry of Land, Infrastructure, Transport and Tourism. The distance is minutes it takes to move by railroad[7] from *i*th prefectural capital to *j*th prefectural capital.

Table1 shows the results by OLS at the restriction in model1. Table1 reports the estimated values and () indicates this standard error. Last row shows the average of all prefectural, () indicates stander error[8] of this average. The estimated values of α_t are almost 0.5 and unchanging for estimation periods. The estimated values of β_t are

---

[6] The results using the Labor instead of the Capital are almost same. Therefor IC_{it} is calculated by only Capital Data.

[7] Because the distance data is calculated by the railroad, the data of prefectural not connected to railroad is all zero.

[8] We calculate the standard error assuming that the correlation between prefectural is zero. If this correlation exists, the standard error has biased. When the correlation is positive, the bias of the standard error is negative. Thus, generally supposing that the correlation is positive, the standard error may be smaller than true value.

almost 0.5. These values are more instable than α_t. However, these values exist in interval from 0.4 to 0.6. Because the estimation model is the Cobb-Douglas production function, α_t is capital's share of income and β_t is labor's share of income. Generally value of capital's share of income is in interval from 25% to 40%. The estimation result shows that capital's share of income is larger than the expected values. However since we use manufacturing data, this industry may be more intensive capital industries. Thus estimation results may be not mistake. The estimated values of γ_t are about 0. This result is unchanging for estimation periods and robust. Furthermore since the standard errors of γ_t are enough large in comparison with these estimated values, the hypothesis on $\gamma_t = 0$ is accepted. Thus under restriction of model1 the production function is constant returns to scale. The result shows that when this prefectural is concentrated of industry, productivity of this prefectural is not raised. In contrast, the estimated values of τ_t are positive. At all period the values are about 0.2 and the hypothesis on $\tau_t = 0$ is rejected. This result shows that when a nearby prefectural is concentrated of industry, productivity of the prefectural is raised. Namely the effects of industry concentration from nearby prefectural may exist. However this result may mean that simply high productivity prefectural are concentrated. Thus, under the restriction of model2 we estimate the product function and test whether industry concentration influence the productivity or not.

Table2 shows the estimation results under the restriction of model2 by OLS method. We estimate structures at each prefectural using time series data. The disposition of estimation results is more unstable than model1. Some of the estimated values are not satisfied with the sign condition of α_i and β_i. Many of the estimated values of α_i especially are negative. Namely labors and capitals may not influence outputs. Or since labors and capitals are not adjusted by capacity utilization, the estimation may be unsuccessful. However the average of estimated values of β_i is 0.66 and this value is expected by prior research. Thus, the estimation is almost success. Many of the estimated values of γ_t and the average are negative. This means that the production function is decreasing returns to scale. Since the results of many of the prefectural show that the hypothesis on γ_t=0 is accepted, the production function may be constant returns to scale. Namely, according to the estimation results the production function is not increasing returns to scale. Thus when this prefectural is concentrated of industry, productivity of this prefectural is not raised. In addition many of estimated values of τ_t are negative and are not satisfied with the sign condition. This result shows that when a nearby prefectural is concentrated of industry, productivity of the prefectural is not raised. The both result show that the effects of industrial concentration is not unobservable. Thus under the restriction of model2 the effects of industrial concentration do not exist.

4. Concluding Remark

Under the restriction of model1 the correlation between industrial concentration and productivity is observed, and under the restriction of model2 the correlation is unobserved. This shows that the effect of industrial concentration does not influences high productivity in location place but high productivity in location place influence the effect of industrial concentration.

References

[1]Henderson, J.V. (1986) “Efficiency of resource usage and city size,” *Journal of Urban Economics,* Vol.19, No.1, pp.47-70.

[2] Marshall, A. (1890) *Principles of Economics,* Macmillan, London.

[3] Moomaw, R.L. (1981) “Productivity and city size: a critique and evidence, ” *Quarterly Journal of Economics,* Vol.96, No.4, pp.675-688.

[4] Nakamura, R. (1985) “ Agglomeration economics in urban manufacturing industries: A case of Japanese cities,” *Journal of Urban Economics,* Vol.17, No.1, pp.108-124.

