

The Spatial Density of Production Activity and Productivity Differentials across Regions: A Case of Korea*

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This study investigates the effects of the spatial density of production activity on labor productivity and total factor productivity in Korean manufacturing. A theoretical model that directly relates productivity growth to the spatial density of production activity is developed. The empirical results show that a higher density of production activity would lead to an increase in productivity in four regions (Gwangju, Gyeongsangbuk-do, Chungcheongnam-do, and Gyeonggi-do) out of 15 regions. Our empirical analysis further suggests that any increase in the density of production activity in the metropolitan cities (except for Gwangju) could lead to a decrease in productivity. It can be thus concluded that there is a potential for Korean firms to increase productivity by readjusting the density of production activity across regions.

JEL Classification: R12, R30

Keywords: spatial density, urban economics, new economic geography, localization, globalization, labor productivity, agglomeration effect

* Received November 30, 2007. Accepted August 7, 2008. The authors are grateful to the Asian Institute for Regional Innovation at Pusan National University for the financial support. The authors are also thankful to three anonymous referees for the valuable comments and suggestions which have significantly improved this paper.

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1. INTRODUCTION

This study aims to analyze productivity differentials across regions in Korea and to evaluate the relocation of production bases to foreign countries by Korean firms. One of the most pressing issues that faces the Korean economy is a slowdown in potential growth that seems to be associated with declines in productivity growth. This study investigates whether it is possible for Korean firms to achieve a higher rate of productivity growth by rearranging the spatial density of production activity across regions.

The Korean economy has increasingly moved toward globalization externally and localization internally since the early 1990s. The globalization of the Korean economy has catapulted Korean firms into fierce competition in the international marketplace, and the localization of the Korean economy has progressed in tandem with the need for a balanced national land development. Global competition and local specialization have exerted significant impacts on the structure of the Korean economy. The localization of the Korean economy has led to the construction of many production clusters in local areas, and the globalization of the Korean economy has propelled many Korean firms to move production facilities to foreign countries.

As localization and globalization have intensified, the Korean economy has been increasingly confronting new challenges. The most troublesome problem faced by the Korean economy is that the costs of operating factories have been rising rapidly in the face of the fierce competition from foreign competitors. The prices of industrial sites have soared and wages have steeply risen, but the productivity of Korean workers has significantly lagged behind that of workers in competitive countries. These factors have worked as obstacles to the enhancement of competitiveness by firms, which has made it inevitable for Korean firms to spearhead international competition by pursuing a different business strategy from confining production activities to the domestic territory. Many Korean firms have begun to relocate their production facilities to foreign countries to reduce the costs of production

and to enhance competitiveness in the international marketplace. The establishment of diplomatic ties with China in 1992 was a catalyst for the transfer of production bases to China and other South-East Asian countries.

The main purpose of this study is to investigate whether Korean firms could enhance the productivity of workers by readjusting the spatial density of production activity domestically across regions and to evaluate whether the relocation of production bases to foreign countries is the best solution. It is argued that overseas production bases are not the best solution to the deterioration of productivity growth if it is possible for firms to increase labor productivity by readjusting the density of employment domestically.

This paper is organized as follows. Section 2 reviews the recent literature on the spatial models of productivity. Section 3 develops a model that relates labor productivity to the spatial density of production activity in the spirit of the Ciccone-Hall model. Section 4 presents empirical results and discusses the implications of the empirical findings. Section 5 contains the concluding remarks.

2. THE MODEL

The past 10 years has witnessed a remarkable progress in the study of spatial disparities in labor productivity or wages. One distinguishing feature of these new developments is that they have attempted to explain spatial disparities in productivity growth and wages as a reflection of increasing returns to scale in the context of monopolistic competition. These new attempts are found in Combes and Lafourcade (2001, 2004), Forslid, Haaland and Knarvik (2002), Combes and Overman (2003), Head and Mayer (2003), Brakman, Garretsen and Schramm (2004), Combes, Duranton and Gobillon (2004), and Redding and Venables (2004).

There are two major competing theories explaining the spatial concentration of economic activity: New Economic Geography (NEG) theory and Urban Economics (UE) theory. NEG emphasizes varying market

potential, whereas UE stresses the importance of the density of production activity rather than market potential in explaining the spatial differentials in productivity and wages.

There have been also efforts to combine the two positions of the NEG and UE Models. The UE Model denies the effect of market potential that is the core of the NEG Model, and the NEG Model does not consider the effect of linkages, which is the essence of the UE Model. Some unified models bring the two perspectives together as a single empirical model in the form of an artificial nesting model. For example, Venables (1996) and Krugman and Venables (1995) explicitly model inter-sectoral linkages, and de Vaal and van den Berg (1999) derive a modified model in the NEG framework that takes into account producer service linkages. Finally, Redding and Venables (2004) and Amiti and Cameron (2004) attempted to combine the elements of the NEG Model and the UE Model by introducing intermediate inputs into the model.

