Agglomeration Economies and Location Choice of Inward Foreign Direct Investments in Korea

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<Abstract>
Employing the micro data for 1997-2005, we analyze the role of agglomeration and geographical characteristics in the location choice of inward foreign direct investments in Korea. Form the estimation results for the overall industries, the nested logit estimation results confirm that not only industry-specific foreign-firm agglomeration economies but also Korean domestic firm agglomeration economies are important main factors in location decision of FDIs in Korea. On the vertical agglomeration backward linkage relationship is important. When we re-estimate the model into two industry groups, we can find the location decision factors which is consistent to each industrial characteristics.

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Ⅰ. Introduction

Recently, one of the main issues in urban and international economics is about the role of economic concentration and firm's location choice in a regional economic growth. Many theoretical and empirical research papers have supported the idea that regional economic concentration gives the chance of residential firms to increase their productivity and save costs. Furthermore, this chance raises the probability of firm's location choice in an economically concentrated region. In this article, we analyze empirically the role of the regional agglomeration in the location choice of foreign direct investments in Korea from 1997 to 2005.

While the influx of FDIs made a slow progress before the foreign currency crisis in Korea, the positive role of FDIs in regional economic growth is reemphasized and FDIs expand rapidly in size after 2000. For example, while the size of FDIs was 0.8 billion dollars at 1990, its size is up to 11.2 billion dollars at 2006 which is 14 times larger than that of 1990. Even though we have experienced the rapid increase of FDIs influx into Korea, there are no enough researches about the location decision process of FDIs in view of agglomeration, especially, at firm's micro data level.

As Krugman (1991) suggests, since the spatial concepts are not regarded as important in the traditional economics especially in international trade, the problem of location choice itself paid little attention to most of economists in international trade. From the viewpoint of this background, the researches about the inward FDIs into Korea focus only on analyzing the impact of inward FDIs on economic growth and employment or explaining the incentives of inward FDIs. Therefore, the location choice problem of FDIs still has not been studied enough.

And a few empirical studies about location decisions of FDIs are limited to only analyze the gravity equation model with geographical and economic variables or simply estimate the coefficients of the exogenous factors, etc. So it is needed to develop the explanation for the

endogenous mechanism of agglomeration economies which shows where the inward FDI firms locate and how much it affects. Since the inward FDIs in Korea has increased rapidly during the period from 2005 to 2005, it provides a good sample for us to identify the effects of agglomeration economies on the location choice of foreign investors in Korea. This paper focuses on the following factors to investigate the location choice, which are somewhat different from previous literature.

First, we specify the different types of agglomerations and estimate the effect of each type of agglomeration on location decision. Especially, we introduce the forward/backward linkage agglomeration into the location decision. We expect that this will explain the role of intermediate good availability or market accessibility in location decision in detail by considering the industrial input-output relationship to each other. We classify the agglomeration types into four groups; i) the agglomeration comes from the concentration of foreign direct investment in a region ii) the region-industry specific endowment driven agglomeration iii) forward linkage agglomeration, and iv) backward linkage agglomeration. And we investigate whether agglomeration economies are relevant for location choices of the FDIs in Korea and which types of agglomeration economies are important.

Second, we include the analysis of location decision by industry group. Each industry has different characteristics in terms of factor intensity, the degree of linkage between related industries, technological basis and so on, therefore, these would affect the location decision patterns. In this sense, following the classification of Ministry of Industry and Resources, we categorize industries into two groups: high-tech industry and low-tech industry[1].

Third, using an extensive firm-level dataset on inward FDIs in Korea, we employ nested logit model of multinomial choice to examine the factors determining the location choices of FDIs from abroad. Normally, lots of previous researches about the location choice depend on the

[1] See Appendix. 1.

conditional logit model (Head et al. 1995; Woodward, 1992; Hilber and Voicu, 2006). But the conditional logit model requires error terms that are independent across locations. This raises the argument about the independence of irrelevant alternatives problems. To avoid this IIA problem, nested logit model is recommended. Furthermore, as we look at the regional distribution of industries in <Fig. 1>, the area of capital Seoul and its vicinities and the other regions show big differences in the concentration of companies and business environments. Therefore, the selection of location within the Seoul and its vicinities and the other regions must be treated differently. So we take a generalized approach that permits hierarchical decision process like the nested logit model.

<Fig. 1> here

Our paper proceeds as follows. Section 2 summarizes the theoretical background of this paper and review the existing literature. Section 3 presents the nested logit setup in more detail. In section 4, we describe the data and discuss the variables that are expected to explain the location of FDIs. Section 5 then presents empirical results. Section 6 provides concluding remarks.

Ⅱ. Background and Literature Survey

Firms in the same industry tend to agglomerate in particular regions. According to the traditional regional economics, the spatial concentration of companies in the same industry can create positive externalities in view of region, which can not be perceived as a good one to each company in that region though (so called MAR externalities). Marshall (1920) suggest the following three as the source of externalities; i) economics of labor pooling coming from the spatial concentration of workers with specific skills ii) the economies of non-tradable industry specific intermediate goods and service concentration iii) technology

spillover.

Even though localization(agglomeration) economies work on both foreign firms as well as domestic ones, the location decisions of foreign firms can be somewhat different from those of domestic ones. For example, many foreign firms would be confronted with trade barriers such as institution, culture, language, etc., which are not barriers to domestic ones. In fact, as Caves (1996) pointed out, the search costs are much higher for foreign compared to domestic firms due to the uncertainty with regard to regional quality and subsequent information. Meanwhile, the business relationship or communication network among same nationality, which can be added as a different form of localized externalities, would be very important for foreign start-ups, which less for domestic firms. Above discussion implies that the analysis for the location decision of foreign companies should be done with different location factors from domestic ones (Glickman and Woodward, 1988).