[5] Porter, M.E. (1990) *The competitive advantage of nations,* Free Press, New York.

[6] Sveikauskas, L.A. (1975) “The productivity of cities,” *Quarterly Journal of Economics,* Vol.89, No.3, pp.393-413.

Table1

Year	α_t		β_t		γ_t		τ_t	
1993	0.561	(0.063)	0.475	(0.032)	0.036	(0.032)	0.179	(0.051)
1994	0.563	(0.059)	0.467	(0.030)	0.030	(0.030)	0.172	(0.048)
1995	0.561	(0.056)	0.463	(0.028)	0.024	(0.028)	0.181	(0.045)
1996	0.507	(0.059)	0.536	(0.031)	0.043	(0.031)	0.175	(0.049)
1997	0.509	(0.064)	0.540	(0.033)	0.049	(0.033)	0.191	(0.052)
1998	0.489	(0.060)	0.569	(0.030)	0.057	(0.030)	0.166	(0.048)
1999	0.444	(0.068)	0.601	(0.036)	0.045	(0.036)	0.190	(0.056)
2000	0.422	(0.071)	0.611	(0.036)	0.034	(0.036)	0.199	(0.057)
2001	0.425	(0.069)	0.607	(0.034)	0.032	(0.034)	0.192	(0.054)
2002	0.485	(0.070)	0.553	(0.036)	0.039	(0.036)	0.212	(0.057)
2003	0.535	(0.068)	0.491	(0.036)	0.026	(0.036)	0.196	(0.058)
2004	0.554	(0.066)	0.475	(0.034)	0.029	(0.034)	0.226	(0.056)
2005	0.564	(0.069)	0.462	(0.036)	0.026	(0.036)	0.254	(0.058)
2006	0.610	(0.051)	0.384	(0.026)	−0.006	(0.026)	0.247	(0.042)
2007	0.567	(0.057)	0.445	(0.028)	0.012	(0.028)	0.243	(0.045)
2008	0.545	(0.063)	0.467	(0.032)	0.011	(0.032)	0.254	(0.052)
2009	0.572	(0.052)	0.444	(0.028)	0.015	(0.028)	0.185	(0.045)
2010	0.583	(0.054)	0.440	(0.030)	0.023	(0.030)	0.153	(0.047)
Average	0.527	(0.015)	0.502	(0.008)	0.029	(0.008)	0.201	(0.012)

