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# **The Effect of Manufacturing Firms' Spatial Distributions and Entrepreneurship on the Productivity of Manufacturing Industries: An Empirical Study from Korea**

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This paper investigated the spatial distributions of firms and entrepreneurship in relation to productivity. To analyze the effect of manufacturing firms' detailed distribution patterns on the productivity of manufacturing industries, micro geographic data were used. This approach avoids systematic problems relating scales and borders of box units; that is, administrative territories. First, agglomeration distances for every sub-industry were estimated; that is, the spatial boundaries of localization effect. Three main variables relating firms' spatial distribution patterns in the same industrial classification; that is, (1) the number of firms, (2) the average distance to other firms, and (3) disperse index from the standard deviation of firms' Euclidian coordinates, are computed from Euclidian coordinates of firms in the agglomeration boundaries. In addition, we checked the relationship between entrepreneurship and productivity. These tests were applied to an exhaustive dataset of manufacturing firms in Korea including the Seoul Metropolitan Area provided by NSO. We can predict the following for most sub-industries: (1) the number of firms with the same industrial classification in the agglomeration boundary has a positive effect on productivity; (2) the average distance to other firms has a positive effect below a specific distance and a negative effect beyond that; and (3) the more disperse firms are, productivity decreased. In addition, entrepreneurship can affect productivity under our basic assumption that entrepreneurship is effective if the firm is growing in sales volume and reputation.

## I. Introduction

Companies can create competitive power by taking advantage of a region's unique local characteristics in which companies are located. Maskell et al. (1998) called local characteristics, which affect businesses or industries, "localized capabilities." In today's knowledge-based economy, valuable local capacity becomes the ability to take advantage of creating, acquiring, accumulating, and using knowledge more quickly than competitors, where the firms are located in terms of cost. Recently, local capability-related academic authorities and policy makers have expressed a growing interest on industry clusters and regional innovation systems, which is based on such theories as Marshall's Industrial District (Marshall, A.); succeeding institutional economics; and the theory of Innovation Spaces by mainly the Neo-Schumpeterian Approach. According to Marshall (1890), industrial agglomeration can improve the firm's productivity by using mass production (internal economies that are identical to scale economies at the firm's level); availability of specialized input services; forming a highly specialized labor force; producing new ideas, based both on accumulating human capital and face-to-face communications; and the existence of a modern infrastructure. These become the key factors to enhance local capability. In addition, recent economic studies within various fields such as urban economics, economic geography, and knowledge economics are based on the Marshall's (1890) Industrial District theory. Industrial agglomeration, the key factor of companies' competitive power and local capabilities, is defined as spatial adjacency and improved productivity in addition to contributing to local growth. In fact, many studies regarding these claims explain the result of demonstration analysis, that the aggregation of population and industries' impacts on enterprises' and local productivity. These studies consider variables such as localization effects, represented by the degree of specialization and number of homogeneous company workers; urbanization effects, represented by industrial diversity and number of heterogeneous company workers; local

R&D stock; level of education; and social overhead stock. Mostly, these studies use aggregate data in an administrative district unit. For analyzing industrial/economic space, there is some room that possibly statistical biases may occur. These studies have primarily used the Si-Gun-Gu administrative districts in Korea as analysis units and have noted that the Si-Gun-Gu administrative districts area have large variations in size and area. Besides the Gun districts, Si-Gun-Gu units show the area difference of minimum 2.80 km<sup>2</sup>(Jung-gu, Pusan) with a maximum of 1,520.97 km<sup>2</sup>(Andong-si, GyeongBuk). Even when variables that are converted to unit area are used, the problem cannot be resolved. In other words, they transform dots on a map into units in boxes.<sup>1</sup>

Further, the spaces of industrial agglomerations may be restricted to some areas within administrative districts or may be formed by transcending the boundaries of administrative districts. Problems still remain, therefore, with the range settings of the spaces of agglomerations, even if the analysis model can be modified by considering adjacent administrative districts and the distance between districts.

This study, therefore, will verify the effects of agglomerations for individual firms by transforming the spatial distribution of individual enterprises in a metropolitan area into Euclidean coordinates in the Eup-Myeon-Dong unit to the degree that the National Statistical Office provides data. For this, we will analyze how the variables, which are based on the distribution of homogeneous firms located within the specified distance, will affect productivity by using point pattern analysis after the strength and the distance of manufacturing sub-agglomeration are established. It is important to analyze the information exchange and trade between individual firms of homogeneous industries and how this affects firms' productivity by verifying the external effects of localization economies. In addition to the effect of the localization of the economy, the urbanized economy effect of various local

attribute variables should be considered. This study, however, leaves that topic for future research. Studies on industrial agglomeration after Marshall (1890) have been classified into three categories. First is the study of the external effects of agglomeration and the mechanism by MAR (Marshall-Arrow-Romer) and Jacobs (1969) and Porter (YEAR) who can be called neo-Marshallian. These researchers see the key factors of dynamic external effects in industrial agglomeration as knowledge spillover, see favorable conditions for the spillover, and establish the mechanism of local growth.

