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ABSTRACT

This study explores the spatial pattern of industry dynamics in the counties in the Nagoya metropolitan area, Japan. The methods of exploratory spatial data analysis (ESDA) are applied to the long-term sustained growth rates of the manufacturing and service sectors. As a methodological contribution, the spatial weight matrix that reflects both geographical and technological proximity between regional industries is introduced into ESDA. Applying the two-dimensional spatial structure allows one to give proper identification to the sectoral composition and geographical bounds of growth clusters. The descriptive results detect the positive multilayered growth clusters with different sectoral compositions and geographical scales.

Keywords: Exploratory spatial data analysis, Dynamic externality, Technological proximity, Growth cluster, Nagoya metropolitan area

JEL classifications: O18, R11, R12, R15

INTRODUCTION

An increasing number of theoretical and empirical studies have found that the external effects of knowledge spillovers resulting from industrial agglomeration drive economic growth in cities and regions. In particular, a large volume of empirical studies triggered by the seminal paper of GLAESER et al. (1992) have investigated the role of these dynamic externalities for a variety of geographical scales and industrial aggregations. Following the attention paid to industrial scope by GLAESER et al. (1992), existing studies have tried to obtain insights into whether specialization (Marshall–Arrow–Romer or MAR externalities) and/or diversity (Jacobs externalities) are/is related to regional growth. ROSENTHAL and STRANGE (2004) and DE GROOT et al. (2009), on the basis of comparative surveys of the empirical literature, report that the evidence as to which type of agglomeration externality is most beneficial for growth is rather mixed and differs across regions, sectors, and the time period.

The purpose of this study, based on the theories of dynamic externalities, is to uncover the spatial pattern of industry dynamics in the county-level regions in the Nagoya metropolitan area (hereafter, the Nagoya MA) over the period 1986–2006, focusing particularly on the importance of spatial proximity in both its geographical and technological aspects. The methods of exploratory spatial data analysis (ESDA) are applied to investigate spatial associations of positive and negative regional industrial growth. Testing industrial growth patterns in the Nagoya MA is of great interest from both an academic and a policy perspective because as this area is one of the world's largest manufacturing centers, the prominent agglomeration of automobile enterprises including TOYOTA Motor Corporation and their related industries can be observed. Based on the Industrial Cluster Project, the Ministry of Economy, Trade and Industry (METI) designated the Nagoya MA as a region to promote effective innovations and new technology in manufacturing industries (METI, 2009). Therefore, there is a high motivation to clarify the diffuse nature of externalities in this area.

ESDA is a collection of techniques to describe and visualize spatial distributions; identify atypical locations or spatial outliers; discover patterns of spatial association, clusters or hot spots; and suggest spatial regimes or other forms of spatial heterogeneity (ANSELIN, 1994). These methods have been applied in a variety of fields of study including economic issues. Among others, LE GALLO and ERTUR (2003), DALL'ERBA (2005), and ERTUR and KOCH (2006) apply these spatial tools to European regional data on per capita GDP and its growth rate and find evidence of global and local spatial autocorrelations as well as spatial heterogeneity. While an industrial perspective is not incorporated into their studies, the recent studies by GUILLAIN and LE GALLO (2010) and DE DOMINICIS et al. (2012) apply similar methods of ESDA to investigate the spatial agglomeration patterns for each industrial sector in Paris and Italy, respectively. Applying ESDA, PATACCHINI and RICE (2007) investigate whether the disparities in economic performance in Great Britain come about through spatial association in occupational composition or productivity. However, as pointed out by GULLAIN and LE GALLO (2010), there is a need for further investigation into the determinants of agglomeration since previous studies only consider the spatial associations among same sectors, but not among different sectors. In existence studies, particularly those based on the ESDA approach, the nature of industry co-agglomeration remains to be fully elucidated.

It is usual in ESDA that, given observations of a region r $(r = 1, \cdots, N_r)$, the proximity among regions is described by the $N_r \times N_r$ spatial weight matrix. In this study, the growth of the industry i $(i = 1, \cdots, N_i)$ in region r is employed as the observations for ESDA and the scale of the spatial weight matrix is extended to $N_r N_i \times N_r N_i$. That is, an extensive spatial weight matrix that reflects not only the geographical proximity but also technological proximities of industrial linkages is put forward. As an indicator of the economic proximity between industries, the *average propagation length* (APL) proposed by DIETZENBACHER et al. (2005) is applied. APL is an index that measures how closely the round flows of intermediate goods between industries arise, and it can be referred to as “economic distance.” There are other simpler measures that indicate the size or the quantity of sectoral linkages, such as the Leontief and Ghosh inverse coefficients applied in the conventional input–output analysis. However, if extensive knowledge spillovers are more likely to occur directly or indirectly in the nearer round in the production chains, the adoption of APL along with the indicators for the size of sectoral linkages would provide more valuable information for testing the relationships among industrial growth due to dynamic externalities.

The paper is organized as follows. The next section presents the study area and the data and identifies the observations on industrial growth for ESDA. The spatial weight matrix used in this study is set out in the subsequent section, and then the empirical results of the spatial associations of industrial growth in the Nagoya MA are presented. In conclusion, the paper gives a summary and then discusses the implications for growth empirics on dynamic externalities.

DATA FOR EXPLORATORY SPATIAL DATA ANALYSIS (ESDA)

Data description

The Nagoya MA is positioned roughly in the center of Japan and extends into three prefectures, Gifu, Aichi, and Mie. This area, with a population of around 11 million on a prefectural basis as of 2010, is the third largest metropolitan area after Tokyo and Osaka.

The data is extracted from the Establishment and Enterprise Census of 1986, 1991, 1996, 1999, 2001, 2004 and 2006, each of which provides information on the number of employees and establishments at both a geographical and an industrial level. As the geographical unit, the counties –*shi*, *ku*, *cho*, and *mura*–, which are less aggregate than the prefectures and the smallest administrative divisions in the Population Census of Japan, are employed. To estimate the observations on industrial growth for ESDA below, the administrative boundaries of the counties surveyed in each year are converted to those in 2006. The geographical coverage of the analysis is based on the *Metropolitan Employment Area* (MEA) developed by KANEMOTO and TOKUOKA (2001). The MEA is defined in terms of population density and commuting flows. This study considers 118 counties of 15 MEAs in Gifu, Aichi, and Mie prefectures. Hereafter, the area covered by these 15 MEAs is called the Nagoya MA, which is illustrated in Fig. 1. The Nagoya MA is also subdivided into 13 districts consisting of counties (see Fig. 1). Usually on the basis of this geographical unit, regional promotion policies such as infrastructure development and attraction of enterprises by both the local and national governments are planned and implemented.