The empirical literature on the location choice for the foreign companies is very broad. Head et al. (1995) analyze the location choice decisions of Japanese firms in the US with conditional logit model. Based on the estimation results, they argue that a location theory about agglomeration-externalities explains the Japanese firms' behavior better than the traditional location theories with the resource endowment differences among states. Belderbos and Carree (2002) also investigate the Japanese firms' location decision. They suggest that the Japanese FDI (Foreign Direct Investment) in China tends to have high incentives of locating the place where Japanese firms concentrate, especially when the business relation firm within *keiretsu* is small-medium size.

Meanwhile, regional resource endowments are another important factor which leads localization. Traditional Heckscher-Ohlin theory in international trade predicts that the location choice of firm depends on the regional differences of production factors and raw material endowments. Even within one country border, because each region is heterogeneous individual firm will choose the location which is suitable for the firm among several heterogenous regions in view of resource

endowments. Then it is likely that the companies in the same industry gather together in a same region (endowment-driven theory). This suggests that we need to control the effect of regional resource endowment difference in the study of agglomeration economies.

Recently, Du et al.(2007) focus on the role of vertical agglomeration. Vertical agglomeration explains the type of spatial agglomeration of companies which have backward or forward linkages to the other companies in the same region. Forward linkages agglomeration is the agglomeration of companies which provide the upstream parts. Then, the region with the concentration of upstream manufacturers is attractive to the FDI which is the downstream of them because of the easy availableness to intermediate goods. This will generate positive externality to the FDI. In Head and Ries (1996), they find the significant positive effect of the existence of intermediate good suppliers on the location choice.

Those goods can be used as intermediate goods or final goods for other companies which are in the downstream of production process, too. The backward linkage agglomeration focuses on such situation as the above. That is, the backward linkage agglomeration shows how much FDI considers the demanders in its location choice. As Du et al. (2007) suggests, forward linkage shows the importance of intermediate goods accessibility in FDI location choice and backward linkage does the importance of market accessibility in the location choice. Generally producers typically like to choose locations that have good access to large markets and to suppliers of intermediate inputs.

With regard to empirical study for linkage effects, Head and Ries (1996), Komoriya and Tsukata (2003) indicate that the agglomeration of potential intermediate goods producers has the positive effect on the location choice of FDI in China. Head and Mayor (2004) pay attention to the market potential that is demand side agglomeration. They focus on the location decision of Japanese FDI in EU and find that the market potential also is one of important factors for FDI to decide the location.

Ⅲ. Methodology

Let's think about the location choice of a representative foreign investor in a specific industry. The geographical dimension used in this research is the 16 major administrative districts in Korea, those are seven major cities and nine provinces.

Let's define π_{ij} to be the profits of firm i when it chooses its location in region j (at time t). If the profit that individual firm earns from locating in any of the potential locations is determined by the attributes of that location, then we can express profit as

$$\pi_{ij} = \beta' X_j + \varepsilon_{ij} \tag{1}$$

where X_j is the vector of attributes in j region, β is the vector of coefficients that should be estimated and ε_{ij} is the unobserved region specific or firm specific characteristics. (or ε_{ij} is a disturbance term.) We assume that each firm is rational therefore chooses the location that offers the highest expected profits. Thus the probability (P) that a particular region j is chosen by firm i is

$$P_{ij} = \text{Prob}\{\pi_{ij} > \pi_{ir}\} \quad \forall\, r \neq j \tag{2}$$

As McFadden(1974) suggests if ε_{ij} follows Type I extreme value (Gumbel) distribution, then it can be shown that $P_{ij} = \dfrac{\exp(\beta' X_j)}{\sum_{j=1}^{J} \exp(\beta' X_j)}$ where J is the set of locational choices faced by firm i. The above equation

then can be estimated by the conditional logit model.

While we consider the location distribution of manufacture in Korea, it is easily observed that the manufactures are highly concentrated at the area of capital Seoul and its vicinity because, historically, the national policy has been inclined to the capital area. This capital area concentration raises a statistical problem in the estimation of the model. That is, it is highly likely that the variances of disturbances among region are not same. This is so called heteroscedasticity problem. To avoid this problem, the error structure of the model must be adjusted.

One way to relax the homoscedasticity assumption in the conditional logit model is to partition the alternatives into subgroups that allow the variance to differ across the subgroups while maintaining the IIA assumption within the subgroups, which is a nested logit model (Green, pp. 725). And each subgroup contains choices with similar attributes. Therefore, the NL approach allows dividing the choice set a prior into mutually exclusive subgroups (here 2 groups).

In this study, in order to examine the location determinants of the inward FDIs in Korea we use the nested multinomial logit(NL) frame that is widely used method on firm location. And the dependent variable in the model is the region chosen by each investor.

To fix ideas, it is useful to think of this specification as follows. First of all, we partition the 16 alternatives (these are seven manor cities and nine provinces) into two subgroups: One is the area of capital and its vicinities, the other is the area of others.

The area of capital and its vicinities contains Seoul, Incheon(city) and Gyeonggi-do (province). And the other contains thirteen major cities and other provinces. And this regional classification is consistent with location choice literatures and regional policy classification in Korea.

And we may think of the choice process as a two-tier choice structure where each foreign participant choose between the capital and

vicinities and the other area and then making the specific choice within the chosen subgroup. This method can be regarded as a tree structure where each firm choose between the 2 subgroups in the upper nest level and then choose specific region in the lower nest.

Fig. 2 illustrates the process of sequential decision of a representative FDI firm for the choice of specific location.

<Fig .2> here

For a two-level nested logit model, we index the first-level alternatives as u and the second-level alternatives as l. Let X_{il} and Y_u refer to the vectors of explanatory variables specific to categories (u, l) and (u), respectively. This means that the data consists of observations on the attributes of the choices X_{il} and attributes of the choice sets Y_u.

