Ph.D. Dissertation of Economics

Essays on Industrial Location and Job Selection of University Graduates

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Abstract

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This research examines issues in the factors determining job location choice of university graduates as a source of regional human capital as a source of regional human capital, and identifies the location determining factors of small firms and large enterprises as an effect of abundant regional labor market pooling.

The first essay attempts to adopt the frame of the firms' managerial theory to shed light on the different locations of the small firms and large enterprises. The first essay targets to electronics manufacturing industry, which is one of the key force for driving economic growth in Korea. The electronics manufacturing firms in Korea are being geographically concentrated in the Seoul Metropolitan Area. However, along with firm size, small firms and large enterprises have exhibited in different locations. Small firms more concentrated on the Seoul Metropolitan Areas than large enterprises. This study identifies the location of small firms and large enterprises by using binary logit model. The econometric results suggest that an abundant labor market pool has

affected the small firms' location patterns. Concretely, firms facing financial constraint and expertise constraint tend to be located in the regions close to the main domestic market. On the contrary, large enterprises have a tendency to agglomerate only in the region close to a high-speed railroad station and to be less deregulated. In addition, large enterprises do not tend to locate in overpopulated constraint districts and nature conservation districts rather than in growth management districts according to Seoul Metropolitan Areas Readjustment Planning Acts. In the view of the subcontract relation between small firms and large enterprises, small firms tend more to be close to the cluster of large enterprises. These results indicate that when establishing regional industrial policies, the direction of effective policy is suggested depending on the type of industry, size of firm and features of local labor market.

For the second essay, Korea have experienced an increasing imbalance of human capital as well as economy between the Seoul Metropolitan Areas and the other regions. The main objective of this study is to analyze the determining factors of job location choice of university graduates. Bivariate probit models with sample selectivity are used to target university graduates whose domiciles are lagging regions in Korea. The econometric results suggest that even if education investment in local universities is increased or education investment is concentrated in local public universities, it has not been able to reduce the outflow to the Seoul Metropolitan Areas to receive university education. However, the high school graduates from lagging regions with local public universities did not tend to go to the metropolitan universities. In order to compensate

for the limited effect of educational investment on local universities, this study stresses that graduates of metropolitan universities choose job location as lagging regions, or that graduates of local universities remain in the lagging regions without leaving to the Seoul Metropolitan areas for a job. Common factors for the two paths are individual college majors. Graduates who majored in education or medicine are more likely to return to lagging regions or to remain in those regions. In addition to major, there are two main factors to stimulate to return to lagging regions with high level of R&D investment in research institutes to their home village at state level. On the other hand, there are two main factors to encourage to remain in lagging regions after graduation. Graduates in lagging regions with a high proportion of heavy industry are less flowed out to developed regions. Additionally, individuals tend to remain when they get a job in their domiciles or regions with their colleges. These results of the second essay skeptically ask whether existing education and R&D investment in local universities is effective in attracting talented people. In addition, this study suggests a policy implication that non-economic factors contributes to selecting job location different with the case of migration patterns from rural to urban areas.

Keyword: Regional labor market, industrial location, small firms and large enterprises, job location choice of university graduates, return migration, educational investment

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To my parents

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Chapter 1 Introduction

Many economists have focused on the importance of the regional labor market in terms of a source of regional human capital, as endogenous production factors, and labor quantities, as traditional production factors. In addition, regions with large labor market may exhibit high levels of potential growth rate according to the Keynesian approach[1]. This economic potential can be realized with industrial activities, leading to agglomeration economic benefits, and may be improved by various types of investment to retain in or attract human capital from a space. Korea's local areas have been in affliction derived from poor labor market due to brain drain. According to the 2015 national account statistics, the SMA has 49.5% of the total population and 52.2% of the prime working age population (25–49 years old age cohort), occupying 11.9% of the national total land area. In this regard, concentrating on designing population policies should be valuable in how to thicken labor markets in local areas.

[1] Scacciavillani and Swagel (1999) suggested that literature in potential

This research studies urban and regional economics among a wide variety of economics fields. Specifically, regional economics points out the determining factors of increasing human capital in-migrants, leading to enlarging regional labor supply in terms of regional economics (Krugman, 1998)[2]. The representative academic traditions studying regional economics have focused on the causality between wages and the interregional labor market, factor allocation, along with the beneficial and detrimental economic effects of interregional migration (McCann, 2013). In addition, urban economics investigates the relation between the regional labor market pool and industrial agglomeration in terms of urban economics (Marshall, 1920). An important stream of research associated with the labor market in urban economics has documented the various sources, the types of agglomeration economies, the clustering of firm and people, the spatial distribution of industrial activities, etc.

Even so, most empirical works in agglomeration economies did not propose the different effects of the regional labor market on

[2] Krugman (1998) suggested that thick labor market sustained big cities by increasing returns rather than constant returns thanks to thickness of local labor market.

industrial agglomeration across firm size. The impact of economic determining factors on regional in-migrants has not been proved to be limited in stimulating people to retain within lagging regions. In view of the general aspects and evaluation of the importance of the knowledge of the regional labor market, this research explores the following two research questions about the cause and effect of thick regional labor markets:

1) How significant is the regional labor market in terms of industrial activities? In the case of electronics industry, what kind of firms can be agglomerated by the difference in the regional labor supply?

2) What kind of regional attributes can increase in-migrants in lagging regions? Focusing on youth migration, can the educational investment work properly for this purpose?

By using these decision models, this research aims at understanding 1) the heterogeneous location behaviors of firms by size and 2) the different impact of regional attributes in developed

regions and lagging regions. This research considers the regional variation such as a) the size of labor market pooling, b) the access to transportation, c) the level of deregulation, d) the amount of educational investment, e) the presence of local universities etc., in studying regional labor market. Each of the two essays analyzes the determining factors on firm location and the determining factors of in-migrants. Specifically, the first essay concentrates on the effect of regional labor market on firm location, which varies depending on firm size. The second essay focuses upon the education and R&D investment on the in-migrants of young people in lagging regions. Figure 1.1 illustrates the framework of the two essays in this dissertation.

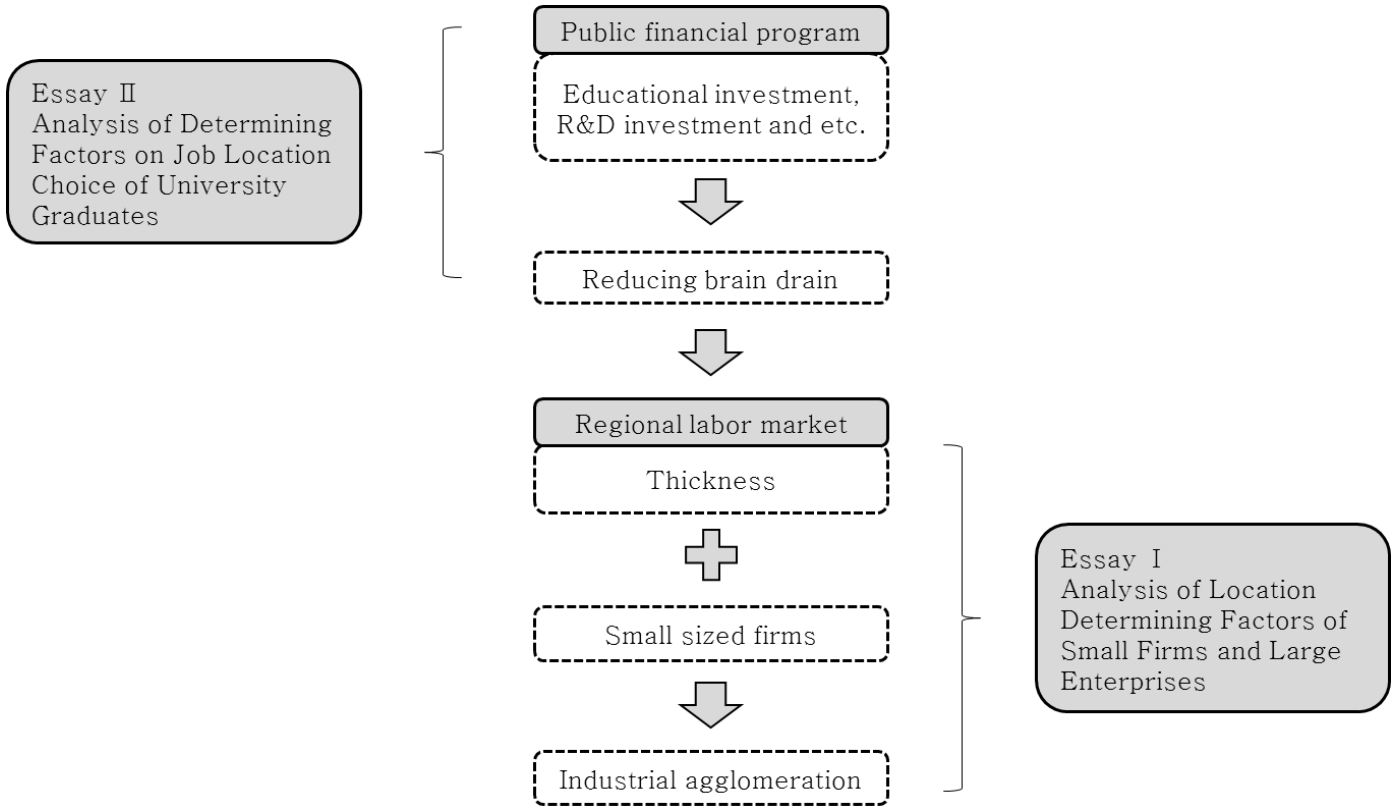

Figure 1.1 Research Framework

The first issue discusses the location of small firms and large enterprises, through data analysis with a focus on electronics manufacturing industry. Dependent variable is hot spot calculated by Local Moran's I index based on the number of employment. Independent variables are population size, population growth rate, the number of employment in intermediate sector, the proximity to high-speed railroad station, and deregulation index. A logit model structure is applied to identify the location of industrial agglomeration at the municipality (Sigungu in Korea) level, using three years of pooled data on the establishments of the electronics manufacturing sector in Korea (2002, 2007 and 2012) during the empirical analysis. Then this essay discusses the unique features of small and medium-sized enterprises in the view of business and managerial literature. They are exemplified in the conditions known as resource poverty under severe financial constraints and expertise constraints (Thong, 2001).

The second issue discusses the determining factors of job location choice of university graduates with a focus on less developed regions domiciled students. Dependent variable is where to work in developed regions or lagging regions. However, a

response to where to work has a prior question to there to study in developed regions or lagging regions. Such a two-stage of decisions on the location of university and job should be analyzed by using a bivariate probit regression with sample selection. Independent variables are family backgrounds, individual specifications, and regional attributes, with focus on educational investment. The Graduates Occupational Mobility Survey (GOMS) of 2010 sets to trace a graduate' domicile, college location and final job location.

This paper is comprised of four chapters. Chapter 1 introduces the background and the purpose of this research. Chapter 2 analyzes the determinants of industrial agglomeration in the electronics industry firms, with the focus on the different location behaviors with respect to regional labor markets across various firm sizes. Chapter 3 studies on the determining factors on job location choice of university graduates focusing on stimulating return migration and hindering the out-migrants. Chapter 4 summarizes the results of the two essays and discusses policy implications to make regional labor market.

Chapter 2 Analysis of Location Determining Factors of Small Firms and Large Enterprises: A Focus on Electronics Manufacturing Industry

2.1 Introduction

The high-technology industry is a key force driving economic growth, creating high value-added outputs and high quality employment. From 2002 to 2013, the value-added growth rate of Korea's electronics industry, one of the country's high-tech manufacturing sectors, was 10.20%. Meanwhile, over the same time span, the high-tech industry overall showed 7.31% growth. In 2013, this sector's shares of national value-added output and total employment were 8.06% and 2.38%, respectively. The electronics industry contributed more to Korea's national value-added outputs and employment than the automobile industry, also one of Korea's key industries, whose shares of national value-added output and total employment were 3.93% and 1.67%, respectively. The ratio of these shares (3.39) in the electronics industry was much higher

than that of the automobile industry (2.60). This indicates that the electronics industry has contributed substantially to the creation of high value-added per employment in comparison with other key sectors.

With this in mind, understanding the location determinants of industrial agglomeration in the electronics sector is a significant issue. This understanding can lead to designing an efficient industrial policy aiming to increase returns on production in the form of agglomeration economies. Korea's electronics firms are geographically concentrated in a few regions. Most of these regions are in the southern part of the Seoul Metropolitan Area (SMA). However, when we control for heterogeneity along with firm size, small- and medium sized-enterprises (here called SMEs) and large-sized enterprises (here called LEs) have exhibited concentration in different locations. For example, LEs are mainly concentrated south of the SMA, while SMEs are more concentrated within the SMA. SMEs are also more distributed around the center of the other local metropolitan cities in the Southeast of Korea. According to Korea's Census on Establishments, the southern part

of the SMA accounted for 65.38% of the LEs and 54.48% of the SMEs, with the other small firms (10.84%) being in Seoul.

The fundamental differences between SMEs and LEs have long been studied in the managerial literature. In fact, a recurring strand of literature has pointed out that small firms, unlike large enterprises, face financial resource poverty (poverty (Welsh and White, 1981; Chandler and McEvoy, 2000; Kotey and Sheridan, 2001; Kroon et al., 2013; Smallbone et al., 2012; Lai et al., 2016). Based on these prior findings, the present study aims to extend the concept of financial resource poverty to urban location theory.

Firms make decisions to optimize their location as a response to budget constraints, including land price or office rent. SMEs' location decisions are assumed to be affected by factors different from LEs' location determinants due to their more serious constraints on finance or expertise. Holmes and Stevens (2002) and Yamawaki (2002) have offered empirical evidence of different locations across firm sizes. For example, the level of industrial agglomeration varies depending on firm size (Holmes and Stevens, 2002). In addition, according to Yamawaki (2002), SMEs' location choices rely on benefits in terms of product specialization, ease of

procurement, technology diffusion, and policy support. Meanwhile, access to labor pooling is not advantageous for SMEs. On the other hand, the relation between SME locations and LE locations has been often viewed as focusing on an interdependency cycle. SMEs and LEs co-agglomerate due to supplier-buyer linkages or subcontracting patterns (Braun et al., 2002; Storper, 2007; Rama et al., 2003).

In this regard, identifying different sized firms' locations might be valuable when considering two features: 1) different location choice and 2) co-agglomeration patterns. In this paper, we analyze the factors determining location choice, focusing on regional variation in the labor market. Additionally, we weigh the geographical distance between SME locations and LE locations. This approach provides evidence that SMEs and LEs locate not far from each other, even though they have different agglomerating forces.

The purpose of this study is to identify the location of electronics-manufacturing firm agglomeration, with a focus on the variation in regional labor markets in South Korea. The key findings show that SMEs tend to agglomerate in areas with more abundant

labor supplies. Meanwhile, LEs are strengthened by access to transportation facilities and deregulation. This finding suggests that urban amenities tend to compensate for the lower real wages of SMEs. In addition, the location of SME clusters is more positively affected by the location of LE clusters than vice versa. This chapter is structured as follows. Section 2 provides a brief review of the empirical literature on the location of the electronics industry and location theory. Section 3 describes the data and model, and Section 4 presents the results. Section 5 offers our conclusions.

2.2 Literature Review

2.2.1 Small Firms and Large Enterprises

Strategy choices for efficient resource management and economic performance vary depending on firm size (Lai et al., 2016). This claim is based on the fact that resource poverty[3] is one of the main distinctive features[4] of small firms as opposed to large companies (Welsh and White, 1981; Chandler and McEvoy, 2000; Kotey and Sheridan, 2001; Kroon et al., 2013; Smallbone et al., 2012). According to Halme and Korpela (2014), finance and expertise constraints highlight the significance of abundant resource combinations with the R&D cooperation, networks and industry knowledge, and stimulated technology innovation to high technology

[3] Firms' resources are comprised of tangible and intangible assets according to Wernerfelt (1984). Specifically, tangible assets indicate financial and physical resources, while intangible assets include human and intellectual property assets (Hall, 1992), social and organizational assets (Barney, 1991), and reputational assets (Grant, 1991; Greene et al., 1997).

[4] Welsh and White (1981) analyzed financial concepts such as cash flow, break-even analysis, return on investment, and debt-equity ratio to compare small firms and big business. They concluded that managing a small firm requires a different outlook and principles than operating a large enterprise.

small firms' growth in terms of diminishing returns. Economies of scale and economies of scope enable large firms to achieve better product performance than small firms (Porter, 1980; Ghemawat, 1986). In contrast, recent literature has suggested that resource poverty stimulates small firms to find ways to achieve more fruitful economic and managerial performance, particularly in terms of innovation (Gibbert et al., 2007; Hoegl et al., 2009).

Some of literature on small firms' finance and expertise constraints has focused on a different subset of the labor market. This market can be subdivided by the criteria of real wages: employment stabilization (a full-time contract), opportunities for a company training program, and working conditions (Belfield, 1999)[5]. For instance, the level of real wage differs for SMEs versus LEs. Graduates perceived that the working conditions were worse in SMEs (Belfield, 1999). In addition, highly educated potential laborers' perceptions of working conditions are critical to determine job search patterns (Nickell, 1990; Devine and Kiefer, 1991).

[5] When small firms make choices of where to locate, they use constrained information in less complicated decision process than large enterprises (Greenhalgh, 2008).

Referring to the management literature on small firms' human resource management, it is typically more informal in small firms than in large firms, even though they do not have experts with respect to human resource management or related departments (Marlow et al., 2010; Saridakis et al., 2013). However, several studies have revealed that on-the-job training might encourage small firms to achieve better performance with respect to innovation and flexibility, and to reduce the risks of mismanagement, which is directly associated with their survival and growth (Barrett and Mayson, 2006; Hayton et al., 2013).

Recently, there have been researches on the different impacts on small and large firms of the financial crisis brought about by the collapse of the subprime mortgage market in the US. Particularly, small firms are more vulnerable to economic shock and downturn compared to large firms. During the 2008 financial recession, small firms tended to be more likely to freeze or cut laborers' wages, whereas large firms tended to lay off or to reduce human resource management, financial rewards and development opportunities for employees (Lai et al., 2016).

Focusing on geographical locational aspects of difference between SMEs and LEs, SMEs and LEs have interdependency due to supplier–buyer linkages such as the share of the founding entity and funding bodies (Braun et al., 2002). This relationship might lead to concentration in a certain region, as suggested by the 'new industrial district' (Storper, 2007; Rama et al., 2003). Such a co-location was attributed to their subcontracting patterns. According to Yamawaki (2002), SMEs' location choices relied on the benefits in terms of specialization of their own production, ease of procurement, technology diffusion and government support. In contrast, SMEs turned out not to locate in such places because they were not advantageous in terms of access to human capital.