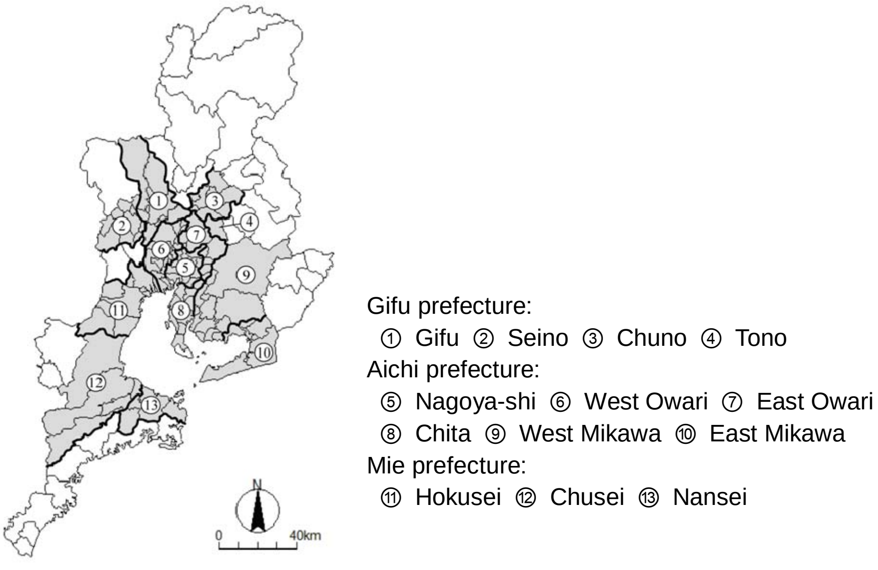


Fig. 1. Study area

Estimates of the observations for ESDA

Since the purpose of our analysis is to investigate the spatial pattern of the long-term dynamics of regional industries, computing ESDA by the average growth rates for the sample period may produce biased results. The results are dependent on the start and end years, which can be at different points in the business cycle (DOWRICK and NGUYEN, 1989; LE GALLO and ERTUR, 2003), and on other temporal effects such as a subsidy policy to attract large enterprises to the region. Further care must be taken to ensure that the results of ESDA are significantly affected by the regional-independent but industry-specific effect on long-term growth, which corresponds to the industry-mix effect of the shift-share analysis.[1] Indeed, a significant tendency for the number of employees in medical, business, and personal services to increase can be observed in most of the counties in the Nagoya MA during the period under study. It is possible that if the industry-mix effects in these service sectors are relatively larger than any productivity effects, ESDA will fail to detect the spatial associations between regional industries related to productivity gains or losses.

To filter any temporal effects and the industry-mix effects out of the actual growth rates, an error-component model that decomposes the growth rates into the contributions specific to regional, industrial, and temporal effects is specified (STOCKMAN, 1988; COSTELLO, 1993; MARIMON and ZILIBOTTI, 1998). The model employed is:

$$\begin{aligned} y(r,i,t) &= comp(r) + comp(i) + comp(r,i) \\ &\quad + comp(t) + comp(i,t) + comp(r,t) + \varepsilon\,(r,i,t) \end{aligned} \tag{1}$$

where:

$y(r,i,t)$: the average annual growth rate of employment in industry i in region r at time period t,

$comp(r)$: time invariant regional trend component that is shared by industry,

$comp(i)$: time invariant sectoral trend component that is shared by all regions,

$comp(r,i)$: time invariant effect that is specific to industry i in region r,

$comp(t)$: a pure time effect,

$comp(i,t)$: the interaction between a fixed industry and time effect,

$comp(r,t)$: the interaction between a fixed region and time effect,

$\varepsilon(r,i,t)$: an idiosyncratic disturbance that is orthogonal to all other effects.

The given dummy structure associated with each component to estimate equation (1) is composed of the terms with perfect collinearlity and is unidentified unless a sufficient number of restrictions are imposed. Here the following restrictions taking the respective sample means as a reference point, instead of a particular region, industry, or year, are imposed (GREEN and SEAKS, 1991; MARIMON and ZILLIBOTTI, 1998):

$$\begin{cases} \sum_r comp(r) = 0, \\ \sum_t comp(t) = 0, \\ \sum_r comp(r,i) = 0, \ \forall i = 1, \cdots N_i \,, \\ \sum_i comp(r,i) = 0, \ \forall r = 1, \cdots N_r \,, \\ \sum_i comp(i,t) = 0, \ \forall t = 1, \cdots N_t \,, \\ \sum_t comp(i,t) = 0, \ \forall i = 1, \cdots N_i \,, \\ \sum_r comp(r,t) = 0, \ \forall t = 1, \cdots N_t \,, \\ \sum_t comp(r,t) = 0, \ \forall r = 1, \cdots N_r. \end{cases} \tag{2}$$

A set of $2N_r + 2N_i + 2N_t + 2$ restrictions, of which all but three restrictions are independent, guarantees the precise identification of equation (1). Furthermore, imposing the above restrictions makes it possible to disentangle the variance of $y(r,i,t)$ on the orthogonal components of each effect.

Note that the largest regional industry in our data—transportation equipment in Toyota-shi—has employment of 65,146, and the smallest—transportation equipment in Higashi-ku—has 1,012 as of 1986. The absolute changes in the growth rates in the small regional sectors tend to be considerably larger than those in the large sectors, and thus result in an inherent heteroskedasticity problem in the OLS estimation of equation (1). To address this issue, the estimation model is weighted with a factor $p(r,i,t)$, which is given by the employment of each regional industry divided by aggregate employment in all industries at time period t. This weight also reflects their respective importance for aggregate employment (SUEDEKUM and BLIEN, 2005). The estimation equation has the following form:

$$\begin{aligned} y^*(r,i,t) &= comp^*(r) + comp^*(i) + comp^*(r,i) \\ &\quad + comp^*(t) + comp^*(i,t) + comp^*(r,t) + \varepsilon^*\,(r,i,t) \end{aligned} \tag{3}$$

where a superscript $*$ over each term represents the component weighted by $p(r,i,t)$.

The weighted long-term growth across regional industries $y^*(r,i)$ is captured by the following components, which are not affected by the industry-mix effect or any time-specific effects:

$$y^*(r,i) = comp^*(r) + comp^*(r,i) \tag{4}$$

The estimated $y^*(r,i)$ is used as the observations for ESDA. Hereafter, $y^*(r,i)$ is denoted by y^* for notational simplicity.

SPATIAL WEIGHT MATRIX

Geographical spatial weight matrix

The geographical spatial weight matrix $\mathbf{W}^{\mathrm{geo}}(d)$ is defined by the elements $w_{ri,sj}^{geo}(d)$ indicating the relationship of geographical proximity between industry i in region r and industry j in region s. The form of the matrix used in this study is the following:

$$\begin{cases} w_{ri,sj}^{geo}(d) = 0 \ \text{ if } ri = sj, \ \text{i.e.}, \mathrm{diag}[\mathbf{W}^{\mathrm{geo}}(d)] = 0 \\ w_{ri,sj}^{geo}(d) = 0 \ \text{ if } r \neq s \text{ and } d_{rs} > d \\ w_{ri,sj}^{geo}(d) = 1/d_{rs} \ \text{ if } r \neq s \text{ and } d_{rs} \leq d \\ w_{ri,sj}^{geo}(d) = 1/0.5d_{rs}^{min} \ \text{ if } r = s \text{ and } i \neq j \end{cases} \qquad (5)$$

The elements are defined on the basis of transportation time by road, d_{rs} (minutes), between the municipal offices of counties r and s. Using the National Integrated Transportation Analysis System developed by the Ministry of Land, Infrastructure, Transport and Tourism, the values of d_{rs} under the road networks in 1991 are measured so that the generalized cost of each connection is at a minimum. A critical cut-off threshold of the geographical distance is denoted by d (minutes). The geographical linkages between industries i and j (with $i \neq j$) within the same county are given by half of the time distance to the nearest neighbor, $0.5d_{rs}^{min}$, as defined by the last equation of (5).