Second, to estimate the effects of agglomeration economies, Sveikauskas (1975), Moomaw (1981), Henderson (1986), Nakamura (1985), Carlton (1983), Glaeser et al. (1992), Henderson, Kuncoro, and Turner (1995), Ciccone and Hall (1996) have conducted numerous empirical studies. These studies verify the effect of local characteristics on productivity and firms' location choices based on the production function model using geographic characteristics as independent variables and location choice models for the firm's foundation and relocation.

Third, Ellison and Glaeser (1997) and their successor Sédillot (1999), Devereux, Griffith, and Simpson's (2004) dartboard approach; Arbia and Espa's (1996) approach using Ripley's (1979) K-Function; Marcon and Puech (2003a, b), Quah and Simpson (2003), Duranton and Overman (2005, 2008) have studied the subject on economic measures for localization economy by the industry's spatial distribution pattern analysis.

In particular, various studies have been conducted on the effect of agglomeration economies. Mun and Hutchinson (1995) showed that productivity accelerates when the number of workers was increased at Toronto office firms. They also found the effects of agglomeration were the largest in the city, where the number of office employees increased.

Rosenthal and Strange (2003) showed in their analysis that new firms' employment creation is sensitive to the employment level of homogeneous industries in the neighborhood

of the respective firms. They also showed that the average of localized effects was reduced to approximately 50% of the rate per mile. We believe this study verifies the spatial effects of agglomeration beyond an administrative district. The external effects of an urbanized economy depend on the target area of study. Nakamura (1985) claimed that heavy industry is affected by the localized economy, while light industry is affected by the urbanized economy.

Duranton and Puga (2000) proved that the majority of new factories in France are located in diverse areas, while Rosenthal and Strange (2003) insisted that the effects of diversity are more dominant than that of specialization. Studies on the external effect of industrial agglomeration in Korea has been based primarily on the mythology that the external effect due to the production function is regressed to agglomeration economy variables, human capital variables, and the trans-log production function. Some researches have analyzed this using the trans-log cost function, spatial econometrics model, agglomeration index, and so on. These studies have statistical convenience, as mentioned above. Park et al. (2009) estimated the industry localized index based on the geographic coordinates of the manufacturers within a metropolitan area in Korea, drawing meaningful analyzed results that estimated the external effects of the localized economy for the industry with the high agglomeration intensity.

In addition, we investigate the effects of entrepreneurship on a firm's productivity. We focus on this topic because management skill plays an important role in management goals and performance. We assumed that small firms suffer from difficulties gathering important information and hiring promising employees. Hence, it is reasonable that entrepreneurship will be effective as the firm grows in sales volume and reputation.

## II. Models and Variables

### 1. Numerical Models

Fujita and Thisse (2002) established urban structure as a numerical model using bid rent theory and generalized equilibrium theory. They also created a numerical model that the external economy of the localization economy forms industrial agglomeration based on the model, which is structured by forming central business district(CBD, land use, and relevant city size, setting the information exchange of enterprises and workers, or accessibility as external effect. Following the work of Fujita and Thisse (2002), agglomeration coefficients that are modified by simplifying the reasoning processes are induced as follows.

This paper names global accessibility  $A(x)$ , which is integrated with local accessibility,  $a(x, y)$  of all locations,  $x \in [-b, b]$  within an agglomeration radius and agglomeration coefficients of enterprises.

Agglomeration coefficients for firms are used to establish the following production function coefficients, such that this paper aims to determine how the location coordinates of an enterprise,  $x$ , and the total number of enterprises  $pM$  function agglomeration coefficients. Therefore, if the density function of an enterprise  $m(x)$  is defined as similar to the secondary function instead of the cosine function, agglomeration is induced as follows:

$$\text{If } m(x) = 1 - \frac{x^2}{b^2},$$

$$A(x) = \int_x [\beta - \tau |x - y|] m(y) dy = \frac{9}{32} pM (2\beta - \tau) + \tau \left( \frac{1}{6b^2} x^4 - x^2 \right)$$

$$\left( \because pM = \int_x \left( 1 - \frac{y^2}{b^2} \right) dy = \frac{4}{3} b \right)$$

In this formula, we can intuitively find the definition of the relationship between the number of firms,  $pM$ , and the agglomeration coefficient,  $A(x)$ . The distance from the center point,  $x = 0$ , and the agglomeration coefficient,  $|x|$  have negative relationships through the following first-order derivative:

$$\frac{dA(|x|)}{dx} = \tau \left( \frac{2|x|^3}{3b^2} - 2|x| \right) \leq 0 \quad (\because 0 \leq |x| \leq b)$$

