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Agglomeration Economies and Intra-metropolitan Location of Firms: A Spatial Analysis on Chicago and Seoul

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집적경제와 도시내 기업입지에 대한 공간분석: 서울과 시카고를 대상으로

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Abstract : Urban spatial structure is closely related to the spatial distribution of urban economic activities. The spatial distribution pattern is no more than an aggregated expression of the location and/or relocation behavior of individual firms and establishments. In this respect, it is important to identify and examine the factors that affect the spatial behavior of individual firms for a more comprehensive understanding of urban space. Agglomeration economies are one of the most prominent urban economic phenomena in the modern metropolitan area. Most firms in an urban space seek external economies through the spatial clustering of their activities. Agglomeration economies feature prominently in the analysis of urban economic structure across urban areas. While the agglomeration economies between cities focus at the macro-scale of analysis, such economies within any given city focus more on the micro geographical scale. There have been a number of researches on agglomeration economies, among which there are relatively few approaches based on an intra-urban context. This paper explores the agglomeration economies at the micro scale and tries to reveal the spatial realization of the agglomeration economies within and between sectors. Three sectors are considered in the analysis; manufacturing, retail and service. The model is based on simultaneous equation systems combined with spatially weighted variables and estimated by the KRP estimators.

Key Words : agglomeration economies, intra-metropolitan location, simultaneous equation systems, Chicago, Seoul

요약 : 도시공간구조는 도시경제활동의 공간적 분포를 반영한다. 또한 공간분포는 개별 경제활동주체들의 입지 또는 재입지 행태의 집합적 표현에 다름 아니다. 이러한 견지에서, 개별기업의 공간행태에 영향을 주는 요인들을 검증해 보는 것은 도시공간의 포괄적인 이해를 위해 매우 중요하다. 집적경제는 대도시 지역 내에서 매우 두드러진 도시경제현상 중의 하나이다. 도시공간 내 대부분의 기업들은 경제활동의 공간적 집중을 통해 외부경제를 추구한다. 본 연구의 촛점은 도시내 경제구조의 분석을 통해 집적경제를 고찰하는 것이다. 많은 수의 기존 연구들이 보다 거시공간적 규모에서 도시간 집적경제의 패턴에 대해서는 분석을 하였으나 도시내 패턴에 대한 연구는 상대적으로 적다. 본 논문은 집적경제를 미시공간적 규모에서 고찰함으로써 경제부문간 및 부문내 집적경제의 공간적 분포를 파악하고자 한다. 제조업, 소매업 및 서비스업이 분석대상으로 모형에 이용되었다. 분석모형은 공간 계량경제학적으로 보정된 변수들을 이용하는 연립방정식 모형이 이용되었으며 회귀결과는 KRP 기법으로 추정되었다.

주요어 : 집적경제, 도시내 입지, 연립방정식 모형, 시카고, 서울

1. Introduction

Urban spatial structure embraces various different aspects of geographic distribution. While it could mean a distribution pattern of physical entities in a narrow sense such as buildings, houses and roads, urban (economic) geographers and economists have more often used this term in a broader context: the

spatial distribution pattern of urban economic activities and population. Economic activities in an urban area are a major driving force of development, while a city provides an attractive environment for economic activities to flourish. Such advantages include well-equipped infrastructure, shared information and knowledge and easier backward and forward linkages between industries among many. At a more general level, these are the benefits induced by external economies. In other words, urban environment provides such external economies to economic activities and, at the same time, (a group of) firms create(s) such environment. Urban spatial structure and, more specifically, the distribution pattern of urban economic activities are an aggregated expression of an individual location and/or relocation behavior of the agents (firms and establishments) in an urban area. They are two sides of a coin in that a more complete explanation of the distribution pattern provides a better understanding of the location and/or relocation pattern and vice versa.

One of the most prominent features highlighted by many studies related to urban economic activities is agglomeration economies. In terms of taxonomy, these are classified as a subset of the external economies mentioned above. In other words, agglomeration economies are the special type of external economies that can be realized under a certain environment. A spatial analysis on the agglomeration economies induced by external economies tends to be more interested in firms' locational and distributional behavior as an independent decision maker. The spatial scale of agglomeration economies is another issue that makes the concept more complicated. While there have been various different spatial scales applied to empirical works, relatively few efforts other than case studies have been addressed on the matters in an intra-urban context.

This paper performs a spatial analysis on the distribution patterns of urban economic activities and their synergetic locational effect between industrial sectors in order to examine the spatial realization of agglomeration economies in Chicago and Seoul in the 1990s. For the spatial analysis, spatial simultaneous equation systems are used with spatially weighted variables. The KRP (Kelejian-Robinson-Prucha) estimation is adopted to obtain the result. And three macro economic sectors are considered to check urban spatial structure[1]: manufacturing, retail and services.[2]

The next section summarizes previous researches especially focusing on the relationship between agglomeration economies and their influence from the spatial aspect. The third section presents a spatial econometric version of simultaneous equation systems as well as the estimator to be used in estimation process. The fourth section first shows the estimated result of each equation with a detailed interpretation and then provides a more structured explanation based on the interpretation. And the last section concludes the paper with some future research agenda.

2. Methodological Reviews: Spatial Analyses on Agglomeration Economies

While there has been a great deal of attention focused on the interrelations between economic activities and residences, it is hard to find the researches examining the interactions among different industrial sectors in economy.[3] The location (distribution) pattern of a single (a group of) firm(s) in a certain sector is affected by the pattern of residents. Similarly, one might expect that the distribution and location pattern of firms in other sectors also have an influence on the distribution or location decision of an individual firm. Generally speaking, firms show some level of attraction to firms within the same industry or to firms providing important inputs or markets for products. The explanation for these phenomena is rooted in the concept of external economies or agglomeration economies.[4] Firms seem to be better off when they are spatially aggre-

gated than dispersed; this is especially the case when the functional specialization between firms exists and geographic closeness matters.[5] Two perspectives can be adopted to explore the role of agglomeration economies, although they are not strictly exclusive. The intra-industry perspective, locating near firms in the same industry, provides a firm with great access to a more relevant infrastructure. The inter-industry perspective, locating near those firms in other economic sectors, offers a firm direct access to the sources of backward and/or forward linkages. According to a more popular typology of agglomeration economies among urban economic literatures, the former is termed as localization economies whereas the latter as urbanization economies. (e.g. Pascal and McCall, 1980; Goldstein and Gronberg, 1984; Nakamura, 1985; Fogarty and Garofalo, 1988; McMillen and McDonald, 1998).[6] While the effect of those two economies may not be clearly divided, Fogarty and Garofalo (1988) adopted the function of the scale of the manufacturing sector (returns-to-scale) as the estimate of localization economy and the function of urban scale (the efficiency parameter of the production function) as the estimate of urbanization economy in their model. They revealed that localization factors were significant in explaining productivity at the SMSA level, but they suggested that urbanization economies might not be solely significant and rather, the urban spatial structure or arrangement of economic activity also needed to be considered in the model. With a more disaggregate sectoral classification of manufacturing, Nakamura (1985) concluded that light manufacturing industries were more influenced by urbanization economies and heavy manufacturing industries more by localization economies in his research focusing on the Japanese cities.