In short, there is a general agreement that firm location differs by firm size, and that firms that have different sizes are associated with one another due to ease of procurement. Labor market on the supply side, human resource management, and crisis response depend on firm size. Comparing the spatial attributes of location between SMEs and LEs is a reasonable method to suppose two subsets of the labor market. This treatment seems to provide evidence of heterogeneous preference for location choice.

2.2.2 Industrial Agglomeration and Location

Many determinants of location choice of industrial activity have already been well documented. These determinants include proximity to labor and transportation facilities, vertical and horizontal linkages, natural advantages, access to markets and airports, land supply, and government support. Labor market pooling has particularly been attended to as an important determinant of firm location decisions. Firms can obtain workers with similar occupations with specialized skills when filling a vacancy without high costs (Audretsch and Feldman, 1996; Dumais et al., 2002). However, according to Rosenthal and Strange (2001), labor pooling is effective in industrial agglomeration within a nation because of free movement. Meanwhile, knowledge is restricted from spreading and affecting agglomeration levels due to rapidly decreasing effects with distance.

Intermediate input is one of the most effective determinants on industrial agglomeration. Specifically, Helsley and Strange (2007) focused on the outsourcing effect at an international level. In this context, outsourcing was mutually decided between vertically

integrated firms, and thus those firms were geographically concentrated in a location. More specifically, forward and backward linkages (input sharing) increased agglomeration at the firm level. A number of studies on the impact of input sharing on spatial agglomeration have focused on only the impact of location choice on firms. Some studies have examined variations in this impact depending on sector or geographical level. For example, Coughlin and Segev (2000) demonstrated that the level of dependence on suppliers differs across types of sectors.

On the other hand, urbanization economies are frequently argued to influence the agglomeration level in addition to the localization economies (input sharing). Audretsch (2003) revealed that there was an indirect route from urbanization diversity to industrial agglomeration thanks to innovation activities. Alkay and Hewings (2012) found that the determinants of spatial agglomeration varied depending on the geographical or the industry-specific level in Turkey. They showed that urbanization economies fostered agglomeration more than the localization economies in Istanbul.

Besides labor market pooling and input sharing, the impacts of transportation facilities, government support, and tax breaks have also been discussed in the urban location literature. Several studies on the relation between transportation and economic growth have shown that access to markets has a positive effect on the location decisions of firms. Kawamura (2001) found that freeway ramps and transit stations promote access to markets. Specifically, firms located in the urban core prefer proximity to railroad stations while those in suburban areas value access to freeway ramps. This idea can be extended to explain the influence on relocation and the initial location of firms. Targa et al. (2006) showed that roads with improved function and capacity positively affect firms' relocation decision in the case of four counties in Maryland.

Deregulation targeted to firms has decisive impacts on the location decision of firms as well. The impacts of tax incentives have been widely recognized as having a positive impact on location choice (Smith and Florida, 1994; Feld and Kirchgassner, 2003; Devereux et al., 2007; Rathelot and Sillard, 2008). Meanwhile, this impact might vary depending on features of regions or sectors. Hanson and Rohlin (2010) demonstrated that tax incentives

negatively influenced establishments in Chicago while positively affecting those in New York. In addition, these tax incentives made a stronger contribution to attracting firms in the wholesale and retail services rather than in the manufacturing sector. The impact of environmental regulations on the firms' location decisions has long been discussed in the urban economics literature. Strict regulations discouraged manufacturing firms from locating in certain regions (McConnell and Schwab, 1990; Lian et al., 2016). Furthermore, the magnitude of the regulations' impacts was similar to other factors in a firm's location choice when the regulation of industry pollution was at a relatively high level (Mulatu et al., 2010).

A growing body of research emphasizes the differences in location choice between small and large firms. Holmes and Stevens (2002) argued that the degree of geographic concentration varies depending on the relative scale of firms. Yüzer and Yüzer (2014) surveyed the location preferences of small, medium, and large sized manufacturing industries in Istanbul, Turkey. They demonstrated that agglomeration in the metropolitan cities is not decentralized from the metropolis owing to advantages such as agglomeration economies, labor market pooling, existing markets, and

transportation facilities. In particular, intermediate suppliers were most important to the SMEs, whereas labor supply was most important to the large firms.

In sum, the literature on location choice shows how location decisions vary depending on firm size with different impacts of labor pooling, intermediate inputs, transportation facility and deregulation. The next subsection examines the features of the locations of the electronics industry.

2.2.3 Cluster of the Electronics Manufacturing Firms

There are a few empirical studies of the locations of the electronics-manufacturing sector. The electronics industry has been exemplified in a sector that creates high value-added output. Thus, the literature emphasizes the relation between the R&D sector and government support. Kenny and Florida (1994) found that, in Japan, electronics and biotechnology firms have closer geographical linkages to production engineering companies and applied research firms than to basic research firms. In contrast,

those firms in the US and Europe are spatially remote from the basic and applied firms. Nam (2008) focused on the R&D division and electronics-manufacturing firms by interviewing the employees of Samsung Electronics in Korea. Samsung's semiconductor and display panel division, represented by high technology intensive manufacturing jobs, was located near Seoul. Meanwhile, Samsung's home electronics division, denoting price-sensitive manufacturing jobs, was located in Gumi and Gwangju, over 200 km from Seoul. Audretsch and Feldman (1996)'s findings support the idea that the location of the electronics industry - which highlights innovative activities - tends to be more concentrated than the other sectors, owing to R&D labs and skilled labor. Glaeser (1999) and Frenkel (2001) demonstrated that knowledge-based industries are geographically located within cities or metropolitan areas. This behavior is driven by government incentives, proximity to a highly educated labor pool, and telecommunications infrastructure.

Rama et al. (2003) suggested evidence of a 'hub-and-spoke' district by demonstrating the presence of electronics-manufacturing firms' co-agglomeration with suppliers in Madrid, Spain. They proposed that subcontracting relations encouraged

firms to agglomerate with one another for technological learning and innovation. He and Romanos (2015) assessed the location of the communications equipment manufacturing industry (CEM) in the US metropolitan areas. Their results showed that vertical and horizontal linkages to suppliers have significant impacts mainly on spatial agglomeration. Access to suppliers enhances the agglomeration level of the CEM due to positive externalities, including cheap raw resources and various choices of suppliers in metropolitan areas. Moreover, low corporate tax is one of the important determinants of CEM establishment.

In sum, the clusters of the electronics-manufacturing sector are centered in metropolitan areas. Access to a well-educated labor pool, knowledge, R&D and telecommunications infrastructure is regarded as important factor when firms make location decisions. Recent literature has shed light on the location differences across sectors, firm size, and regions. This study, therefore, identifies the determinants of an agglomerated location, which varies depending on firm size. In addition, this study measures the maximum distance of factor impacts on attracting small firms toward large firms' clusters, and large firms toward small firms' clusters. In addition,

this study estimates the neighboring effects of another important variable, namely proximity to high speed rail (here called HSR) stations. This difference may be reinforced, attenuated, or even reversed in the presence of geographical asymmetries between SMEs and LEs due to the ease of access to an abundant labor market pool. Thus, it is clear that if those regions where small firms are located have specific locational advantages, then they do not coincide with the regions where large firms agglomerate. SMEs and LEs will unambiguously favor different regions in the electronics-manufacturing sector.

An abundant labor market pool can identify high-technology manufacturing locations with a meaningful link between urban amenities and economic geography. According to conventional location theory, industrial agglomeration is affected by the spatial distribution of intermediate inputs, goods markets, and labor market pooling (Rosenthal and Strange, 2001). Based on the empirical analyses described in Sections 2.2 and 2.3, this study will control for the interplay between small and large firms' locations, considering various locational aspects such as deregulation, access to transportation, and the regional labor market pool.

2.3 Analysis

2.3.1 Descriptive Analysis

Before presenting the methodology, this section will briefly review the geographical distribution of the SMEs and the LEs in the electronics-manufacturing sector. An SME is defined as a firm that has fewer than 300 employees, while an LE is defined as one that has 300 employees or more. Of Korea's 226 cities and counties, 56 cities and counties had no SMEs in the electronics sectors, while 184 areas had no LEs in 2012. As shown in Figure 2.1 and Figure 2.2, the SMEs are more evenly located than the LEs that did not cluster in the capital city of Korea, Seoul.

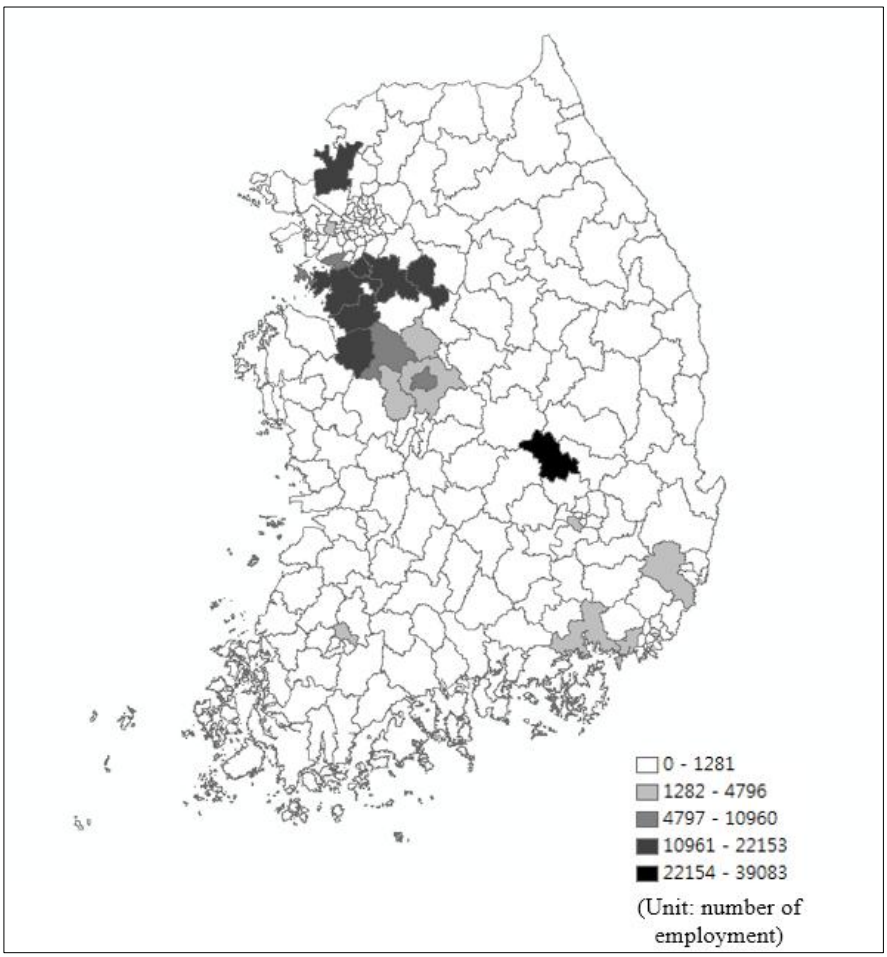

Figure 2.1 The Spatial Distribution of SMEs in Electronics Manufacturing Sector

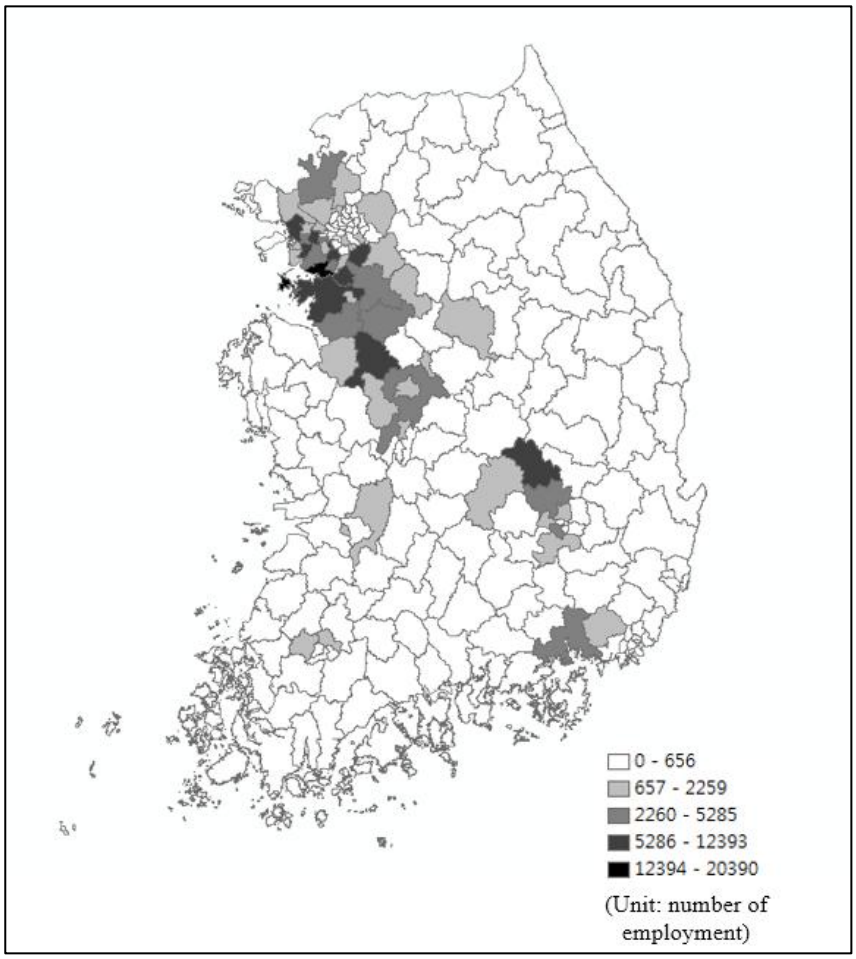

Figure 2.2 The Spatial Distribution of LEs in Electronics Manufacturing Sector

Figure 2.3 shows a kernel distribution of the log electronics-manufacturing sector's employment (solid line)[6], and those worked in SMEs (dashed line) and in LEs (dotted line) by using data from 2012. This graph supports the differences in spatial distribution across firm size. For example, LEs show lower density than SMEs. However, the graph shows similar densities between SMEs and LEs at 10 log employment levels. Overall, SMEs obtain more advantages from agglomeration economies than LEs.

Another interesting aspect of the spatial distribution of the electronics sector is in the difference between regions close to and remote from the center of the capital city. Figure 2.4 illustrates the log employment of SMEs and LEs located in regions below or above the mean proximity[7] from the center of the capital city. We can see that LEs in the regions below (dot-dashed) and above (dotted) the mean show low density of employment. This takes into account that LEs do not have significant density externalities whether regions are close to or remote from the center of the capital city.

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[6] The employment per capita was calculated by using the number of prime age workers.

[7] The proximity denotes the time distance from the center of the capital city, Seoul. The mean of proximity is 200 minutes for the 226 cities and counties.

In contrast to the density of LEs, the distribution shows that the SMEs in the regions below the mean from the center of the capital city (solid) have a higher probable density of employment than the SMEs in the regions above the mean from the center of the capital city (dashed). SMEs close to Seoul may be obtaining advantages from agglomeration economies. Overall, the different results in Figure 2.3 and Figure 2.4 can be attributed to the fact that SMEs favor regions closer to the capital city more than do LEs.

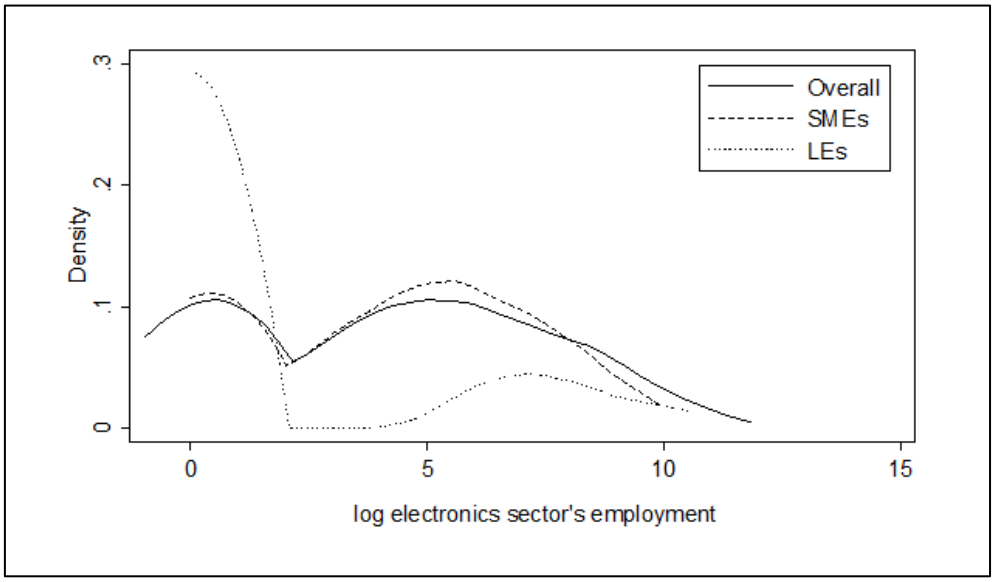

Figure 2.3 Kernel Density Estimates of Log Electronics Manufacturing Sector’s Employment

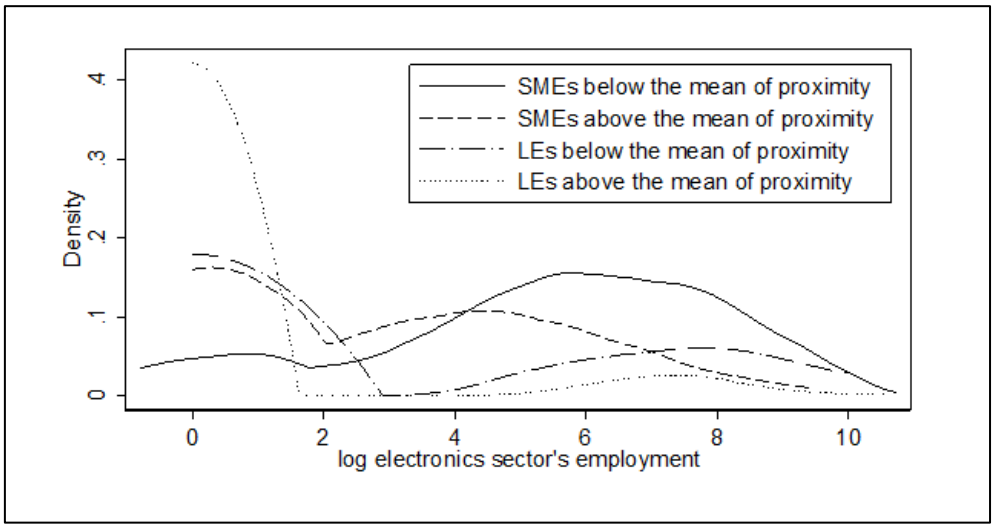

Figure 2.4 Kernel Density Estimates of Log Electronics Manufacturing Sector’s Employment by Distance

Table 2.1 provides a brief description of the variables used in the empirical analysis. Table 2.2 shows descriptive statistics of the independent variables.