This chapter develops a spatial production model that addresses productivity differentials across regions in the spirit of Ciccone and Hall (1996). The Ciccone and Hall (CH) methodology has several merits over existing NEG studies and particularly studies based on the UE Model that focus on industry size or population size.

First, by formulating the spatial density of economic activity as an important determinant of differences in productivity across regions, one can explicitly incorporate spatial efficiency into the model. Second, the Ciccone-Hall methodology adopts a parametric approach that has the advantage of comparing productivity differentials across regions by comparing estimated coefficients. Third, the Ciccone and Hall model enables one to figure out how much one area is more productive than other areas by estimating the density index of areas. Finally, the Ciccone-Hall methodology considers not only the agglomeration effect, but also the congestion effect in analyzing regional productivity, which enhances the reality of the model.

The theoretical model of spatial density used in this study is constructed

based on a significant modification of the Ciccone-Hall model. The Ciccone-Hall model is more suitable for the description of a large economy such as the U.S. economy. In the model of spatial density, the density of economic activity means the intensity of labor, human resources, and physical capital per square foot. The model emphasizes that density rather than size is a more accurate determinant of productivity. If a larger amount of labor and capital participates in production activity in a given area, then the density of economic activity increases, and vice versa. The density of economic activity is closely related to the determinants of total factor productivity. More specifically, the density of economic activity affects total factor productivity through the following channels:

i) Increasing returns to scale: If production technology exhibits constant returns to scale, but the transportation of products from one stage of production to the next involves costs that increase with distance, then the technology for the production of all goods within a particular geographical area will have increasing returns to scale, because a higher density will lead to a lower cost of production. The ratio of output to inputs will then rise with density.

ii) Externalities (= Spillovers): If there are technological spillovers from one firm to another, these externalities will bring about an additional increase in output, and density will contribute to productivity for this reason as well.

iii) Specialization: The third channel through which density affects productivity growth is the higher degree of beneficial specialization. Denser economic activity has advantages from specialization.

The production function describing output produced in an acre (or square kilometer) in city (or area) c by employing n_c workers and k_c machines is represented by

$$A_s [(e_c n_c)^\beta k_c^{1-\beta}]^\alpha (q_c / a_c)^{(\lambda-1)/\lambda}, \quad (1)$$

where A_s is a Hicks-neutral technology multiplier in area s encompassing

city c , e_c is a measure of the efficiency of labor at the city level (c), q_c is total output produced in city c , and a_c is total acreage in city c . Here α represents the coefficient of output elasticity. It shows that if output produced by the use of labor and capital in city c increases by 1%, output per acre will increase by α percent. Finally, q_c/a_c measures output per acre in city c and consequently the density of production activity. It is assumed that externality effects depend on the measure of density, that is, output per acre (q_c/a_c) and that the elasticity of output with respect to density is given by $(\lambda - 1)/\lambda$, which is constant.

Output produced in city c is given by

$$q_c = a_c A_s [(e_c n_c / a_c)^\beta (k_c / a_c)^{1-\beta}]^\alpha [q_c / a_c]^{(\lambda-1)/\lambda}. \quad (2)$$

Solving equation (2) for output per acre, we obtain

$$q_c / a_c = A_s^\lambda [(e_c n_c / a_c)^\beta (k_c / a_c)^{1-\beta}]^\gamma. \quad (3)$$

Note that $\gamma = \alpha\lambda$. This term needs further explanation. As discussed, α is the coefficient of total output with respect to production from physical input, and it is assumed to be less than 1. Production from physical inputs $((e_c n_c)^\beta k_c^{1-\beta})$ may exhibit decreasing returns to scale due to the congestion of production activity. As the employment of labor and capital inputs increases, returns to scale may decrease as a result of a higher density of production activity. On the other hand, $(\lambda - 1)/\lambda$ measures the coefficient of the elasticity of agglomeration associated with a higher density of production activity. This agglomeration effect comes from increasing returns to scale, externalities, and specialization. Since α measures the effect of congestion, and λ measures the effect of agglomeration, $\alpha\lambda$ can be either greater than or less than 1. If $\gamma = \alpha\lambda$ exceeds 1, then this is an indication that the agglomeration effect outweighs the congestion effect.

This study assumes that the labor efficiency index (e) depends log-linearly

on workers' average years of education (h).

$$e_c = h_c^\eta, \quad (4)$$

where η is the elasticity of efficiency labor with respect to education.