Much portion of the theoretical and empirical research on agglomeration economies has explored the relationship between agglomeration economies and other urban and economic features. For example, Abdel-Rahman (1990) developed a theoretical framework to examine a different size and type of cities associated with the dominant agglomeration forces between cities. He argued that the industrial structure within a city or the spatial proximity between related industries was an important factor in explaining the differences. With an empirical model, Mitra (1999) also focused on the city size issue. Comparing city size with agglomeration economies measured as technical efficiency, he concluded that those two had a positive relationship even if the diseconomies of scale would be realized over a certain threshold level of city size. Research with a focus on the relationship between agglomeration and other factors includes a consideration of technical change (Calem and Carlino, 1991), the urban capital market (Helsley and Strange, 1991), and land rents and wages (Dekle and Eaton, 1999). While many authors linked agglomeration economies with the economies of scale, Goldstein and Gronberg (1984) attempted to explain this relationship through an appeal to the economies of scope realized through a vertical integration process in production. Unlike most others who focused on manufacturing activity, Mun and Hutchinson (1995) extended the research interest, in a case study of Toronto that focused on intra-urban locations, in terms of geographical scale and economic scope. However, an existence of the probable external economies between industries remains unexplored.

Another line of research has revealed a greater interest in a spatial context of these agglomeration economies. Lee (1981) adopted a standard distance measure from the economically weighted centroid to individual firms in each sector as well as contiguity measures to check the level of agglomeration economies or the spatial concentration of individual industries. Since the measures were limited to a consideration of firms in the same sector, the scope of research was confined to exploring the level of intra-industry agglomeration economies. Maurel and Sedillot's (1999) paper was one of the few that dealt with intra- and inter-industry relations at the same

time. Based on previous work, they derived several indices measuring the level of geographic concentration; these indices were interpreted as the correlation between the location decisions of two firms. By applying them to the French manufacturing industries, the authors sought to identify the spatial realization of agglomeration economies. While those indices are useful to check the overall pattern of spatial distribution, the causality between industries with respect to the distribution may not be identified. Hanson (1996) proved in his empirical research that spatial economic pattern experiences an iterative process of agglomeration, dispersion and reagglomeration due to the changing role of external economies and diseconomies. Dekle and Eaton (1999) explored the distance decay effect of agglomeration economies and concluded that the financial sector was more sensitive to the effect than manufacturing and, as a result, had more limited geographical spillover effects.

Agglomeration economies are only a part of the explanation for urban growth. DeCoster and Strange (1993) used the term spurious agglomeration to represent the situation in which an excessive concentration of economic activity occurs due to incentive programs. They noted that the system would be inefficient and could be relieved by certain tax measures. Both Moomaw (1985) and Hansen (1990) revealed that the contemporary economy was in transition from a stage that favored agglomeration economies to another; for example, Moomaw (1985) showed the productivity advantages of large cities have declined in eight 2-digit manufacturing sectors accounting for more than one third of the production worker employment. Hansen (1990) proposed that a productivity advantage of the center was offset by higher land and labor costs and the result suggested that market forces might lead eventually to a decentralization of industries. Smith and Florida (1994) also mentioned that there also seemed to be conflicting effects of agglomeration economies, so that those on the negative side (diseconomies) included higher factor costs resulting from locations in brown-field sites, higher wages, higher levels of unionization, and greater social problems. In his probit model to test firms' location behavior, Cooke (1983) showed that the traditional measures of agglomeration economies such as the proximities to backward and forward linkage activities lacked an explanatory power. Rather, as he noted, demand changes, initial plant size or transport cost in relative magnitude has gained more importance.

3. Spatial Simultaneous Equation Systems as a Spatial Analysis Tool

The spatial distribution of a certain economic activity in the model is explained by several factors related to economic activities, employment and residence. The factors related to economic activities are disaggregated into intra-sectoral and inter-sectoral effects. The former reflects what may be termed as spatial autoregressive simultaneity while the latter focuses on feedback and spatial cross-regressive simultaneity.[7] Variables are selected to explain different aspects of agglomeration economies within and between sectors; the factors related to residence are population in general and the employed residents in a specific economic sector. While the former is seen as a proxy for the market potential for firms, the latter is considered as the labor pool of a specific industry. Generally, a larger population leads to a higher level of demands on goods and services with the result that firms may prefer staying closer to the areas with higher demands to maintain a larger market share by reducing transportation cost (and as a result, reducing the market price of goods and services). In a similar fashion, a larger labor pool leads to a higher level of cheap labor supply. A cheaper supply of labor enables firms to lower production costs and as a consequence, the market price of those goods and services. In this sense, those two effects are expected to work as centripetal forces in certain

zones. Equations (1) through (3) yield the equilibrium conditions for the simultaneity for three economic sectors.8) As Anselin and Bera (1998) noted, when data are based on administratively determined units, there is no good reason to expect economic behavior to conform to these units. As a consequence, it might be reasonable to use variables with spatial weights (W) attached on them to bridge the gap between the two as the model below specifies. It should be noted that exogenous variables are taken as the values in the initial year, *t-1*. It is appropriate for the model to have a temporal gap between explanatory and dependent variables, considering causal relationships need some time to develop.

One of the concerns in this type of time-lag model is temporal autocorrelation. In other words, the level of an economic activity at time t is not totally independent of the one at *t-1*. For example, if a certain zone had a relatively higher level of manufacturing activity at *t-1*, it is not surprising to expect a relatively higher activity level of manufacturing there at t. This paper escapes such problem in that (1) it is, by property, a cross-sectional model and not a time-series model that causes temporal dependency,[9] and

$$\begin{aligned}\Delta MAN_i &= \varphi_0 + \varphi_1 \Delta W\_MAN_i + \varphi_2 (I+W)\Delta RET_i + \varphi_3 (I+W)\Delta SER_i \\ &+ \varphi_4 (I+W)MAN_{it-1} + \varphi_5 (I+W)RET_{it-1} + \varphi_6 (I+W)SER_{it-1} \\ &+ \varphi_7 (I+W)EMP^m_{it-1} + \varphi_8 (I+W)EMP^{nm}_{it-1} + \varphi_9 (I+W)POP_{it-1} + v^m_{it}\end{aligned} \quad (1)$$