Table 2.1 Variable Descriptions

Variables	Name	Definition
Agglomeration	SME	The existence of cluster of SMEs (less 300 employees), equal to one, and zero otherwise
	LE	The existence of cluster of LEs (more 300 employees), equal to one, and zero otherwise
Firm cluster of different size	L0010	The existence of LE within 10 km, equal to one, and zero otherwise
	L1015	The existence of LE from 10 km to 15 km, equal to one, and zero otherwise
	L1520	The existence of LE from 15 km to 20 km, equal to one, and zero otherwise
	L2025	The existence of LE from 20 km to 25 km, equal to one, and zero otherwise
	S0010	The existence of SME within 10 km, equal to one, and zero otherwise
	S1015	The existence of SME from 10 km to 15 km, equal to one, and zero otherwise
	S1520	The existence of SME from 15 km to 20 km, equal to one, and zero otherwise
	S2025	The existence of SME from 20 km to 25 km, equal to one, and zero otherwise

Table 2.1 Variable Descriptions (Continued)

Variables	Name	Definition
Population	POP	The number of population
	NPOP	The number of population within neighboring area
	PGR	Average growth rate of population during recent three years
	NPGR	Average growth rate of population during recent three years within neighboring area
Deregulation[8]	DR	Index regarding incentives or tax to firms, convenience of administration process, and environment charges (the top 30% =1)
	RPA_k	The impact of Seoul metropolitan area readjustment planning acts (RPA) Non-SMA area and growth management zone (reference) k=1 if Overpopulated constraint district (=1) k=2 if Nature conservation district (=1)
Input sharing	PM	The number of employments of primary metal industries
	NM	The number of employments of nonmetallic minerals: stone, clay, glass and concrete products
R&D	RD	The number of employments of physics, chemistry, electronics and natural science-related R&D service sector

[8] This index is provided from the Korea chamber of commerce and industry (KCCI) to notice the level of regulation for firms that varies across region.

Table 2.1 Variable Descriptions (Continued)

Variables	Name	Definition
High speed railroad station	RS	The existence of HSR station, equal to one, and zero otherwise
	RS0010	The existence of HSR station within 10 km, equal to one, and zero otherwise
	RS1020	The existence of HSR station between 10 to 20 km, equal to one, and zero otherwise
	DST	Distance to the center of Seoul (capital city in Korea)
	RS*DST	Interaction term between RS and DST
Land price	LP	Land price except for housing (dollar / m^2)
Time effects	Y2005	The 2005 year effects, equal to one, and zero otherwise
	Y2010	The 2010 year effects, equal to one, and zero otherwise

Table 2.2 Descriptive Statistics for Independent Variables

	Mean	SD	Min	Max	Unit
Employment in SME	873.0	2,072.0	0.0	20,390.0	employees
Employment in LE	923.3	3,622.4	0.0	39,083.0	
DR	0.59	0.49	–	–	–
RPA_1	0.17	0.37	–	–	–
RPA_2	0.02	0.14	–	–	–
PM	583.9	2,094.9	0.0	37,600.0	employees
NM	818.3	1,639.2	0.0	13,000.0	
RD	270.4	1,223.1	0.0	14,000.0	
POP	192.4	182.3	200.0	1,000.0	thousand persons
NPOP	1,938.6	1,302.4	0.0	600.0	
PGR	−0.03	2.61	−5.90	24.80	%
NPGR	0.05	1.67	−3.40	11.40	
RS	0.14	0.35	–	–	–
LP	27.3	95.6	0.09	1440.6	thousand dollar/m^2
DST	159.64	107.93	0.00	356.20	km

Note: the number of observation is 226 at municipality level (sigungu in Korea).

2.3.2 Methods and Data

Local indicators of spatial autocorrelation (LISAs) are used to identify spatially agglomerated regions in Korea's electronics-manufacturing sector. For our analytic approach, a binary logistic regression model is appropriate to analyze the determinants in the agglomeration location. Clusters are detected using an index, local Moran's I (Anselin, 1995) as shown in equation (2.1):

$$I_i = \frac{z_i - \bar{z}}{\sigma^2} \sum_{j}^{n} \left[w_{ij} \left(z_j - \bar{z} \right) \right] \tag{2.1}$$

where $\bar{z}$ is the average number of employees in the electronics-manufacturing sector; z_i is the number of the employees at location i; z_j is the number of employees at all other locations; σ^2 is the variance in the number of employees; w_{ij} is the spatial weight matrix calculated as the inverse of the distance d_{ij} between regions i and j; n is the number of areal units. This process allows us to detect clusters among the 226 counties and cities in Korea.

Two empirical models are used to estimate the determining factors of firm location, in order to highlight the features of the two different firm types, SMEs and LEs. We used three years of polled data on the number of employees: 2002, 2007, and 2012. The Population and Housing Census, the Statistical Yearbook of Railroads, input-output tables, and the Census on Establishments[9] are used to include the data on demography, transportation, and sectoral employment. At the city and county levels, these statistics contain data on sectoral employees for input sharing and knowledge trade, population and population growth rate for labor market pooling, and high speed railroad (HSR) stations for transportation facilities.

The electronics-manufacturing sector is defined based on the KSIC 2-digit code. These codes are divided into six 3-digit industry groups: 1) semiconductors, 2) electronic components, 3) computers and peripheral equipment, 4) telecommunications and broadcasting apparatus, 5) electronic video and audio equipment,

[9] Since 1998, Korea's *Census on Establishments* has annually surveyed the number of establishments and workers by sector, number of workers, age group and gender of the CEO, number of workers by gender, and employment condition of workers. The *Census* also provides information on the county level address of each firm.

and 6) magnetic and optical media. This study regards the electronics-manufacturing sector as a high technology industry. Thus, it would be meaningful to compare the similarity in terms of the amount of R&D investment.

Figure 2.5 illustrates the amount of R&D investment by the six sub-sectors of the electronics-manufacturing sector. The shares of national value-added differ by each sub-sector. Accordingly, this study normalizes the R&D investment by several economic indicators such as industrial profit, cost, and so on. Those indexes are used to test the significance of the difference between six groups by an ANOVA test and a Mann-Whitney U-test. The ANOVA test determines whether two or more than two groups have the same mean rank according to parametric procedures. Meanwhile, the Mann-Whitney test detects differences among groups through a nonparametric procedure (Conover and Iman, 1981).

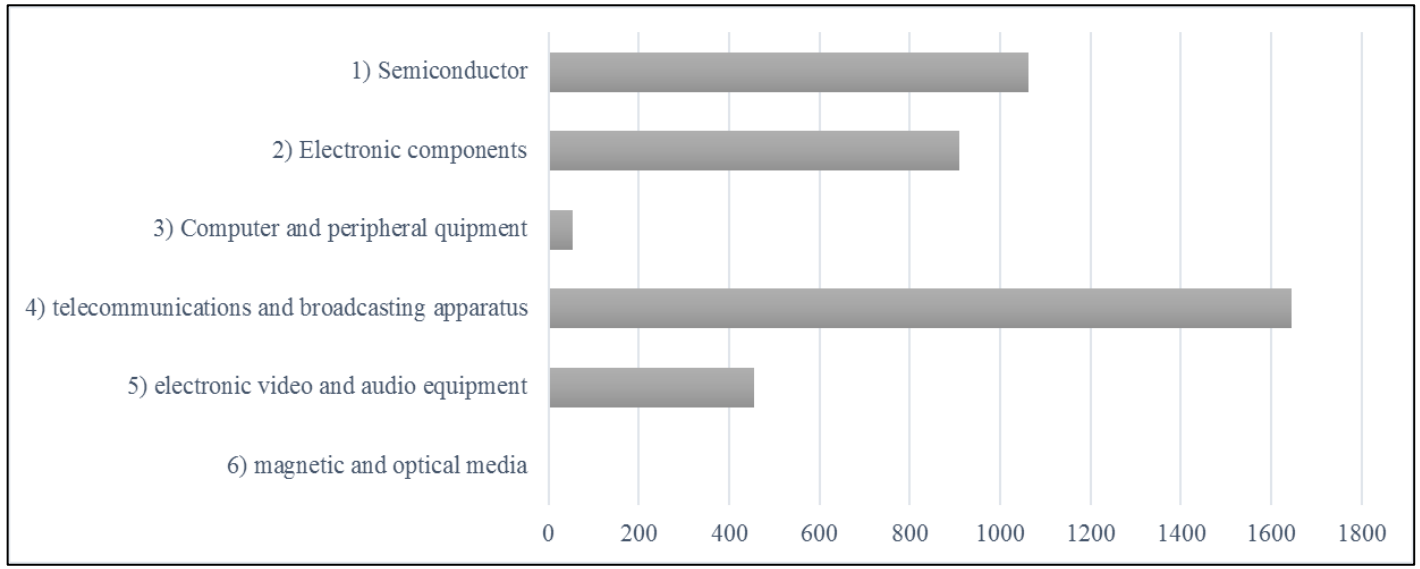

Figure 2.5 The Amount of R&D Investment by Six Sub-sectors of Electronics Manufacturing Sector[10]

[10] The unit of Figure 2.5 is million dollars.

Table 2.3 Testing for the Significance of Similarity within Each of the Subsectors

	ANOVA	Mann-Whitney
R&D expenditure / employees	0.985	2.553
R&D expenditure / firms	0.804	2.659
R&D expenditure / sales	4.651**	6.750*
R&D expenditure / profits	1.845	4.371
R&D expenditure / costs	3.891*	5.659
R&D expenditure / labor costs	0.919	2.258

Note: the coefficients of ANOVA are *F*-values and those of Mann-Whitney are *Chi-squared* value.
Note: ** significance at 5% level; * significance at 10% level.

As shown in Table 2.3, the six sub-sectors are similar in terms of most conditions: R&D expenditure per employee, firms, profits and labor costs. The result of the R&D expenditure compared to the costs shows the same results among the six sub-sectors only in the Mann-Whitney test. Overall, it reveals that the sub-groups do not differ from one another at any given statistical level except for sales.

$$\log\left(\frac{\mathrm{P}}{1-\mathrm{P}}\right)_{SME} = \alpha_0 + \alpha_1 LE + \alpha_2 L0010 + \alpha_3 L1015 + \alpha_4 L1520 + \alpha_5 L2025$$

$$+\alpha_6 DR + \alpha_{7k} RPA_k + \alpha_8 PM + \alpha_{10} NM + \alpha_{11} RD$$

$$+\alpha_{12} POP + \alpha_{13} NPOP + \alpha_{14} PGR + \alpha_{15} NPGR$$

$$+\alpha_{16} RS + \alpha_{17} RS0010 + \alpha_{18} RS1020$$

$$+\alpha_{19} DST + \alpha_{20}(RS * DST) + \alpha_{21} LP$$

$$+\alpha_{22} Y2005 + \alpha_{23} Y2010 + \varepsilon_{i1} \qquad (2.2)$$

$$\log\left(\frac{\mathrm{P}}{1-\mathrm{P}}\right)_{LE} = \beta_0 + \beta_1 SME + \beta_2 S0010 + \beta_3 S1025 + \alpha_4 S1520 + \alpha_5 S2025$$

$$+\alpha_6 DR + \alpha_{7k} RPA_k + \alpha_8 PM + \alpha_{10} NM + \alpha_{11} RD$$

$$+\alpha_{12} POP + \alpha_{13} NPOP + \alpha_{14} PGR + \alpha_{15} NPGR$$

$$+\alpha_{16} RS + \alpha_{17} RS0010 + \alpha_{18} RS1020$$

$$+\alpha_{19} DST + \alpha_{20}(RS * DST) + \alpha_{21} LP$$

$$+\alpha_{22} Y2005 + \alpha_{23} Y2010 + \varepsilon_{i1} \qquad (2.3)$$

In the first regression model, this study analyzes the determinants of SME clusters (SME) as shown in equation (2.2). This is a function of the existence of LE clusters (LE), HSR station (RS), deregulation level (DR), Seoul Metropolitan Area Readjustment Planning Act (RPA_k), input sharing (PM and NM), R&D sectors (RD), and population (POP, NPOP, PGR, NPGR). Population variables represent labor supply in the regional labor market. Those variables comprise the population and its growth rate of the surrounding regions as well as the corresponding region. This model measures the maximum distances of LEs' impact on creating a SME cluster (L0010, L1015, L1520 and L2025). Similarly, this study quantifies the maximum distance of a HSR station's impact on generating a SME cluster (RS, RS0010 and R1020). In addition, this study incorporates the distance variable (DST) from the center of Seoul and the interaction between the existence of HSR station and distance from Seoul (RS*DST).

To choose the main suppliers for quantitative analysis, we explored the sectors whose trade amount is above the average, and the growth rate of trade increases based on input-output tables. Thus, the primary metal industry (PM) and the nonmetallic minerals

industry (NM) were selected from among the input sharing of the electronics-manufacturing sector. This paper includes a land price variable to consider location cost (LP). This study includes two-year dummy variables to control for possible time effects (Y2005 and Y2010). Another model is used to identify the locations with LE clusters. The function is similar to the first one as shown in equation (2.3).

There are two econometrics issues: the endogeneity problem and choice of an appropriate method. First, a year-long lag was judged to be deficient time span for a firm to make a location decision and move to the location. In this regard, a time lag of two years for all the explanatory variables is used to mitigate possible endogeneity. On the other hand, we did not use the spatial Durbin model but instead used logit analysis because our models involve a spatial effect of treatment structure (see the variables of L0010, L1015, L1520, L2025, S0010, S1015, S1520, S2025, RS0010, RS1020, NPOP and NPGR). In particular, this alternative is valid in the sense that the spatial Durbin model does not provide the maximum distance of the explanatory variables despite the presence of spatial dependence.

2.4 Result

Table 2.4 presents the result of test statistics for spatial dependence of SME and LE clusters. The null hypothesis of zero spatial correlation was rejected at the one percent level of significance based on the global Moran's I statistics[11]. Specifically, the number of clusters diminishes over time for both SMEs and LEs. The autocorrelation index decreases for SMEs, while it has an increasing and decreasing pattern for LEs during the period from 2002 to 2012. Moreover, the number of mean employees decreases in the SME case but increases in the LE case. These results suggest that LEs have a stronger tendency for industries with increasing returns to scale than SMEs. In addition, LEs obtain more benefits from economies of scale and scope. Thus, this result is in accord with the case of small firms that have faced financial resource poverty, as mentioned in the literature (see Kroon et al., 2012; Smallbone et al., 2012).

[11] Global Moran's I index shows a value between −1 and 1 with statistical significance. The values close to 1 indicate a high level of spatial clustering.

Table 2.4 Spatial Statistics regarding to SMEs' and LEs' Cluster

	SMEs' cluster			LEs' cluster		
	2002	2007	2012	2002	2007	2012
Statistics of autocorrelation	0.172***	0.149***	0.121***	0.017***	0.034***	0.027***
Cluster	36 (15.93)	34 (15.04)	31 (13.72)	21 (9.29)	17 (7.52)	15 (6.64)
Non-cluster	190 (84.07)	198 (84.96)	195 (86.28)	205 (90.71)	209 (92.48)	211 (93.36)
Total	226 (100)	226 (100)	226 (100)	226 (100)	226 (100)	226 (100)
Mean employees	890	776	858	942	872	1052

Note: the unit of mean employees is a thousand persons.
Note: *** significant at 1% level

Figure 2.6 and Figure 2.7 illustrate the spatial distribution of local clusters for SMEs and LEs, respectively. Local clusters of LEs are less concentrated in the capital city of Seoul, and are located south of the SME clusters. LE clusters gradually move to the south from Seoul, which is different from SME clusters that have maintained the location of their cluster throughout time.