Aggregating output to the regional (or provincial) level gives output per acre produced in region s as follows

$$\begin{aligned} Q_s / a_s &= A_s^\lambda \{ [(e_s n_s) / a_s]^\beta [k_s / a_s]^{(1-\beta)} \}^\gamma \\ &= A_s^\lambda \{ [(h_s^\eta n_s) / a_s]^{\beta\gamma} [k_s / a_s]^{\gamma(1-\beta)} \} \\ &= A_s^\lambda h_s^{\eta\beta\gamma} (n_s / a_s)^{\beta\gamma} (k_s / a_s)^{\gamma(1-\beta)}. \end{aligned} \quad (5)$$

We divide Q_s / a_s by the number of workers in area s to obtain average productivity per acre in region s .

$$\begin{aligned} Q_s / (a_s n_s) &= [A_s^\lambda / n_s] [(h_s^\eta n_s) / a_s]^{\beta\gamma} [k_s / a_s]^{\gamma(1-\beta)} \\ &= A_s^\lambda h_s^{\eta\beta\gamma} [n_s^{\beta\gamma} / a_s^{\beta\gamma}] [1 / a_s]^{\beta\gamma} [k_s / a_s]^{\gamma(1-\beta)} \\ &= A_s^\lambda h_s^{\eta\beta\gamma} [n_s^{(\beta\gamma-1)} / a_s^{(\beta\gamma-1)}] [1 / a_s] [k_s / a_s]^{\gamma(1-\beta)}. \end{aligned} \quad (6)$$

Finally, we derive average productivity in region s by rearranging equation (6).

$$Q_s / n_s = A_s h_s^{\eta\beta\gamma} [n_s / a_s]^{(\beta\gamma-1)} [k_s / a_s]^{\gamma(1-\beta)}. \quad (7)$$

In order to obtain an estimation equation, we take logs of both sides of the equation (7).

$$\begin{aligned}
\log(Q_s / n_s) &= \lambda \log A_s + (\eta\beta\gamma) \log h_s + (\beta\gamma - 1) \log(n_s / a_s) \\
&\quad + \gamma(1 - \beta) \log(k_s / a_s) \tag{8} \\
&= \lambda \log A_s + \varphi_1 \log h_s + \varphi_2 \log(n_s / a_s) + \varphi_3 \log(k_s / a_s).
\end{aligned}$$

where $\varphi_1 = \eta\beta\gamma$, $\varphi_2 = \beta\gamma - 1$, and $\varphi_3 = \gamma(1 - \beta)$. By estimating φ_1 , φ_2 , φ_3 , it is possible to obtain the estimates of β , γ , η .

Finally, the index of density is given by

$$D_s = [(n_s h_s^\eta)^\theta a_s^{(1-\theta)}] / n_s. \tag{9}$$

where $\theta = \gamma\beta / [1 - \gamma(1 - \beta)]$. The estimation of equation (8) permits one to obtain the estimate of the index of density. Equation (9) shows that as the efficiency labor increases by 1 percent, then the density index increases by θ percent, which is positively related to the productivity of workers in area s .

There are some parallels between our model and the UE Model formulated by Fingleton (2006). Fingleton's wage equation is given by

$$\ln(w^0) = k_1 + (\gamma - 1) \ln(E) + (\gamma - 1) \ln(A). \tag{10}$$

In the Fingleton model, $\gamma = \alpha[1 + (1 - \beta)(\mu - 1)]$ and $\mu / (\mu - 1)$ is the elasticity of substitution between different services. α and β in the Fingleton model are the same as α and β in this study. As discussed, if γ is greater than 1, this indicates that increasing returns to scale occur as the density of employment increases. The coefficient γ in the UE Model formulated by Fingleton has a similar implication to θ in this study.

Our model has the following implications. Productivity in a denser area could be greater or smaller than productivity in a less dense area. If the effect of agglomeration such as increasing returns to scale, externalities, and specialization brought by a higher density outweighs the effect of congestion, then productivity in an area will increase as the area becomes denser.

Conversely, if the effect of congestion associated with a higher density dominates the effect of agglomeration associated with a higher density, then productivity in an area will decrease as the area becomes denser.

According to Ciccone and Hall (1996), the effects of agglomeration and congestion on productivity can be stated in terms of parameters as follows:

i) If the value of θ is greater than 1, labor productivity will increase with density, and if the value is less than 1, labor productivity will decrease with density. Thus, it is possible to raise labor productivity by moving workers from an area where θ is less than 1 to an area where θ is greater than 1. Thus $\theta = 1$ is a threshold point: if the value exceeds 1, the agglomeration effect dominates the congestion effect.

ii) Similarly, the coefficient γ measures the effect of production density on total factor productivity. If the value of γ is greater than 1, total factor productivity will increase with density, and if the value is less than 1, total factor productivity will decrease with density.