$$\begin{aligned}\Delta RET_i &= \gamma_0 + \gamma_1 \Delta W\_RET_i + \gamma_2 (I+W)\Delta MAN_i + \gamma_3 (I+W)\Delta SER_i \\ &+ \gamma_4 (I+W)MAN_{it-1} + \gamma_5 (I+W)RET_{it-1} + \gamma_6 (I+W)SER_{it-1} \\ &+ \gamma_7 (I+W)EMP^r_{it-1} + \gamma_8 (I+W)EMP^{nr}_{it-1} + \gamma_9 (I+W)POP_{it-1} + v^r_{it}\end{aligned} \quad (2)$$

$$\begin{aligned}\Delta SER_i &= \eta_0 + \eta_1 \Delta W\_SER_i + \eta_2 (I+W)\Delta MAN_i + \eta_3 (I+W)\Delta RET_i \\ &+ \eta_4 (I+W)MAN_{it-1} + \eta_5 (I+W)RET_{it-1} + \eta_6 (I+W)SER_{it-1} \\ &+ \eta_7 (I+W)EMP^s_{it-1} + \eta_8 (I+W)EMP^{ns}_{it-1} + \eta_9 (I+W)POP_{it-1} + v^s_{it}\end{aligned} \quad (3)$$

where

ΔMAN_i = temporal change in number of manufacturing establishment in zone i

ΔRET_i = temporal change in number of retail establishment in zone i

ΔSER_i = temporal change in number of service establishment in zone i

ΔW_MAN_i = temporal change in number of manufacturing establishment around zone i

ΔW_RET_i = temporal change in number of retail establishment around zone i

ΔW_SER_i = temporal change in number of service establishment around zone i

$(I+W)\Delta MAN_i$ = temporal change in number of manufacturing establishment in and around zone i

$(I+W)\Delta MAN_i$ = temporal change in number of retail establishment in and around zone i

$(I+W)\Delta MAN_i$ = temporal change in number of service establishment in and around zone i

$(I+W)MAN_{it-1}$ = number of manufacturing establishment in and around zone i at time t-1

$(I+W)RET_{it-1}$ = number of retail establishment in and around zone i at time t-1

$(I+W)SER_{it-1}$ = number of service establishment in and around zone i at time t-1

$(I+W)EMP^m_{it-1}$ = number of manufacturing employed residents in and around zone i at time t-1

$(I+W)EMP^r_{it-1}$ = number of retail employed residents in and around zone i at time t-1

$(I+W)EMP^s_{it-1}$ = number of service employed residents in and around zone i at time t-1

$(I+W)EMP^{nm}_{it-1}$ = number of non-manufacturing employed residents in and around zone i at time t-1

$(I+W)EMP^{nr}_{it-1}$ = number of non-retail employed residents in and around zone i at time t-1

$(I+W)EMP^{ns}_{it-1}$ = number of non-service employed residents in and around zone i at time t-1

$(I+W)POP_{it-1}$ = total population in and around zone i at time t-1

(2) the dependent variable here is the growth between two years, rather than the value at t. Rather, the model tries to capture any kind of such, if any, spatio-temporal association pattern in its theoretical framework: competition and collaboration.[10]

The traditional estimation method for simultaneous equation systems is the two-stage least squares (2SLS) estimation. Rather than directly using actual endogenous variables, this estimation uses the projected values of those variables in the regression. While simultaneity can be adjusted with 2SLS, spatial factors remain as another potential disturbance that might possibly lead to biased estimators. Rey and Boarnet (1998) have tested various different estimators that explicitly incorporate spatiality using the Monte Carlo simulation. The result showed that the Kelejian-Robinson-Prucha (KRP) estimator performed relatively well compared with other estimators. The KRP estimator, developed in a series of papers by Kelejian and Robinson (1993) and Kelejian and Prucha (1998) is based on the 2SLS. However, the difference between the 2SLS and the KRP estimator is that the latter also incorporates spatially lagged independent variables in the projection matrix. Equations for those two estimators are listed in the appendix. In the empirical analysis, the spatial simultaneous equation systems are estimated using both the 2SLS and the KRP estimators, but the result is reported only for the KRP estimation.[11]

4. Spatial Economy in Chicago and Seoul

Chicago and Seoul have a few key features in common in the past and the current urban development path: (1) they both have grown heavily based on the manufacturing sector and experienced a transition from the manufacturing-dominant to an advanced service-dominant economies in the recent decades, and (2) they have been uncontestable regional (national) centers for many decades to the Midwestern economy and the rest of Korea, respectively. Furthermore, globalization has led to an increasing level of similarity of urban features between cities across the world. For example, some of the famous multinational fast food chains, such as McDonalds or Burger King can be found at almost any corner of a block near the big customer markets in any big city in the world. In this respect, it is interesting to examine and compare whether the two cities share the similar type of a spatial agglomeration pattern as well corresponding to the similarity in an urban economic aspect described above.

The empirical analysis of Chicago was performed on 306 ZIP Code zones in the Chicago CMSA. Variables used in the model were obtained from the 1990 U.S. Population Census, the 1992 U.S. Economic Census and the 1995 ZIP Code Business Pattern.[12] The analysis on Seoul was done on 61 administrative areas in the Seoul Metropolitan Region (SMR). Data were obtained from the 1990 Korean Population Census, the 1991 and 1996 Korean Report on Establishment Census.[13] All the variables were standardized by dividing the values by their corresponding areal sizes to eliminate the influence of an areal size effect.

The results from the KRP estimation for Chicago are shown in tables 1. In the manufacturing sector, the distribution pattern of manufacturing in the previous stage ($(I+W)\_MAN92$) plays an important role in increase/decrease of the number of manufacturing firms. In other words, if a certain zone has more concentrated manufacturing activities in the previous stage, the zone will experience a greater number of manufacturing firms concentrating in the future. The explanation may be derived to the proposition that the zones with a larger number of manufacturing firms in an earlier period usually have a relatively well-maintained infrastructure for these firms and the well-established production networks between firms. These types of favorable economic environments will work as attraction factors for other manufacturing firms. Note also that the spatially lagged dependent variable ($W\_\Delta MAN$) has a positive rela-

tionship with the dependent variable even though it is not significant in explaining the changing number of manufacturing firms. This implies that the agglomeration process of manufacturing is self-reinforcing possibly through backward and forward linkage process, the interaction with the demand and supply side of the economy respectively.14) While the retail sector in the previous time ((*I+W*)_*RET92*) exerts a negative influence on the expansion of the manufacturing sector, the contemporary changes in the number of retail firms ((*I+W*)_*ΔRET*) provide a positive influence. The coefficient of the former is very small in absolute terms, so that the explanation afforded will be limited. The latter implies that manufacturing grows in concert with the retail sector as can be confirmed again later in the retail equation. In other words, there seems to be a simultaneous interaction between the two sectors that reinforces each other. The service sector in the previous stage ((*I+W*)_*SER92*) is not significant, but the contemporary change of the same sector ((*I+W*)_*ΔSER*) has a negative influence on manufacturing. Since many of the recently growing service firms in Chicago perform higher functions (such as business-related services), they need to be located in the central places (mostly, the CBD) with the cost of higher rents. Accordingly, manufacturing firms cannot compete with them for in the same zone and surrounding areas. As a result, an increase in the number of service firms works as a repellent factor for manufacturing firms. The table also reveals that the location decision of manufacturing firms may not be affected by either the distribution of labor force ((*I+W*)_*MEMP90* and (*I+W*)_*NMEMP90*) or the size of market ((*I+W*)_*POP90*).[15]