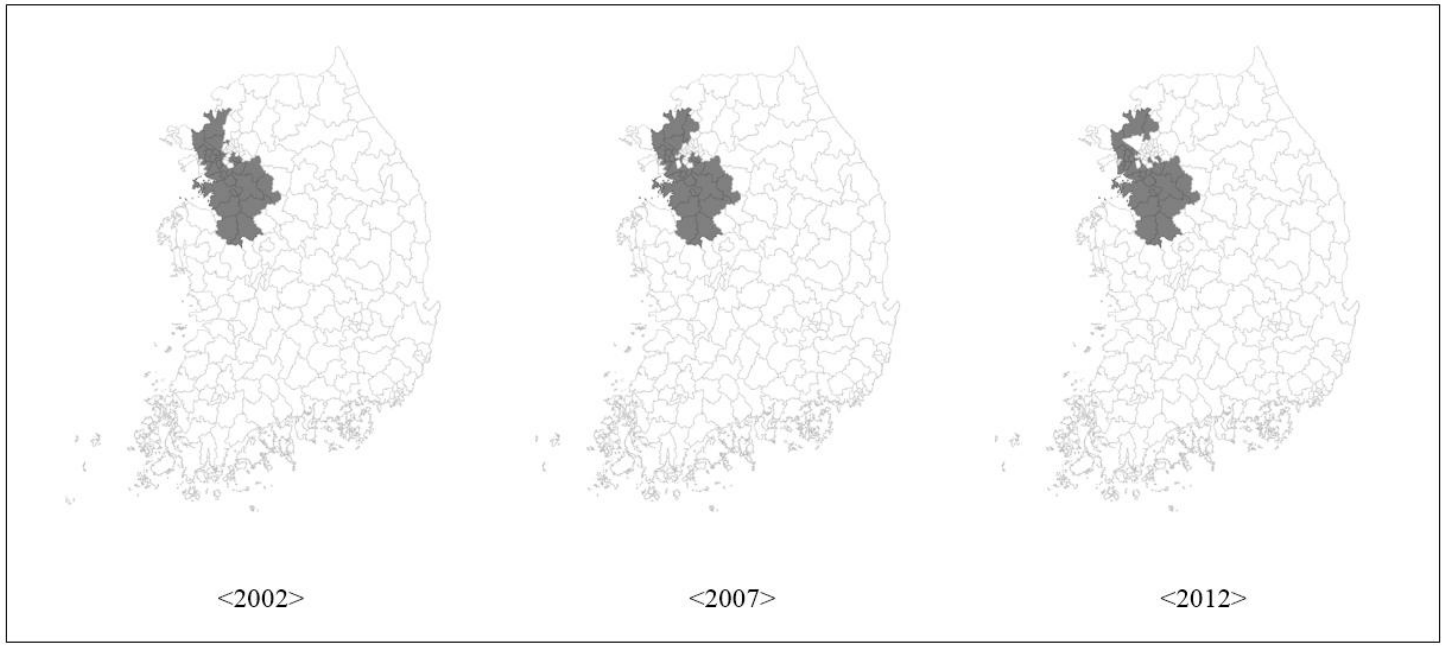

Figure 2.6 Location Change of SMEs Clusters

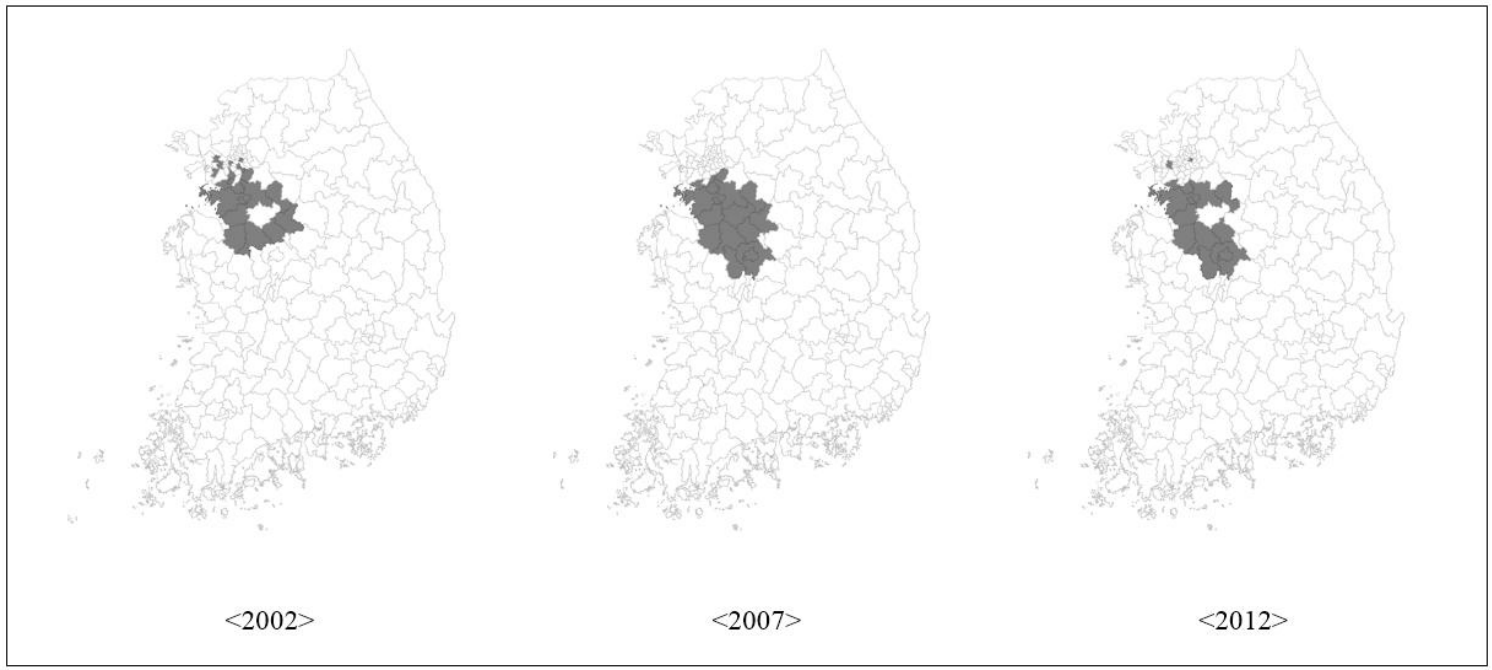

Figure 2.7 Location Change of LEs Clusters

Table 2.5 shows the heterogeneous effects on a firm's agglomeration of the determinants between SMEs and LEs[12]. The variables of regional population, the neighboring regions' population, and compound annual growth rate for the period of three years of neighboring regions' population are statistically significant, and positive to the SME cluster formation. However, only the neighboring regions' population growth serves as a determinant of LE cluster generation. The maximum distance of a LE cluster's influence to generate an SME cluster is 20 km, as shown in column (1) of Table 2.5. In contrast, there is a tendency for LEs to agglomerate only in the regions where SMEs are agglomerating, as shown in column (2) of Table 2.5.

The presence of a HSR station increases the probability of creating LE clusters in regions located within 10 km of a HSR station. However, connectivity to a HSR station does not affect the probability of SME cluster formation. The coefficients of distance from the center of Seoul are negative for both SME clusters and LE clusters, with statistical significance. In order to explain the spatial association of HSR stations, all variables being equal, the interaction

[12] The number of observations is multiplied by the number of municipalities (226) and the three years (2002, 2007 and 2012).

term is adopted between HSR variables and the distance from the center of capital city, Seoul[13]. The signs of the interaction between HSR stations and the distance from the center of capital city are negative to form SME clusters and LE clusters, with statistical significance. These results indicate that a station far from the center of the capital city has a smaller impact on the formation of both SME clusters and LE clusters than a station close to Seoul.

This result suggests a significant effect of deregulation of which index includes the incentives or taxes to firms, convenience of administration process, and environment charges. LEs tend to locate in regions with a deregulation index in the top 30% level. This result is consistent with earlier findings (Lian et al., 2016) that strict regulation discourages a firm's location decision. Meanwhile, the results of deregulation's impact on SME clusters are consistent with the finding of Hanson and Rohlin (2010) that tax incentives were negatively associated with in firms' location in Chicago. In addition to the deregulation index variable, this research analyzes the impact of the Seoul Metropolitan Area Readjustment Planning Acts. LEs tend to avoid locating in overpopulated constraint

[13] I regarded Gangnam-gu as the center of Seoul, which is the heart of Korea's business center.

districts or nature conservation districts, showing negative signs for both, with statistical significance. Meanwhile, SMEs have a tendency not to locate only in overpopulated constraint districts.

Intermediate suppliers and R&D labor have positive impacts on forming SME clusters. In contrast, primary metal industries and R&D service sectors are not geographically related to forming LE clusters. Meanwhile, nonmetallic mineral industries negatively affect cluster formation. This study also found differences in time effects among the control variables. SMEs are less agglomerated after 2005 and 2010 as compared to 2000 under the identical conditions, while LEs are clustered only after 2010. This result indicates that the 2008/9 recessions had a deeper negative impact on small firms and subsequently they relocated to cheaper sites to cut pay-related costs (Lai et al., 2016).

Table 2.5 Identification of SMEs' and LEs' Cluster

(1) SMEs cluster				(2) LEs cluster			
Variable	Coeff.		S.E.	Variable	Coeff.		S.E.
Intercept	−15.304	***	4.055	*Intercept*	−1.154		4.055
LE	22.397	***	7.786	SME	1.605	**	7.786
L0010	11.756	***	3.393	S0010	0.441		3.393
L1015	6.137	*	3.625	S1015	0.618		3.625
L1520	3.445	*	1.886	S1520	−0.190		1.886
L2025	0.581		1.290	S2025	−1.068		1.290
DR	−5.666	***	1.898	DR	0.942	*	1.898
RPA_1	−5.648	**	2.391	RPA_1	−1.456	*	2.391
RPA_2	0.816		133.042	RPA_2	−1.878	*	133.042
PM	2.155		1.583	PM	−0.214		1.583
NM	6.182	***	1.622	NM	0.246	*	1.622
RD	0.977		0.833	RD	0.049		0.833
POP	1.780	***	0.493	POP	0.214		0.493
NPOP	3.494	***	0.911	NPOP	−0.378		0.911
PGR	0.125		0.317	PGR	0.082		0.317
NPGR	0.282	*	0.425	NPGR	0.517	***	0.425

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10 % level.

Table 2.5 Identification of SMEs' and LEs' Cluster (Continued)

(1) SMEs cluster				(2) LEs cluster			
Variable	Coeff.		S.E.	Variable	Coeff.		S.E.
RS	3.527		3.173	RS	0.422		3.173
RS0010	0.320		1.184	RS0010	1.054	**	1.184
RS1020	0.179		1.035	RS1020	−1.632	**	1.035
RS*DST	−0.368	**	0.162	RS*DST	0.001		0.162
DST	−0.215	***	0.051	DST	−0.025	**	0.051
LP	−0.001		0.003	LP	0.002		0.003
Y2005	−2.416	*	1.247	Y2005	−0.056		1.247
Y2010	−2.895	**	1.234	Y2010	−0.232		1.234
Pseudo R^2	0.912			Pseudo R^2	0.495		
Log likelihood	−25.090			Log likelihood	−96.428		
LR−chi^2	520.580			LR−chi^2	188.860		
Prob>chi^2	0.000			Prob>chi^2	0.000		
Number of observation	678						

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10 % level.

In order to explain the spatial association of deregulation, all variables being equal, this study uses various criteria with respect to the deregulation variable. Each criterion is adopted as follows: from the top 10% equals to one, others zero (DR10) with respect to the index regarding incentives or taxes to firms, convenience of administration process, and environment charges, to the top 90% equals to one, and others zero (DR 90).

Table 2.6 reports estimation results of the deregulation variable at the nine different levels. The signs of the other variables' coefficients except for deregulation are in accord with the result of Table 2.5. Specifically, the regions with SMEs' clusters do not have familiar business environments while LEs cluster settled in the regions with them do. This evidence supports the hypothesis of this study, given Korea's context that the regulatory environment for businesses in regions far from the central city is generally relaxed. Small firms would like to be connected to positive externality in urban areas rather than renouncing advantages of deregulation in local regions. Meanwhile, large firms are likely to end up settled away from the main local economic center to obtain advantages of deregulation.

Table 2.6 Deregulation Impacts Adopted by Various Criteria on SMEs' and LEs' Cluster

		SMEs			LEs		
		coeff.		*se*	*coeff.*		*se*
a)	DR10	−5.475	**	1.976	0.662		0.644
b)	DR20	−5.477	**	1.976	0.269		0.566
c)	DR30	−5.666	***	1.898	0.942	*	0.492
d)	DR40	−6.933	***	2.269	0.529		0.504
e)	DR50	−5.341	**	1.782	0.658		0.474
f)	DR60	0.411		1.101	0.577		0.497
g)	DR70	0.539		1.003	0.139		0.488
h)	DR80	2.188	*	1.103	−0.218		0.585
i)	DR90	2.162	*	1.224	−1.394	*	0.786

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10 % level.

In addition, this study performs additional analysis to illustrate causality. The relation between an LE cluster and a HSR station seems to have the endogeneity problem that a HSR station tends to connect large central cities to one another or with a few intermediate railroad stations. A difference in difference method (DID method) was adopted to verify the impact of railroad stations on LE clusters (Vickerman, 1997; Rus and Nash, 2006). Because the dependent variable is binary in this study, there are three ways to analyze DID:

1) Maintain the common trend with a continuous dependent variable as in standard DID.
2) Use the nonlinear DID framework proposed by Athey and Imbens (2006), in which case this paper will get partial identification.
3) Use a logit model with a fixed time and group effects.

The second method could not be conducted due to being unable to obtain an analysis code. In the third method, the time fixed effect is expressed in Table 2.7, but it is difficult to increase the variable

to estimate the group fixed effect due to the limit on the number of data. For these reasons, this study adopts the first option. This method allows for estimating only the effect of the HSR station, eliminating a time effect in areas with HSR stations. Gyeongbu Express Railroad opened in 2004, and thus the time lag is expected to be sufficient. Accordingly, this study conducts the analysis for 2000 and 2010.

Table 2.7 Railroad Station Impacts on LE' s Cluster Using Difference in Difference Method

		Coeff.	*s.e.*
Base line	Control	0.133	–
	Treated	0.056	–
	Diff	−0.076	0.059
Follow up	Control	0.106	–
	Treated	0.156	–
	Diff	0.049	0.043
Diff−in−diff		0.126*	0.072

Note: *** significant at 1% level; ** significant at 5% level; * significant at 10 % level

Table 2.7 presents the results of our analysis of HSR stations' impacts on LE clusters using the difference in difference (DID) method. The result shows that the p-value for the treatment effect, or DID estimator, is 0.126, statistically significant at the 10% level. Therefore, a HSR station increases the probability of generating LE clusters in a region when this study controls for endogenous relation between a LE cluster and a HSR station.

The examples of Sweden and the UK provide a way to empirically evaluate our results. Sweden's electronics-manufacturing firms are primarily located within Dalarna (LCD), Karlskrona (communication equipment), and Stockholm (IT communications). Kista Science City is widely known as a region with strong R&D activities of universities and a strong government role in stimulating the collaborative linkage system between enterprises and universities. This area was designed to be located within 15 km of an international airport as well as 10 km from Stockholm. Ericsson and IBM, as representative enterprises[14] in Kista Science City, played a key role in inviting IT companies,

[14] Adobe, Compaq, Hewlett-Packard, Ericsson, Sun Microsystem, IBM, Microsoft, Nokia are the representative large enterprises located in Kista Science City in Sweden.

including Apple and Microsoft, in the late 1980's. Of course, the other geographical advantages were various universities with highly skilled students. In the 2000s, several cluster districts targeted to SMEs were developed near the Kista Science City.

For the UK experience, Trafford Park in Manchester is known as a successful knowledge-based cluster. It has operated urban regeneration programs for the deteriorated industrial complexes since the 1970s. Particularly, one of the factors for succeed in regeneration was construction of roads and highways, trucking and railroad terminals, and public transportation. In addition, the shopping and leisure complexes, the residential environment improvement projects, and the neighborhood park service provision played an important role in industrial complex regeneration.

These past experiences underpin the causality between a HSR station and an LE cluster. This indicates that a HSR station is very significant for LEs to enjoy benefits to reduce the transport cost for business travels to the capital city where LEs' headquarters are situated (Barrón et al., 2009). In addition, LEs obtain a form of public goods advantages from the existence of urban amenities (Fujita and Thisse, 2002; Graham, 2005; Venables, 2007). In

contrast, for most SMEs there is an advantage to selling their goods in local markets[15] (O' Donoghue et al., 2014). Instead, SME clusters satisfied the electronics industry's demand in large metropolitan areas due to the large population (Villa, 2014).

It can support our result that the SMEs have a stronger tendency to be located near LEs than vice versa. However, SME clustered regions cannot obtain spin-off effects unless the economic environment includes highly educated workers. In addition, without the development of transportation facilities in a region remote from the metropolitan area, both SME and LE clusters will continue to be located within or near the capital city of the country. This result is consistent with Rosenthal and Strange (2001), Glaeser and Kerr (2009) and Jofre-Monseny et al. (2011).

[15] The main output market of SMEs is their local market, and the rest is elsewhere in region, the rest of the nation, or exported to Ireland (Teagasc local business survey). O' Donoghue *et al.* (2014) analyzed the SMEs' embeddedness of business by location type in the local economy. By location type, the SMEs located in rural, towns, and cities, sell 64.1%, 75.4% and 64.1% of their products in the local market (within 40 km), respectively.

2.5 Conclusion

Economic geography theory suggests that economic resources such as human capital, natural capital and intermediate inputs have a significant impact on industrial agglomeration across regions. However, considering firm size, practically speaking, SMEs and LEs have been located in different regions from one another due to different preferences for economic resources. There has been no theoretical or empirical research on the reason why firms are differently located across firm size.

This study adopted the framework of managerial theory to shed light on the different location choices of SMEs and LEs. SMEs have faced chronic problems of financial resource poverty. This constraint allows SMEs to search for positive externalities in an abundant labor market pool. In contrast, large enterprises tend to agglomerate only in regions close to high-speed railroad stations and tend to be less deregulated. In addition, large enterprises do not tend to locate in overpopulated constraint districts and nature conservation districts; rather they locate in growth management districts according to the Seoul Metropolitan Areas Readjustment

Planning Acts. In the view of the subcontracting relation between small firms and large enterprises, small firms more often tend to locate close to clusters of large enterprises.

The econometric results suggest that an abundant labor market[16] has affected small firms' location patterns. Concretely, everything else being equal, firms facing financial constraints and expertise constraints tend to be located in regions close to the main domestic market, i.e., Seoul in Korea. In contrast, large firms have a tendency to agglomerate only in regions with a HSR station. In the view of subcontracting relation between SMEs and LEs, SMEs tend to locate close to clusters of LEs, rather than vice versa. According to this evidence of SMEs' resource poverty, though "agglomeration diseconomies" may prevail (i.e., congestion cost or high land rent), spatial concentration of economic activities will continue in urban areas.

The results carry several regional policy implications for industrial agglomeration strategies. First, a comparative view of small and large firms' agglomeration may be essential in establishing a more comprehensive perspective on the full regional

[16] Abundant population could be explained by more urbanization or better amenities in terms of traditional urban theory.

character. Particularly, the impact of industrial policies should differ by region. Regions far from the capital city are subject to plan when trying to invite large firms. A metropolitan condition is a necessary condition to attract small firms for a successful regional strategy. In this regard, the industrial cluster policy may be more readily implemented in regions close to a HSR station or with a relatively low level of firm regulation targeted to large firms. Second, industrial activities will tend to be concentrated in denser and more populous metropolitan areas, as long as small firms suffer from resource poverty. This supports the benefits of agglomeration economies in a few urban locations. Policy makers should develop additional local strategies for dealing with industrial activities in rural areas.

Our results suggest a few other research avenues. First, an interesting extension of our study would be to examine whether the locational factors are heterogeneous across the sub-sectors of the electronics industry. Sub-sectors were regarded as homogeneous based on R&D expenditure in the sense that this study assumed electronic sectors to be part of a high-technology industry. This assumption allowed us to answer questions such as: "Is population

particularly important for those sub-sectors that make more intensive use of labor?" or "What factors influence on spatial agglomeration of more intensive use of capital?" It is possible to more precisely access a firm's location by using the 3-digit KSIC code of this industry, or to extract labor intensive sub-sectors of the electronics industry. Second, if a firm's location choice is tied to agglomeration economies, firms are expected to concentrate more under economic uncertainty, in order to compensate for risk. Increasing economic uncertainty often shifts the degree of industrial agglomeration in the electronics industry. Presumably, the maximum distance between SMEs and LEs would become smaller in order to reduce risk. It would be interesting to measure this distance. Finally, the present analysis could also be extended to the different geographies of firms located in heterogeneous regions in terms of income level or geographical attributes. For example, urbanization economies did not have a positive impact on a firm's location choice in less developed regions but may in developed regions. I leave these investigations for future research.