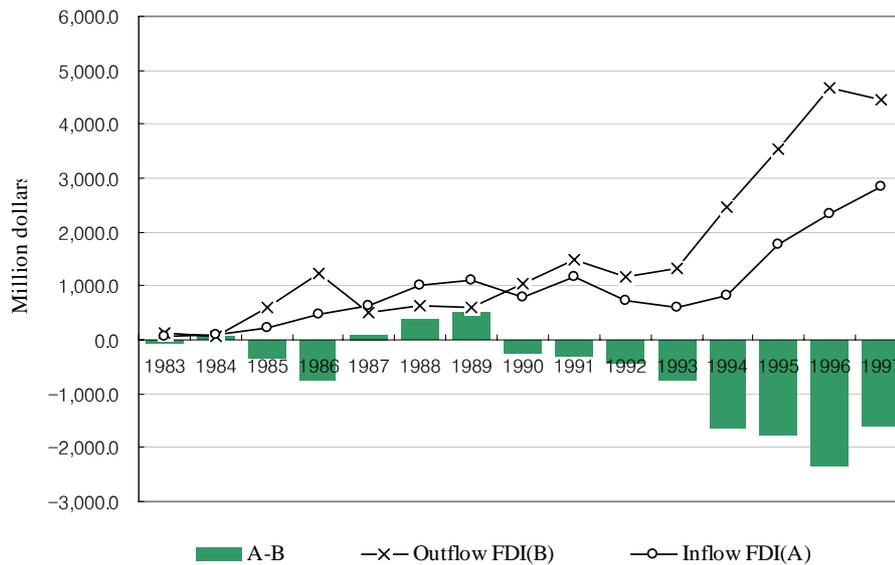
iii) For the purpose of illustration, it is assumed that θ is 1.06, γ is 1.04, and η is 0.40. The fact that θ is 1.06 implies that a doubling of employment density in area s increases average labor productivity by 6%. The fact that γ is 1.04 implies that a doubling of employment density in area s increases total factor productivity by 4%.

iv) Finally, assume that the index of density in area A is 1.94, and the index of density in area B is 1.59. This indicates that the productivity of workers in A is 22% higher than that of workers in area B [$1.94 = (1.59) \cdot (1.22)$].

3. EMPIRICAL ANALYSIS

3.1. Data

The data set used in this study (1983-1994) was taken from the Survey of Mining and Manufacturing Statistics compiled by the National Statistics Office (NSO). The primary purpose of this study is to investigate the effect of

Figure 1 FDI Inflows and Outflows

Source: Bank of Korea, ECOS.

the spatial density of production activity on labor productivity and total factor productivity across regions and to evaluate the relocation of production bases to foreign countries intensified in the middle of the 1990s. Naturally, this paper used the cross-sectional data spanning from the late 1980s to 1994 to estimate the spatial productivity model.

There are several reasons for using the data up to 1994. During this period, the industry policy that focused on the localization of industries made great progress in building industry clusters in the south-western and central areas. The intensive development of the south-western area was reinforced as the area emerged as a potential foothold for trading with China and South-East Asian countries.

At the same time, the globalization of the Korean economy and the relocation of Korean production facilities to foreign countries began to increase in the middle of the 1990s. As seen from figure 1, the capital account balances have turned into a deficit since 1990, and the magnitude of

the capital account deficits has increased substantially since 1994. Although not all of the capital account deficits were attributable to foreign direct investment (FDI), a considerable portion of the flow of domestic funds would be proportional to the transfer of production activity to foreign countries.

Finally, the focus of this study is on the analysis of the effect of spatial density on productivity growth before the financial crisis of 1997. There might be discontinuity in economic activity between the prior-financial crisis and the post-financial crisis, which may result in some distortion in the analysis of productivity growth.

The Survey of Mining and Manufacturing Statistics contains output, total employment, labor costs, and physical capital for 23 industries in the 15 metropolitan cities and provinces. The 15 areas include six metropolitan cities (Seoul, Busan, Daegu, Incheon, Gwangju, and Daejeon) and nine provinces (Gyeonggi-do, Gwangwon-do, Chungcheongbuk-do, Chungcheongnam-do, Jeollabuk-do, Jeollanam-do, Gyeongsangbuk-do, Gyeongsangnam-do, and Jeju-do). The sample used in this study includes 4,190 firms.¹⁾ Gyeonggi-do has the largest number of firms (806 firms) followed by Gyeongsangnam-do (473 firms), Gyeongsangbuk-do (455 firms) and Seoul (416 firms). Jeju-do has the smallest number of firms (36 firms).