## 2. Empirical Model for Production Function

In this study, productivity is defined as annual output per capita for an individual firm. The log value of annual output per one work unit will be applied especially for a demonstration model. Annual output per worker is defined as capital input per capita, intermediate goods input per capita, and the function of agglomeration coefficients. So, this equation can be based on the Cobb-Douglas function. In Cobb-Douglas production function, because the index of each input element represents the production elasticity, it is a useful structure to understand the role of each element in the production process. In addition, estimates of the model are simple, and it is easy to estimate the elasticity. To understand the scale of production elements, however, each element of the economy, the relationships between each production, and local production elasticity, additional procedures are needed. The Cobb-Douglas production function is applied for the variables other than agglomeration coefficients because this study focuses on the agglomeration coefficients.

First, to analyze productivity by distance  $x$  from the center, the number of homogeneous enterprise variables that affect the agglomeration coefficients, this study set production functions composed of capital assets per worker, intermediate inputs per worker, and agglomeration coefficients. The following discussion is based on Henderson's (1986)



model that analyzed urban data in the United States and Brazil. The model is modified by the agglomeration coefficients based on the above theoretical models instead of the local variables that he used.

$$Y = A(\square)F(K, M, W)$$

Here,  $Y$  equals the company's annual gross;  $A(\square)$  the agglomeration coefficients;  $K$  capital assets, with tangible fixed assets at year-end, exclusive of assets;  $M$  main production costs as intermediate inputs;  $W$  as the gross annual wages as labor inputs; and  $L$ , employees. If  $F(K, M, W)$  is constant returns to scales, the above formula is expressed as follows.

$$Y / L = A(\square)F(K / L, M / L, W / L)$$

If log is applied on both sides of this formula, the following transformational Cobb-Douglas Production Function is derived:

$$\log(Y_i / L_i) = \alpha_0 + \log A_i(\square) + \alpha_1 \log(K_i / L_i) + \alpha_2 \log(M_i / L_i) + \alpha_3 \log(W_i / L_i)$$

$Y_i$ : Company  $i$ 's annual output

$L_i$ : Number of workers in Company  $i$

$K_i$ : Capital assets of Company  $i$

$M_i$ : Intermediate inputs of Company  $i$

$A_i(\square)$ : Agglomeration coefficients of Company  $i$

### 3. Agglomeration coefficients

Agglomeration coefficients  $A(\square)$  have a functional relation with the number of homogeneous firms,  $pM$  and the distance  $|x|$  from the agglomeration center. Let us assume that the agglomeration spaces in the mathematical model are circular, forming the agglomeration distance  $b$  from the agglomeration center. It is impossible, however, to set the agglomeration center on physical map and split absolute agglomeration spaces constantly. So, in this study, let us assume that the agglomeration distance is derived with the distance from K-Function, which is explained later. The relative agglomeration spaces of each firm are set in circular form with the location of each firm.

So, the variable  $pM$  is the number of homogeneous companies within agglomeration distance from other companies, and  $x$  is the average distance between each company and the party within agglomeration distances. Agglomeration form as a theoretical model is expressed as the bell-shaped form, which is demonstrated by a cosine curve. The distribution of companies within agglomeration spaces is very diverse, however, because the agglomeration location is relativized in the demonstration analysis. Thus, the coordinates dispersion index acts as control variables for the agglomeration form, which expresses the standard deviations of the coordinates of the company within agglomeration distance.

The coordinates dispersion index is defined as the standard deviation of the coordinate  $x$  and  $y$ , which is the square root sum of the variation of the coordinates of each company within the agglomeration space. Let us set the average coordinates of companies within the agglomeration distance,  $(x_0, y_0)$  and the coordinates of each companies,  $(x_i, y_i)$ .

$$SD_{xy} = \sqrt{VAR_x + VAR_y}$$

$$VAR_x = \sum_{i=1}^n (x_i - x_0)^2 / (n-1),$$

$$VAR_y = \sum_{i=1}^n (y_i - y_0)^2 / (n-1)$$

The agglomeration coefficients are thus expressed as follows.  $A(\square) = F(pM, x, SD_{xy})$  To simplify the name of variables and avoid duplication, the number of homogeneous firms  $pM$  is expressed as the ratio  $shM$  of the total of each industry and the number of homogeneous companies. The coordinates dispersion index,  $SD_{xy}$  is expressed as  $SD$ . The average distance  $x$  is transformed to  $X$  to distinguish the variables of location in mathematical models.

$$A_i(\square) = \exp(\beta_0 + \beta_1 shM_i + \beta_2 X_i + \beta_3 SD_i)$$

$A_i(\square)$ : Agglomeration coefficients of firms,  $i$

$shM_i$ : Company,  $i$  ratio of the total of each industry and the number of homogeneous firms.