Chapter 3 Analysis of Determining Factors on Job Location Choice of University Graduates: A Focus on the Students from Less Developed Regions

3.1 Introduction

As reported by *The Guardian* in 2015, the UK's Northern Ireland and Scotland exhibited the highest retention of graduates among any UK regions, while the east Midlands had the lowest, suffering from a brain drain of graduates. The UK has tried to alleviate such geographic imbalance, but these efforts have been unsuccessful, mainly due to the higher probability of studying at universities in London. Brain drain[17] has also been a longstanding

[17] According to endogenous economic growth theory, skilled laborers tend to concentrate in a specific area due to a wage premium, whereas a source region may lose the development potential. Human capital is one of the significant production factors with increasing returns, according to a new theory of endogenous economic growth (Lucas, 1988; Romer, 1990). New growth theories by Romer (1986) and Lucas (1988) formulate equilibrium models with increasing returns to scale and imperfectly competitive sectors. The theories also deal with two research paradigms: New International Economics and New Economic Geography (Nijkamp and Poot, 1998). While the former reformulates trade and trade policy theories, the

issue in Korea, namely migration to the Seoul Metropolitan Area (SMA) from the non-Seoul Metropolitan Area (non-SMA)[18]. According to the 2008 Korean Graduates Occupational Mobility Survey (GOMS), 80.2% of high school graduates originally from the non-SMA migrate to the SMA for post-secondary education and then remain in the SMA after graduation due to access to better jobs or higher wages. In contrast, only 17.1% of high school graduates domiciled in the SMA, who migrated for higher education to the non-SMA, enter employment in the non-SMA. In this regard, Korea is experiencing an increasing imbalance between the SMA and the non-SMA in terms of economic opportunities such as gross regional product per capita, human capital, and financial capital. The SMA, occupying only 11.9% of the nation's total land area, accounted for 60.5% of workers with a master's or higher degree and 52.2% of the prime working age population (25-49 years old age cohort), according to Korea's 2015 national account statistics.

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latter describes the spatial distribution of economic activity at the regional scale, focusing on urban systems and regional development (Krugman, 1991).

[18] Korea is composed of eight metropolitan areas and nine provinces. Specifically, two metro cities and one province comprise the SMA, whereas six other metro cities and eight other provinces comprise the non-SMA.

A recent wave of research has suggested empirical evidence of positive feedback effects after return migration, when graduates have additional skills to establish knowledge networks (McCormick and Wahba, 2000; Katz and Rapoport, 2005; Agrawal et *al.*, 2008; Beine et al., 2008). In this sense, it would be meaningful to explore the determining factors of return migration to lagging regions. Wage premium or employment opportunity can be expected to encourage return migration, as is often suggested in the literature (e.g. Kazakis and Faggian, 2017; Crescenzi et al., 2017). However, these traditional factors have been argued to be ineffective with respect to the reasons for return migration to lagging regions.

For example, Kaplan et al. (2016) pointed out that wider employment opportunity has significant effects on developed regions but not on inferior regions in Germany. Similarly, Liu et al. (2017) proved that education and R&D investments positively influenced return migration of human capital only in the developed regions in China. According to Woo et al. (2017), educational investment was rarely effective in attracting well educated workers to lagging regions. Rather, job training (to accumulate knowledge and skills) targeted to native people had a greater impact on

migration to lagging regions by increasing educational investment. This finding indicates that an increase in return migration is more practicable when trying to attract young talent originally from developed regions.

The main objective of this study is to analyze the determining factors of job location choice of university graduates, with a focus on domiciled students in less developed regions. Particularly, this study takes into account the interaction between investment and the local public university, demonstrating the ineffectiveness of higher educational investment in attracting graduates to lagging regions, as seen in earlier studies (e.g. Liu et al., 2017). This study investigates the 2010 GOMS data set from a survey of graduates on how factors positively or negatively influence a person's location choice for higher education, and then for a job, which is conditional on the decision of the university. The findings are twofold. First, the graduates' migration varies depending on the interaction between local public universities and educational investment. Second, this study sheds light on the changing attributes of return migration behavior, which relies on having a proper local labor market, in terms of university majors and industrial structure.

This study classifies the graduates' migration patterns into the following four categories. The first type is when the migrant moves from the domicile location to enter university in the SMA and then remains there to enter the job market (here called a university stayer). The second type is when the migrant moves from the domicile to enter university in the SMA and then returns to the non-SMA for a job (here called a return migrant). The third type is when the migrant enters university within the non-SMA, but then moves away to the SMA (here called a late migrant). The final type is a person who studies and stays for a job in the non-SMA (here called a non-migrant).

The remainder of this study is organized as follows. Section 2 reviews the previous studies on the beneficial and detrimental impacts of brain drain, the determinants of migration including educational investment, and the linkage of return migrants with the regional labor market condition and urban agglomeration. Section 3 describes the data and the equation systems of two sub-national regions. In addition, this study will show the results of the bivariate probit model with sample selectivity. The final section discusses the findings and conclusions.

3.2 Literature Review

3.2.1 Mobility of University Graduates

Studies of university graduates' mobility adopt three lines of inquiry: to estimate detrimental effects and beneficial feedback effects, to explore the determinants of brain drain, and, more recently, to assess return migration behavior. However, the economic effects of brain drain have been studied in terms of international migration. Thus, this study reviews the literature on brain drain only in terms of interregional migration.[19]

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[19] Traditional approaches have agreed that human capital is highly mobile (Pacione, 1984; RitsiläÈ and Tervo, 1999); these two approaches are based on the neoclassical model and endogenous growth model. The neoclassical growth model anticipates regional convergence. Educated workers move to labor-scarce regions due to high returns to labor. Similarly, capital has a tendency to flow to capital-scarce areas to equalize marginal returns. Consequently, regional economic growth would become convergent, balancing the price and quantity of labor and capitals across regions. In contrast, according to the endogenous growth model, income inequality is dominant between regions. Human capital embedded in labor and capital tends to concentrate in metropolitan areas, thanks to the human capital externality, leading to agglomeration economies (Massey, 1990; Lucas, 2002; Waldorf, 2009). Lucas (2002) provides a theoretical framework underlying human capital externality by which capital does not move for higher benefit until the capital price becomes 3.3 times higher in a destination. This allows capital to get higher benefits in an origin

Studies attempting to identify the factors determining the mobility of university graduates can be categorized as having two perspectives: the maximization of utility and the innovation process. For the utility channel, expected wage compared to origin is one of the most well-known determinants of migration between two different regions (Sjaastad, 1962; Decressin, 1994; Todaro and Smith, 1985; Oswald, 1990; Beine et al., 2001; Gabriel and Rosenthal, 2004). In addition to wage, workers with additional knowledge have more opportunities to get a wage premium on skills due to the higher demand or network effect in a city (Chung et al., 2009; Eggert et al., 2010).

In the process of innovation, education and R&D investment have been found to be emerging key factors in the decline in brain drain. In particular, research activities of local universities (Anselin et al., 2000) and university quality[20] (Ciriaci, 2014) have directly contributed to the reduction in the brain drain, pulling skilled workers into these regions. Further, research activities of local universities have indirectly influenced the decline in brain drain, and

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although the capital price is lower than in the destination.

[20] The proxy for university quality was the average number of professors per student in Italy (Ciriaci, 2014).

thus stimulated innovation processes at the regional level (Anselin et al., 2000). The level of innovation varies depending on the level of R&D cooperation within a firm, or networks among suppliers, customers, universities, and a government's research institutions, as proposed by Simonen and McCann (2008), increasing the inflow of high-skilled young labors. Interestingly, Faggian and McCann (2009a), using a three-stage least squares simultaneous equation model (3SLS), found that the interrelationships between human capital inflow and innovation improved cumulative processes at the regional level, not to subject to diminishing returns.

The other determining factors of migration are various: living cost (Todaro and Smith, 1986; Moretti, 2004), land price (Gabriel and Rosenthal, 2004; Moretti, 2004), agglomeration (Berry and Glaeser, 2005; Preschi and Lenzi, 2010), industrial structure (Moretti, 2004), and physical capital formation (Acemoglu, 1996; McCann, 2001). Specifically, some empirical evidence has shown that human capital moves to affluent regions due to positive net benefits in spite of the high living costs. Agglomeration provides a variety of opportunities to high skilled workers. Knowledge spillovers take place only when R&D activities of local universities

are in a certain industry. For example, in the US, spillovers took place in the Electronics (SIC36) or the Instruments (SIC38) sectors but not in the Drugs and Chemicals (SIC28) and the Machinery (SIC35) sectors (Anselin et al, 2000; Moretti, 2004). In addition, physical capital tends to concentrate in more developed regions due to reduced capital utilization (Acemoglu, 1996; McCann, 2001).

3.2.2 Return Migration of University Graduates

There has been an increasing body of literature focusing on return migration to lagging regions after students' graduate college in a developed region. What factors cause graduates to return to a lagging region, which differs from the migration behavior to a developed region (Romano, 2016)? Additionally, graduates' return migration decision differs from older generations' migration behavior (Lundholm, 2016)[21]. The determining factors of return migration can be categorized into three types: economic, social, and

[21] Lundholm (2016) targeted return migrants whose age is above 55 to find the determinants of their return.

geographical opportunities. First, a graduate tends to move to a less developed region when he or she is able to earn a higher wage there (Kazakis and Faggian, 2017). Similarly, if a lagging region has ample opportunities in terms of labor market outcome (e.g. wage or employment), an individual returns to that region (Kaplan et al., 2016; Crescenzi et al., 2017). Meanwhile, according to Kaplan et al. (2016) and Liu et al. (2017), return migration is highly improbable unless a region is economically developed, despite investment in higher education or job opportunities. Young talent may be prompted to return by opportunities to be hired by top research institutes as well as for familiar or personal reasons (Censis, 2002).

On the other hand, a low unemployment rate does not seem to be an attractive condition for the local labor market (Liu et al., 2017). Instead, there may be a conditional effect with respect to relative unemployment between origin and destination regions. For example, Clemente et al. (2016) provided empirical evidence that when the unemployment rate of the destination region under study was 12.7% below that of the origin region, graduates did not return. This implies that return migration to a less developed region is a rare phenomenon in the sense that an economically developed

condition is necessary and sufficient. Focusing on other aspects of economic opportunity, graduates return to their home village with return savings when return migrants make the decision to employ themselves (Démurger and Xu, 2011).

Second, social networks have increasingly been acknowledged as shaping return migration decisions. A feeling of belonging or being similar to those living in a neighborhood tends to decrease the likelihood of leaving (Clark and Coulter, 2015). However, the propensity of mobility varies depending on individual, household, and dwelling factors. Specifically, a person who was living in economically deprived area or earning higher wages is more likely to leave (Rodriguez et al., 2002). Also, a graduate may want to return to feel close to family members, if he or she attended a college located in his or her home village but had job experience outside the village (Crescenzi et al., 2017).

Finally, return migrants are likely to experience a relative increase in accessibility to the major cities where they graduated from university. Geographical distance does not have much influence on return migrants when the origin city has favorable conditions (Clemente et al., 2016). Particularly, Koramaz and

Dökmeci (2016) provided empirical evidence that graduates returned to regions 200 to 400 km from a major city where they graduated college in Turkey.

In sum, graduates have shown different patterns of mobility to a less developed region from an economically developed region. This study anticipates that educational investment is one of the primary ways to reduce out-migrants and to stimulate innovation, as suggested by the results of earlier works (Anselin et al., 2000; Lazzeretti and Tavoletti, 2005; Simonen and McCann, 2008; Faggian and McCann, 2009a; Liu et al., 2017). However, financial investments alone are not sufficient to drastically reduce brain drain. Thus, this study additionally focuses on identifying favorable labor market conditions to stimulate return migration.

From the literature above, we hypothesize that brain drain behavior depends on education and R&D investment (i.e., investment in higher education or research institutes) as well as the local attributes in terms of the regional labor market condition. Brain drain behavior will decrease when educational investment in scaled universities is instituted in lagging regions. This result is distinct from the results of earlier works in the sense that the

impact varies depending on the size of the university (Anselin et al., 2000; Lazzeretti and Tavoletti, 2005; Simonen and McCann, 2008; Faggian and McCann, 2009a; Liu et al., 2017).

In addition, we hypothesize that return migration behavior will become more frequent when the amount of the R&D investment in research institutes increases. However, the level of return migration probability will vary by the level of opportunities to be employed as wage workers in the manufacturing sector in urban areas and as own business (i.e., self-employed) workers in rural regions of the study area. If the regional population is less than one million, and the opportunities are adequate to be employed as own business workers, the return migration of young educated people is likely to be relatively high.

3.3 Analysis

3.3.1 Methods and data

This research focuses on the observed dichotomous responses to whether a graduate studies in the non-SMA and remains there for employment. Seminal work on two-stage estimation shows the problem of selection bias derived from nonrandom samples (Heckman, 1979). Analysis of determining factors of graduates' job location choice is materialized within the framework of a bivariate probit regression with sample selection. This procedure allows for control over self-selection bias when an individual is making a two-stage decision regarding the location of his or her university and job.

The most common way to analyze an individual's selection is a binary logit or a probit model. A univariate decision model yields inconsistent estimates of the independent variables due to sample selection bias (Winship and Mare, 1992). In addition, the dependent variable can be underestimated in the whole sample with a binary model. Therefore, this type of analysis requires a bivariate probit

regression with sample selection (Kaplan and Venesky, 1994).

Let y_{ur}^{*} be the propensity to study in the non−SMA, given that a respondent is eligible to study in the non−SMA. Also, let y_{jr}^{*} denote the corresponding propensity of the respondent to migrate for a job to the SMA. This propensity is assumed to be continuous and normally distributed. The observed responses need be denoted because we cannot observe each graduate's propensity. Let y_{ur} and y_{jr} represent the observed dichotomous responses to these two questions: whether a respondent studied in the non−SMA and whether the graduate migrated to the SMA to get a job, respectively. Each observed response's propensities can be measured by separate probit regression equations. For example, the equation for studying in the non−SMA can be expressed as equation (3.1)

$$y_{ur} = \beta'_{ur} X_{ur} + \epsilon_{ur} \tag{3.1}$$

where β'_{ur}, X_{ur}, and ϵ_{ur} are a vectors of unknown parameters, a vector of explanatory variables, and the disturbance, respectively.

Disturbance ϵ_{ur} has a conditional mean of zero and variance of one with a correctly specified probit model. The observed response's propensity y_{ur} can be expressed by using the response propensity y_{ur}^{*} as shown in equation (3.2).

$$y_{ur} = \begin{cases} 0 \; if \; y_{ur}^{*} \leq 0 \\ 1 \; if \; y_{ur}^{*} > 0 \end{cases} \tag{3.2}$$

Similarly, the equation of job location choice in the second stage exhibits the form

$$y_{jr} = \beta_{jr}' X_{jr} + \epsilon_{jr} \tag{3.3}$$

where β_{jr}', X_{jr}, and ϵ_{jr} are a vector of unknown parameters, a vector of explanatory variables, and the disturbance, respectively. The observed response' propensity y_{jr} can be expressed by using the response propensity y_{jr}^{*} as shown in equation (3.4).

$$y_{jr} = \begin{cases} 0 \; if \; y_{jr}^{*} \leq 0 \\ 1 \; if \; y_{jr}^{*} > 0 \end{cases} \tag{3.4}$$

Some predictors can be omitted from both models of equations (3.1) and (3.3). These equations result in a non−zero covariance between the two disturbance terms ϵ_{ur} and ϵ_{jr}, respectively. There is a nonrandom selection when respondents answer the question of job location choice. For example, a respondent cannot migrate for a job to the SMA without graduating from a university in the non−SMA. The separate equation for migrating for a job does not have a predictive variable associated with probability of studying in the non−SMA. In this case, the assumption of the disturbance ϵ_{jr} cannot satisfy a conditional mean of zero and variance of one. This separate application of probit regression would lead to incorrect inferences regarding the association of where to study and where to get a job. Applying a bivariate probit regression with sample selection can solve this problem. This model assumes that disturbances, ϵ_{ur} and ϵ_{jr} are normally distributed with marginal means of zero.

In addition, the bivariate probit model makes an assumption of the presence of variances σ_{ur}^2 and σ_{jr}^2, and covariance $\sigma_{ur,jr}$. Importantly, y_{jr} and x_{jr} can be observed only when a respondent studied in the non−SMA ($y_{ur} = 1$). A separate application of the

model can yield unbiased estimates when the covariance equals zero ($\sigma_{ur,jr} = 0$). If the covariance does not equal zero ($\sigma_{ur,jr} \neq 0$), the population regression function of the sub-sample of the graduates who studied in the non-SMA can be written as follows:

$$\mathrm{E}\left(y_{jr} \middle| X_{jr}, y_{ur}^{*} > 0\right) = \beta_{jr}' X_{jr} + \mathrm{E}\left(\epsilon_{jr} \middle| X_{jr}, y_{ur}^{*} > 0\right) \tag{3.5}$$

$$= \beta_{jr}' X_{jr} + \mathrm{E}\left(\epsilon_{jr} \middle| \epsilon_{ur} > -\beta_{ur}' X_{ur}\right) \tag{3.6}$$

The second term on the right-hand side of equation (3.6) can be changed by using a scalar value population regression coefficient (β_{λ}) and the inverse of Mill's ratio (λ) as follows:

$$E\left(\epsilon_{jr} \middle| \epsilon_{ur} > -\beta_{ur}' X_{ur}\right) = \beta_{\lambda} \lambda \tag{3.7}$$

where β_{λ} equals the covariance divided by the square root of the variance ($\sigma_{ur,jr}/\sigma_{ur}$) of the disturbance term (ϵ_{ur}) for respondents studied in the non-SMA.

Without explicit nonrandom sampling, the conditional mean of the disturbances given to the predictors is not zero. Equation (3.6) showing explicit nonrandom selection mechanism yields the sample regression function by adding an estimate of Mill's ratio, λ as shown in equation (3.8).

$$y_{jr}|y_{ur}^{*} > 0 = \beta_{jr}' X_{jr} + \beta_{\lambda}\hat{\lambda} + \tilde{\epsilon}_{jr} \tag{3.8}$$

where $\mathrm{E}\left(\tilde{\epsilon}_{jr}\middle|y_{ur}^{*} > 0\right) = 0$ is satisfied when the conditional mean of the disturbances is zero in the population.

2010 GOMS data includes 18,078 university graduates, four percent of all college graduates. The survey targeted people who graduated in 2010 and traced them after two years. The data contains information on locations of domicile, college, and the first job to present job. It also includes individually detailed information about each subject's gender, age, college major, parental income, work experience, and occupational category (wage employees or self-employed). The data does not reveal the location of the birth, so this study uses the municipality (sigungu level in Korea) where a person graduated from high school (here called the domicile region).

In examining the brain drain of each individual, this paper divides municipalities into two major groups: the SMA and the non-SMA. The target is the university graduates whose domiciles are in the non-SMA. This study investigates how a high school student makes decisions regarding college location, and then job location after graduation, by positing that the probability that return migration varies across space, depending on the aspects of local industrial attributes and urban agglomeration. This study pays special attention to educational investment effects, referring to the situation where the effect of the education and R&D investment on the graduates' migration varies by the size of the local university.