Since the Survey of Mining and Manufacturing Statistics does not contain information on the acreage of each production area, data on the area provided by the Ministry of Government Affairs and Home Affairs is used. The whole country is divided into sub-regions of *si* (cities), *gun* (counties), and *goo* (wards) that have production activity, and the production acreage is calculated.

Unlike the existing studies that use the years of education as a proxy for the efficiency index of labor, this paper used the difference between the average wage and the establishment wage as a measure of labor efficiency.

¹⁾ These firms have been sampled by the National Statistics Office, and a set of data on sampled firms is available from the Office.

Table 1 Basic Statistics (1994)

Region	Firms	Log (Q/n)	Log (h)	Log (n/a)	Log (k/a)
Seoul	416	3.9728 (0.5074)	0.5704 (1.6915)	2.2614 (1.6607)	5.0297 (1.9570)
Busan	230	3.9148 (0.6586)	0.6019 (1.8446)	2.1017 (1.8566)	5.1122 (2.1589)
Daegu	138	3.8991 (0.5761)	0.3645 (1.9293)	1.5854 (1.8242)	4.7938 (2.2041)
Incheon	126	4.3155 (0.9101)	1.4793 (2.0052)	2.3681 (2.0358)	5.9007 (2.5324)
Gwangju	69	3.7847 (0.8379)	0.0134 (1.8662)	0.4417 (1.6509)	3.6227 (2.1995)
Daejeon	95	3.848 (0.6933)	0.2243 (1.5493)	0.6103 (1.6551)	3.8064 (2.1416)
Gyeonggi-do	806	4.0705 (0.6432)	0.7401 (1.6693)	0.4216 (2.0193)	3.6451 (2.4534)
Gangwon-do	232	3.7491 (0.8718)	-1.1109 (1.5252)	-1.9328 (2.0453)	1.3601 (2.5233)
Chungcheongbuk-do	249	4.0393 (0.8106)	-0.2895 (1.6458)	-1.3025 (1.6172)	2.2814 (2.1321)
Chungcheongnam-do	308	4.007 (0.8416)	-0.3555 (1.6523)	-1.1759 (1.7255)	2.5061 (2.2834)
Jeollabuk-do	256	3.7333 (0.8707)	-0.8329 (1.7142)	-1.4934 (1.7886)	1.763 (2.3030)
Jeollanam-do	301	3.7979 (0.8163)	-1.1092 (1.5596)	-1.6805 (1.8256)	1.6756 (2.1436)
Gyeongsangbuk-do	455	3.8962 (0.8144)	-0.4484 (1.7350)	-1.1585 (2.1352)	2.3906 (2.5580)
Gyeongsangnam-do	473	3.9239 (0.8683)	-0.0043 (2.0818)	-0.7097 (2.0982)	2.7214 (2.4559)
Jeju-do	36	3.8367 (0.5643)	-1.0848 (1.2176)	-1.9932 (1.3943)	1.4761 (1.9919)

Note: The numbers in parentheses are standard deviations.

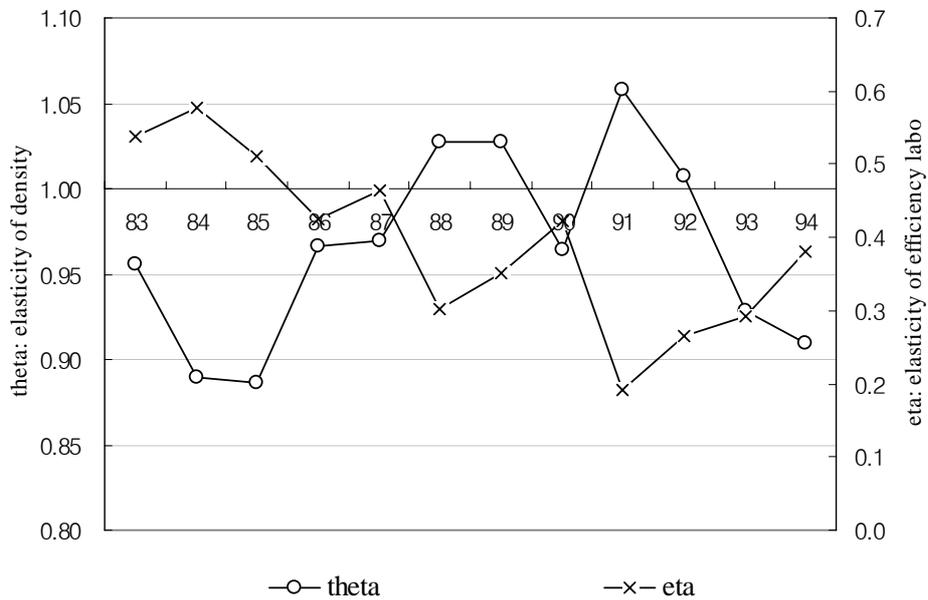
Source: National Statistical Office, Survey of Mining and Manufacturing Statistics, 1994.