And when we assume that the error term is distributed as extreme value distribution, the probability of a company choosing alternative l in subgroup u is

$$P_{ul} = P_{l|u} \times P_u \tag{3}$$

The conditional probability $P_{l|u}$ will involve only parameters β.

$$P_{l|u} = \frac{\exp(\beta' X_{ul})}{\sum_n \exp(\beta' X_{un})} \tag{4}$$

$$P_u = \frac{\exp(\alpha' Y_u + \tau_u I_u)}{\sum_m \exp(\alpha' Y_m + \tau_m I_m)} \tag{5}$$

where I_u is the inclusive value for the u th subgroup as $I_u = \ln(\sum_u \exp(\beta' X_{un})$. And in Eq.(5), the new parameter τ_u must be 1 to produce the original conditional logit model. And if all the parameters τ_m are equal to 1, then the nested logit model becomes conditional logit model. In other words, the nested logit model arises if these restrictions ($\tau_m = 1$) are relaxed, then

$$P_{ij} = \frac{\exp(\beta' X_{ij} + \alpha' Y_i)}{\sum_m \sum_n \exp(\beta' X_{mn} + \alpha' Y_m)} \quad (6)$$

In this sense, the estimated coefficient on the inclusive value, τ, is of particular interest as it provides information on whether the model is properly specified.

In general, there are two ways to estimate parameters of the nested logit model: sequential estimation and the full-information maximum likelihood(FIML) estimation provides more efficient parameters than two-step estimation, we use the FIML method for estimating the NL model.

Ⅳ. Variables and Data

As mentioned earlier, the probability that a representative foreign firm chooses a particular region as a location depends on the region's characteristics that influence profits. In this section, the variables of region's characteristics are explained. In the literature, generally, the following four effects are suggested as main determinants of the FDI location choice: agglomeration effects, factor cost effects, market demand condition and infrastructure effects.

<Agglomeration variables>

The main purpose of this paper is to analyze the determinants of FDI at the regional level and to assess the importance of various types of agglomeration effects among determinants. In order to do this, we specify different types of agglomerations and estimate the effects of each type of agglomeration on the location decisions of inward FDI.

Usually, agglomeration economies are divided into two categories: localization economies and urbanization economies. Besides urbanization and localization, considering the vertical industrial linkage between production processes, one can find more traditional sources of industrial concentration that is called vertical agglomeration with regard to backward and forward linkages. In this sense, we deal with three types of agglomeration to capture the effects of agglomeration on location decision. Therefore, we focus on three types of agglomeration such as localization, urbanization and industrial linkage agglomeration.

Localization economies are the economies that come from the agglomeration of firms within the same industrial classification in a particular area, and we capture this form the two aspects: one is the agglomeration of foreign firms and the other is the agglomeration of domestic firms.

The former describes industry-specific foreign agglomeration economies, a form of localization economies. According to the literature on new economic geography, the agglomeration of firms in the same industry brings about potential benefits(externalities) that are related to input sharing, specialized labor market pooling, knowledge spillover, access to infrastructure and public goods, and increasing competition pressure among firms (Porter, 1988; Krugman, 1991).

Add to these traditional externalities of industry-specific foreign agglomeration, foreign firms can get the substantial reductions in the information and search costs associated with foreign investors' high

uncertainty about the local environment. Therefore, foreign manufacturing firms may be attracted to regions with previously concentrated region of foreign-owned firms in the same industry due to externalities[2].

The latter variable represents both industry-specific domestic agglomeration (another form of localization economies) and endowment effects. Traditional Heckscher-Ohlin theory in international trade predicts that the location choice of firm depends on the regional differences of production factors and raw material endowments. Even within one country border, because each region is heterogenous individual firm will choose the location which is suitable for the firm among several heterogenous regions in view of resource endowments. Then it is likely that the companies in the same industry gather together in a same region (endowment-driven theory). This suggests that we need to control the effect of regional resource endowment difference in the study of agglomeration economies. Thus this variable has a role to control for endowment effects, allowing us to obtain a more precise estimate of industry-specific foreign agglomeration economies.

As the agglomeration variable to capture industry-specific foreign agglomeration economies, we use the log of the cumulative number of foreign participants in the same industry (KSIC 3 digit) as the investor. Here, like in the Head et al. (1995), agglomeration is measured as one plus the previous year's number of inward FDI firms in the establishments' industry to avoid log of zero problem in variable calculation.

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[2] In fact, as Caves(1996) pointed out, the search costs are much higher for foreign compared to domestic firms due to the uncertainty with regard to locational quality and subsequent information. Meanwhile, the business relationship or communication network among same nationality, which can be added as a different form of localized externalities, would be very important for foreign start-ups, which less for domestic firms. Above discussion implies that the analysis for the location decision of foreign companies should be done with different location factors from domestic ones(e.g. Glickman and Woodward, 1988).

Relating data can be found in the Oversea Direct Investment Information Network of Korea Ministry of Finance and Economy. They provide the information of the inward FDI in detail such as the name of local subsidiary, the region where the FDI is established, etc. Among them, we focus on 1,961 inwards FDIs from 1996 to 2005 which are adequate to the industry classification.

The second agglomeration measure is the log of the number of the Korean domestic establishments in the same industry as the investor. As noted earlier, this variable is used to control the region-industry specific endowment driven agglomeration effects depending on the geographical distribution of production related factor endowments. This approach is suggested by Head et al. (1995).

The data of the domestic firms are collected from the current mining and manufacturing survey from 1992 to 2005. The current mining and manufacturing survey announces Economic Census Survey every year and we can find the number of establishments, value of shipments, paid employees and annual payroll data of individual firm level by region and by KSIC 3 digit class in the survey.