Table2

region	α_t		β_t		γ_t		τ_t	
Hokkaido	0.420	(0.193)	0.696	(0.112)	0.115	(0.119)	−2.605	(4.138)
Aomori	−0.560	(0.214)	−1.624	(0.582)	−3.184	(0.719)	36.251	(15.474)
Iwate	0.522	(0.349)	0.724	(0.213)	0.246	(0.261)	−1.428	(3.045)
Miyagi	−0.485	(0.336)	0.690	(0.194)	−0.795	(0.230)	6.702	(2.716)
Akita	−0.083	(0.289)	0.648	(0.173)	−0.436	(0.243)	4.963	(5.383)
Yamagata	0.651	(0.353)	0.164	(0.245)	−0.185	(0.424)	−3.114	(6.516)
Fukushima	0.133	(0.251)	0.088	(0.367)	−0.780	(0.535)	3.009	(4.598)
Ibaraki	1.015	(0.697)	0.623	(0.367)	0.638	(0.684)	−3.947	(5.661)
Tochigi	−0.120	(0.358)	0.431	(0.232)	−0.689	(0.439)	0.239	(1.798)
Gunma	0.308	(0.171)	0.845	(0.262)	0.153	(0.400)	−2.648	(3.040)
Saitama	−0.053	(0.274)	1.052	(0.195)	−0.002	(0.288)	−0.842	(1.789)
Chiba	0.715	(0.528)	0.662	(0.236)	0.377	(0.410)	−0.717	(2.605)
Tokyo	0.515	(0.281)	0.718	(0.323)	0.233	(0.093)	−0.244	(2.852)
Kanagawa	−0.639	(0.799)	1.491	(0.418)	−0.147	(0.423)	−1.404	(2.111)
Niigata	0.331	(0.305)	0.426	(0.154)	−0.243	(0.376)	−1.826	(4.363)
Toyama	2.528	(0.737)	0.939	(0.266)	2.467	(0.649)	−21.882	(5.738)
Ishikawa	−0.142	(0.255)	0.325	(0.243)	−0.818	(0.414)	8.524	(4.383)
Fukui	−0.104	(0.333)	0.429	(0.126)	−0.675	(0.359)	2.339	(3.159)
Yamanashi	1.628	(0.797)	1.405	(0.566)	2.033	(1.160)	−13.696	(7.230)
Nagano	0.070	(0.405)	0.375	(0.277)	−0.555	(0.528)	4.424	(6.041)
Gifu	0.122	(0.216)	0.637	(0.172)	−0.242	(0.259)	−0.052	(1.843)
Shizuoka	0.715	(0.441)	0.478	(0.304)	0.193	(0.608)	−1.989	(2.517)
Aichi	0.775	(0.583)	0.552	(0.507)	0.327	(0.640)	−1.977	(2.737)
Mie	0.532	(0.150)	0.915	(0.347)	0.447	(0.387)	−7.593	(2.840)
Shiga	−0.247	(0.142)	0.885	(0.337)	−0.362	(0.327)	−0.956	(1.374)
Kyoto	0.478	(0.580)	0.556	(0.191)	0.034	(0.492)	0.886	(2.304)
Osaka	−0.411	(0.118)	1.159	(0.080)	−0.252	(0.059)	0.633	(0.695)
Hyogo	−0.322	(0.331)	0.926	(0.197)	−0.396	(0.266)	2.197	(1.977)
Nara	0.272	(0.398)	0.928	(0.519)	0.200	(0.212)	−2.341	(2.973)
Wakayama	−0.531	(0.193)	0.263	(0.175)	−1.269	(0.213)	−0.699	(3.445)
Tottori	0.776	(0.231)	0.458	(0.143)	0.234	(0.277)	−7.391	(4.920)
Shimane	−0.121	(0.368)	0.496	(0.141)	−0.625	(0.328)	7.983	(7.206)
Okayama	−0.663	(0.517)	1.008	(0.335)	−0.656	(0.304)	2.868	(3.102)

Table2 continued..

region	α_t		β_t		γ_t		τ_t	
Okayama	−0.663	(0.517)	1.008	(0.335)	−0.656	(0.304)	2.868	(3.102)
Hiroshima	0.273	(0.214)	0.610	(0.210)	−0.117	(0.299)	−0.919	(2.977)
Yamaguchi	−0.418	(0.559)	0.435	(0.267)	−0.983	(0.336)	−1.023	(3.705)
Tokushima	0.385	(0.283)	−0.422	(0.294)	−1.037	(0.555)	−3.489	(4.175)
Kagawa	0.365	(0.372)	0.620	(0.158)	−0.015	(0.418)	2.668	(3.548)
Ehime	−0.513	(0.390)	0.675	(0.147)	−0.838	(0.490)	−1.170	(5.703)
Kochi	0.144	(0.343)	1.218	(0.142)	0.362	(0.409)	−5.730	(6.948)
Fukuoka	−0.355	(0.457)	0.993	(0.181)	−0.361	(0.341)	−3.715	(3.021)
Saga	0.196	(0.174)	0.586	(0.295)	−0.218	(0.416)	5.839	(4.890)
Nagasaki	0.015	(0.428)	−0.005	(0.622)	−0.990	(1.006)	8.188	(12.268)
Kumamoto	0.539	(0.248)	0.848	(0.374)	0.387	(0.587)	−4.856	(5.731)
Oita	−0.226	(0.232)	0.304	(0.356)	−0.922	(0.502)	−4.968	(6.284)
Miyazaki	0.014	(0.146)	0.490	(0.139)	−0.496	(0.206)	5.775	(5.259)
Kagoshima	0.405	(0.201)	0.081	(0.205)	−0.514	(0.242)	11.289	(6.276)
Okinawa	−0.209	(0.440)	4.408	(1.266)	3.199	(1.064)	0.000	(0.000)
Average	0.184	(0.057)	0.664	(0.051)	−0.152	(0.070)	0.246	(0.738)