3.2. Empirical Results

3.2.1. Estimation of the Model

Figure 2 displays the density elasticity (θ) and the elasticity of efficiency labor (η) using the estimates obtained from equation (8). The elasticity of density was less than 1 until the middle of the 1980s, and then began to rise, hovering between 1.0 and 1.05 until the early 1990s when the value began to fall rapidly. This finding indicates that the overall Korean manufacturing sector benefited from agglomeration effects, exhibiting increasing returns to scale and economies of scale from the middle of the 1980s to the early 1990s, but since the early 1990s, congestion effects have begun to outweigh agglomeration effects. The elasticity of efficiency labor has also shown a downward trend during the period.

Figure 2 The Elasticity of Density and the Elasticity of Efficiency Labor (1983-1994)



Source: National Statistical Office, Survey of Mining and Manufacturing Statistics.

Table 2 Estimation of Various Elasticities for Region

Region	γ	β	θ	η
Seoul	0.9262	0.7169	0.8999	0.1941
Busan	0.9233	0.5943	0.8774	0.2174
Daegu	0.9577	0.7005	0.9406	0.1704
Incheon	0.9577	0.7005	0.9406	0.1704
Gwangju	1.1052	0.5777	1.1973	0.0738
Daejeon	0.9083	0.6137	0.8588	0.4063
Gyeonggi-do	1.0029	0.6244	1.0047	0.1764
Gangwon-do	0.941	0.648	0.9117	0.4061
Chungbuk-do	0.9835	0.7404	0.9778	0.3183
Chungnam-do	1.0233	0.6454	1.0366	0.2468
Jeonbuk-do	0.9795	0.6223	0.9675	0.3528
Jeonnam-do	0.9361	0.6619	0.9066	0.3834
Gyeongbuk-do	1.0275	0.6996	1.0398	0.2065
Gyeongnam-do	0.9787	0.612	0.9657	0.3484

Source: National Statistical Office, Survey of Mining and Manufacturing Statistics, 1994.

This study is primarily concerned with whether differences in average labor productivity and total factor productivity are present across regions in Korea and whether it is possible to raise labor productivity and total factor productivity by readjusting the density of employment across regions. To this end, this study estimated various elasticities for 15 areas to examine productivity differentials across regions. We are particularly interested in the values of the parameters γ , β , θ . Table 2 presents the estimation results for various elasticities.²⁾

²⁾ Since these parameters are calculated from various estimated coefficients, this paper does not report the standard errors. The estimated coefficients upon which γ , β , θ are calculated are significant at the conventional level of significance. The standard errors and t -statistics of these coefficients are in the appendix.

3.2.2. Analysis of Empirical Results

(1) Agglomeration effects versus congestion effects

This study first estimated the value of γ to examine the effect of the density of production activity on total factor productivity (TFP). If γ is greater than 1, this indicates that the agglomeration effect attributable to a higher density of production activity is larger than the congestion effect attributable to a higher density of production activity. The agglomeration effect is due to increasing returns to scale, externalities, and specialization. Thus, the value of γ is closely related to the growth of total factor productivity.

The estimation result shows that the value of γ is greater than 1 in four areas: The coefficient is highest in Gwangju City (1.1052), followed by Gyeongsangbuk-do (1.0275), Chungchungnam-do (1.0233) and Gyeonggi-do (1.0029). This finding implies that in these four areas, the agglomeration effect outweighs the congestion effect and that as the density of production activity increases in these areas total factor productivity will also increase. The implications of the findings are as follows:

- i) Gwangju City (1.1052): A doubling of employment density increases total factor productivity by 10.5%.
- ii) Gyeongsangbuk-do (1.0275): A doubling of employment density increases total factor productivity by 2.8%.
- iii) Chungchungnam-do (1.0233): A doubling of employment density increases total factor productivity by 2.3%.
- iv) Gyeonggi-do (1.0029): A doubling of employment density increases total factor productivity by 0.3%.

The value of γ in other areas is smaller than 1. These areas include Seoul, Busan, Daegu, Incheon, Daejeon, Gangwon-do, Chungcheongbuk-do, Jeollabuk-do, Jeollanam-do, Gyeongsangnam-do, and Jeju-do. The area where the value of γ is smallest is Daejeon (0.9083) followed by Busan

(0.9233) and Seoul (0.9262). This finding implies that the congestion effect dominates the agglomeration effect in these areas and that as the density of production activity increases in these areas, total factor productivity will decrease.