In the retail equation, a similar analogy can be applied to the relationship between the manufacturing and the retail sector,[16] confirming the interaction between the two sectors again from a locational per-

Table 1. Estimation results of Chicago

Variable name		Manufacturing	Retail	Service
Constant		.00718 (.294)	-.02136 (.165)	-.58548 (.000) **
Exogenous Variables	*(I+W)_MAN92*	.01974 (.000) **	-.05285 (.000) **	.30878 (.000) **
	(I+W)_RET92	-.00192 (.000) **	.00456 (.000) **	-.00795 (.641)
	(I+W)_SER92	.00105 (.370)	N/A	-.00491 (.048) *
	(I+W)_MEMP90	-.00038 (.690)		
	(I+W)_NMEMP90	-.00001 (.653)		
	(I+W)_REMP90		-.00076 (.010) **	
	(I+W)_NREMP90		13.0333 (.000) **	
	(I+W)_SEMP90			-.00069 (.950)
	(I+W)_NSEMP90			15.4653 (.002) **
	(I+W)_POP90	.04370 (.512)	.29782 (.066)	4.87691 (.000) **
Endogenous Variables	*(I+W)_ΔMAN*		1.10479 (.000) **	-1.37942 (.328)
	(I+W)_ΔRET	.72747 (.000) **		2.41008 (.000) **
	(I+W)_ΔSER	-.04673 (.000) **	.10098 (.000) **	
	W_ΔMAN	-1.15569 (.766)		
	W_ΔRET		1.20468 (.359)	
	W_ΔSER			1.18115 (.000) **
Adj-R^2		.5571	.3114	.8960

spective. Two coefficients for the retail sector ((*I+W*)_*RET92* and *W*_Δ*RET*) show positive signs, implying that a self-reinforcing concentration is in progress in this sector. As a result, other things being equal, a strong agglomeration will be observed in terms of the distribution in retail firms possibly due to the external economies of a region.[17] An increase in the number of service firms ((*I+W*)_Δ*SER*) also works as an attracting factor to retail firms, in large part because many retail functions serve people within and around the same geographic area. Hence, an increase in the number of service firms (such as offices) gives rise to an increase in the number of people working in the offices, the retail market is enlarged and finally a larger number of retail firms (such as restaurants or shops) move in. Increases in the labor force in the retail sector ((*I+W*)_*REMP90*) generate a negative influence on the growth of the retail sector in a zone. The number of non-retail employed residents ((*I+W*)_*NREMP90*) is interpreted in two ways: (1) as an attraction factor for non-retail firms to be close to labor force as the 'jobs follow people' hypothesis promotes, and (2) as a narrowly defined market composed of pure consumers that separates retail employees as suppliers, as opposed to the comprehensive market composed of the total population. Since both the manufacturing and service sectors do not have a strong relationship between their locations and the distribution of employed residents in the corresponding sectors in the table, the first interpretation may not be so plausible in this case. Rather, (*I+W*)_*NREMP90* is viewed as a market for the retail sector along with (*I+W*)_*POP90*. Those two have positive relations with the growth of the retail sector, implying that a larger size of a market is in favor of a concentration of the retail sector.

In the service sector, the distribution of manufacturing firms in the previous stage ((*I+W*)_*MAN92*) may affect the change in the number of service firms ((*I+W*)_Δ*MAN*) in a positive way. On the other hand, the changes in the number of manufacturing firms are not so relevant to those of service firms. One explanation is that service firms prefer to choose the locations in which a large pool of manufacturing firms are already established rather than opting for the locations in growing manufacturing regions. In this sense, a mature market should be a more stable option for firms than a growing regional market. An increase in the number of retail firms ((*I+W*)_Δ*RET*) has a positive influence on the increase in the number of service firms. As mentioned in the retail equation, this is a further example of the synergetic effect between two sectors. The two coefficients related to the distribution of the service sector ((*I+W*)_*SER92* and *W*_Δ*SER*) reveal that the change in the number of service firms in a region is negatively related to the initial distribution of service firms and positively related to the change in the number of firms around the region (W_ΔSER). If there are a number of service firms in a region, it means that there should be a severe competition among them as well as certain advantages derived from external economies. If the service market is almost saturated, then the disadvantage from the former may exceed the advantage from the latter. If this is the case, a negative relationship will be observed between the two variables. On the other hand, an increasing number of service firms in a region may reflect that the market is not yet fully covered, leading to an entry of additional service firms in the region until the market becomes fully served. The service sector is also insensitive to the distribution of labor force ((*I+W*)_*SEMP90*) as was the case in the previous two sectors. Again, the same explanation can be applied to the non-service sector labor force ((*I+W*)_*NSEMP90*) and population ((*I+W*)_*POP90*) as in the retail sector case: a larger market leads to a concentration of service firms.

Finally, in terms of explanatory power, the equation for services has the highest R^2, followed by manufacturing and retail. A relatively low R^2 for the retail sector seems to be ascribed to the spatial distribution characteristics of the sector. That is, retail

firms are distributed over space more evenly to have an easy access to and from customers (mostly people rather than firms). As a result, it is hard to identify a particular spatial pattern for the retail sector and to explain the pattern with other types of spatial distribution patterns (i.e., through the independent variables specified). The manufacturing and the service sectors are thought of as having more localized characteristics in terms of spatial distribution, which are relatively well matched with the distribution patterns of the explanatory variables.