$X_i$ : Company,  $i$ , average distance from homogenous firms within the agglomeration distance

$SD_i$ : Standard deviation of coordinates of homogeneous firms within the agglomeration distance

#### **4. Empirical Model for Tests**

The factor analysis model, with the agglomeration coefficients inserted into the production function is as follows:

$$\log(Y_i / L_i) = \alpha_0 + \alpha_1 \log(K_i / L_i) + \alpha_2 \log(M_i / L_i) + \alpha_3 \log(W_i / L_i) + \beta_1 shM_i + \beta_2 X_i + \beta_3 SD_i$$

In the theoretical model above, only positive (+) external effects are considered due to agglomeration. In reality, however, the negative (-) external effects may occur due to agglomeration if the level of agglomeration is increased to some degree. So, an alternative model for demonstration analysis, which includes the average distance, the variable is applied in quadratic formula can be set as follows:

$$\log(Y_i / L_i) = \alpha_0 + \alpha_1 \log(K_i / L_i) + \alpha_2 \log(M_i / L_i) + \alpha_3 \log(W_i / L_i) + \beta_1 shM_i + \beta_2 X_i^2 + \beta_3 X_i + \beta_4 SD_i$$

### III. Data and Summary Statistics

#### 1. Database

The data in this study include micro-data from the National Statistical Office mining manufacturing research (2006). The administrative districts of each company are composed of the Eup-Myoen-Dong unit. In addition, industry is classified by medium sized manufacturing industries. This study excluded “D16 Tobacco Manufacturing,” because such firms do not exist in the capital area. In addition, “D30 Computer and Office Equipment Manufacturing” and “D32 Electronic Components, Video, Sound, and Communication Equipment Manufacturing” were integrated then analyzed. These two industries were merged according to the 2007 industrial standard classification in the National Statistical Office. Euclidean coordinates of individual firms were randomly distributed to the firms that are located in each Eup-Myoen-Dong by extracting random coordinates within Eup, Myoen, and Dong using arcGIS software. This assumes that each company is distributed uniformly, due to the limitations of the information the National Statistical Office provided. Assuming Eup-Myoen-Dong, the smallest administrative unit currently provided by the National Statistical Office is circular, the average radius is 1.23 Km. The Euclidean coordinate of each company, therefore, has 1.23 Km average error.

## **2. Agglomeration Distances**

Agglomeration distance is needed to derive the variable associated with agglomeration coefficients. For this, K-density estimation by probability density curves of bi-distances (Duranton and Overman, 2005) was applied, using Ripley's (1979) K-Function. The K-density estimation is the method that tests the significance of probability distributions of bi-distances between companies.<sup>3</sup>

First, the Kernel probability density curve of every mutual distance for individual firms can be calculated using the Euclidean coordinates of companies in a particular industry. The next step is to set counterfactuals and imaginary companies because the number of companies for industry analysis are randomly distributed to the coordinates of the currently existing manufacturing companies (1,000 votes of independent trials). Finally, local confidence intervals and global confidence bands for each distance are made, using 1,000 Kernel probability density curves for mutual distance for randomly distributed coordinates.

With this, it is possible to compare the distribution and random distribution of actual mutual distance. In this study, the agglomeration distance is the distance between the probability density curve of the actual mutual distance for every company that belongs to a particular industry and the curves of global confidence bands. The meaning of local confidence intervals and global confidence bands refers to Duranton and Overman (2005).

The following is an example of a K-density probability density curve. We can see that industry code D33 (Medical, Precision, and Optical Instruments and Watch-making) is strongly integrated within an agglomeration distance 28.92 Km. In contrast, industry code D37 (Reproductive Worked Material Manufacturing) is distributed without the presence of agglomeration distance.