One important implication to be drawn from the empirical analysis is that the mega cities except for Gwangju City have a value of γ that is smaller than 1. This finding signifies that these metropolitan cities have reached a threshold value of the density of production activity. These results show that there is room for productivity improvement when firms move production activities from the metropolitan cities (especially Daejeon, Busan, and Seoul) to other areas whose values of γ are greater than 1.

(2) Differences in Average Labor Productivity

In our model, the value of θ measures the effect of the density of production activity on labor productivity. As expected, the value θ has shown a similar trend to the value of γ . That is, θ is greater than 1 in Gwangju City (1.1973), Gyeongsangbuk-do (1.0398), Chungcheongnam-do (1.0366), and Gyeonggi-do (1.0047). These findings have the following implications:

- i) Gwangju City (1.1973): A doubling of employment density increases average labor productivity by 19.7%.
- ii) Gyeongsangbuk-do (1.0398): A doubling of employment density increases average labor productivity by 4.0%.
- iii) Chungcheongnam-do (1.0366): A doubling of employment density increases average labor productivity by 3.7%.
- iv) Gyeonggi-do (1.0047): A doubling of employment density increases average labor productivity by 0.5%.

The value of θ in other areas has turned out to be less than 1. In particular, the metropolitan cities except for Gwangju City have a relatively low value of θ . For example, θ is 0.8588 in Daejeon, 0.8774 in Busan,

and 0.8999 in Seoul. All these values are considerably lower than 1. As the density of employment increases in these areas, average labor productivity falls.

(3) Distribution of Income

The coefficient β is the distribution coefficient that measures the share of labor and capital in total output, respectively. More specifically, β measures the share of efficiency labor in total output, and $(1-\beta)$ measures the share of capital in total output. The value of β estimated from this study is a little bit larger than the values reported by previous studies. This difference seems to be attributable to the fact that this study has estimated the share for efficiency labor.

The areas where the value of β (labor share) is smaller than 0.6 include Gwangju (0.5777) and Busan (0.5943), and the areas where the value is larger than 0.7 include Incheon (0.7005), Daegu (0.7005), Jeju (0.7126), Seoul (0.7169), and Chungcheongbuk-do (0.7404). Overall, the areas that have a higher value of θ tend to have a lower value of β (labor share), and vice versa. For example, Gwangju has the lowest value of β (0.5777) among the 15 areas, but Gwangju has the highest value of θ . However, Busan is a noticeable exception to this pattern: β and θ in Busan are both relatively small.

This feature appears to be consistent with the theory of wage differentials across regions. That is, Gwangju has not fully taken advantage of spatial density yet and the productivity of workers in this area can be increased through an increase in the density of employment. If wage differentials can be explained by productivity differentials, then the wages of workers in an area where the value of θ is relatively large will be smaller than the wages of workers in an area where the value of θ is relatively small. It follows from this finding that if wages reflect productivity, the value of β should move opposite to the value of θ .

4. CONCLUDING REMARKS

The Korean economy is at the crossroads externally and internally. In particular, the rapid expansion of the Chinese economy is a big challenge to the Korean economy, but at the same time it is an opportunity for the Korean economy. Many Korean policymakers and business people have the sentiment that “the Korean economy is sandwiched by the Japanese economy and the Chinese economy” (Kun-Hee Lee, Chairman of the Samsung Group). Japanese firms have been leapfrogging Korean firms in technology, thus widening the technology gap between Korean firms and Japanese firms. At the same time Chinese firms have been chasing Korean firms in technology, thus narrowing the technology gap between Korean firms and Chinese firms.

More fundamentally, the problems faced by the Korean economy have become increasingly structural ones. Rapid increases in wages and sharp rises in the value of the won have made many Korean firms less competitive in the international marketplace. The strategy aimed at balancing the development of the nation across regions has led to steep hikes in the price of land for factory sites. Furthermore, the acceleration of globalization has sharpened labor disputes.

Faced with such challenges and hardships, many Korean firms have moved their production bases to foreign countries, especially to South-East Asian countries such as China, Vietnam, and the Philippines where labor costs are much lower than in Korea. The relocation of production facilities has been motivated to reduce production costs and to enhance the competitiveness of a firm. However, this study raises the question of whether such a strategy is the best solution to the deterioration of the competitiveness of Korean firms. In particular, this paper is concerned with whether it is possible for Korean firms to increase labor productivity by readjusting the spatial density of production activity domestically across regions. Our empirical results offer some insight into this question.