As the second type of agglomeration economies, urbanization economies are those economies of agglomeration which accrue to firms across different sectors(Jacobs, 1960).

The geographical concentration of various types of activities in a particular area also brings economics benefits to firms externally. While localization economies are external to the firm but internal to the industry, urbanization economies are external both to the firm and to the industry but internal to the city as a whole. Thus urbanization economies are the concepts which focus on the potential benefits that come from the diversity of industry in the urban area.

Since the urbanization means the diversity, we can use the inverse of concentration index. Duranton and Puga (2000) suggest an index as

follows;

$$RDI_r = \frac{1}{\sum_i \left| \frac{E_{ir}}{E_r} - \frac{E_{in}}{E_n} \right|} \quad (7)$$

where E_{ir} is the employment in sector i in region r and E_{in} is the employment in sector i in the country. E_r represents total employment in region r, E_n indicates the total employment in the country. In this research we use the number of establishments to calculate RDI index. Since the employment size of major industry in the region can dominate the effect of the industry on the externality generation, the effect of the major industry on the externalities from diversity might be biased. To avoid that, the number of establishments in each industry, instead of employments, is used to calculate the denominator of eq. (7). So the value of index increases as the regional establishment distribution approaches that of the country level. The data of the sectoral number of establishments by region are gathered from the current mining and manufacturing survey.

Since the above relative diversity index are measured only for the manufacturing sector, this cannot reflect the service sector agglomeration in the urban area. As noticed, because the above RDI is not based on the service sector information we need to measure the externalities which come from the service industry distribution in a region. Especially, there exists another benefit to individual foreign companies which locate in that region.

As Woodward (1992) argues, for the foreign companies the geographical availability of business service products such as accounting, law and financial services is one of the important determinants of the location choice decision in products. And this geographical business service product availability is important not only for the start-up periods of new establishments but also for their successive operation periods.

This is why foreign firms often prefer the availability of local professional business services. To measure the business service agglomeration, we use the ratio of total employment in this sector per square kilometer for the region.

Vertical agglomeration reflects the concentration of domestic firms with backward and forward linkages to the FDIs. According to the recent development of NEG, in addition to the externalities of agglomeration mentioned earlier, there are backward and forward linkages that tend to concentrate the upstream and downstream producers in a single location (Venables, 1996; Krugman and Venaboles, 1995).

Backward linkage agglomeration is the agglomeration of domestic upstream manufacturing firms which are suppliers of intermediate inputs to the FDIs located in the same region. The concentration of intermediate good producers in the region makes FDIs' intermediate goods availability highly possible. Furthermore, the geographical closeness between FDIs and intermediate goods suppliers enhance their interactive cooperation through the linkage relationship and it can make production cost low. Head and Ries(1996) uses regional manufacturing production as a proxy for forward linkage agglomeration and shows positive relationship between the location choice of firms and the regional manufacturing production.

However, if a region with a large volume of manufacturing production has little input-output relation with the products of the FDI firms, then the probability that the region be selected as a location by the FDIs would be low. This implies that total manufacturing production in a region as a backward linkage agglomeration index must be adjusted using an appropriate weight based on vertical production linkage, for which we use input coefficients of Input-Output Table as weight in making variables.

The backward agglomeration in region j is defined as follows;

$$IPU_{oj} = \sum_{i=1}^{I} \frac{a_{io} x_{ij}}{X_j} \quad (8)$$

where x_{ij} is the real output of industry i in region j, a_{io} is the input coefficient reflecting the inputs from the upstream industry i required for one unit of product of industry o[3] (here, o is the industry which is same to the industry classification of FDI firms) and X_j is the total manufacturing output(in real term) in region j.

It is probable that the region with high production amounts will produce more various intermediate goods. Thus, in view of FDIs, since the availability of intermediate goods will be high in the region with highly developed supporting industry, the region as its production site is highly attractive. Following this logic, we expect (+) sign of IPU_{oj} in the location decision estimation.

Here, instead of the count of companies in the region, we use production amounts as an index for the forward linkage agglomeration, which can be weighted with input coefficients. And since IPU_{oj} has a high correlation with total production amounts, we scaled it with regional real manufacturing output.

Some manufacturing goods that FDI firms produced are also demanded for the domestic firms as intermediate inputs. Forward linkage

[3] Each industry input coefficient is the ratio of intermediate input amounts with total input amounts in the transaction table at producer goods and services. Here, we need to match the industry classification in I/O table with KSIC 3 digit classification. We use code-match table which is provided by ISTANS at KIET(Korea Institute for Industrial Economics and Trade). Since I/O table is announced every 5 years and supplement table is announced third year within each 5 year periods, the input coefficient in the missing year is assumed to be same to the previous input coefficient which is based on the data.

agglomeration is the agglomeration of domestic companies or final consumers which are regarded as downstream agents in the production process of FDI's products. A forward linkage agglomeration (IPD_{oj}) is defined as follows;

$$IPD_{oj} = \sum_{i=1}^{I} \frac{b_{oi} x_{ij}}{X_j} \tag{9}$$

where b_{oi} is the input coefficients which show FDI products are used as an intermediated or final goods for industry i in region j. Therefore, the righthand side of equation (9) presents the potential intermediate demand for the products of FDIs in j region. Similarly in the IPU_{oj} calculation, we measure the index IPD_{oj} by scaling with the region's total manufacturing output. The region with highly developed downstream industries/final consumer can be attractive to FDI. Therefore, the expected sign of that variable is (+) in the location choice estimation.

<Other variables>

Out model includes other additional factors that are expected to affect the location decision of FDIs.