fig.1 K-density probability distribution curve of D33 industry

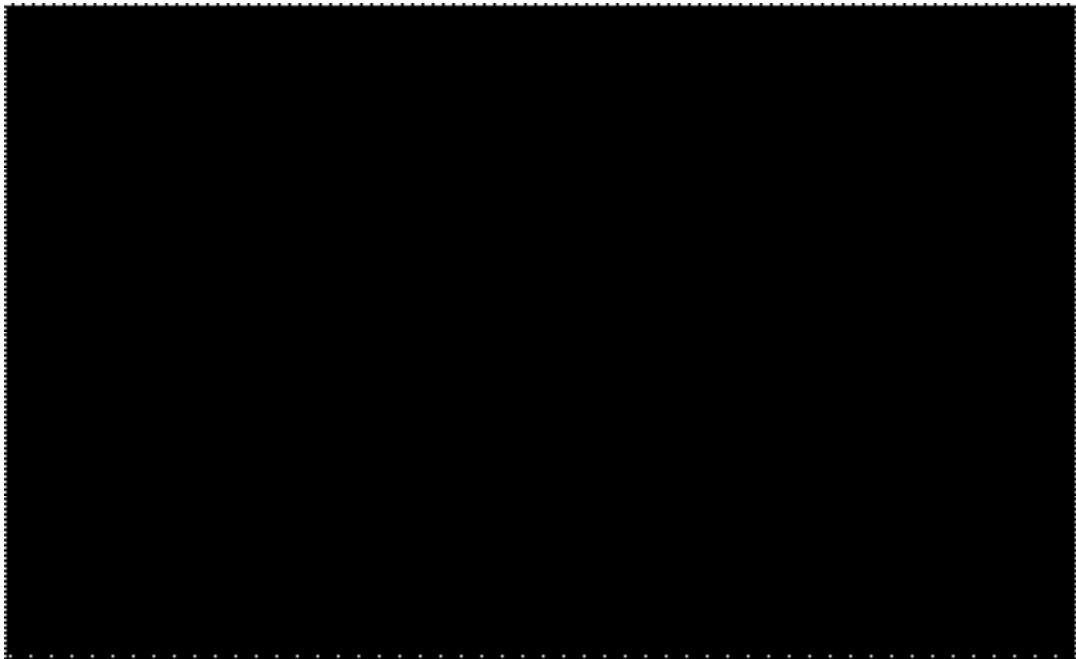


fig.2 K-density probability distribution curve of D37 industry

The results of the extracted agglomeration distance for each industry is presented in Table 1. The analysis shows that 11 industries are integrated within an agglomeration distance between 8.50 Km and 28.92 km and the rest are distributed. The weighted

agglomeration distance by number of companies for agglomerative industries is an average of 20.38 Km.

**Table 1: Agglomeration Distance for each Industry**

Industrial code	Agglomeration distances (kilometers )
D15 Groceries	-
D17 Textiles except sewing garments	17.89
D18 Sewing garments, and fur products	24.90
D19 Leather bags and shoes	30.08
D20 Wood and wood productions except furniture	-
D21 Pulp, paper, and paper products	-
D22 Publishing, printing, and recording media	34.39
D23 Coke, oil refined products, and nuclear fuel	-
D24 Chemicals and chemical products	-
D25 Rubber and plastic products	-
D26 Non-material mineral products	-
D27 The primary metallic industries	4.96
D28 Fabricated metal products except machinery and furniture	18.56
D29 Other machinery and equipment	24.02
D31 Other electrical machinery and electricity conversion device	54.57
D30 Computer and Office equipment D32 Electronic components, video, sound, and communication equipment	48.09
D33 Medical, precision, and optical instruments and watches	37.11
D34 Car and trailers	-
D35 Other transportation equipment	9.05
D36 Furniture and other products	69.41
D37 Reproductive worked materials	-
Weighted average distance of agglomeration industry	30.44

### 3. Summary Statistics

The main variable technical statistics for every manufacturing industry are presented in Table.

2. The unit of  $X$ ,  $SD$  that are associated with distance is Km; the unit of yearly productions  $Y$ ; capital assets  $K$ ; intermediate inputs  $M$ ; wages  $W$ ; 1 million won; and the unit of worker number is person.

**Table 2: Summary Statistics for Total Manufacturing Industries**

Variable	Mean	SD	Min	Max
$\log(Y / L)$	4.48	0.91	9.55	-2.56
$shM$	0.47	0.29	0.95	0.00
$X$	11.59	4.06	25.01	2.95
$SD$	10.50	3.24	17.75	2.92
$\log(K / L)$	2.48	1.63	8.46	-4.07
$\log(M / L)$				
$\log(W / L)$	3.42	1.63	8.14	-4.44

The technical statistics of every industrial variable are omitted for space reasons, but the technical statistics of the dependent variables that show industrial productivity will be discussed. The industrial dependent variable in Table 3 is log value of the output per worker  $\log(Y / L)$ .