In order to investigate whether productivity growth is closely related to the density of economic activity and whether it is possible to increase

productivity by readjusting the spatial density of economic activity across regions, this paper has developed a model that relates labor productivity to the density of economic activity. Our model has been built based on the Ciccone and Hall (1996) model that is in the tradition of the UE (urban economics) model. This study has been particularly interested in how the density of production activity affects labor productivity and total factor productivity. As the density of production activity increases, we can expect some positive effects on productivity such as increasing returns to scale, externalities (spillovers), and specialization. These positive effects are agglomeration effects. However, there might be some negative effects on productivity such as the congestion of transportation and the deterioration of environment. Depending on the relative strength of these two forces, a higher density of production activity could increase or decrease productivity.

This study has found that there is a potential for Korean firms to increase labor productivity and total factor productivity by readjusting the spatial density of production activity domestically across regions. More specifically, it is possible for firms to increase labor productivity and total factor productivity by moving production activity from areas where θ (productivity elasticity) and γ (agglomeration elasticity) are less than 1 to areas where θ and γ are greater than 1. The areas where θ is greater than 1 include Gwangju City, Gyeongsangbuk-do, Chungcheongnam-do, and Gyeonggi-do. The areas where γ is greater than 1 are also Gwangju City, Gyeongsangbuk-do, Chungcheongnam-do and Gyeonggi-do. Our empirical results further show that the metropolitan cities except for Gwangju (Daejeon, Busan, Seoul, Incheon, and Daegu) have reached the inflection point of production density. In particular, Daejeon, Busan, and Seoul have the lowest values of γ and θ .

The relocation of production facilities to foreign countries (especially China) has been fashionable since the early 1990s. There are many factors (such as profit) that affect the decision of firms to move production bases abroad. One of the factors is profit. As long as firms could increase profits by relocating production facilities abroad, such a decision would be justified.

This study shows that the spatial density of production activity should also be an important factor in choosing between domestic and foreign production bases, because firms can also increase productivity and enhance competitiveness by readjusting the spatial density of production activity across regions in the domestic territory. Furthermore, the readjustment of the spatial density of production activity domestically has the effect of increasing spillover effects, creating more jobs, boosting consumption, and ultimately contributing to the balanced development of the nation.

APPENDIX

Table A1 OLS Estimates by Region

Region	Intercept	Log(<i>h</i>)	Log(<i>n/a</i>)	Log(<i>k/a</i>)
Seoul	3.3404 (36.1049)	0.12886 (4.4356)	-0.336 (-8.8522)	0.2622 (10.1261)
Busan	2.8764 (24.6830)	0.11931 (4.2354)	-0.4512 (-11.6268)	0.3746 (11.6394)
Daegu	3.0042 (19.1397)	0.1143 (3.5420)	-0.3292 (-5.9955)	0.2868 (6.3157)
Incheon	1.8814 (9.8226)	0.05677 (1.1921)	-0.7742 (-11.6577)	0.709 (13.4256)
Gwangju	2.2529 (9.3128)	0.04715 (0.6984)	-0.3615 (-4.2364)	0.4667 (6.6397)
Daejeon	2.7317 (12.7998)	0.22649 (2.9280)	-0.4425 (-4.6987)	0.3509 (5.4228)
Gyeonggi-do	2.7803 (36.0294)	0.11045 (5.8088)	-0.3738 (-13.4908)	0.3767 (15.4883)
Gangwon-do	2.8202 (20.0964)	0.24763 (5.4592)	-0.3903 (-8.8340)	0.3313 (8.9772)
Chungcheongbuk-do	3.188 (19.5173)	0.23182 (5.6262)	-0.2718 (-5.0528)	0.2553 (6.0240)
Chungcheongnam-do	2.7522 (20.7336)	0.163 (4.1551)	-0.3395 (-7.3556)	0.3628 (10.6798)
Jeollabuk-do	2.6769 (16.3546)	0.21504 (4.1979)	-0.3904 (-6.4050)	0.37 (8.4033)
Jeollanam-do	2.8842 (18.3941)	0.23759 (5.5290)	-0.3803 (-7.4564)	0.3165 (7.4066)
Gyeongsangbuk-do	2.9087 (24.1787)	0.14843 (4.9183)	-0.2811 (-7.0309)	0.3086 (9.7187)
Gyeongsangnam-do	2.5812 (21.6825)	0.20866 (7.4374)	-0.401 (-10.1470)	0.3798 (11.3046)
Jeju-do	2.9605 (10.5462)	0.16808 (1.4256)	-0.3312 (-2.7032)	0.2698 (4.1152)

Note: The numbers in parentheses are *t*-statistics.

Source: National Statistical Office, Survey of Mining and Manufacturing Statistics, 1994.

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