Economic distance between industries

The elements of the technological spatial weight matrix used for ESDA indicate the degree to which industries i and j (including with the case of $i = j$) are closely connected. It is natural to refer to this as the "economic distance" between two sectors. In this study, the proximity of economic distance is measured by using the average propagation lengths (APLs) developed by DIETZENBACHER et al. (2005). As is well known in the literature on the input–output analysis, the Leontief inverse matrix with endogenized imports, say $\mathbf{L}$, can be extended to a power series under the common assumptions for solvability:

$$\mathbf{L} = \mathbf{I} + (\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A} + \{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^2 + \{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^3 + \cdots \qquad (6)$$

where $\mathbf{I}$ denotes the identity matrix, and $\mathbf{A}$ denotes the input coefficient matrix composed of the elements $a_{ij} = x_{ij}/x_j$ where x_{ij} gives the intermediate deliveries from industry i to j, and x_j gives the total input in industry j. The import coefficient matrix $\widehat{\mathbf{M}}$ has the diagonal elements m_i, which give the import share of the domestic products in industry i.

The element (i, j) of the LHS in equation (6) after neglecting the initial exogenous injections is expressed as:

$$l_{ij} - \delta_{ij} = (1 - m_i)a_{ij} + [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^2]_{ij} + [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^3\}]_{ij} + \cdots \tag{7}$$

where l_{ij} gives the element of $\mathbf{L}$, and δ_{ij} gives the Kronecker delta (i.e., $\delta_{ij} = 1$ if $i = j$, and 0 otherwise). $[\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^k]_{ij}$ denotes the element (i, j) of matrix $\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^k$. The first term of the RHS in equation (7) expresses the direct requirement of intermediate inputs in industry i due to a one-unit increase in the exogenous demand of industry j (the 1st round effect). The second term shows the intermediate requirement in industry i for the products throughout industries directly caused by a one-unit increase in the exogenous demand of industry j (the 2nd round effect). The third term shows an indirect requirement in industry i via two industries (the 3rd round effect). And so forth.

Using the share of the total effect that requires k rounds as a weight, the APL is defined as the average number of rounds in industry i required for a demand-pull in industry j as follows:

$$apl_{ij} = [1 \cdot (1 - m_i)a_{ij} + 2 \cdot [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^2\}]_{ij} + 3 \cdot [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^3\}]_{ij} + \cdots]/(l_{ij} - \delta_{ij}) \tag{8}$$

The smaller (larger) value of apl_{ij} implies that the required intermediates in industry i due to demand in industry j tend to occur in earlier rounds (later rounds); thus, the economic distance between industries i and j can be interpreted as close (distant).

In the matrix notation, equation (8) is expressed as:

$$\mathbf{APL} = [1 \cdot (\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A} + 2 \cdot \{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^2 + 3 \cdot \{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^3 + \cdots]./(\mathbf{L} - \mathbf{I}) \tag{9}$$

where "./" represents the element-by-element division. Let the numerator of the RHS of equation (9) be denoted by $\mathbf{H}(\mathbf{A})$. Then, $\mathbf{H}(\mathbf{A})$ is easily calculated by:

$$\mathbf{H}\,(\mathbf{A}) \equiv \textstyle\sum_k^{\infty} k \cdot \{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{A}\}^k = \mathbf{L}(\mathbf{L} - \mathbf{I}) \tag{10}$$

Similarly, the APL can also be defined from the cost-push direction. Let the output coefficient be denoted by $\mathbf{B}$ composed of the elements $b_{ij} = x_{ij}/x_i$ and the Ghosh inverse matrix by $\mathbf{G} = \{\mathbf{I} - (\mathbf{I} - \widehat{\mathbf{M}})\mathbf{B}\}^{-1}$. The APL for a cost-push is expressed as:

$$apl_{ij} = [1 \cdot (1 - m_i)b_{ij} + 2 \cdot [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{B}\}^2]_{ij} + 3 \cdot [\{(\mathbf{I} - \widehat{\mathbf{M}})\mathbf{B}\}^3]_{ij} + \cdots]/(g_{ij} - \delta_{ij}) \tag{11}$$

It is immediately clear that the expression for the APL in equation (8) is equal to that in equation (11).[2] This result is in line with the intuition that the average number of forward steps required to get from industry i to j would be equal to the average number of backward steps required to get from j to i (DIETZENBACHER et al., 2005).

For empirical analysis, the APLs between 31 industries are measured by using the input–output table of the Chubu region for 1990 developed by the Chubu Bureau of Economy, Trade and Industry. While the Chubu region is composed of five prefectures including Gifu, Aichi, and Mie and has a broader geographical coverage than the Nagoya MA, among the available regional tables it most closely matches the area this study is concerned with.[3]

Technological spatial weight matrix

Before applying the APLs to the elements of the technological spatial weight matrix, two points should be noted. First, it seems obvious to take APLs into consideration only in those cases in which the size of the linkage is sufficiently large (DIETZENBACHER et al., 2005). Therefore, based on a threshold value f of the size of the linkage, only values of APLs for industries with a substantial size of linkage are applied to the technological spatial weight. In line with the fact that the APLs are capable of two interpretations, a demand-pull or a cost-push, the size of the linkages is measured by taking both directions into account. Following DIETZENBACHER et al. (2005), the sizes of the linkages are given by the matrix $\mathbf{F}$ with the elements f_{ij}, defined as the average of the backward effect of a demand-pull and the forward effect of a cost-push:

$$\mathbf{F} = 0.5 \times \{(\mathbf{L} - \mathbf{I}) + (\mathbf{G} - \mathbf{I})\}. \tag{12}$$

As a part of the obtained results, the size and the economic distance of the linkage related to transportation equipment are shown in Fig. 2.

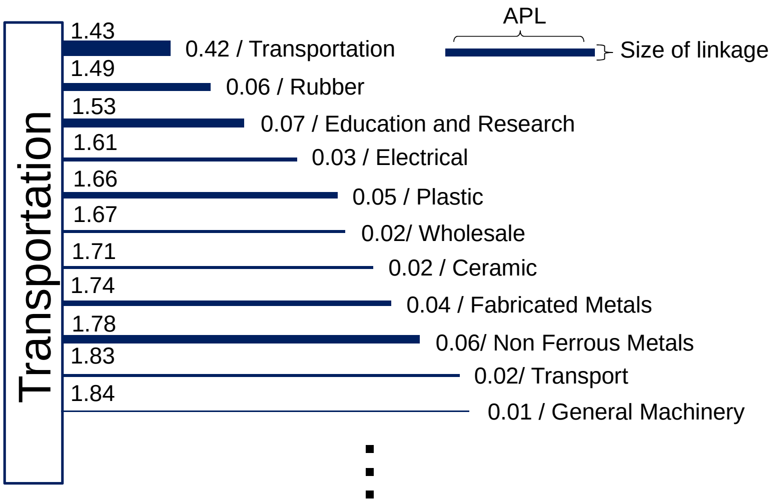


Fig. 2. Size and economic distance related to transportation equipment

Second, the values of apl_{ij} and apl_{ji} are usually not equivalent. In case of $apl_{ij} \gg apl_{ji}$, while the value of apl_{ij} shows that the economic distance from industry j to i is distant in terms of the backward direction, the value of apl_{ji} shows that the distance from j to i comes close in terms of the forward direction. However, the element (i, j) of the spatial weight matrix does not identify those directions of proximity. Therefore, the economic distance between industries i and j is given by the average of apl_{ij} and apl_{ji}, each of which is weighted by the respective size of the linkage defined by equation