**Table. 3. Summary Statistics for Independent Variables for each Industries**

Industry code	N	Mean	Standard deviation	minimum	Maximum
D15	8,130	4.41	1.16	-0.56	9.16
D17	8,417	4.31	0.97	-1.95	8.20
D18	8,290	3.53	0.94	-1.61	7.77
D19	1,906	4.03	1.05	0.00	7.19
D20	2,024	4.55	0.86	-0.10	7.07
D21	3,032	4.69	0.76	-1.14	7.56
D22	6,117	4.31	0.67	-0.45	7.30
D23	117	5.83	1.30	2.99	9.55
D24	4,220	4.99	1.06	-2.30	9.53
D25	9,068	4.65	0.76	-2.56	8.71
D26	4,115	4.88	1.02	-2.08	8.29
D27	3,138	5.32	1.03	1.04	9.68
D28	14,906	4.63	0.72	-1.79	9.10
D29	16,278	4.75	0.71	-2.40	8.39
D31	6,303	4.67	0.85	-2.08	8.09
D30/32	6,033	4.52	0.99	-2.08	8.43
D33	3,164	4.38	0.82	0.10	7.60
D34	4,127	4.74	0.90	-3.33	10.40



D35	1,115	4.40	1.00	-5.21	8.19
D36	6,094	4.32	0.78	-0.32	8.94
D37	469	5.14	1.08	0.51	8.55

In the technical statistics of the dependent variables, the most productive industries are D23, D27, and D37. For D18, D19, and D17, and so on that belong to traditional light industries, productivity is relatively low, while the deviation of productivity in homogeneous industries is relatively large.

## IV. Results

### 1. Results for Total Industries, Agglomerative Industries, and other Industries

In this study, we can understand the overall tendency of manufacturing prior to industrial analysis. The analysis of results for agglomerated industries and distributed industries are compared through the K-density probability density distribution curve. Because the agglomeration distances for each industry varies, the variables are extracted by average distance of agglomeration industry, which is weighted by the number of companies for each industry. The results of regression analysis are displayed in Table 4.

Table. 4. Results for Total Manufacturing Industries

Variable	co-efficient	t-value	p-value
intercept	1.540 ***	208.10	<2e-16
<i>shM</i>	0.063 ***	12.10	<2e-16
<i>X</i>	-0.003 ***	-11.70	<2e-16
<i>SD</i>	-0.001 ***	-18.90	<2e-16
$\log(K / L)$	0.018 ***	23.10	<2e-16
$\log(M / L)$	0.471 ***	526.90	<2e-16
$\log(W / L)$	0.462 ***	190.50	<2e-16

Squared R = 0.842 F-stat. = 1.04e+05 (<2e-16)

D.W. = 1.778 (<2e-16)

\* 10% signif., \*\* 5% signif.. \*\*\* 1% signif.

The overall productivity of manufacturers is analyzed to react very sensitively to the number and the distribution pattern of homogeneous firms within the agglomeration boundary. The number of homogeneous companies affects the productivity positively; the average distance between homogeneous companies, negatively; and the standard deviation of coordinates of homogeneous companies within agglomeration distance, negatively. The distribution of homogeneous firms within the agglomeration distance and the standard deviation variable,  $SD$ , of the coordinates showed strong negative effects to productivity. This means that productivity increases more when the companies become closer within the agglomeration distance. The industry derived the significant agglomeration distance by K-density probability density curve is illustrated in Figure 1, while Figure 2 shows agglomeration industry. In other words, it is called a distribution industry. See Table 1 for the industry. Table 5 displays the results of agglomeration, while Table 6 displays the analytic result of distribution. Variables  $shM$  and  $X$  are calculated using the average agglomeration distance above overall industry analysis.

Table. 5. Results for Agglomerative Industries

Variable	co-efficient	t-value	p-value
intercept	1.630 ***	186.45	<2e-16
$shM$	0.041 ***	7.39	0.000
$X$	-0.002 ***	-6.62	0.000
$SD$	-0.001 ***	-16.39	<2e-16
$\log(K / L)$	0.015 ***	16.95	<2e-16
$\log(M / L)$	0.441 ***	436.24	<2e-16
$\log(W / L)$	0.462 ***	152.93	<2e-16

Squared R = 0.840      F-stat. = 7.16e+04 (<2e-16)

D.W. = 1.784 (<2e-16)

\* 10% signif., \*\* 5% signif.. \*\*\* 1% signif.

Table. 6. Results for other Industries

Variable	co-efficient	t-value	p-value
intercept	1.161 ***	80.26	<2e-16
$shM$	-0.208 ***	-9.58	<2e-16
$X$	0.000	0.57	0.568
$SD$	0.012 ***	3.55	0.000
$\log(K / L)$	0.019 ***	13.35	<2e-16
$\log(M / L)$	0.577 ***	328.63	<2e-16
$\log(W / L)$	0.428 ***	108.34	<2e-16
Squared R = 0.867    F-stat. = 3.82e+04 (<2e-16)			
D.W. = 1.829 (<2e-16)			
* 10% signif., ** 5% signif.. *** 1% signif.			

All variables of agglomeration industry affect the productivity in same direction with above result of manufacturing industry. The impacts on productivity of the three variables corresponding to agglomeration industry and distribution industry are all in opposite directions.

It is possible to analyze industrial agglomeration and distribution pattern, therefore, by K-density probability density curve and understand the effects of variables used as a technology index for productivity analysis regression model constantly.