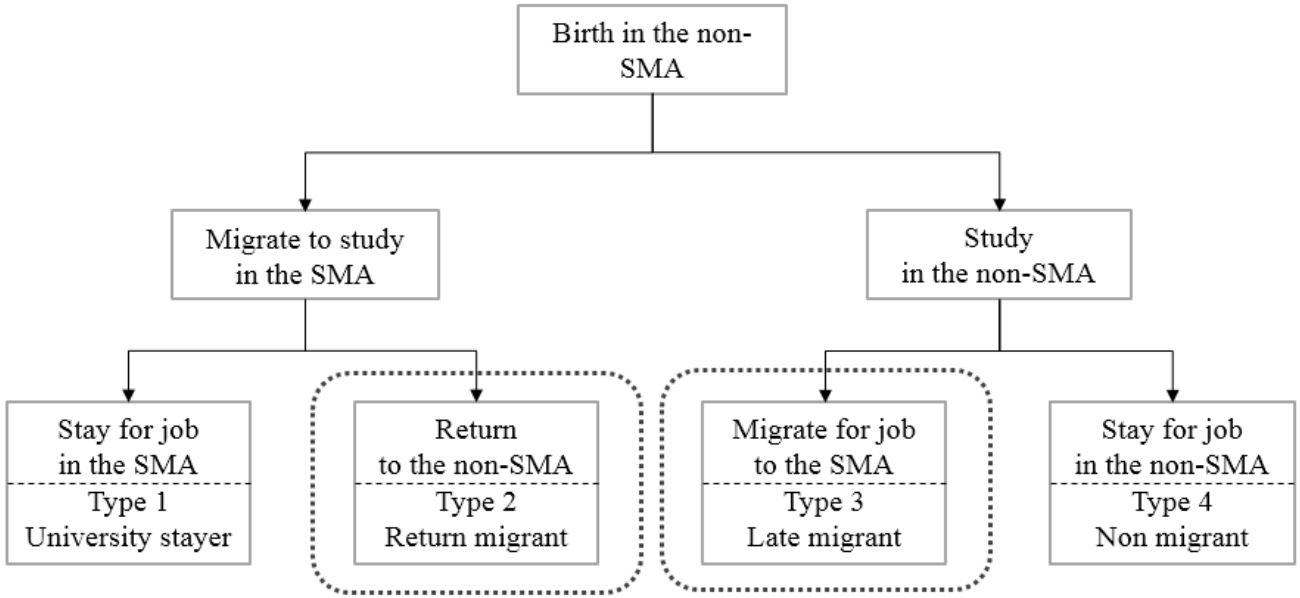

Figure 3.1 Four Types of Graduates' Migration

University graduates' migration can be graphically visualized using a two-stage decision tree as depicted in Figure 3.1. An individual chooses his or her university location: migrating to study in the SMA or studying in the non-SMA. Then, the individual who moved to study in the SMA may also make the decision to stay for a job in the SMA (university stayer) or to return to the non-SMA after graduation (return migrant). On the other hand, another individual who studies in the non-SMA may choose to migrate for job to the SMA (late migrant) or to stay for a job in the non-SMA (non-migrant).

Table 3.1 gives a brief description of the variables used in the empirical analysis. The GOMS data affords us with the information on city-province details of the domicile, university and the last employment workplace location of each graduate. It is necessary to integrate the spatial data with regional knowledge assets, including university education data, local labor market data, and regional and geographical structural data. Individual data is from the GOMS, and regional attributes data is from the Korean Statistics Bureau. The spatial unit is 226 cities and counties.

Table 3.1 Variable Descriptions

Variables	Name	Definition
University location	UNIV	University within the SMA (=1)
	LUNIV	University within the non-SMA (=1)
Job location	JOB	Job within the SMA (=1)
	LJOB	Job within the non-SMA (=1)
Gender	GEND	Male (=1)
Family background	$PEDU_k$	Father to receive a middle school education (reference) k=H if father to receive a high school education (=1) k=U if father to receive a university education (=1) k=G if father to receive a graduate school education (=1)
	PINC	Father's income when an individual entered the university
Individual experiences	KAT_i	Korean scholastic aptitude test level, high score (=1)
	MJR_m	m = 1 if social science (=1) m = 2 if humanities (=1) m = 3 if education (=1) m = 4 if engineering (=1) m = 5 if natural science (=1) m = 6 if medicine (=1) m = 7 if art and physics (=1)
	GRDLATE	Graduation more than one year late (=1)
	EXPRGW	Job experience of regular work condition (=1)
	EXPSEOUL	Job experience in Seoul (capital city of Korea) (=1)

Table 3.1 Variable Descriptions (Continued)

Variables	Name	Definition
	RTMA	When his/her domicile is metropolitan areas remote from capital city over 300 km (e.g. Gwangju, Ulsan and Pusan)
Job condition	WAGE	Present monthly wage of the present job compared to reservation wage
	SCL	The number of employment of the present job's enterprise
	RGW	Regular worker (=1)
	HIND	Heavy industry or resource oriented industry of the present job (=1)
	OWNBZ	Present job is in own business (=1)
R&D investment	RDU	Education R&D investment per research manpower
	RDI	R&D investment per research manpower in public or private research institute
Educational environment	LPU	Local public university existing within domicile region (with twenty thousand students)
Social network	SN1	Consistency between domicile and job location (=1)
	SN2	Consistency between university and job location (=1)

Table 3.1 Variable Descriptions (Continued)

Variables	Name	Definition
Labor market condition	RINC	Regional income of destination region compared to origin region
	POP	Population of destination region compared to origin region
	LCOST	Present living cost per month
Labor market condition	JOBOPP	Job opportunity measured by the number of employment compared to population
	OWNBZOPP	The number of non-wage workers compared to total employment

This study constructs two bivariate probit models (Model 1 and Model 2) to identify two types of graduate migration. Model 1 explains return migrants as shown in equations (3.9) and (3.10). Equation (3.9) describes the odds of migration to study in the SMA. Gender, family background and regional attributes are included in addition to the education and R&D investment. The square term[22] of educational investment is contained to capture diminishing or increasing returns to the investment.

[22] This study uses the square term of education R&D investment to test whether brain drain exhibits diminishing returns or increasing returns to educational investment.

This study formulates equation (3.10), where the dependent variable is the odds of return behavior that is conditional on the decision to study in the SMA. College major, prior work experience, present job condition, regional industrial features[23], and the R&D investment in research institutes are the explanatory variables. A dummy variable of the consistency between domicile and job location is included to measure the social network effect (Crescenzi et al., 2017). This fits by controlling the unobserved effects related to the personal emotion of belonging to neighborhood, or non-economic behavior (Clark and Coulter, 2015). The statistical significance of the estimate of the product term of this dummy variable and wage illustrates that wage is more effective in a lagging region, which is a graduate's domicile. Meanwhile, the statistical insignificance may emphasize only domicile effects where economic factors do not fit return migration. The dummy variable of the firm sector (HIND) equals one if the firm is included in a heavy or natural resource oriented manufacturing industry. Model 1 is specified as:

[23] The variable of the industrial features (HIND) represents eight 2-digit industry categories for those industries that are usually located along the coastline in Korea.

<Model 1>

$$UNIV_i = \alpha_0 + \alpha_1 GEND_i + \alpha_{2ki} PEDU_{ki} + \alpha_3 lnPINC_i + \alpha_4 KAT_i$$
$$+\alpha_5 lnRINC_r + \alpha_6 lnPOP_r + \alpha_7 lnRDU_r + \alpha_8 (lnRDU_r)^2$$
$$+\alpha_9 LPU_r + \alpha_{10}(lnRDU_r \times LPU_r) + \alpha_{11} RTMA_r$$
$$+\alpha_{12}(ln\, RINC_r \times RTMA_r) + \alpha_{13}(ln\, POP_r \times RTMA_r) + \varepsilon_i \tag{3.9}$$

$$LJOB_{(i|UNIV=1)} = \beta_0 + \beta_1 GEND_i + \beta_2 RGW_i + \beta_3 lnWAGE_i + \beta_{4mi} MJR_{mi}$$
$$+\beta_5 HIND_i + \beta_6 (HIND_i \times MJR_{(i|m=4)})$$
$$+\beta_7 EXPRGW_i + \beta_8 EXPSEOUL_i + \beta_9 GRDLATE_i + \beta_{10} OWNBZ_i$$
$$+\beta_{11} SN1_i + \beta_{12}(SN1_i \times RGW_i) + \beta_{13}(SN1_i \times lnWAGE_i)$$
$$+\beta_{14} lnRDI_r + \beta_{15}\, ln\, JOBOPP_r + \beta_{16}\, ln\, OWNBZOPP_r + \varepsilon_i \tag{3.10}$$

where subscripts i and r refer to individual and region at the state level, respectively. The reference for college majors (see subscript m) is art and physics.

Model 2 explains late migrants as shown in equations (3.11) and (3.12). Equation (3.11) describes the odds of studying in the non-SMA. The explanatory variables are assumed to be the same as in equation (3.9) in Model 1. This study includes the interaction terms of the presence of local public universities and educational investment. The sign of this estimate suggests evidence of effective allocation of educational investment in local universities in lagging regions.

Equation (3.12) describes the odds of migration behavior for a job to the SMA that is conditional on the decision to study in the non-SMA. Besides college major, prior work experience, present job condition, regional industrial features, and domicile effects similar to equation (3.10), the variables of living cost and whether or not job location is in the region where the student graduated from college are included to explain the brain drain behavior. Model 2 accesses the late migrants represented by equations (3.11) and (3.12):

<Model 2>

$$LUNIV_i = \alpha_0 + \alpha_1 GEND_i + \alpha_{2ki} PEDU_{ki} + \alpha_3 lnPINC_i + \alpha_4 KAT_i$$
$$+\alpha_5 lnRINC_r + \alpha_6 lnPOP_r + \alpha_7 lnRDU_r + \alpha_8 (lnRDU_r)^2$$
$$+\alpha_9 LPU_r + \alpha_{10}(lnRDU_r \times LPU_r) + \alpha_{11} RTMA_r$$
$$+\alpha_{12}(ln\, RINC_r * RTMA_r) + \alpha_{13}(ln\, POP_r * RTMA_r) + \varepsilon_i \tag{3.11}$$

$$JOB_{(i|lUNIV=1)} = \delta_0 + \delta_1 GEND_i + \delta_2 RGW_i + \delta_3 lnW\ \square G\quad E\quad {}_i + \delta_4 SCL_i$$
$$+\delta_{5mi} MJR_{mi} + \delta_6 GRADE_i$$
$$+\delta_7 HIND_i + \delta_8 (HIND_i \times MJR_{(i|m=4)}) + \delta_9 lnLCOST_i$$
$$+\delta_{10} EXPRGW_i + \delta_{11} EXPSEOUL_i + \delta_{12} GRDLATE_i$$
$$+\delta_{13} OWNBZ_i + \delta_{14} SN1_i + \delta_{15} SN2_i$$
$$+\delta_{16} lnRINC_r + \delta_{17} lnPOP_r + \varepsilon_i \tag{3.12}$$

where subscript i and r refer to individual and region at the state level, respectively. The reference for college major (see subscript m) is education.

3.3.2 Result

The results of the two bivariate probit models with sample selectivity are as shown in Table 3.2 and Table 3.3. Besides the estimates of the explanatory variables, the rho values (ρ) are estimated to be significantly different from zero in both two models; a univariate decision model would be inefficient. The rho value represents sample selectivity. The sign of the rho value is positive in Model 1 as shown in Table 3.2. The probability that an individual who moves to study in the SMA decides to return to the non-SMA for a job (return migrant) is higher than the probability that an individual stays for education and a job in the non-SMA (non-migrant). The sign of the rho value is positive in Model 2 as shown in Table 3.3. The probability that an individual who studies in the non-SMA decides to migrate for a job to the SMA (late migrant) is higher than the probability that an individual studies and gets a job in the SMA (university stayer). These results are statistically significant at the 1% level.

Table 3.2 Estimation of Bivariate Probit Model of Return Migrant (Type 2)

Model 1 (Return migrants)					
Migrate to study in the SMA			Return for job to the non−SMA		
Variables	Coefficient	S.E.	Variables	Coefficient	S.E.
Intercept	−67.280 ***	8.621	*Intercept*	−4.590	3.290
GEND	−0.371 ***	0.089	GEND	0.397 ***	0.142
$PEDU_H$	0.320 ***	0.090	RGW	0.278 **	0.111
$PEDU_U$	0.634 ***	0.107	ln(WAGE)	−0.139 °	0.088
$PEDU_G$	0.636 ***	0.167	MJR1	0.352 *	0.220
ln(PINC)	0.119 *	0.073	MJR2	0.249	0.189
KAT	0.981 ***	0.247	MJR3	0.445 *	0.256
ln(RINC)	6.052 ***	0.390	MJR4	0.394 *	0.193
ln(POP)	−2.922 ***	0.411	MJR5	0.513 **	0.206
ln(RDU)	10.672 ***	1.314	MJR6	0.399 *	0.222
$(\ln RDU)^2$	−0.426 ***	0.050	HIND	0.059	0.308
LPU	−3.793 ***	0.374	HIND×MJR4	0.646 *	0.423
ln(RDU)×LPU	0.464 ***	0.071	EXPRGW	0.792 *	0.428

Table 3.2 Estimation of Bivariate Probit Model of University Stayer and Return Migrant (Continued)

Variables	Coefficient	S.E.	Variables	Coefficient	S.E.
RTMA	−0.723 ***	0.148	EXPSEOUL	−1.601 ***	0.520
ln(RINC)×RTMA	6.115 ***	1.089	GRDLATE	−0.370 ***	0.127
ln(POP)×RTMA	−5.461 ***	1.194	OWNBZ	0.184	0.219
Rho(ρ)	0.487 ***	0.088	SN1	3.255 *	1.553
			SN1×RGW	−0.986 ***	0.248
			SN1×ln(WAGE)	−0.289	0.282
			ln(RDP)	0.728 ***	0.239
			ln(JOBOPP)	−2.440 ***	0.273
			ln(OWNBZOPP)	2.987 ***	0.295
Number of observation	5518			1343	
Log likelihood			−1213.496		
Wald chi^2(20)			326.250		
Prob>chi^2			0.000		

Note: P−values in parentheses: *** significant at 1% level; ** significant at 5% level; * significant at 10 % level; ° significant at 15% level.

Table 3.2 presents the estimation results of a return migration decision. The estimate of the education and R&D investment (RDU) is positive and statistically significant, while the square term shows a negative sign with statistical significance, as shown in the left panel of Table 3.2. The results of these two estimates imply that behavior in a university migrant to the SMA exhibits diminishing returns to scale of educational investment in the SMA. The signs of the estimates of the education and R&D investment and the square term show a concave shape, implying a declining average benefit of R&D investment. This indicates that educational investment strengthens the competitiveness of the universities only in the SMA, consistent with an earlier finding (Oh, 2010) that the level of university competitiveness varies depending on the location of a university in Korea. The presence of local public universities (LPU) reduces migration to the SMA, showing a negative sign with statistical significance. Meanwhile, the sign of educational investment in local public universities (RDU×LPU) is positive not to retain high school graduates in the non−SMA.

Father's education level ($PEDU_H$, $PEDU_U$ and $PEDU_G$) and income (PINC) are positively related to entrance to a college

located in the SMA. Korea's best universities are mainly located in the SMA. In this sense, we include as a variable the high school students' scholastic aptitude test (KAT). In addition, according to empirical finding (Causa and Johansson, 2010), parental socioeconomic background is positively associated with education performance and labor market outcome. This relation indicates that intergenerational social mobility is unavoidably confined when the wage gap is mainly exacerbated by education level. In this regard, father's academic and financial status could improve a student's academic ability. Additionally, males (GEND) tend to migrate to study in the SMA less often than females.

With a one percent increase in regional income (RINC) and population (POP) in the SMA, the odds ratio of migration is expected to increase by 6.052 and decrease by 2.922 (significant at the 1% level), respectively. The former finding proves that students tend to make the university location decision based on job opportunities or economic benefits, *ceteris paribus*. The latter result can be explained by decrease in the population of the Korea's capital city, Seoul, due to migration to adjacent regions.

The students domiciled in some of the local areas migrate less to study in the SMA, *ceteris paribus*. Those regions are metropolitan areas 300 km distant from the capital city (see the variable of RTMA) (only including the metropolitan areas of Gwangju, Ulsan and Pusan). Interestingly, the product terms of regional income and population with remote metropolitan areas (RINC×RTMA and POP×RTMA) show positive and negative signs (significant at the 1% level), respectively. High school graduates domiciled in a remote region with a small population are less likely to study in the SMA. Meanwhile, they are more likely to study in the SMA when the regional income of their domiciles is low.

As shown in the right panel of Table 3.2, graduates who studied in the SMA tend to return to the non-SMA where the R&D investment in research institutes (RDP) increases. This result provides evidence that regional knowledge assets, such as research institutes and local universities, increase human capital flows to a region (Faggian and McCann, 2006). In addition, this result supports Korea's current balanced development policies, such as reallocation of public research institutes to the non-SMA and R&D investment in them.

The graduates who majored in humanities (MJR1), education (MJR3), natural science (MJR4), engineering (MJR5), or medicine (MJR6) tend to return more than those who majored in art and physics, showing positive signs with statistical significance. The potential interpretations are as follows: the services of education and medicine are demanded in local areas. In response to such a situation, the related local labor market is as strong as in the SMA. Thus, the labor market outcomes are relatively high even in the non-SMA.

Regions with heavy industries have advantages for return migration, showing a plus sign with statistical significance of the interaction term (HIND×MJR4). Graduates who majored in engineering tend to return to the specialized regions with heavy industry. Accordingly, the potential for return migration would be higher in regions located in the southern coastal areas, part of the non-SMA in South Korea. Additionally, the variable of graduating more than one year late (GRDLATE) shows a negative coefficient, explained by the fact that the graduates seem to need a preparatory period to be able to get a job in the SMA. Furthermore, males (GEND) exhibit a stronger tendency to return than females.

On the other hand, having prior work experience of regular work (EXPRGW) contributes to the return decision, showing a positive sign with statistical significance. Meanwhile, having prior work experience in Seoul (EXPSEOUL) is negatively and highly significantly associated with return migration. Graduates tend to stay in the SMA if they have high levels of knowledge and technology. Thus, prior work experience plays a key role in shaping access to proper job opportunities in the SMA. The variables of regular work position (RGW) and the wage compared to the reservation wage (WAGE) show a positive and a negative sign, respectively. Returnees might consider stability as an important criterion when choosing a job. This finding might shed light on the direction of regional employment policy to stimulate transition from school to full-time work, or from a temporary position to a full-time job.

The variable of job opportunity shows a negative sign (significant at the 1% level). This finding is consistent with Liu et al. (2017), which showed that low unemployment rate did not increase return migration. Rather, return patterns are associated with the empirical results of the own business variable (OWNBZOPP).

Graduates return to regions with a high rate of self-employment, showing a positive sign with statistical insignificance. Specifically, many return migrants seem to be self-employed, consistent with the finding of Démurger and Xu (2011).