(12):

$$\overline{apl}_{ij} = \overline{apl}_{ji} = (f_{ij} \cdot apl_{ij} + f_{ji} \cdot apl_{ji})/(f_{ij} + f_{ji}). \tag{13}$$

The elements of the technological spatial weight matrix used in this study take the gravity form expressed by economic distance between sectors as well as their size of linkage:

$$\begin{cases} w_{ri,sj}^{tech}(f, apl) = 0 & \text{if } ri = sj, \text{ i.e., } \mathrm{diag}\left[\mathbf{W}^{\mathrm{tech}}(f, apl)\right] = 0 \\ w_{ri,sj}^{tech}(f, apl) = 0 & \text{if } ri \neq sj \text{ and } \bar{f} = \left\{0.5 \times \left(f_{ij} + f_{ji}\right)\right\} < f,\ \forall i, j \\ w_{ri,sj}^{tech}(f, apl) = \bar{f}/\overline{apl}_{ij} & \text{if } ri \neq sj \text{ and } \bar{f} = \left\{0.5 \times \left(f_{ij} + f_{ji}\right)\right\} \geq f,\ \forall i, j \end{cases} \tag{14}$$

where $\mathbf{W}^{\mathrm{tech}}(f, apl)$ denotes the technological spatial weight matrix with the elements $w_{ri,sj}^{tech}(f, apl)$, which represents the technological proximity between industry i in region r and industry j in region s. The critical cut-off thresholds of the size of the linkage between industries are denoted by f.[4]

Extensive spatial weight matrix

The extensive spatial weight matrix $\mathbf{W}(d, f, apl)$ accounting for both geographical and technological proximities is developed. The elements of the matrix are defined as the product of the geographical weight and the technological weight as follows:

$$w_{ri,sj}(d, f, apl) = w_{ri,sj}^{geo}(d) \times w_{ri,sj}^{tech}(f, apl) \tag{15}$$

where $w_{ri,sj}(d, f, apl)$ denotes the element of the extensive spatial weight matrix. The RHS of equation (15) indicates the way in which the extensive spatial weight establishes no relationship between industry i in region r and industry j in region s, where a substantial economic linkage in terms of the size or the distance is not confirmed, even if region r is geographically close to region s. In an analogous way, industry i in region r has no relationship with industry j in geographically distant region s from region r, even if industry i is technologically proximate to industry j.

Converting the matrix $\mathbf{W}(d, f, apl)$ to have row sums of unity, the standardized extensive spatial weight matrix $\mathbf{W}^{*}(d, f, apl)$ is obtained. In order to implement ESDA, the values of the respective cut-off thresholds, d on geographical distance and f on the size of inter-industrial linkage, need to be chosen. The following empirical results is based on the thresholds d=40 and f=0.01, unless otherwise noted.[5]

ESDA ON INDUSTRIAL GROWTH, 1986–2006

Global spatial association

The global spatial association for the adjusted long-term industrial growth is captured by examining Moran's I statistics. Formally, using the row-standardized extensive spatial weight, the usual formulation of the Moran's I is extended to the following:

$$I(d,f,apl)=\frac{\sum_r\sum_i\sum_s\sum_j[w^*_{ri,sj}(d,f,apl)](y^*_{ri}-\overline{y^*})(y^*_{sj}-\overline{y^*})}{\sum_r\sum_i(y^*_{ri}-\overline{y^*})} \tag{16}$$

where $w^*_{ri,sj}(d,f,apl)$ denotes the element of the extensive spatial weight matrix after the row is standardized. A value of I larger (smaller) than the expected value, $\mathrm{E}(I)=-1/(N_rN_i-1)$, indicates a positive (negative) spatial autocorrelation and that the variable of interest tends to be distributed in positive or negative clusters (a checker board pattern).[6] A value close to the expected value indicates no proof of the presence of spatial correlation. Under the usual assumption of randomization (CLIFF and ORD, 1981) statistical inference can be based on a permutation approach. The empirical distribution function and the pseudo-significance levels are derived through the 9,999 permutations.

The standardized value of Moran's I statistics for the adjusted long-term growth rates for the 777 industries in the Nagoya MA is 6.97. The result indicates a positive global spatial autocorrelation since the null of spatial independence is rejected with a pseudo-p-value of 0.0004. When calculating Moran's I on the basis of only on the geographical weight, by which, regardless of any technological linkages, each industry is connected to all industries located within a cut-off threshold time distance (40 minutes in this case), the standardized value of the statistics represents 9.87 with a pseudo-p-value of 0.0001. Both of these results showing a significant global spatial autocorrelation add emphasis to the importance of at least geographical proximity for proper understanding of the dependence among industrial growth in the Nagoya MA.

Moran scatterplot

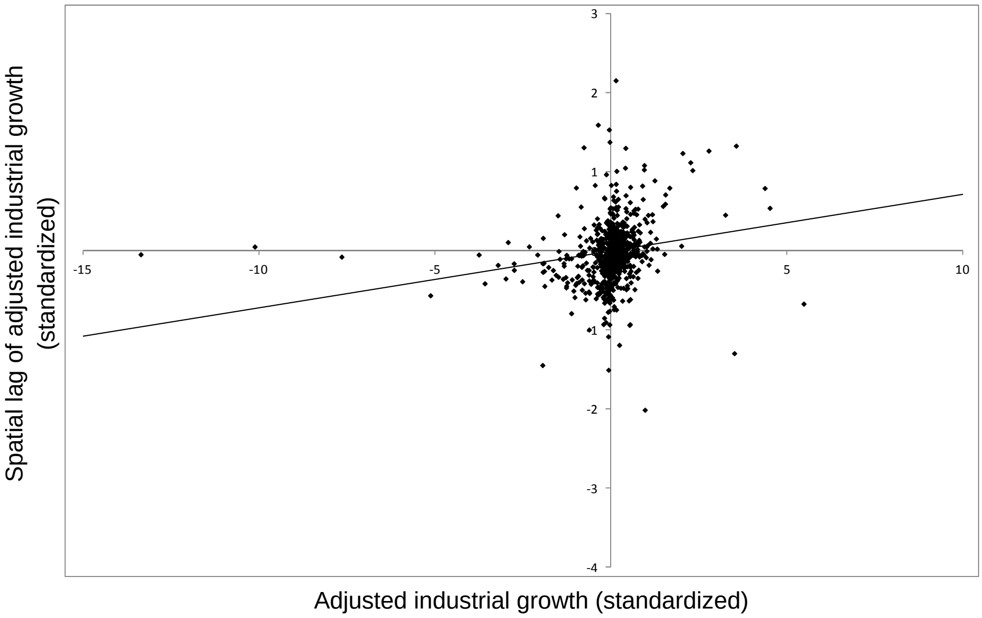
Moran's I statistic is a global measurement, but it does not make it possible to establish the local structure of spatial autocorrelation. To visually identify local clusters or local spatial instability, the Moran scatterplot suggested by ANSELIN (1996) is useful. When the standardized values of the adjusted long-term growth rates of the regional industries are plotted on the horizontal axis against its standardized spatial-weighted average, the so-called spatial lag, on the vertical axis, the scatterplot can be classified into four quadrants. Expressing the growth rates in standardized form allows the slope of the linear regression line fitted to the plots to be the value of Moran's I. As for the interpretations of the plotted observations, quadrant I (III) shows the regional industries with growth above (below) the mean accompanied by the geographical and technological neighbors with growth above (below) the mean. This quadrant is usually denoted as HH (LL). Quadrant II (IV) shows the regional industries with growth below (above) the mean accompanied by the neighbors with growth above (below) the mean, and it is denoted as LH (HL).