Because the independent variables of the demonstration model,  $shM$ ,  $X$ ,  $SD$  were calculated by reflecting each industrial agglomeration distance, the regression analysis in each industry is need for precise analysis. Table 5 shows the industry that can calculate the agglomeration distance, showing significant agglomeration patterns in medium sized manufacturing industries.. In the case of industry codes D17, D18, D19, D27 variable  $X^2$  is used because the variable, average distance  $X$  with quadratic formula is significant.

As the average distance increases, the productivity increased to decrease in quadratic form. This means the average distance has negative effects below the maximum.

The overall significance of variables and marked direction of coefficients do not differ significantly from the regression analysis of the agglomeration industry shown in Table 3. For companies in the categories of D19, D27, D28, D29, D37, D30/D3, and D33 the productivity falls when the number of homogeneous firms within the agglomeration distance increased. In the case of these industries, localization economy cannot be described by other spatial units or estimated agglomeration distance. Further, localized economy cannot be estimated statistically.

## **V. Entrepreneurship and Productivity**

From the encyclopedia, *entrepreneurship* is defined as “the state of being an entrepreneur.”

An entrepreneur is an individual who owns, organizes, and manages a business and, in so doing, assumes the risk of either making a profit or losing the investment. For any business to be successful, an adequate level of funding must be available. The amount needed varies according to the scope and nature of the business. Another key factor in the success of an entrepreneurial organization is planning, including planning for marketing, management, and the financial aspects of the business.

Because management skill plays an important role in management goals and

performance, we focus on this topic as well. It is obvious that checking the relationship between entrepreneurship and productivity is meaningful. Further, to investigate the effects of entrepreneurship on a firm's productivity, we need to begin with various assumptions. We assumed that small firms have difficulty gathering important information and promising employees. Hence, it is reasonable that entrepreneurship will be effective as the firm grows in sales volume and reputation.

The same frameworks are applied for this purpose and the number of workers or sales volume are included as a dummy variable.

In the case of industry total, as the number of workers increases, the productivity increases. We can verify our assumption that entrepreneurship will function as the firm grows in sales volume and reputation.

This is very basic approach for analyzing the relationship between entrepreneurship and productivity.

**Table 8: Results for Entrepreneurships and Productivity (Industry Total)**

<b>Industry Total</b>	<b>Estimate</b>	<b>Std.Error</b>	<b>t-value</b>	<b>Pr(&gt; t )</b>	
(Intercept)	2.44E+00	1.37E-02	178.15	<2e-16	***
shM	1.97E-01	5.83E-03	33.78	<2e-16	***
Xp	6.13E-05	5.72E-05	1.07	0.28	
X	-1.82E-03	1.79E-03	-1.02	0.31	
SD	-1.08E-03	7.00E-05	-15.37	<2e-16	***
KL	2.98E-02	8.76E-04	33.96	<2e-16	***
ML	5.34E-01	9.32E-04	572.92	<2e-16	***
E1	1.56E-01	3.89E-03	40.12	<2e-16	***
E2	3.53E-01	8.18E-03	43.12	<2e-16	***
E3	3.96E-01	1.82E-02	21.74	<2e-16	***
E4	6.14E-01	4.01E-02	15.31	<2e-16	***
R.sq.	8.01E-01				

The results using sales volume instead of using number of workers are shown in Table 9. Further, in the case of industry total, as the sales volume increases, productivity also increases.

**Table 9: Results for Entrepreneurships and Productivity (Industry Total)**

Industry Total	Estimate	Std.Error	t-value	Pr(> t )	
(Intercept)	2.57E+00	1.25E-02	205.41	<2e-16	***
shM	1.83E-01	5.31E-03	34.43	<2e-16	***
Xp	-4.13E-06	5.22E-05	-0.08	0.94	
X	-7.39E-04	1.63E-03	-0.45	0.65	
SD	-7.87E-04	6.38E-05	-12.34	<2e-16	***
KL	1.69E-02	8.03E-04	20.99	<2e-16	***
ML	4.62E-01	9.68E-04	477.02	<2e-16	***
R1	3.20E-01	2.80E-03	114.2	<2e-16	***
R2	5.55E-01	4.30E-03	129.1	<2e-16	***
R3	7.40E-01	8.13E-03	91.06	<2e-16	***
R4	9.77E-01	9.66E-03	101.15	<2e-16	***
R.sq.	8.34E-01				

## VI. Conclusion

In this study, industrial agglomeration patterns of middle class manufacturing was identified based on the location coordinates of the individual firm, not the administrative unit. With this aim, this study shows the external effects of the manufacturing industry, which calculated spatial distribute-related variables of homogeneous companies. The number of homogeneous companies within agglomeration distance affects productivity positively; while the average distance between homogeneous companies affects productivity negatively above a certain distance. The standard deviation of location coordinates affects productivity negatively.