The result from the estimation for Seoul is shown in tables 2. In the manufacturing equation, (I+W)_MAN91 was negatively significant, implying that new manufacturing firms did not like to establish their factories near other manufacturing firms. One possible explanation is that this may be more related to an outbound location/relocation process of such firms from the city of Seoul to surrounding areas. And this movement may be, to a large extent, an outcome of the industrial zoning policies taken for decades since the 1980s. Table 3 shows some examples of those policy measures during the period. The insignificance of *W_ΔMAN* implies that the expansion of manufacturing activities leads to a more or less random distribution over the region, so that no specific distributional tendency can be traced related to the location/relocation of the other firms in a sector. In relation to the retail sector, *(I+W)_RET91* was not significant but *(I+W)_ΔRET* showed a positive sign. As the case in Chicago and as can be seen in the retail sector equation, the manufacturing and the retail sectors had a synergetic effect on each other. In other words, a growing number of retail firms attracted more manufacturing firms and vice versa. Both variables representing the service sector, *(I+W)_SER91* and *(I+W)_ΔSER*, were not so significant. This result is interesting in that, during the 1980s and 1990s, the business service sector along with the FIRE (Finance, Insurance and Real

Table 2. Estimation results of Seoul

Variable name		Manufacturing	Retail	Service
Constant		2.04877 (.673)	26.9594 (.087)	-33.0335 (.033) *
Exogenous Variables	*(I+W)_MAN91*	-.12815 (.023)*	.034530 (.012) *	-.02657 (.798)
	(I+W)_RET91	.06439 (.167)	-.43171 (.000) **	.23112 (.002) **
	(I+W)_SER91	.04952 (.687)	.58847 (.031) *	-.78706 (.000) **
	(I+W)_MEMP90	.00438 (.745)		
	(I+W)_NMEMP90	-.01961 (.312)		
	(I+W)_REMP90		.11911 (.010) **	
	(I+W)_NREMP90		-.01095 (.711)	
	(I+W)_SEMP90			.05576 (.304)
	(I+W)_NSEMP90			-.00760 (.761)
	(I+W)_POP90	.00203 (.747)	-.00214 (.854)	.00171 (.873)
Endogenous Variables	*(I+W)_ΔMAN*		.89440 (.032) *	-.09187 (.840)
	(I+W)_ΔRET	.17807 (.044) *		.54889 (.001) **
	(I+W)_ΔSER	-.00601 (.964)	1.10948 (.000) **	
	W_ΔMAN	-.59866 (.766)		
	W_ΔRET		-1.84009 (.001) **	
	W_ΔSER			.48444 (.318)
Adj-R^2		.5182	.6322	.5967

Note: * significant at 0.05 and ** significant at 0.01.

Estate) industries became the top forward linkage sector in Korea.[18] Some of the possibilities are either (1) that such a strong industrial linkage has not been reflected in the spatial distributional pattern, or (2) that the producer services have not been the bigger sharer of the service sector, so that even though such activities might have a great interaction with the manufacturing sector, they did not seem to be enough to represent the whole service sector to be significantly connected with the manufacturing sector in a spatial context in the SMR. As in Chicago, all the labor force related and market related factors, *(I+W)_MEMP90*, *(I+W)_NMEMP90* and *(I+W)_POP90*, were not very significant, implying that the sector does not count much on the distribution of labor forces and customers.

In the retail equation, both *(I+W)_MAN91* and *(I+W)_ΔMAN* were positive and significant. Combined with the result from the manufacturing equation estimation, both sectors were thought of as having a synergetic effect on each other in terms of location/relocation process. Especially, an asymmetric relationship between two sectors in exogenous distribution factors (*(I+W)_MAN91* and *(I+W)_RET91*) might reflect that a number of formerly manufacturing dominant areas in the city of Seoul have been taken over by the retail sector that, in many cases, could pay a higher rent, but not on the other way around (*(I+W)_MAN91* to retail, but not *(I+W)_ΔRET91* to manufacturing). Both of the retail distribution factors, *(I+W)_RET91* and *(I+W)_ΔRET*, showed a sign of negativity. Overall, this implied an expansion or dispersion of the sector over the region. In a sense, new retail firms wanted to locate their

Table 3. Legislative actions and major policy instruments in Korea since 1960

Year	Legislative actions	Major policy instruments
1964	Export Industrial Estate Development Promotion Law	Preferential sale of publicly owned land Provision of basic infrastructure Administrative endorsement
1970	Local Industrial Development Law	Tax exemption and reduction Provision of basic infrastructure
1973	Industrial Site and Water Resource Development Law	Creation of the government corporation in charge of industrial estate development Land price freeze for compensation of the proposed site for industrial estate
1977	Industrial Distribution Law	Adoption of national industrial zoning Reduction of corporate income tax (10% of building cost for relocated plant into inducement zone and 5% in other zones) Accounting 10% loss for the purpose of relocation reserve Exemption of capital gains tax of corporation for the sale of land and buildings occupied by relocated firms from dispersal zone Higher basic exemption rate of capital gains tax for the sale of individual premises Exemption of acquisition and registration tax for relocated worker's housing initially for one year Accelerated depreciation rate
1982	Seoul Metropolitan Region Redevelopment Planning Law	Delineated the SMR into five sub-categories by intensity of development control Introduction of development permits for new location andexpansion of industrial plant and facilities Strengthened land use control
1993	Seoul Metropolitan Region Redevelopment Planning Law (revised)	Changes from physical control to economic disincentive (congestion charge) Redelineation of the SMR into three sub-categories by intensity of development control

Source: Kim and Choe (1997, 55)

shops far from the area where there already were a number of such functions as in the major parts of the city ((*I+W*)_*RET91*) and also far from the area where there are growing numbers of retail functions ((*I+W*)_*ΔRET*). Avoiding competition is thought of as more critical than pursuing collaboration in terms of spatial distribution. The two service sector distributions, (*I+W*)_*SER91* and (*I+W*)_*ΔSER*, showed a positive influence. Similar to the manufacturing sector, firms and people in the service sector are also a substantial market for retail firms. The relationship of the retail sector with manufacturing and service suggested a market orientedness of the sector in location/relocation process. It is also noted that the distribution of labor force was considered important in retail firm's location decision (more labor forces at some place, more of sectoral activities near). It may be related to the situation in which a larger portion of the retail sector employees in the SMR are self-employees and their workplaces are not separated from the residences or at least are quite close to where they live. The two market factors, (*I+W*)_*NREM90* and (*I+W*)_*POP90*, were not so significant in the analysis.

In the service equation, both (*I+W*)_*MAN91* and (*I+W*)_*ΔMAN* did not show any significance in explaining the distribution of the service sector, reflecting a weak spatial linkage between two sectors. Again, as in the explanation on manufacturing, it is thought that both have not had a strong spatial bondage in spite that the two sectors (especially manufacturing and producer services) have experienced an increasing level of linkage with each other. It is possible that those business-related service sectors have been a smaller portion of all service activities and the other non-business-related service sectors have not had so an intimate linkage with manufacturing. Both of the retail sector variables, (*I+W*)_*RET91* and (*I+W*)_*ΔRET*, were positively significant. As before, a synergetic effect can be found between the two sectors. In a sense, it is partly related to the fact that a large number of retail and service firms have gathered to such places in and around cities where manufacturing had prevailed in the previous stage. While (*I+W*)_*SER91* showed a negative impact, (*I+W*)_*ΔSER* provided a positive sign even though the latter was not very significant. In terms of the competition-collaboration tradeoff, service firms seemed to feel more competitive in a saturated market (a negativity to (*I+W*)_*SER91*) and to feel more collaborative in a growing market but with a less significance (a positivity to (*I+W*)_*ΔSER*). This is a very similar trend as in the Chicago case. All labor force and market oriented variables, (*I+W*)_*SEMP90*, (*I+W*)_*NSEMP90* and (*I+W*)_*POP90*, were not significant in the model.In terms of explanatory power, a lower R^2 of the manufacturing sector may imply the fact that something other than economic impetus, such as policy incentives, has played a critical role in shaping the distribution pattern of manufacturing firms. On the other hand, the retail and the service sectors showed a relatively higher level of explanation, reflecting more of their market-driven (as opposed to government-intervened) characteristics.