Fig. 3(a) displays the Moran scatterplot based on the extensive spatial weight matrix. The result indicates that 31.9% of regional industries belong to quadrant HH, 27.0% to LL, 13.6% to LH, and 27.4% to HL. Only about half (58.9%) of the industries are characterized by positive spatial association. However, it shows that more than a few industries belonging to HH or LL occur in the area away from the origin, and these industries have a remarkable tendency of positive spatial autocorrelation. Moreover, some atypical HL relationships should not be ignored.

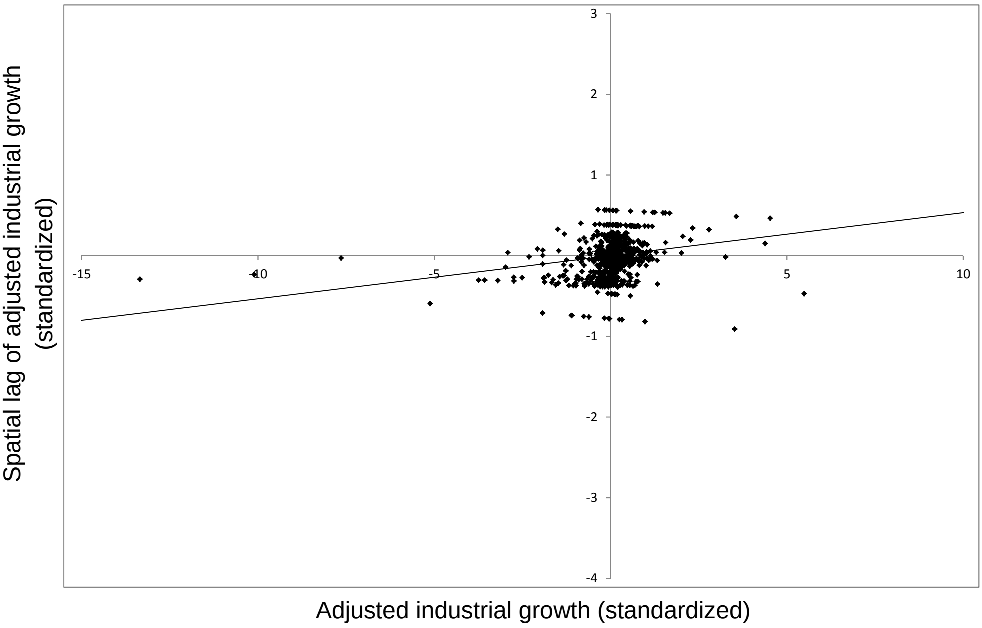
It is prominent that among the HH industries transportation equipment in the West and East Mikawa districts (the eastern area of the Nagoya MA, see Fig. 1) is plotted depart from the origin. Transport, wholesale, and business services in these districts are also remarkable. In particular, a variety of industries including transportation in Toyota-shi (belonging to West Mikawa), where the headquarters of TOYOTA Motor Corporation is located, are shown in the upper right of the scatterplot. In quadrant HH, some industries in Okazaki-shi and Anjyo-shi, which are the neighbors of Toyota-shi, can also be observed. In the West and East Mikawa districts, a number of the *keiretsu* firms related to the automobile industry are located. This result suggests that positive growth clusters driven by the automobile-related industries would be formed in these districts.

In contrast, the industries in quadrant LL can be mainly found in Nagoya-shi (the center of the Nagoya MA, see Fig. 1), which is composed of 16 *ku* (wards) and serves as the central business district (CBD) of the Nagoya MA. The industries that are distant from the origin are information, business, and personal services rather than manufacturing. Despite the prefectural capital of Aichi and the center of politics and business in the Nagoya MA, there may be negative growth clusters of services in this region.

However, some exceptions are observed in the core of this LL cluster; that is, real estate and business services in Naka-ku and business services in Nakamura-ku are classified into the lower right of quadrant HL. The counties located around the core or on the fringe of Nagoya-shi also have other services as well as some manufacturing classified into HL. These results reveal the locational dynamics of industries within the CBD, which shows a tendency for only business services and real estate to concentrate in the core region, whereas the other industries including manufacturing move away to the fringe of the CBD.



(a) Spatial lag calculated using the extensive spatial matrix



(b) Spatial lag calculated using the geographical spatial matrix

Fig. 3. Moran scatterplot for adjusted industrial growth in the Nagoya metropolitan area

Fig. 3(b) displays the Moran scatterplot replacing the spatial lags calculated by the extensive spatial weight matrix with those employing the geographical spatial weight matrix normally used in literature. Compared to Fig. 3(a), only 2.5% (1.0%) of industries classified into HH (LH) move to HL (LL). A more striking feature from the comparison of the two figures is that many more regional industries in Fig. 3(a) are plotted away from the origin on the vertical direction than those in Fig. 3(b). This result shows that although only a small number of industries are reclassified into the different quadrants, the Moran scatterplot based only on geographical proximity may be more conservative in evaluating the magnitude and intensity of positive and negative clusters than those also accounting for the technological proximity of linkages across industries.

Local spatial association

In this sub-section, a more detailed statistical analysis of local spatial association focusing on a specific regional industry and its proximity industries is conducted. One of the local spatial statistics allowing for tests of a hypothesis about the spatial dependence of the variable concerned is the local Moran, which is a kind of local indicator of spatial association (LISA) defined by ANSELIN (1995). It corresponds to the local version of Moran's *I*. In this study, the local Moran of the adjusted long-term growth of industry i in region r is specified as follows:

$$I_{ri}\left(d,f,\overline{apl}\right) = \frac{y^*_{ri} - \overline{y^*}}{m_2} \sum_{s} \sum_{j} [\, w^*_{ri,sj}(d,f,apl)](y^*_{sj} - \overline{y^*}) \tag{17}$$

where:

$$m_2 = \sum_{r} \sum_{i} \frac{(y^*_{ri} - \overline{y^*})^2}{N_r N_i}$$

Note that the interpretation of a positive (negative) value of the local Moran indicates positive (negative) spatial autocorrelation or spatial similarities (dissimilarities), as in the interpretation of the global Moran's *I*. Combining the information obtained from the Moran scatterplot and the value of the local Moran, it can be assessed whether each industry classified into any of the four quadrants is significantly associated with geographical and technological proximate industries.