Interestingly, the result reporting a statistically significant and positive sign is that graduates tend to return when getting a job in their home municipality. This observed pattern might be explained by a strong preference for a social network, consistent with the empirical results of Kaplan et al. (2016) and Crescenzi et al. (2017). The product terms with wage show a negative sign but statistically insignificant. The likelihood of returning to their home villages would be the same even if higher wages were given, *ceteris paribus*. In addition, the sign of the product term with regular work position is negative with statistical significance. These findings indicate that graduates tend to pay more attention to their social network than to economic benefits such as high wages or a stable job position. This finding supports a policy offering pay incentives to natives who return to their domiciles at the state level (sido level in Korea).

Table 3.3 Estimation of Bivariate Probit Model of Late Migrants (Type 3)

Model 2 (Late migrants)					
Study in the non−SMA			Migrate for job to the SMA		
Variables	Coefficient	S.E.	Variables	Coefficient	S.E.
Intercept	71.742 ***	9.154	*Intercept*	−1.039 **	0.495
GEND	0.390 ***	0.090	GEND	−0.007	0.076
$PEDU_H$	−0.339 ***	0.091	RGW	0.209 ***	0.073
$PEDU_U$	−0.661 ***	0.108	ln(WAGE)	−0.045	0.070
$PEDU_G$	−0.682 ***	0.172	SCL	−0.026 **	0.014
ln(PINC)	−0.084	0.075	MJR1	0.359 **	0.165
KAT	−1.010 ***	0.255	MJR2	0.087	0.133
ln(RINC)	−6.298 ***	0.388	MJR4	0.234 *	0.136
ln(POP)	3.109 ***	0.409	MJR5	0.158	0.149
ln(RDU)	−11.382 ***	1.399	MJR6	0.162	0.149
$(\ln RDU)^2$	0.454 ***	0.054	MJR7	0.238	0.161
LPU	3.833 ***	0.382	GRADE	0.040	0.084
ln(RDU)×LPU	−0.467 ***	0.073	HIND	−0.245	0.245

Table 3.3 Estimation of Bivariate Probit Model of Late Migrants (Type 3) (Continued)

Variables	Coefficient	S.E.	Variables	Coefficient	S.E.
RTMA	0.770 ***	0.151	HIND×MJR4	−0.793 **	0.334
ln(RINC)×RTMA	−5.604 ***	1.069	ln(LCOST)	−0.184 ***	0.036
ln(POP)×RTMA	4.816 ***	1.156	EXPRGW	−0.593 ***	0.192
Rho(ρ)	0.426 ***	0.120	EXPSEOUL	1.064 ***	0.259
			GRDLATE	0.153 °	0.106
			OWNBZ	−0.185	0.168
			SN1	−0.478 ***	0.080
			SN2	−1.980 ***	0.128
			ln(RINC)	0.134 ***	0.050
			ln(POP)	0.975 ***	0.047
Number of observation	5456			4113	
Log likelihood			−1690.453		
Wald $chi^2(20)$			1097.710		
Prob>chi^2			0.000		

Note: P−values in parentheses: *** significant at 1% level; ** significant at 5% level; * significant at 10% level; ° significant at 15% level.

Table 3.3 presents the estimation results of a late migration decision. The signs of the estimates are opposite those of the results in the left panel of Table 3.3 due to the composition of the same explanatory variables. As illustrated in the left panel of Table 3.3, the estimate of educational investment (RDU) is negative, but the square term is positive, both with statistical significance. Opposed to the results shown in Table 3.2, educational investment (RDU) does not seem to stop migration to the SMA. This finding corresponds to the estimation result by Liu et al. (2017) in that investing in higher education is effective at curbing brain drain only in those lagging regions with a high level of regional income. Moreover, the product term between educational investment and dummy indicating the presence of a local public university with 20,000 students shows a statistically significant and negative sign (see RDU×LPU).

Interestingly, investment in a local public university does not have any impact on reducing migration to the SMA. With the presence of local public universities (LPU), migration to study in the SMA can be reduced, showing a positive sign with statistical significance. This result is opposed to the finding of Crescenzi et al.

(2017) that high quality of universities is one of the essential factors preventing graduates from moving out of less developed regions. Meanwhile, this finding is consistent with empirical findings that educational investment is not effective in stimulating return migration in economically lagging regions (Kaplan et al., 2016; Liu et al., 2017).

Besides the variables related to educational investment, father's educational ($PEDU_H$, $PEDU_U$ and $PEDU_G$) and financial status (PINC) are negatively associated with selection of university in the non-SMA. A high-quality student does not tend to go to a university located in the non-SMA, *ceteris paribus*, showing a negative sign with statistical significance (KAT). Males (GEND) have a stronger tendency to stay to study in the non-SMA than females. The signs of regional income (RINC) and population (POP) are negative and positive (significant at the 1% level), respectively. High school graduates consider urban benefits when making the decision to attend college in the non-SMA rather than regional economic level (RINC×RTMA and POP×RTMA).

As shown in the right panel of Table 3.3, the graduates who specialize in humanities (MJR1) or engineering (MJR4) tend to

migrate to the SMA more than those who specialize in education, showing positive signs with statistical significance. Graduates who major in engineering might have the advantage of getting a job in the SMA despite graduating from a college in the non-SMA, thanks to the demand for high-technology goods. Similar to the results in Table 3.2, local areas with heavy industries have advantages to retain graduates who major in engineering in the non-SMA (HIND×MJR4), showing a negative sign (significant at the 5% level). Thus, the potential for retaining graduates would be higher in regions located in the southern coastal areas. Additionally, the variable of graduating more than one year late (GRDLATE) shows a positive coefficient, explained by the fact that the graduates have prepared to get a proper job (i.e., a stable or permanent high-paying job) in the SMA.

Graduates who had prior experience of regular work (EXPRGW) tend to migrate less for a job in the SMA, showing a negative sign. Meanwhile, the variable of prior work experience in Seoul exhibits a positive sign with statistical significance. Graduates who had worked in the SMA (EXPSEOUL) have a strong tendency to migrate for a job to the SMA. The variable of regular work position (RGW)

shows a positive sign with statistical significance. Meanwhile, the wage compared to the reservation wage (WAGE) is not statistically significant. They make the decision to migrate for a job in the SMA when they get regular work, regardless of the wage level due to migration and settlement costs. Firm size is negatively related to choosing to migrate for a job in the SMA (SCL). This result indicates the possibility that these graduates are mainly employed in small and medium sized enterprises. Labor market outcomes of the students who graduated in the SMA are better in terms of earnings attainment than in the non-SMA (Kang, 2010; Yoo et al., 2014)[24]. The variable of living cost (LCOST) shows a negative sign (significant at the 1% level). This finding sheds light on the regional population policy with a focus on cost advantages targeted to graduates in the non-SMA.

Young workers who graduated in the non-SMA tend to stay for a job in their domicile regions (SN1) or the regions that their universities are in (SN2), showing a negative signs for both variables. These results are consistent with earlier findings (Kaplan

[24] In Korea, the labor market performance of graduates is also relatively poor because the universities in the non-SMA are less competitive than those in the SMA. As a measure of the performance of the labor market, employment in large companies is widely used in Korea (Kang, 2010).

et al., 2016; Crescenzi et al., 2017) of a strong preference for social networks. Regional income (RINC) and regional population (POP) have an upward effect on migration to the SMA after graduation. These associations are consistent with the migration theory (Sjaastad, 1962; Todaro and Smith, 1985; Decressin, 1994) and the city premium approach (Roback, 1982; Glaeser and Mare, 2001), respectively. Regions with relatively large populations in the SMA are likely to attract more university graduates. This phenomenon fosters a state of "cumulative growth of human capital" among developed regions (Bleicher, 2013; Sunmeet and Roy, 2014).

The empirical findings from these two bivariate probit models with sample selectivity shed light on educational R&D fiscal policy to reduce migration in terms of improving allocation of production factor across regions. Educational investment is ineffective in reducing migration despite financing of the local public universities. Rather: a) the presence of those universities reduces only high school graduates' migration to the SMA. After retaining them to study in the non-SMA, b) low cost of living is one of few determining factors to reduce brain drain. In addition, graduates tend to stay mainly in c) the regions of their domicile or college if

they make the decision to stay in the non-SMA. In sum, educational investment fails to retain young students. Moreover, the other determining factor is low cost of living.

In this regard, it is valuable to discuss the positive determinants of return migrants' behavior. They return: d) with getting regular work, e) to the regions with high levels of R&D investment in research institutions, f) to their domicile regions, or g) to regions with large demand for education or medicine. Among these determinants, R&D investment in local research institutions helps supplement the constraints of educational investment by increasing return migration through regional employment policies.

To discuss the regional variation of the magnitude of the impact from labor market condition, an urban premium might be useful in explaining the stylized pattern of return migration. As proposed in Glaeser and Mare (2001), an urban premium positively influences highly skilled workers' migration; thus, it is meaningful to compare the behavior of return migration between metropolitan areas and to provinces among the non-SMA regions at the municipality level. Figure 3.2 illustrates the distribution of the SMA's five metropolitan areas and eight provinces as of 2010.

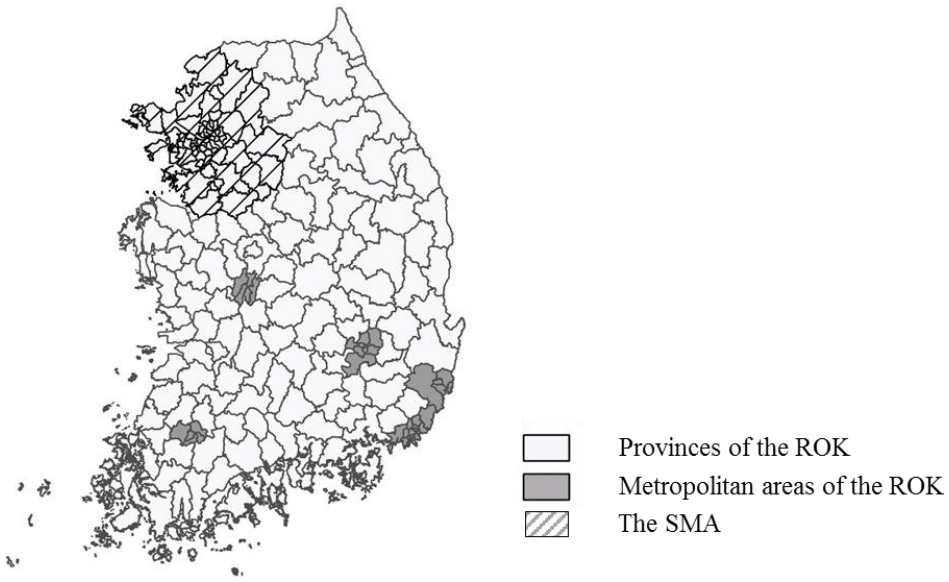

Figure 3.2 Distribution of the non-SMA's Metropolitan Areas and Provinces

Table 3.4 gives the summary statistics of the mean populations of the SMA and non-SMA. The mean population of the SMA (7.375 million persons) was greater than that of the non-SMA (1.786 million persons). Moreover, focusing on other aspects of human capital and youth aside from labor (population), the non-SMA might be in an inferior position. Particularly, the numbers of people who completed college and who were age 20 to 34 were 1.358 and 1.511 million persons in the SMA, compared to 0.262 and 0.372 million in the non-SMA, respectively.

On the other hand, among the non−SMA regions, the disparity is apparent from Table 3.4. For example, the mean population was 1.869 million persons in the metropolitan areas, larger than in the provinces, 1.735 million persons. These figures for the metropolitan areas and the provinces are higher by 4.62% and lower by 2.89% compared to the mean population, respectively. The mean population that completed college and were age 20 to 34 in the metropolitan areas is likely to be much larger than in the provinces. The values of these greatly differ by 25.29% in the metropolitan areas but (−)15.80% in the provinces, compared to the non−SMA's mean population that completed college and were age 20 to 34. This indicates a spatial gap between the metropolitan areas and provinces with respect to youth's human capital as well as population within the non−SMA. Therefore, it would be useful to contrast the metropolitan areas with the provinces with respect to labor market condition.

Table 3.4 Mean Population of the Metropolitan Areas and Provinces Placed in the non−SMA

	Population		Population completed college		Population of age 20 to 34		Population completed college of age 20 to 34	
	Number	Difference	Number	Difference	Number	Difference	Number	Difference
SMA (3)	7.375	−	1.577	−	1.818	−	0.589	−
Metropolitan areas (2)	5.822	−21.06	1.358	−13.91	1.511	−16.87	0.525	−10.96
Provinces (1)	10.483	42.13	2.016	27.82	2.431	33.74	0.718	21.91
Non−SMA (13)	1.786	−	0.262	−	0.372	−	0.101	−
Metropolitan areas (5)	1.869	4.62	0.335	27.80	0.424	13.91	0.127	25.29
Provinces (8)	1.735	−2.89	0.217	−17.37	0.340	−8.69	0.085	−15.80
TOTAL (16)	2.834	−	0.509	−	0.643	−	0.193	−

Note: The parenthesis represents the number of regions at the level of metropolitan areas or provinces.
Note: The unit is million persons and percent.

The probability of return migration is calculated under the mean condition by the non-SMA's 161 cities and counties at the municipality level. Each coefficient is based on the result of the right panel in Model 1 (see Table 3.2). Figure 3.3 illustrates the probability of return migration at the local level. The darker the background color, the higher probability of return migration.

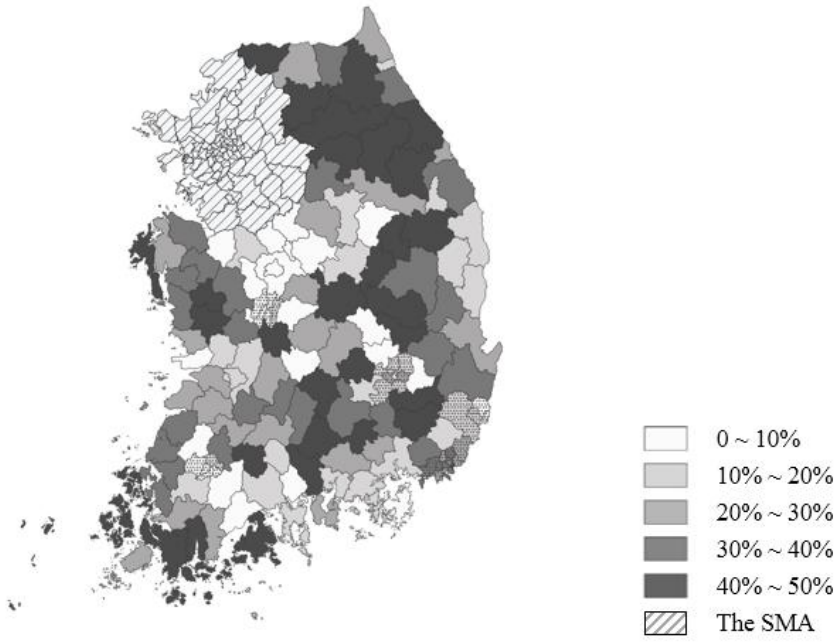

Figure 3.3 Probability of Return Migration at Municipality Level

The probability with respect to return migration of university graduates for a job turns out to be highest (upper 20%) among cities and counties located in some of the neighboring areas of the SMA (some cities in mountainous areas) or the regions centered in the metropolitan areas of the non-SMA (Daejeon, Daegu, Pusan, Ulsan and Gwangju).

The mean probability of return migration for the non-SMA's 161 cities and counties is 76.2% as shown in Table 3.5. The probability of return migration to metropolitan areas evaluated at the sample mean of exogenous variables is 71.0%, lower than the case of the provinces, 77.9%. The probability for metropolitan areas ranges from 25.1% to 92.8%, showing a lower deviation than those for provinces, which range between 8.4% and 97.2%. These suggests that an urban premium has little positive influence on return migration within the non-SMA. In addition, some of the non-SMA's provinces might be in a relatively dominant position due to the mean and the maximum value of the provinces return migration probability.

Table 3.5 Mean Probability of Return Migration of the non-SMA's Metropolitan Areas and Provinces

	Mean	Min	Max
Metropolitan areas	0.710	0.251	0.927
Provinces	0.779	0.084	0.972
Total	0.732	0.084	0.972

In addition, regions with high probability of return migration can be potentially interpreted as having two regional characteristics as follows. The majority of the regions ranked in the top 20% in terms of return migration are close to the metropolitan area (dotted areas) of the non-SMA but not included in the metropolitan area. In addition, they have been a favorable location for the high level of own business opportunities as shown in Figure 3.4. This result is related to the result of the above analyses that graduates return with own business. Those regions are not industrialized enough to have many proper jobs. However, the graduates return expecting benefits from the neighboring metropolitan areas and low land prices.

Focusing on other aspects of regional knowledge aside from job characteristics, the R&D sector (KSIC 70) and the administration service sector (KSIC 84) are intensively located in regions remote from the metropolitan areas, as shown in Figure 3.5. These industries have the advantages of access to proper jobs or knowledge. This result is consistent with the literature (e.g. Kazakis and Faggian, 2017). This distribution implies that these regions might be in a superior position with respect to economic potential, including a high level of regional knowledge. In addition, this result can justify a decentralization policy of allocating the public sectors to local areas in Korea.

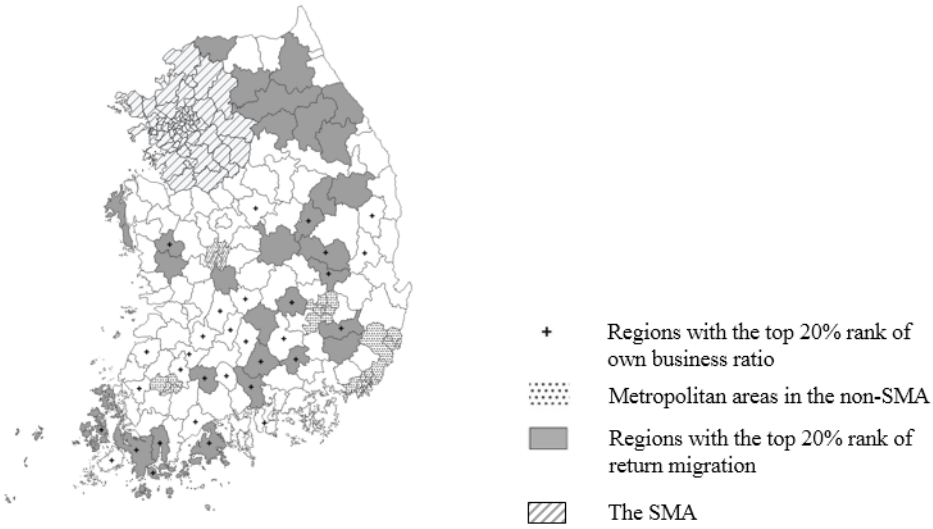

Figure 3.4 Distribution of Own Business

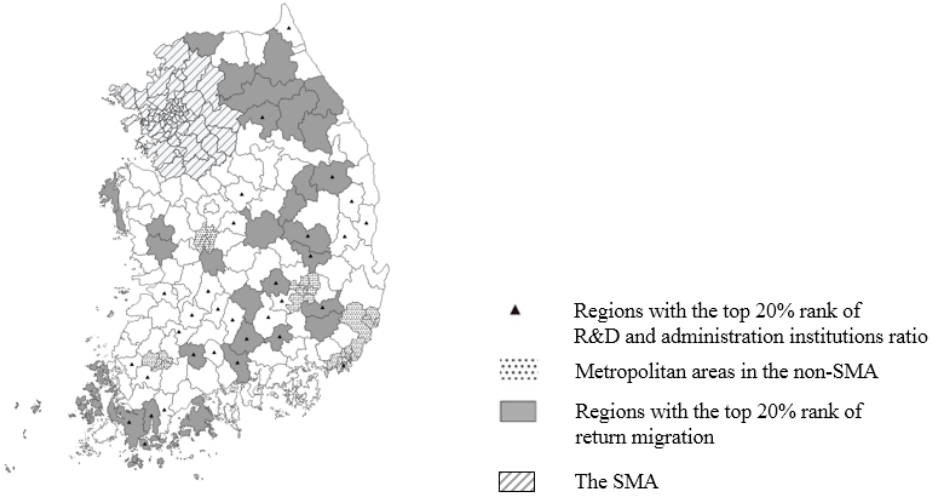

Figure 3.5 Distribution of R&D and Administration Institutions

3.4 Conclusion

This study analyzed the determining factors of graduates' migration, focusing on the impacts of education and R&D investment. A bivariate probit model with sample selectivity was used, targeting university graduates whose domiciles are in lagging regions in South Korea.