5. Conclusion: Spatial Collaboration and/or Competition

While detailed interpretations were provided in the previous section, there are several interesting results to be noted. First, in terms of the backward- and forward-linkage effects between industries, there was some evidence that external economies and, as a result, possible agglomeration economies existed between the manufacturing and the retail sector and between the retail and the service sector in Chicago. However, there was no such effect between the manufacturing and the service sector. Rather, the relationship showed more dominant repellent forces between two sectors, especially from service to manufacturing. There was also a strong tendency that the service sector is self-reinforcing in

that it has attracted more and more activities of a similar type in the same zone or surrounding area. Figure 1 summarizes the endogenous relationships among the three economic sectors in Chicago. These findings may be considered in comparison to the relationships obtained from an estimated input-output table for the Chicago region for 1997; manufacturing's dominant linkage is internal, followed by services and then retail. For retail, service backward linkages dominant, followed by manufacturing while for services, the dominant relationships are with itself and manufacturing. Hence, while manufacturing and services are strongly linked in an input-output sense at the macro region level, this does not necessarily translate into a strong spatial association within a major metropolitan region. In Seoul, cross-reinforcing impacts between manufacturing and retail and retail and service were found. But there was no self-enforcing dynamics inside of each sector as in Chicago. In addition, there was no obvious relationship between manufacturing and service. Overall, there were a less number of significant spatial association patterns found in and between economic sectors in Seoul than in Chicago. The endogenous relationship in Seoul was summarized in figure 2.

Secondly, if attention is directed to the previous economic settings or environment, the inter-industry relation might be a little different from the one when investigating endogenous relations. In case of Chicago, neither the manufacturing nor the retail sector could be considered an attractive incubator to the other when firms make decisions on location and/or consider relocation. While the size of an individual sector in a zone (the number of firms in a sector) is not an incentive for the firms in the other sector to move in, the growth of the sector in the zone (the change in the number of firms in a sector) is revealed as an attraction factor between the manufacturing and the retail sector. From the viewpoint of

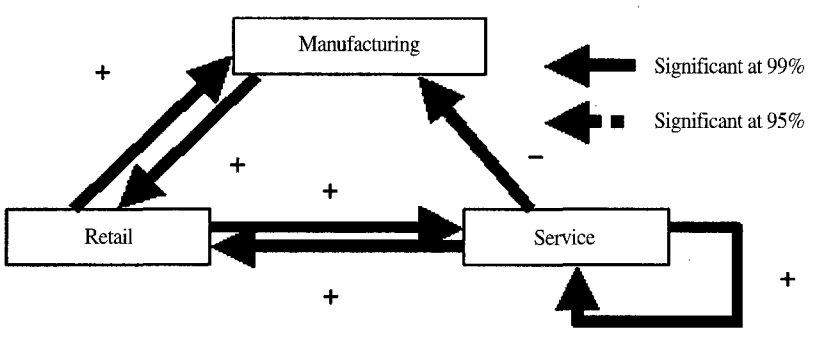

Figure 1. Endogenous relationship among three sectors in Chicago

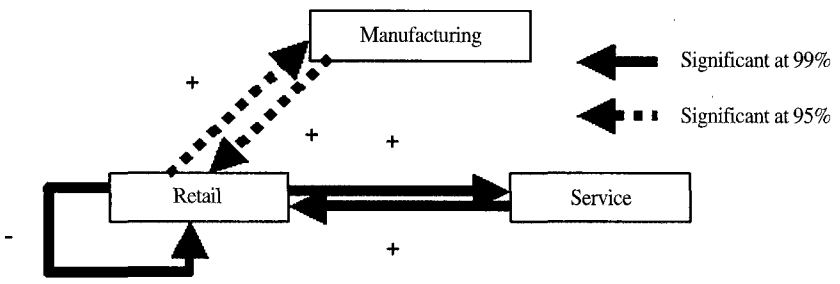

Figure 2. Endogenous relationship among three sectors in Seoul

the retail sector, fully-developed manufacturing areas may already have enough number of retail facilities to serve them, whereas growing manufacturing markets provide more opportunities. From the perspective of the manufacturing sector, a fully-grown retail area may not be considered as the prime location for them in large part due to a relatively high rent, the lack of available vacant space and so forth. The manufacturing sector, however, functions as an incubator for the service sector.[19] Finally, a higher level of economic activities in the same sector in the previous time period works as an attraction factor (an incubator rather than a highly competitive market) for the manufacturing and the retail sectors while a repellent (a highly competitive market rather than an incubator) for the service sector. In Seoul, no sector showed a sign of self-reinforcement process on the previous economic settings (a highly competitive market rather than an incubator). Similar as in the endogenous relationship in figure 2, the retail sector lay in the middle of the spatial agglomeration process interacting with the manufacturing and the service sectors. However, it is still noted that a disaggregation of the service sector may uncover a more accurate process of self-reinforcement. For example, some of personal service firms similar to retail firms in their behaviors may show a similar location/relocation pattern. On the other hand, such firms in business services may have different groups of customers and as a result different location strategies. Figure 3 shows the relationships among sectors in Chicago and figure 4 in Seoul.

Third, the traditional hypothesis, "jobs follow people," was not proven to exist in an intra-urban