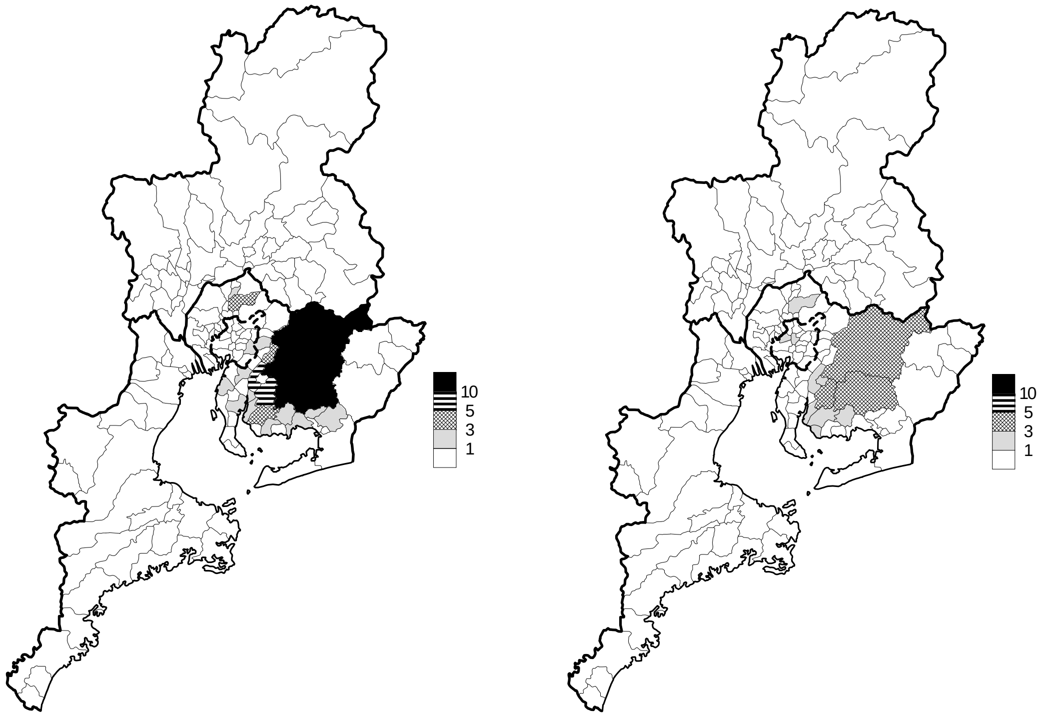
Two issues are raised when implementing statistical inferences. First, for the distribution of the local Moran, an approximation of the null distribution by a normal may not be an appropriate approach, especially in the case where global spatial autocorrelation is present (ANSELIN, 1995). To deal with this issue, the empirical distribution function is derived through 9,999 conditional permutations for each of the local Moran statistics.[7]

The second issue is that inference is complicated by the fact that when the neighborhood sets of two locations contain common elements, the corresponding local statistics will be correlated (GETIS and ORD, 1992; ORD and GETIS, 1995; ANSELIN, 1995). In the presence of the associated problem of multiple comparisons, the significant levels must be approximated by α/m (Bonferroni), where α is the overall significance level and m is the number of comparisons.[8] Note that the use of Bonferroni bounds may be overly conservative with $m = N_r N_i$. Following the ESDA literature, m is set to be k, where k is chosen as the maximum number of common elements such that any two given regional industries in the sample data cannot have more than k common geographical and technological neighbors.

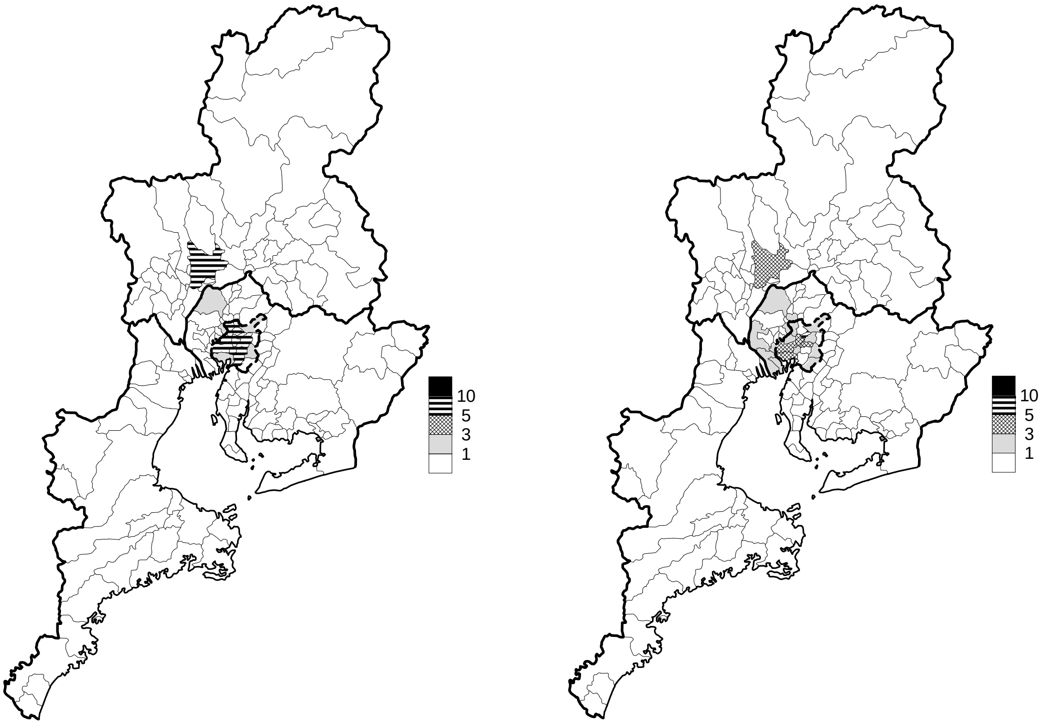
The results for industrial growth are shown from the third to sixth columns of Table 1, which shows the number of industries judged to be significantly correlated with the proximate industries. For the Nagoya MA as a whole, 209 industries (26.9% of the total sample) are significant at the 5% pseudo-significance level. Among these statistics, 68 industries (8.8%) are classified into a spatial association of the type HH and 81 industries (10.4%) are classified into LL; then 19.2% of regional industries exhibit significant positive spatial association. On the other hand, 60 industries (7.7%) exhibit significant negative spatial association; 40 industries (5.1%) are classified into HL and 20 industries (2.6%) into LH. Adopting the Bonferroni criteria, 27 industries (3.5%) (shown in parentheses in Table 1) remain statistically significant; most of them (21 industries) are characterized by HH, and 3 industries belonging to LL, 2 industries to HL, and 1 industry to LH are also detected. These results reconfirm that industrial growth in the Nagoya MA globally tends to have the relative trend of positive spatial association with their geographically and technologically proximate industries.