The variables which reflect the effect of cost-side on the location choice are the prices of production factors such as labor, capital and land. Especially, immobile production factors such as lands and location specific labors are one of the main factors causing spatial concentration of industry. Those prices may affect firms' production costs directly or indirectly: On the one hand, an increase in the factor prices raises the production cost of a firm which uses those factors as inputs (direct cost increase), on the other hand, it raises the price of cost increase of a firm when those business services are used as inputs in the production

process of that firm (indirect cost increase).

The largest component of variable costs is labor. Thus inter-province wage gap could be a significant influence on the location choice.

In general, higher labor costs are expected to deter inward FDIs, which implies the sign of estimated coefficient be negative. Since the labor costs reflect the productivity, however, if FDI prefers the high quality of labor then the estimated coefficient might be positive.[4] This suggests that when measuring labor cost, one needs to account for the productivity of labor since workers differ in skills and level of qualification (Woodward, 1992).

To address this issue, following Coughlin and Segev(2000), Devereux and Griffith(1998), Woodward(1992) and Boudier-Bensebaa(2005) we include in our specification unit labor cost variable which is defined by dividing the labor costs (average annual gross earnings of industry per province) by labor productivity (industrial production divided by total employment of that industry) for each province. In addition, we include in our specification the ratio of vocational/apprentices school per total manufacturing employment as proxies for the educational and skill levels of the local work force. And we expect the sign of the estimated coefficients associated with unit labor costs is negative. However, as some empirical evidences on the impact of labor cost indicate, the unit labor cost might be non-significant or positively correlated with the location of FDIs if labor costs account for small parts in the firm's decision making or the variable captures not only cost effects but also skill effects. As for the skilled labor, we expect the sign for that variable to be positive: a usual finding in the literature(see, for example, Glickman and Woodward, 1987; Coughlin and Segev, 2000).

[4] In fact, empirical evidence on the effect of wage is not always consistent. For example, Bartik(1985), Coughlin et al. (1991), Friedman et al. (1992) report that higher wages make a location less attractive to foreign investors, while Woodward (1992) does not get a significant effect of wage on the choice of county for the business location.

Land costs are another potential location determinant on the cost side of the profit function. But usually, it is not easy to get a meaningful absolute land price data by area in many countries, therefore, many previous studies use population density as a proxy for the land cost (Bartik, 1988; Guimaraes et al. 2000). This argument here is that population density likely reflects land costs because residential and industrial users compete for land.

Fortunately, we can find an appropriate proxy for the land price in Korea. Korea Industrial Complex Corporation releases the land sales price of national industry park at a particular year. So we can gather the information of land price of national industry park in each region at 2007.[5] Furthermore, KookMin Bank, one of commercial banks in Korea, announces the index of housing price change every year. This can provide interpolation base for the time series expansion of the national industry park land price.[6] By using this information, we can interpolate the national industry park land price and it is used as a proxy for regional land cost. And we expect the sign of the estimated coefficients associated with land cost is negative.

Capital costs, which can be proxied by interest rate, represent another cost component. However, since the interest rates vary little across the potential locations and we can not find enough information for the capital stock by province and industry, we do not include capital costs as explanatory variable in our estimation model.

On the revenue side, it is argued that market potential is the important motivation for manufacturing location. The size of the market is usually measured by the GRDP, which can be expected to be related positively to FDIs.

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[5] Two places (Daegu and Jeju) do not have national industry park. In this case, we gather the land price information of local industry park at the same year.

[6] The index of housing price change is admitted as one of official national statistics.

Infrastructure level is regarded as one of the important factors in location decision making since well-developed infrastructure enhances the regional productivity and firm profits.

Here we include two transportation infrastructure variables as explanatory variables in the model. One is the total road length and the other is the freight cargo volume of airport in each province. Both variables are measured in log terms. In particular, the latter variable is measured by adding up 1 to the value of that variable in order to avoid taking the log of zero.

Transportation facilities matters significantly especially when foreign firms serve other markets in other countries with a large majority of their goods produced there or purchase intermediate goods form other areas. Other things equal, therefore, an area with well-developed transportation system will be more attractive as location site to FDIs.

Thus we can expect positive relationship between those transportation infrastructure variables and FDIs as other previous studies (Bartik, 1985; Head and Ries, 1996; Coughlin and Segev, 2000). In fact, it is widely reported in the previous studies that regions with well-developed transportation facilities are more attractive to foreign firms. We gather the relating information from Korea/Incheon Airports Corporation and Korea National Statistical Office.

To consider the policy variable, we include dummy variable for the existence of the foreign-only industrial complex in a region. In Korea, to make a region as a location of FDIs attractive, national and local governments provide a various incentives including tax exemption. So the introduction of dummy variable for foreign-only industrial complex in the estimation of the location choice model can confirm whether the incentive policy of governments work or not.

Ⅴ. Empirical Results.

For the estimation of the location choice of inward FDIs in Korea for 1997-2005, we first consider all industry sectors without separating observations by industry group. The parameter estimates for all foreign firms are reported in Table 1. In the table, first column (named model 1) is the estimation results with nested logit setup and second is with conditional logit estimation method.

By comparing these two models, we try to check the degree of possible estimation bias and robustness of estimates. As noted earlier, if error distribution shows homogeneity then conditional logit is an appropriate approach. But if not, that is, heterogenous error, then it makes sense to estimate the model with nested logit approach.

After the both models are estimated, we check the test statistics for the appropriateness of the way of nest. The likelihood ratio test for the joint restriction of inclusive variable[7] shows the rejection of null hypothesis that the inclusive variables are jointly equal to 1. And the Hausman test to check whether there is systematic difference between conditional logit and nested logit estimators shows that there is strong evidence of systematic difference between those estimators[8]. So we can support that the nested approach is more reasonable and the grouping is suitable for the estimation with this sample. We focus on the results of nested logit model for the interpretation.

For the overall sector, the estimated coefficient of capital and its vicinities area, which is the only upper nest level parameter, is significant and positively related to inward FDIs, meaning that the capital and its vicinity area is preferred to other areas as a location site for the foreign investors, if other things equal.