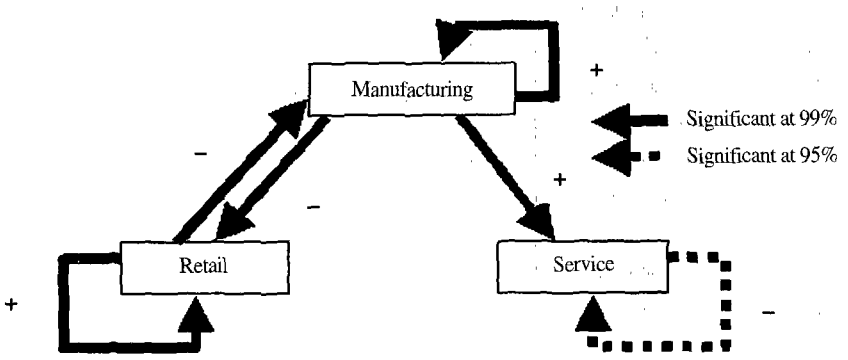

Figure 3. Exogenous relationship among three sectors in Chicago

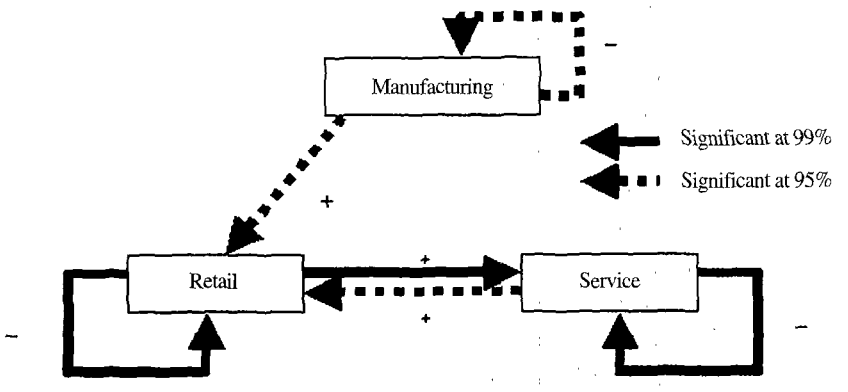

Figure 4. Exogenous relationship among three sectors in Seoul

context in Chicago. None of the three sectors showed a significant influence from this variable. For example, the distance between home and work, or the closeness to labor force may not be such important considerations within a city, while obviously important in intercity or interregional contexts. Using a more aggregated division of the metropolitan economy, Hewings et al. (1999) revealed the significant movement of workers and income across zones, while the volume of interzonal trade was relatively weak. Hence, an access to labor force may take on a very different connotation spatially than an access to supplier or market. In the Seoul case, the result was almost identical except one sector (retail) in which "jobs follow people" hypothesis was in effect.

Finally, closeness to market (represented by population and the number of employed residents in other sectors) did not provide a significant explanatory power overall even though there were a few significant variables detected. However, those variables deal only with the distribution of people through their residences. In other words, if the distribution of people in terms of workplace (i.e. the number of employees in a zone) is considered, that will be another comparable market for firms[20] and as a result, the explanatory power of this variable would be enhanced.

One of the limitations of the analysis is that the model does not explicitly separate the effect of agglomeration economies from the one led by the economic growth of the system when estimating the coefficients of each industry variable. A more refined estimation result will be obtainable if the model explicitly handles this difference. There are several possible alternatives to approach this problem; extract a growth index for the region of interest or the whole economic system and apply it to the growth rate of firms in the corresponding zones in the region or, more explicitly, combine the system growth factor in the regression model as an independent variable. The growth index should, however, be selected with care since the remaining agglomeration effect might be very sensitive to the specification of the index; for example, whether to choose such index for the whole region or whether to differentiate for several sub-regions (i.e. for each MSA in the Chicago CMSA and/or for Seoul, Inchon and the rest of the SMR in the SMR) since there is also a regional variation in the growth pattern. This type of sensitivity could be explored if the model is estimated iteratively after various different specifications of growth indices are combined in it, which still remains as one of the future research agenda for this paper.

Notes

1) One reason to limit the number of sectors as three is related to the identification problem of the simultaneous equation system. That is, in order for the model to be identified with a more number of sectors, it requires the same or a more number of corresponding independent variables (the number of employed residents in the corresponding economic sector in this case), which are not often available at a more disaggregated economic and spatial level.
2) The service sector includes the sectors in Division I (Services) in the U.S. SIC. Corresponding to this, the sectors in the KSIC include 502 (Sale of Motor Vehicle Parts and Accessories), 526 (Retail Sale in Other Specialized Stores), 551 (Accommodation), 71 (Renting of Machinery and Equipment without Operator and of Personal and Household Goods), M (Business Activities), O (Education), P (Health and Social Work), Q (Recreational, Cultural and Sporting Activities), R (Other Community, Repair and Personal Service Activities), and S (Private Households with Employed Persons).
3) A notable exception would be the works on clustering; however, most of these applications focus on the linkages within one spatial unit (a region or a metropolitan area). See a recent review by Feiser and Bergman (2000)
4) The concept of increasing returns to scale provides a starting point of the economic process of agglomeration economies. For an extensive review of the literatures on this topic, refer to Fujita and Thisse (1996).
5) The terms, functional specialization and "geographic closeness" were two dimensions to explain the level of

agglomeration economies in the paper by Bergsman, Greenston and Healy (1975).

6) Some authors did not explicitly use those terms to present the characteristics of those two economies (e.g. Pascal and McCall (1980) and McMillen and McDonald (1998)) or had more than two types of economies classified. (e.g. Pascal and McCall (1980) and Goldstein and Gronberg (1984)) But the fundamental idea behind those is still under the general classification scheme of localization and urbanization economies first suggested by Hoover (1971).
7) The terminologies used here were borrowed from Rey and Boarnet (1998).
8) For a more detailed derivation process of the model, refer to Sohn and Hewings (2000).
9) In a time-series model, it causes a biased estimator since independent variables are not independent of error terms.
10) For example, the relevant questions are whether the competition factor is dominant, so that the model observes a lower growth of the manufacturing activity in a zone with huge manufacturing activities at *t-1* or whether the collaboration factor is dominant, so that a higher growth is expected in such area ($DMAN_i$ against $(I+W)MAN_{i,t-1}$).
11) The results from the two estimation methods are very similar and the Chicago case shows more similarity than the other.
12) 1990 is used as *t-1* for the sectoral employed resident and population variables and 1992 is used as *t-1* for the sectoral establishment variable. 1995 is used as *t*.
13) Again, 1990 is used as *t-1* for the sectoral employed resident and population variables and 1991 is used as *t-1* for sectoral establishment variable. 1996 is used as *t* in Seoul.
14) For more discussion on backward and forward linkages, refer to Fujita, Krugman and Venables (1999).
15) Note that market may be outside metro area of Chicago due to the hollowing-out process. For more detailed exploration of hollowing-out process in Chicago economy, refer to Hewings et al. (1998).
16) For example, $(I+W)\_MAN92$ and $(I+W)\_\Delta MAN$ have conflicting signs and the coefficient of the former is very small compared to the latter.
17) It is not unusual in that many retail outlets concentrate in some parts of a city in America rather than be dispersed, which ultimately gives external economies to the firms located in such area.
18) See Cho, Sohn and Hewings (2000, p.129) for more information on the forward linkage hierarchy in Korea between years.
19) In a sense, a positivity in the endogenous relationship between manufacturing and retail and a positivity in the exogenous relationship between manufacturing and service may be related to the time lag required for the firms in each sector to react to a changing environment. That is, it may be an evidence that retail firms respond faster to the change in the economic environment than service firms.
20) For example, people may want to go shopping during a lunch hour or after work. They may also want to do some personal businesses related to personal service firms during those time periods of a day. In this situation, they may prefer choosing closer retail and service firms from their workplaces. In the viewpoint of retail and service firms (suppliers), they may be considered as another equivalent potential market.