(Table 1 around here)

The significant industries with respect to the type HH are dominated by those located in the West Mikawa district. They account for 83.8% (100%) of the significant HH industries at the 5% (the Bonferroni 5%) significance level. To deepen insight into the geographical patterns of industry dynamics, the results of the local spatial statistics are visualized on maps, where each county is categorized by the use of a color code according to the number of local spatial statistics judged to be significant at the 5% level. Fig. 4(a) displays the significant statistics belonging to HH. It unveils that a positive growth cluster is formed in West Mikawa and extends to some counties in East Mikawa, East Owari and Chita, which are neighboring districts of West Mikawa. There are some significant industries characterized by the type LH, which seem to have locational distribution similar to that of the significant HH industries but the number of significant industries is lower (Fig. 4(b)). Focusing particularly on the location of the significant HH industries, the dark-shaded counties on the map are Okazaki-shi and



(a) Number of significant HH industries (b) Number of significant LH industries



(c) Number of significant LL industries (d) Number of significant HL industries

Fig. 4. Number of significant local Moran statistics for regional industrial growth in the Nagoya metropolitan area (d=40)

Toyota-shi, which are made up of 15 and 14 of the significant industries, respectively.[9]

All counties within this positive growth cluster contain transportation equipment as a significant HH industry and their values of the local Moran statistic are substantial. This result reconfirms with statistical significance that the positive growth clusters driven by automobile and the associated industries are formed in this area. Note that this cluster, especially the core of the cluster, is composed of not only manufacturing but also of service sectors. This fact seems to support the hypothesis on dynamic externalities suggested by Jacobs, which is that variety and diversity of geographically proximate industries leading to cross-sectoral spillovers would act as a driving force for regional growth. Further consideration of this implication shall be provided in the next sub-section by paying careful attention to the size of growth clusters.

In regard to the significant industries belonging to the type LL, 87.7% (100%) of those at the 5% (the Bonferroni 5%) significance level are in Nagoya-shi. It can be confirmed from Fig. 4(c), which shows the number of the significant statistics belonging to LL, that a geographical pattern of a negative growth cluster is mainly formed in Nagoya-shi. Every ward in Nagoya-shi, except the two eastern wards, contains the industries characterized by LL, which are composed of manufacturing and service sectors. Gifu-shi, the prefectural capital of Gifu, has an industrial structure similar to that of Nagoya-shi, and therefore, it is also represented by the LL-type industries.

The significant regional industries that are perceived as more dynamic than their geographically and technologically proximate industries (HL) are mainly detected in Nagoya-shi and West Owari (Table 1). They account for 75.0% (100%) and 17.5% (0%) of the significant HL industries at the 5% (the Bonferroni 5%) significance level. The comparison between Figs 4(c) and 4(d) would indicate that the locations of the significant HL industries are interwoven with those of the significant LL industries. However, it can be confirmed the way that the significant HL industries composed of manufacturing and services seem to extend over the fringe and the west side of Nagoya-shi in relation to the locational distribution of the significant LL industries. This result offers statistical reliability for the implication of locational dynamics within and around the CBD, which is obtained by the analysis of the Moran scatterplot.

The local Moran statistics for industrial growth in the Nagoya MA based on the geographical spatial weight matrix are also derived. The number of significant statistics is shown in the seventh to tenth columns of Table 1. The locational tendency of the industrial growth patterns appears similar to the result obtained by the use of the extensive spatial weights. It should be noted, however, that more significant statistics for the HH- and LH-type industries in West Mikawa and for the LL- and HL-type industries in Nagoya-shi can be confirmed. This may imply that the result of the significant industries that dominate each of the four types of local spatial association is too liberal and may be overestimated if any technological proximity among industries is not reflected in the analysis.

Another point that the result reveals is that for the industries with substantial local Moran value based on the extensive spatial weights, the values of the statistics become lower when only considering geographical proximity. This is particularly the case for transportation equipment belonging to the HH-type cluster. For instance, transportation equipment in Toyota-shi (located in West Mikawa) represents a value of 4.75 when the extensive weights are considered, whereas it is 1.73 when only the geographical weights are considered (Table A2 in Appendix). This may suggest that the intensity of the local sectoral associations at the core of the positive growth clusters would be underestimated unless the technological proximity among sectors is considered. This fact is consistent with the remarks obtained through the analysis of the Moran scatterplot.

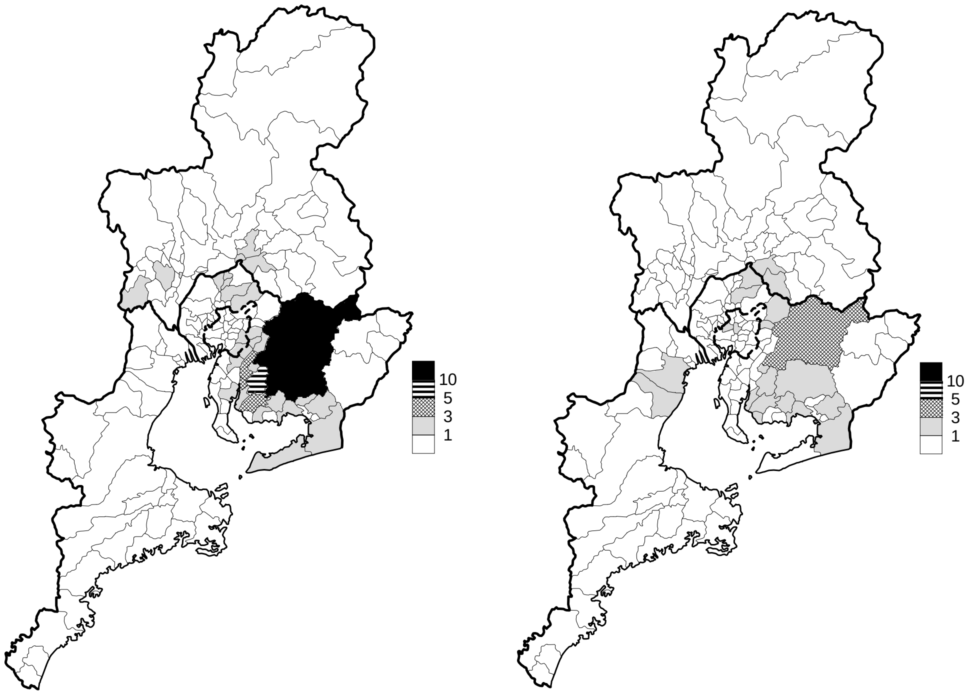
Clusters with different geographical scales

In order to conduct a further inspection of whether local spatial associations with different geographical scales from those shown in Fig. 4 are detected, the local spatial statistics using various values of the cut-off thresholds of geographical distance are derived. The result based on a threshold value of d=120 is shown from the third to sixth columns of Table 2.[10] For the Nagoya MA as a whole, 220 (22) industries are significant at the 5% (the Bonferroni 5%) significance level.[11] Among them, 70 (16) industries are characterized by the type HH, 83 (1) by LL, 42 (3) by HL, and 25 (2) by LH at the 5% (the Bonferroni 5%) significance level.