From the result of the nested logit estimation, we find that the two localization variables (industry-specific foreign agglomeration and industry-specific domestic agglomeration) and two urbanization relating

[7] We estimate the model with STATA ver. 7.0

[8] Hausman Statistics : $\chi^2(11) = 113.21$

variables (urbanization agglomeration in manufacturing sector and business service agglomeration) display the expected signs and are significant, suggesting those variables are important determinants for the foreign firms' location choices in Korea.

Foreign investors tend to locate in the place where other foreign or domestic firms have settled down and where diverse industrial activities or business services are concentrated. However, looking at the magnitude of estimates for two localization variables, we can find that the coefficient of the foreign agglomeration (0.481) is larger than that of domestic agglomeration (0.375), which is similar to the conditional logit estimates. This suggests that the attractive effect of previous inward FDIs would exceed that of prior domestic investments.

Interestingly, the coefficients of the two industry-specific localization variables in the nested logit are very similar to the results obtained by Hiber and Voicu(2006) or Head et al. (1995). Hilber and Voicu(2006), which investigate the location choice of FDIs within Romania, argue that while the signs of two industry specific agglomeration (the agglomeration of foreign firms and that of the domestic firms) are estimated positively together, the magnitude of estimated coefficients of the foreign agglomeration is larger than that of the domestic agglomeration.

As previously described, the spatial concentration (or agglomeration) of economic activities can be explained not only by the cumulative process leading to agglomeration but also by the dissimilarity in the resource endowment conditions across regions. And let's remind that the domestic agglomeration is a proxy variable to control the endowment driven agglomeration effects. Then the above result shows that the foreign manufacturing firms do not simply follow the domestic endowment condition or spatial distribution of the domestic establishments in their industry. Rather the accumulation of foreign companies at one location spurs successive investors in the same industry to choose the same location.

Next the coefficients as associated with vertical agglomeration show interesting results. The sign for the backward linkage agglomeration is positive and statistically significant as one might expect, while that for the forward linkage agglomeration is negative and not significant which contradicts one's expectation. The spatial availability of intermediate good shows statistically significant positive relationship with the location choice of foreign investors within Korea.

The negative and insignificant coefficient estimates of the forward linkage variables suggests that the manufacturing goods produced by foreign firms are demanded little as intermediate inputs by region's domestic downstream firms in production process. In other words, from the estimated result of forward linkage coefficient, we can infer that the sales linkage of FDIs to local domestic market for the intermediate goods is very weak, at least, in view of overall industry.

Let's turn to the demand side. The estimate for the final demand is negative sign and insignificant, which contradicts to our expectation. It is argued in the literature that the markets served by foreign investors are not confined to the region where they located especially if the market size of the region is small (Head et al., 1995; Coughlin and Segev, 2000). Thus the above result with regard to final demand implies that the foreign investors in Korea do not target the market of Korea but, instead they might serve across the boundaries of the province including export to other countries.

The nested logit estimates both for the unit labor cost and for the land cost (proxied by the sales land price of the industrial park or complex) exhibit negative signs as expected. While, however, the estimate of land cost is significant, that of the unit labor cost is not. Considering that nested logit method is adopted in the model specification, above results suggest that once a representative foreign firm chooses one subgroup first, then the land cost is more important determinant than the labor cost in the choice of specific alternatives in the subgroup.

Since the labor cost itself can reflect not only the pure cost but also the quality of labor in that location, for the FDIs, labor quality availability might be more important in view of location choice than the cost itself. So we try to control the labor quality in the region. The estimates of higher education enrollment exhibit positive sign and significant. This implies that labor quality in the region is boosts FDIs. This reveals that the labor quality rather than the labor cost affects the location choice of foreign investors in Korea. Therefore, unit labor cost as a pure cost might not have such explanatory power for the location choice behavior of FDIs.

Also, this might be reflecting the fact that the large parts of FDIs in Korea belong to industries of high-level of technology rather than industries of low-level technology. Furthermore almost of 72% of the total inward FDIs comes from developed countries, and the regional labor quality matters significantly in the location choice for those foreign investors.[9]

As for the transportation infrastructure, the estimated parameters for both road length and freight cargo volume of airport are positive as expected but insignificant statistically. Accordingly it does not seem that transportation infrastructures provide regions with advantage in attracting foreign investors.

In the case of foreign-only industrial park, the estimate is positive and significant. This suggests that the existence or supply of foreign-only industrial park by the national or local government can make the location attractive for the location of FDIs. In Korea, according to the field study of Cha et al. (2003), 25% of FDIs locates at industry park which is contrast to only 13% of domestic firms locating at industry park.

<Estimation results by industry group>

[9] According to Fung, Iizaka and Parker(2000), Gao(2005) and Du et al., regional labor quality significantly affects regional aggregate FDI flows especially from developed countries.

When we consider various industrial technologies, the effect of each determinant on the location choices can be different among industries. To check this heterogeneity of industrial location choices coming from technological difference, we separate the same sample into two industry groups; high-tech foreign firms and low-tech ones.

Table 2 shows the results of estimation by industry group. On the Hausman's test, the null hypothesis that there is no systematic difference between conditional logit estimator and nested one, is rejected only for the high-tech firms, suggesting that it is recommended to adopt the nested logit estimation for the high-tech firms whereas conditional logit specification would suffice for the low-tech firms.

First of all, we can find that the estimation results by industry group with respect to localization and vertical agglomeration variables exhibit similar patterns to those in the previous overall industry estimation results. That is, even with these two different samples, it is consistent that the industry-specific FDIs agglomeration is more influential than the industry-specific domestic firm agglomeration in the location choices of FDIs. And the spatial availability to the intermediate goods suppliers, which is related to the backward linkage as the vertical agglomeration, is also one of the major location choice determinants.