Our results show that educational investment in lagging regions has negative effects on reducing university migrants even with a concentration of investment in a local public university. This result is consistent with the result of Kaplan et al. (2016) and Liu et al. (2017) that educational investment has insignificant effects on retaining human capital in lagging regions. This interaction term calls into question the efficacy of regional development policies aiming to concentrate investment in public universities in lagging regions. Instead, the presence of a public university is effective at retaining young people to study there only when they graduate high school.

In terms of higher education efficiency in Korea, large universities exhibit better college student learning outcomes,

knowledge-transfer activities, and greater R&D funding (Han and Kwon, 2009). In the US case, meanwhile, college students exhibited a low level of learning outcomes at large universities due to less frequent interaction between professors and students (Astin, 1993). This indicates that education and R&D investment could trigger and improve knowledge-transfer activities in large sized universities where a research system is well constructed among students, professors, funding, and the region, consequently leading to regional innovation or regional development.

Focusing on public expenditure allocation, this interaction term can take into account the main support for educational fiscal policy by an intensive investment in large public universities. For this reason, the highest priority should be placed on curbing brain drain with expanded educational investment in education and R&D activities in lagging regions. Specifically, the central government should play a leading role in allocating funding to large universities, while the local government's role can be confined to designing and implementing region-specific programs for relatively small universities.

In addition, R&D investment in local research institutes is effective at increasing return migration to lagging regions. This suggests that the regional knowledge assets, such as research institutes and local universities, increase human capital flows to a region, consistent with the results of Faggian and McCann (2006). This result sheds light on Korea's current balanced development policies such as spatial reallocation of public research institutes to the non-SMA as well as R&D investment in research institutes.

In terms of regional labor market condition, graduates who majored in education and medicine tend to stay in or return to the non-SMA regardless of college location. This result may be explained by the fact that demand for educational or medical services becomes continuous and stable even in local goods markets. However, these demands are expected to increase not from production activities but from consumption. A household's income can eventually decrease in local areas without basic industries or complicated economic structure, consistent with the finding of McCann (2001)[25]. This explanation is supported by the traditional perspective of Fisher (1935) and Clark (1940) that

[25] See McCann (2011) p. 157

consumption structure changes from goods to services with a decrease in income. Meanwhile, graduates who majored in engineering tend to concentrate in some non-SMA regions with manufacturing sectors near metropolitan areas. This regional industrial feature can be linked with regional economic development, unlike consumption-derived labor demand.

Interestingly, graduates tend to return when getting a job in their home municipality. This pattern might be explained by a strong preference for a social network, consistent with the empirical results of Kaplan et al. (2016) and Crescenzi et al. (2017). In addition, the product term between social network and wage is positive but statistically insignificant. These graduates tend to pay more attention to their social network rather than to economic benefits such as high wages or a stable job position.

There are two further research issues regarding the linkages between educational investment and brain drain, particularly return migration. One is that the impact of a local university, as the primary variable in this paper, can be decomposed to account for either the quantity or quality of local university systems. In this paper, the local university is utilized to represent the quantity of

human capital; education investment is overall applied to measure both the quantity and quality of higher education. Higher education quality such as research, teaching programs or a higher education community, as proposed by Brooks (2005), might reduce brain drain; thus, it would be meaningful to decompose the brain drain effect of local universities by considering the quantity and quality of local university systems. Another extension is to develop a framework to estimate regional economic effects of education investment with consideration of brain gain. A possible way to assess these economic effects might be a long-term optimization model. The dynamic optimization model requires regional data for forecasting the control variables. This simulation contributes to an allocation of human capital under constant regional economic growth.

Chapter 4 Conclusion

4.1 Summary

This research focused on the factors determining job location choice of university graduates as a source of regional human capital, and the location determining factors of small firms and large enterprises as an effect of abundant regional labor market pooling. Regional human capital prompts industrial activities, thus consequently increasing regional economic potential. This research analyzes on the patterns of firm location and university graduates' in-migrants. This research consists of two essays aiming to understand 1) the heterogeneous location behaviors of firms by size and 2) the different impact of regional attributes in developed regions and lagging regions.

Chapter 2 used the framework of managerial theory to shed light on the different location choices of SMEs and LEs. SMEs have faced chronic problems of financial resource poverty. This constraint allows SMEs to search for positive externalities in an

abundant labor market pool. In contrast, large enterprises tend to agglomerate only in regions close to high-speed railroad stations and tend to be less deregulated. In addition, large enterprises do not tend to locate in overpopulated constraint districts and nature conservation districts; rather they locate in growth management districts according to the Seoul Metropolitan Areas Readjustment Planning Acts. In the view of the subcontracting relation between small firms and large enterprises, small firms more often tend to locate close to clusters of large enterprises.

The econometric results suggest that an abundant labor market pool has affected small firms' location patterns. Everything else being equal, firms facing financial and expertise constraints tend to be located in regions close to the main domestic market, i.e., Seoul in Korea. In contrast, large firms have a tendency to agglomerate only in regions with a HSR station. In the view of subcontracting relation between SMEs and LEs, SMEs tend to locate close to clusters of LEs, rather than vice versa. According to this evidence of SMEs' resource poverty, though "agglomeration diseconomies" may prevail (i.e., congestion cost or high land rent), spatial concentration of economic activities will continue in urban areas.

The results of this study carry several regional policy implications for industrial agglomeration strategies. First, a comparative view of small and large firms' agglomeration may be essential in establishing a more comprehensive perspective on the full regional character. Particularly, the impact of industrial policies should differ by region. Regions far from the capital city are subject to plan when trying to invite large firms. A metropolitan condition is a necessary condition to attract small firms for a successful regional strategy. In this regard, the industrial cluster policy may be more readily implemented in regions close to a HSR station or with a relatively low level of firm regulation targeted to large firms. Second, industrial activities will tend to be concentrated in denser and more populous metropolitan areas, as long as small firms suffer from resource poverty. This supports the benefits of agglomeration economies in a few urban locations. Policy makers should develop additional local strategies for dealing with industrial activities in rural areas.

In Chapter 3, the determining factors of university graduates' migration were analyzed with focus on the impacts of education and R&D investment. A bivariate probit model with sample selectivity

was used, targeting university graduates whose domiciles are in lagging regions in South Korea. Our results show that educational investment in lagging regions has negative effects on reducing university migrants even with a concentration of investment in a local public university. This result is consistent with the result of Kaplan et al. (2016) and Liu et al. (2017) that educational investment has insignificant effects on retaining human capital in lagging regions. This interaction term calls into question the efficacy of regional development policies aiming to concentrate investment in public universities in lagging regions. Instead, the presence of a public university is effective at retaining young people to study there only when they graduate high school.

Focusing on public expenditure allocation, this interaction term can take into account the main support for educational fiscal policy by an intensive investment in large public universities. For this reason, the highest priority should be placed on curbing brain drain with expanded educational investment in education and R&D activities in lagging regions. Specifically, the central government should play a leading role in allocating funding to large universities, while the local government's role can be confined to designing and

implementing region-specific programs for relatively small universities. In addition, R&D investment in local research institutes is effective at increasing return migration to lagging regions. This suggests that the regional knowledge assets, such as research institutes and local universities, increase human capital flows to a region, consistent with the results of Faggian and McCann (2006). This result sheds light on Korea' s current balanced development policies such as spatial reallocation of public research institutes to the non-SMA as well as R&D investment in research institutes.

In terms of regional labor market condition, graduates who majored in education and medicine tend to stay in or return to the non-SMA regardless of college location. This result may be explained by the fact that demand for educational or medical services becomes continuous and stable even in local goods markets. However, these demands are expected to increase not from production activities but from consumption. A household's income can eventually decrease in local areas without basic industries or complicated economic structure. This explanation is supported by the traditional perspective of Fisher (1935) and Clark (1940) that consumption structure changes from goods to services

with a decrease in income. Meanwhile, graduates who majored in engineering tend to concentrate in some non-SMA regions with manufacturing sectors near metropolitan areas. This regional industrial feature can be linked with regional economic development, unlike consumption-derived labor demand.

Interestingly, graduates tend to return when getting a job in their home municipality. This pattern might be explained by a strong preference for a social network, consistent with the empirical results of Kaplan et al. (2016) and Crescenzi et al. (2017). In addition, the product term between social network and wage is positive but statistically insignificant. These graduates tend to pay more attention to their social network rather than to economic benefits such as high wages or a stable job position.

4.2 Further Research

This research proposed several further research agenda. In the first essay of industrial location, there are a few other research avenues. First, an interesting extension of our study would be to examine whether the locational factors are heterogeneous across the sub-sectors of the electronics industry. Sub-sectors were regarded as homogeneous based on R&D expenditure in the sense that this study assumed electronic sectors to be part of a high-technology industry. This assumption allowed us to answer questions such as: "Is population particularly important for those sub-sectors that make more intensive use of labor?" or "What factors influence on spatial agglomeration of more intensive use of capital?" It is possible to more precisely access a firm's location by using the 3-digit KSIC code of this industry, or to extract labor intensive sub-sectors of the electronics industry. Second, if a firm's location choice is tied to agglomeration economies, firms are expected to concentrate more under economic uncertainty, in order to compensate for risk. Increasing economic uncertainty often shifts the degree of industrial agglomeration in the electronics industry.

Presumably, the maximum distance between SMEs and LEs would become smaller in order to reduce risk. It would be interesting to measure this distance. Finally, the present analysis could also be extended to the different geographies of firms located in heterogeneous regions in terms of income level or geographical attributes. For example, urbanization economies did not have a positive impact on a firm's location choice in less developed regions but may in developed regions. We leave these investigations for future research.

In the second essay of job selection of university graduates, there are two further research issues regarding the linkages between educational investment and brain drain, particularly return migration. One is that the impact of a local university, as the primary variable in this paper, can be decomposed to account for either the quantity or quality of local university systems. In this paper, the local university is utilized to represent the quantity of human capital; education investment is overall applied to measure both the quantity and quality of higher education. Higher education quality such as research, teaching programs or a higher education community, as proposed by Brooks (2005), might reduce brain

drain; thus, it would be meaningful to decompose the brain drain effect of local universities by considering the quantity and quality of local university systems. Another extension is to develop a framework to estimate regional economic effects of education investment with consideration of brain gain. A possible way to assess these economic effects might be a long-term optimization model. The dynamic optimization model requires regional data for forecasting the control variables. This simulation contributes to an allocation of human capital under constant regional economic growth.

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국문초록

산업입지와 대졸자 직업선택에 관한 에세이

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본 논문은 지역노동시장의 효과에 초점을 두고 산업입지와 대졸자의 직업선택에 관한 두 개의 에세이로 구성된다. 첫 번째 에세이는 중소기업과 대기업의 입지 결정요인에 대한 연구이다. 전자산업은 우리나라의 경제성장을 견인해 온 고부가가치 산업 중 하나이다. 한국은행에 따르면, 지난 12년 (2002-2013) 간 전 산업의 부가가치 성장률이 7.31%이었던 것에 비하여 전자산업의 부가가치 성장률은 10.20%였다. 전자산업은 수도권과 대구· 경북을 중심으로 분포하고 있다. 그러나 기업의 규모에 따라 중소기업과 대기업으로 나누어 공간 분포를 관측해 보면 차이가 있다. 대기업보다는 중소기업이 서울에 가깝게 분포하고 있다. 본 연구의 목적은 중소기업과 대기업의 입지 결정요인을 분석하는 것이다. 본 연구에서 사용한 방법론은 이항로짓모형(Binary logit model)이다. 종속변수는 고용자 수를 토대로 국지적 모란아이지수(Local Moran’s I index)를 사용하여 도출한 핫스팟이다. 설명변수로는 인구규모, 인구성장률, 중간재 산업의 고용자 수, 고속철도 접근성, 규제완화 등을 사용하였다. 실증분석에 활용된 자료는 2002, 2007, 2012년 전국사업체조사이다. 중소기업과 대기업을 분석한 결과는 다음과 같다. 다른 조건이 동일할 때 인구규모 및

인구성장률의 증가는 그 지역으로 중소기업의 집적을 증가시켰다. 아울러 서울의 중심지로부터의 거리가 가까운 지역에 산업이 집적한다는 결과가 도출되었고 이것은 앞서 언급한 인구변수 결과와 동일한 맥락을 가진다. 반면, 대기업은 철도 인프라 및 규제완화가 조성되어 있는 지역에 입지하고자 하는 경향을 가지고 있었다. 고속철도 역사에서 10km 이내, 그리고 규제완화수준이 우리나라 상위 30%에 속하는 지역(시군구 수준)을 선호하였다. 수도권 정비계획 중 과밀억제권역 및 자연보전권역에는 대기업이 입지하려는 경향이 낮게 도출되었다. 한편, 중소기업은 대기업이 중소기업에 인접하고자 하는 경향보다 대기업에 인접하고자 하는 경향이 크게 분석되었다. 이 결과는 중소기업과 대기업 간 하도급 관계로 인한 불균형한 의존 관계가 나타난 것으로 해석된다. 이상의 결과는 지역의 산업정책을 수립할 때 산업의 종류, 기업의 규모 및 지역노동시장의 특성에 따라 효과적인 정책의 방향이 무엇인지를 제안할 것으로 보인다.

두 번째 에세이는 비수도권 출신 대졸자의 취업지역 선택요인에 대한 연구이다. 대졸자직업이동경로조사(2008)에 따르면, 수도권 출신자가 비수도권 대학에 진학한 후 잔존하는 비율은 17%이지만 수도권으로 돌아가는 경우는 82%이다. 비수도권 출신자가 수도권 대학에 진학한 후 남아있는 경우는 80%인 반면, 비수도권으로 돌아가는 비율은 19%이다. 대졸자의 불균형적인 이동현상 때문에 일부 지역은 경제성장의 기회를 상실하는 결과를 맞을 수 있다. 이러한 이유로 우리나라 정부에서는 지방대학의 경쟁력을 강화하고 우수인력을 양성하여 지방대학의 발전을 도모하기 위하여 2004년부터 지방대학 혁신역량강화 사업을 시행하여 왔다. 두 번째 에세이의 목적은 대졸자의 취업지역 선택요인을 분석하는 것이다. 본 연구는 비수도권 출신자 중에서 지방대학을 선택한 대졸자 중 수도권에 있는 직업을 선택한 경우를 분석할 때 발생할 수 있는 표본선택에 따른 선택 편의를

완화하기 위하여 이변량 프로빗 모형(Bivariate probit model with sample selectivity)을 적용하였다. 본 연구는 대졸자의 취업지역을 선택하는 경로를 분석하기 위하여 두 개의 이변량 프로빗 모형을 사용하였다. 첫 번째 모형은 수도권 대학을 졸업한 후 취업을 위해 비수도권으로 회귀한 대졸자의 취업지역 선택요인을 분석한 모형이다. 두 번째 모형은 비수도권 대학을 졸업한 후 취업을 위해 수도권으로 이동한 대졸자의 취업지역 선택요인을 분석한 모형이다. 실증분석에 활용된 자료는 2010년도의 대졸자직업이동경로 조사이다. 분석결과는 다음과 같다. 지방대학에 교육투자가 증가되거나 지방거점국립대학에 교육투자가 집중되더라도 대학교육을 받기 위한 수도권 유출 현상을 줄이지는 못하였다. 다만, 지방거점국립대학이 있는 지역 출신의 고졸자는 수도권 대학으로 진학하는 경향이 낮았다. 지방대학에 대한 교육투자의 효과가 제한적이기 때문에 이를 보완할 방안으로 본 연구에서는 수도권 대학 졸업자가 취업지역을 비수도권으로 선택하도록 하거나 지방대학 졸업자가 취업을 위하여 수도권으로 유출하지 않고 비수도권에 잔존하도록 하는 요인에 주목하였다. 두 가지 경로에 대한 공통적인 요인으로는 개인의 대학전공을 꼽을 수 있다. 교육 및 의학을 전공한 대졸자는 비수도권으로 회귀하거나 잔존해 있을 확률이 높았다. 비수도권으로 회귀하도록 하는 주요 요인으로는 두 가지이다. 수도권 대졸자는 연구기관에 대한 연구개발투자가 많은 지역으로 회귀하려는 경향을 가지고 있었다. 아울러 자신의 출신지(시도 수준)에 취업할 경우 회귀할 가능성이 높았다. 비수도권에 잔존하도록 하는 주요 요인 역시 두 가지이다. 중공업 비중이 높은 지방의 대졸자는 수도권으로의 유출이 낮았다. 또한, 비수도권 대학을 졸업한 개인은 출신지나 대학연고지에 취업할 경우 잔존하려는 경향이 있었다. 이 결과는 농촌에서 도시로의 이주의 경우와 달리 비경제적인 요인이 취업지역 선택에 중요한 원인으로 작용하고 있음을 암시한다. 두 번째 에세이에 대한 상기의

결과는 지역인재정책을 설계할 때 기존의 경제적인 유인과 함께 개인의 출신 혹은 전공 등의 요인도 고려되어야 한다는 정책적 함의를 부여한다. 아울러 기존의 지방대학 혁신역량강화 사업의 효과에 대한 의문을 던지는 동시에 지방거점국립대학이 종합대학으로서의 면모를 강조하여야 한다는 대안을 제시하는 바이다.

주요어: 지역노동시장, 산업입지, 중소기업 및 대기업, 대졸자 취업지역 선택, 회귀이동, 교육투자

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