In the case of manufacturing industries with the agglomeration phenomenon, the localization economic impact is identified as has been done in previous research studies. In

addition, the distribution of companies within agglomeration distance affects the productivity significantly. For specific industries in the industrial analysis, the average distance is expressed in a quadratic curve at large. It thus affects productivity negatively above a certain distance (maximum); while below this point it affects productivity positively. This means that excessive adjacency or agglomeration distribution brings negative external effects.

This study is significant because the proposal, that is that the possibility of spatial bias exists is deleted due to differences in the economic space and the administrative space. In particular, the benefit applied in the methodology of this study is that it proposes an industrial systematic standard in the spatial range setting of studies or policies in relation to industrial clusters and region-specification.

This study focuses and makes progress according to localization economy, which is based on homogeneous companies. In the future, however, urbanized economic analysis on other industries in manufacturing or manufacturing-related services, especially business services, finances, R&D appears to be need.

It should be noted that the data used in this study have not be given in detail on Eup-Myoen-Dong unit from spacial viewpoints and the manufacturing middle-class category from industry classification side. A feeling of dissatisfaction remains regarding the data, even though it is the most recognized data in Korea.

In case of overseas research studies such as Duranton and Overman (2005), Arbia, Espa, and Quah (2008), the spatial unit of analyzed data is zip code unit, which does not exceed 100m in distance error. In this case, the accuracy of analysis increases because industry classification is covered by sun-classification or detailed classification.

In summary, this paper aimed to analyzing the relationship between entrepreneurship and productivity using industry data. It found that entrepreneurship, assuming firm size, sales volume, and number of workers affected productivity.



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## Appendix

Industrial code		
ind15	Groceries	Other industry
<b>ind17</b>	Textiles except sewing garments	<b>Agglomeration industry</b>
<b>ind18</b>	Sewing garments and fur products	<b>Agglomeration industry</b>
<b>ind19</b>	Leather bags and shoes	<b>Agglomeration industry</b>
ind20	Wood and wood productions except furniture	Other industry
ind21	Pulp, paper and paper products	Other industry
<b>ind22</b>	Publishing, printing and recording media	<b>Agglomeration industry</b>
ind23	Coke, oil refined products, and nuclear fuel	Other industry
ind24	Chemicals and chemical products	Other industry
ind25	Rubber and plastic products	Other industry
ind26	Non-material mineral products	<b>Agglomeration industry</b>
<b>ind27</b>	The primary metallic industries	<b>Agglomeration industry</b>
<b>ind28</b>	Fabricated metal products except machinery and furniture	<b>Agglomeration industry</b>
<b>ind29</b>	Other machinery and equipment	<b>Agglomeration industry</b>
<b>ind31</b>	Other electrical machinery and electricity conversion device	<b>Agglomeration industry</b>
<b>ind32</b>	Computer and Office equipment Electronic components, video, sound, and communication equipment	<b>Agglomeration industry</b>
<b>ind33</b>	Medical, precision and optical instruments and watches	<b>Agglomeration industry</b>
ind34	Car and trailers	Other industry
<b>ind35</b>	Other transportation equipment	<b>Agglomeration industry</b>
<b>ind36</b>	Furniture and other products	<b>Agglomeration industry</b>
ind37	Reproductive worked materials	Other industry

Variable Description			
<b>Dependent variable</b>	<b>YL</b>	Labor productivity(Output per capita)	Logarithm value of (annual output)/(# of worker)
<b>Independent variable</b>	<b>shM</b>	External effect of localized economy	(# of Homogeneous companies within agglomeration radius)/(# of nationwide homogeneous companies)
	<b>Xp</b>	Distance between homogeneous companies	Square of (average distance between homogeneous companies within agglomeration radius)
	<b>X</b>		(average distance between homogeneous companies within agglomeration radius)
	<b>SD</b>	Spatial distribution of homogeneous companies	(Standard deviation of homogeneous company coordinate within agglomeration radius)
	<b>KL</b>	Capital per capita	Logarithm value of (tangible property year-end balance-asset under construction)/(# of worker)
	<b>ML</b>	Intermediate goods per capita	Logarithm value of (major production cost)/( # of worker)
	<b>E1</b>	# of worker Dummy variable	30 person or more, less than 100 person
	<b>E2</b>		100 person or more, less than 300 person
	<b>E3</b>		300 person or more, less than 1000 person
	<b>E4</b>		1000person or more
	<b>R1</b>	Annual output Dummy variable	1,000 million won or more, less than 5,000 million won
	<b>R2</b>		5,000 million won or more, less than 20,000 million won
	<b>R3</b>		20,000 million won or more, less than 50,000 million won
	<b>R4</b>		50,000 million won or more