However, some interesting results are shown with the above agglomeration variables from the comparison of estimated parameters between high-tech and low-tech group. While the estimated coefficient of industry-specific foreign agglomeration is larger than that of industry-specific domestic agglomeration in the case of high-tech, that estimated result in low-tech is relatively weak. It implies that FDIs in high-tech industry give more weight on the industry-specific foreign agglomeration when they make a decision of location. On the contrary, FDIs in low-tech industry consider the industry-specific domestic firm agglomeration more important in the location decisions.

Furthermore, the above pattern can be verified through the

estimation results of vertical agglomeration results, too. The coefficient size of industrial linkage variables, that is backward and forward linkage variables, is larger in the case of low-tech than in the case of high-tech even though the forward linkage estimate is not statistically significant. It shows that FDIs in low-tech give more weight on the spatial availability of intermediate goods suppliers and demanders in their location choices.

Actually, it is not surprising result that low-tech FDIs show high linkage relationship with domestic companies. It looks natural when we consider the technological pattern in that industry. Since, generally, products in high-tech needs a firm-specific technology, intermediate goods for them are supplied by internal companies or long-contract suppliers with the firm. However because the technology of low-tech products is standardized and that of intermediate goods is also standardized, intermediated goods can be supplied by external companies or outsourcing through market. In this point of view, especially, spatial availability of intermediate goods is one of the important location decision factors in the case of low-tech FDIs.

The estimated parameters of diversity variables in terms of Puga index and spatial service availability exhibit positive for both low-tech and high-tech FDIs, which is identical with those of overall industry sample estimation. One difference from overall industry sample estimation results is that the estimate of diversity variables is significant only for the low-tech FDIs but not for the high-tech ones. It is some what different with the results of Head et al. (1995), Barrios et al. (2006) who have shown that diversity is more important for hi-tech industries.

The estimation results with regard to labor market condition by industry group provide a sharp contrast over those groups reflecting the characteristics of industry. While the coefficient of unit labor cost is estimated negative and significant in the case of low-tech, that of high tech is estimated positive but insignificant. In contrast to that, the estimate of labor quality, which is measured as the ratio of bachelor or above degree holder, is positive significant in the case of high-tech FDIs but negative (insignificant) in the case of low-tech FDIs. These results

are consistent with the usual argument that the cost of labor is more important location determinant for the low-tech firms while the quality of labor is more important for the high-tech ones.

Although the estimated coefficient for land cost proxied by land sales price of industrial complex by region are negative across the industry groups but it is significant only for the high-tech FDIs. Infrastructure coefficients for road, air freight are positive but statistically insignificant. So we can not find any evidence that the variations of infrastructure among regions are considered seriously in the location decision of FDIs in Korea.

Foreign-only industry park or complex dummy coefficient is estimated as positive and significant, which is similar to overall industry location choice estimation. Therefore, we can support that the existence of foreign-only industry park is one of important location determinants regardless of industrial technical characteristics. As a matter of fact, 15% of FDIs in Korea locate at the foreign-only industry park, which supports the estimation result.

VI. Conclusion

Using the comprehensive firm-level data which covers all the inward foreign direct investments within Korea between 1997 and 2005, we estimate the impact of horizontal and vertical agglomeration economies on location choices.

From the estimation results for the overall industry, the nested logit estimation results confirm that not only industry-specific foreign-firm agglomeration economies but also Korean domestic firm agglomeration economies play an important role in the location choice of FDIs in Korea. However, the estimated agglomeration coefficient of foreign firms exceeds that of Korean domestic firms. This shows that the foreign manufacturing firms do not simply follow the spatial distribution of the domestic establishments in the same industry classification in which they

are included. Rather the accumulation of foreign companies at one location spurs successive investors in the same industry group to choose the same location.

The estimation results on the vertical agglomeration variables, forward agglomeration and backward linkage one, show different results. While the effect of backward linkage agglomeration is positive and significant as we expect, the effect of forward is negative and insignificant. This explains that the spatial availability of intermediate good shows statistically significant positive relationship with the location choice for the inward FDI within Korea.

In view of production costs, the estimate of land cost is significant but that of the unit labor cost is not. This means that FDIs give more weight on the labor quality instead of labor cost when they decide the location and land cost itself is a one of major location determinants. Also, industry diversity agglomeration, regional service availability and policy variable such as foreign-only industry park are important in their location decisions.

We re-estimate the model using two sub-samples by industry group: high-tech and low-tech industry. Estimation results exhibit somewhat different patterns by each industry group reflecting the nature of each one. FDIs in both industries are affected by agglomeration factors in their location decisions. However, in the case of high-tech industry, geographical region (capital and its vicinities), foreign-agglomeration, labor quality and land costs are relatively important location decision factors. In contrast to high-tech industry, diversity, backward linkage and unit labor costs are more important location decision factors in low-tech industry.

There has been no through statistical analysis with regard to the location decisions of inward FDIs in Korea. In this sense, this paper provides implications and insights to the questions about foreign firms' location behavior particularly in relation to agglomeration externalities. Yet, there is still need for further research on this issue.