References

Abdel-Rahman, H.M., 1990, Agglomeration economies, types, and sizes of cities, *Journal of Urban Economics*, 27, 25-45.

Anselin, L. and A.K. Bera, 1998, Spatial dependence in linear regression models with an introduction to spatial econometrics, in Ullah, A. and D.E.A. Giles,(eds.), Hand*book of Applied Economic Statistics*, Marcel Dekker, New York, 237-289.

Calem, P.S. and G.A. Carlino, 1991, Urban agglomeration economies in the presence of technical change, *Journal of Urban Economics*, 29, 82-95.

Cho, B., J. Sohn, and G.J.D. Hewings, 2000, Industrial structural change in the Korean economy between 1975 and 1995: Input-output analysis, *Economic Papers*, 3, 109-136.

Cooke, T.W., 1983, Testing a model of intraurban firm relocation, *Journal of Urban Economics*, 13, 257-282.

DeCoster, G.P. and W.C. Strange, 1993, Spurious agglomeration, *Journal of Urban Economics*, 33, 273-304.

Dekle, R. and J. Eaton, 1999, Agglomeration and land rents: Evidence from the prefectures, *Journal of Urban Economics*, 46, 200-214.

Feiser, E.J. and E.M. Bergman, 2000, National industry cluster templates: A framework for applied regional cluster analysis, *Regional Studies*, 34, 1-20.

Fogarty, M.S. and G.A. Garofalo, 1988, Urban spatial structure and productivity growth in the manufacturing sector of cities, *Journal of Urban Economics*, 23, 60-70.

Fujita, M. and J.F. Thisse, 1996, Economics of agglomeration, *Journal of the Japanese and International Economics*, 10, 339-378.

Fujita, M., P. Krugman, and A.J. Venables, 1999, *The Spatial Economy*, The MIT Press, Cambridge.

Goldstein, G.S. and T.J. Gronberg, 1984, Economies of scope and economies of agglomeration, *Journal of Urban Economics*, 16, 91-104.

Hansen, E.R., 1990, Agglomeration economies and industrial decentralization: The wage-productivity trades-offs, *Journal of Urban Economics*, 28, 140-159.

Hanson, G.H., 1996, Agglomeration, dispersion, and the pioneer firm, *Journal of Urban Economics*, 39, 255-281.

Helsley, R.W. and W.C. Strange. 1991, Agglomeration economies and urban capital markets, *Journal of Urban Economics*, 29, 96-112.

Hewings, G.J.D., M. Sonis, J. Guo, P.R. Israilevich, and G.R. Schindler, 1998, The hollowing-out process in the Chicago economy, 1975-2011, *Geographical Analysis* 30, 217-233.

Hewings, G.J.D., Y. Okuyama, and M. Sonis, 1999, *Economic Interdependence within the Chicago Metropolitan Region: A Miyazawa Analysis*, Discussion Paper 99-T-3, Regional Economics Applications Laboratory, University of Illinois, Urbana.

Hoover, E.M., 1971, *An Introduction to Regional Economics*, Knopf, New York.

Kelejian, H.H. and I.R. Prucha, 1998, A generalized spatial two-stage least squares procedure for estimating a spatial autoregressive model with autoregressive disturbances, *Journal of Real Estate Finance and Economics*, 17, 99-121.

Kelejian, H.H. and D.P. Robinson, 1993, A suggested method of estimation for spatial interdependent models with autocorrelated errors, and an application to a county expenditure model, *Papers in Regional Science*, 72, 297-312.

Kim, J. and S. Choe, 1997, *Seoul: The Making of a Metropolis*, John Wiley & Sons, Chichester.

Lee, K.S., 1981, Intra-urban location of manufacturing employment in Colombia, *Journal of Urban Economics*, 9, 222-241.

Maurel, F. and B. Sedillot, 1999, A measure of the geographic concentration in French manufacturing industries, *Regional Science and Urban Economics*, 29, 575-604.

McMillen, D.P. and J.F. McDonald, 1998, Suburban subcenters and employment density in metropolitan Chicago, *Journal of Urban Economics*, 43, 157-180.

Mitra, A., 1999, Agglomeration economies as manifested in technical efficiency at the firm level, *Journal of Urban Economics*, 45, 490-500.

Moomaw, R.L., 1985, Firm location and city size: Reduced productivity advantages as a factor in the decline of manufacturing in urban areas, *Journal of Urban Economics*, 17, 73-89.

Mun, S. and B.G. Hutchinson, 1995, Empirical analysis of office rent and agglomeration economies: A case study of Toronto, *Journal of Regional Science*, 35, 437-455.

Nakamura, R., 1985, Agglomeration economies in urban manufacturing industries: A case of Japanese cities, *Journal of Urban Economics*, 17, 108-124.

Pascal, A.H. and J.J. McCall, 1980, Agglomeration economies, search costs, and industrial location, *Journal of Urban Economics*, 8, 383-388.

Rey, S.J. and M.G. Boarnet, 1998, A taxonomy of spatial econometric models for simultaneous equations systems, *Paper presented in the 45th Annual North American Meetings of the Regional Science Association International*,

Santa Fe.

Smith, Jr., D.F. and R. Florida, 1994, Agglomeration and industrial location: An econometric analysis of Japanese-affiliated manufacturing establishments in automotive-related industries, *Journal of Urban Economics*, 36, 23-41.

Sohn, J. and G.J.D. Hewings, 2000, *Spatial Evidence of Agglomeration Economies in Chicago*, Discussion Paper 00-T-4, Regional Economics Applications Laboratory, University of Illinois, Urbana.

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Appendix: 2SLS and KRP estimator

$$\hat{\theta}_{2SLS} = (z'z)^{-1}z'y_1$$
where
$$\hat{\theta} = [\varphi_0, \cdots, \varphi_9]$$
$$z = [x_1, y_2, y_3, \hat{W}y_1] \qquad \text{(A1)}$$
$$y_2 = py_2, \quad y_3 = py_3 \quad \textit{and} \quad \hat{W}y_1 = pWy_1$$
$$p = x(x'x)^{-1}x' \quad \textit{and} \quad x = [x_1, x_2, x_3]$$

$$\hat{\theta}_{KRP} = (z'z)^{-1}z'y_1$$
where
$$\hat{\theta} = [\varphi_0, \cdots, \varphi_9]$$
$$z = [x_1, y_2, y_3, \hat{W}y_1] \qquad \text{(A2)}$$
$$y_2 = py_2, \quad y_3 = py_3 \quad \textit{and} \quad \hat{W}y_1 = pWy_1$$
$$p = x(x'x)^{-1}x' \quad \textit{and} \quad x = [x_1, x_2, x_3, Wx_1, Wx_2, Wx_3]$$