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<Table 1> Overall Industry Estimation

Variables	Nested Logit	Conditional Logit
<Lower Nest>		
Foreign Agglomeration	0.481**	0.539**
	(8.24)	(10.67)
Domestic Agglomeration	0.357**	0.406**
	(8.41)	(10.15)
Diversity	0.291**	0.241*
	(2.66)	(2.52)
Service Availability	0.317**	0.241**
	(5.07)	(4.36)
Backward Linkage	4.654**	5.598**
	(3.28)	(3.93)
Forward Linkage	-0.753	-1.989
	(0.53)	(1.40)
Final Good Demand	0.179	-0.011
	(1.26)	(0.12)
Unit Labor Cost	-1.128	-1.697*
	(1.34)	(1.99)
% of B.A. Degree Holder	2.369*	2.860**
	(2.34)	(2.92)
Land Cost	-0.287**	-0.039
	(3.21)	(0.53)
Road	0.143	0.098
	(1.43)	(1.24)
Air Freight	0.007	-0.009
	(0.80)	(1.06)
Foreign-only Industry Park	0.534**	0.432**
	(5.78)	(4.80)
<Upper Nest>		
Capital and Its Vicinity	2.196**	-
	(3.25)	
Inclusive Variable 1	1.065**	-
	(8.81)	
Inclusive Variable 2	1.289**	-
	(9.09)	

Log-Likelihood	-3296.57	-3320.24
LR Test(IV1=IV2=1)	$\chi^2(2) = 15.28$	-
Hausman Statistics	$\chi^2(11) = 113.21$	-
No. of Observation	1771	1771

Note: 1) ( ) is the asymptotic z-statistics.

2) ** is significant at 1% significance level, * is at 5%.

<Table 2> Estimation by Industry

Variables	High-Tech (Nested Logit)	Low-Tech (Conditional Logit)[1)]
<Lower Nest>		
Foreign Agglomeration	0.514**	0.472**
	(8.10)	(3.89)
Domestic Agglomeration	0.315**	0.357**
	(5.98)	(5.29)
Diversity	0.140	0.476*
	(1.17)	(2.45)
Service Availability	0.242**	0.329**
	(3.64)	(2.76)
Backward Linkage	3.801**	14.994**
	(2.50)	(3.03)
Forward Linkage	0.673	4.073
	(0.43)	(0.70)
Final Good Demand	0.001	0.284
	(0.00)	(1.32)
Unit Labor Cost	0.131	-4.892**
	(0.13)	(2.77)
% of B.A. Degree Holder	2.943**	-1.130
	(2.58)	(0.50)
Land Cost	-0.292**	-0.097
	(2.86)	(0.59)
Road	0.019	0.227
	(0.23)	(1.23)
Air Freight	0.001	0.007
	(0.08)	(0.36)
Foreign-only Industry Park	0.532**	0.443**
	(4.91)	(2.26)
<Upper Nest>		
Capital and Its Vicinity	3.090**	-
	(3.90)	
Inclusive Variable 1	1.014**	-
	(6.89)	

Inclusive Variable 2	1.360** (7.17)	-
Log-Likelihood	-2606.43	-680.86
LR Test(IV1=IV2=1)	$\chi^2(2) = 9.75$	$\chi^2(2) = 10.73$
Hausman Statistics	$\chi^2(11) = 32.77$	$\chi^2(11) = 11.00$
No. of Observation	1374	397

Note: 1) In the case of low-tech industry estimation, regional grouping is supported by LR test but not supported by Hausman test. Since we pose conservative judgment in the model specification, we do not use nested logit specification in this industry.

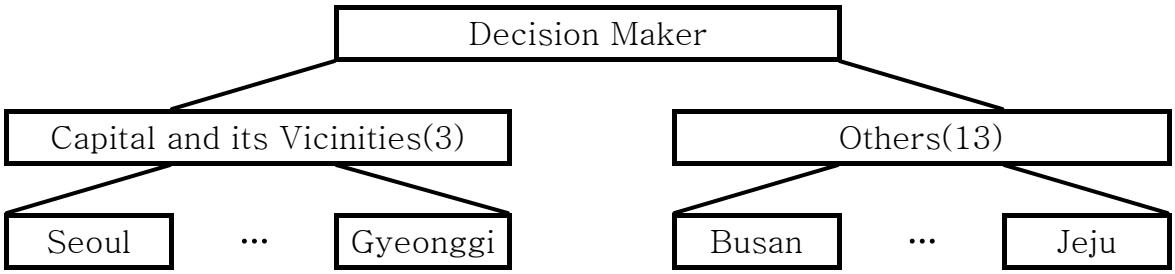
2) ( ) is the asymptotic z-statistics.

3) ** is significant at 1% significance level, * is at 5%.

Figure 1. Regional Distribution of FDIs in Korea(1998 ~ 2005)

Overall Industry High-tech Industry Low-tech Industry

Figure 2. Decision Tree



<Appendix 1> Industry Classification

This classification is based on the 8'th Korean Standard Industry Classification (KSIC) 3-digit level. The high-tech industry is classified based on the Executive Ordinance No. 424 (2007) of Ministry of Industry and Resources in Korea. It provides industry code of high-tech industry at KSIC 5-digit level. Unfortunately, we can not collect regional industry distribution data at 5-digit level. So we classified the sample at 3-digit level. The high-tech industries with KSIC 3-digit code are as follows;

241 basic chemicals
242 pharmaceuticals, medical chemicals and botanical products
243 other chemical products
252 plastic products
261 glass and glass products
262 ceramic wares
269 other unclassified non-metallic minerals
271 basic iron and steel
272 basic precious and non-ferrous metals
289 other metal products: metal working service activities
291 general purpose machineries
292 machine tools for working
293 other special purpose machineries
300 computer and office products
311 electronic motors, generator and transformers
312 distribution and control apparatuses of electricity
314 primary cells, batteries and accumulators
315 electronic lamps and bulbs
319 other electronic equipments
321 semi-conductors
322 telecommunication and broadcasting apparatus
323 televisions, video and other audio equipments
331 medical application and instruments
332 instruments and appliances of measuring, checking etc.
333 spectacles, photographic equipment and other optical instruments
341 motor vehicles and engines for motor vehicle

343 parts and accessories for motor engine and vehicles
353 aircraft, spacecraft and its parts.

Low-tech industries are whole manufacturing industries except the above industries.