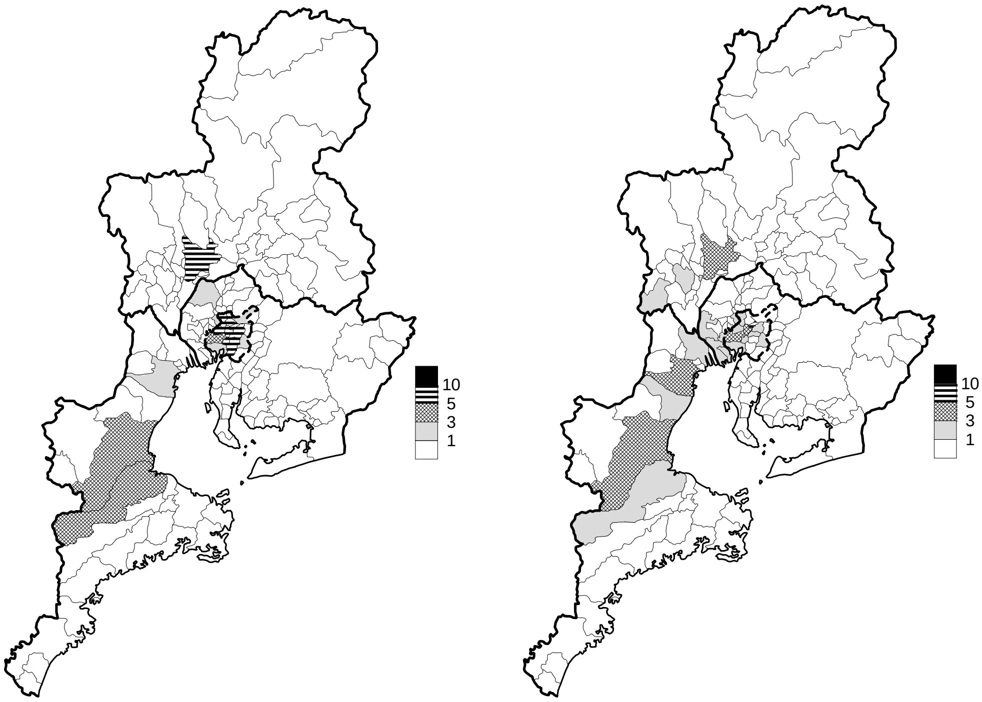
(Table 2 around here)

The significant industries classified into the type HH are not only observed in West Mikawa (accounting for 62.9% of the 5% significant HH industries) but also in the other seven districts (accounting for 37.1%). Even adopting the Bonferroni criteria, these HH industries still remain significant in West Mikawa as well as in its neighboring district, East Mikawa. Fig. 5(a) illustrates the number of HH industries of the 5% significance. The figure indicates that a positive growth cluster covers a broader area.

Another interesting finding is that although the core of this positive growth cluster remains to be formed by diversified industries, including services, the significant HH industries in the periphery of this cluster have less variety; most of them are



(a) Number of significant HH industries (b) Number of significant LH industries



(c) Number of significant LL industries (d) Number of significant HL industries

Fig. 5. Number of significant local Moran statistics for regional industrial growth in the Nagoya metropolitan area (d=120)

transportation equipment and the others are a few industries technologically proximate to transportation, such as wholesale.[12] In other words, the positive growth cluster composed mainly of a single industry (transportation) tends to be distributed over a relatively larger area. This fact seems to support the hypothesis on dynamic externalities suggested by Marshall–Arrow–Romer, which is that industrial specialization leading to spillovers within the industry would act as a driving force for regional growth.

It can be observed from Fig. 5(c) that the significant LL industries follow the analogous locational tendency of the result shown in Fig. 4(c). However, the significant HL industries spread to more distant districts from each prefectural capital, Nagoya-shi and Gifu-shi (Fig. 5(d)). Both the significant LL and HL industries are also found in the relatively densely inhabited counties in Mie prefecture. This may suggest that the more widespread negative growth clusters would be present in the CBD of the Nagoya MA (Nagoya-shi) as well as the counties classified into the second hierarchical regional centers (Gifu and Chusei).

The number of significant local Moran statistics based only on the geographical spatial weights for each district is shown from the seventh to tenth columns of Table 2. In spite of the statistics being based on the more distant threshold value, the result is rarely different from that shown in Table 1. Therefore, the implications obtained above hold also for this case; industries located at the core of the positive and negative growth clusters (West Mikawa and Nagoya-shi, respectively) would be overly judged to have significant local intersectoral associations, whereas the intensity of those associations would be underestimated unless any technological proximity among industries is taken into account. It should also be noted from the comparison between the results in the presence and absence of technological proximity that only taking account of geographical proximity would fail to detect the significant spatial associations around the center of growth clusters. These findings point out that the aspect of technological proximity should be incorporated into analysis in order to properly detect the sectoral composition and the geographical bounds of growth clusters.

CONCLUSION

This study explores the spatial associations between industry dynamics in county-level regions in the Nagoya metropolitan area (the Nagoya MA) during the period 1986–2006. The methods of exploratory spatial data analysis (ESDA) are applied to investigate spatial growth clusters of manufacturing and service industries. To detect industrial growth clusters or dissimilarities, the geographical spatial matrix normally applied in the spatial literature is extended to the matrix by considering the "economic distance" or technological proximity of industrial linkages as well. This methodologically contributes to the empirical literature investigating spatial associations of industries or firms by incorporating the mechanism of knowledge flows through intra- and inter-sectoral linkages.

The results of the global spatial statistics identify a significant positive growth association between industries in the Nagoya MA. The local indicator of spatial association shows that a geographical pattern of a positive growth cluster is mainly formed in the West Mikawa district, whereas a negative growth cluster is mainly formed in Nagoya-shi, the CBD of the Nagoya MA.

In particular, the results reveal the presence of positive multilayered growth clusters with different industrial compositions and geographical scales; the large positive growth cluster mainly composed of transportation equipment encompasses the small positive growth cluster composed of the diverse manufacturing and service sectors. This scenario seems to support the hypothesis on dynamic externalities, that is, industrial specialization would act as the driving force for growth in a relatively broad area, whereas industrial diversity would promote innovation and growth in a relatively small area. In other words, it is suggested that Jacobs externalities could decrease more drastically with an increase in geographical distance than MAR externalities.

The findings also point out that considerable information about both geographical and technological spatial structures would be required for proper identification of the sectoral composition and the geographical bounds of growth clusters. On the basis of the results suggested by ESDA, further econometric analyses exploring the factors or circumstances related to industrial growth in the Nagoya MA will be elaborated in future. Then, it is obvious that a greater emphasis must be placed on introducing technological proximity as well as geographical proximity into the econometric models for establishing more reliable statistical inferences.

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NOTES

1. The industry-mix effect represents the positive and negative effects of the specialization of the regional employment in sectors in which the rate of growth at the national level (or the entire area the study focuses on) is more or less fast (DUNN, 1960; ESTEBAN, 1972).
2. The proof is shown in DIETZENBACHER et al. (2005).
3. The number of employees in the Nagoya MA accounts for 74% of that in the Chubu region as of 1986.
4. On the condition for the size of the linkage in the definition of the technological weight, some alternatives are also considered. But the final results are not significantly changed regarding the choice of the conditions.
5. The benchmark values of the thresholds are explored by specifying the following first-order spatial autoregressive (FAR) model so that the estimated value of the maximum likelihood becomes larger and the test statistic of the estimated parameter ρ is significant.

   $$\mathbf{y}^* = \rho\mathbf{W}^*(d, f, apl)\mathbf{y}^* + \boldsymbol{\varepsilon}, \quad \boldsymbol{\varepsilon} \sim N(\mathbf{0}, \sigma^2\mathbf{I})$$

   where $\mathbf{y}^*$, expressed as deviations from the mean, is the vector of the adjusted long-term average growth rates for the regional industries estimated by equation (4), and $\boldsymbol{\varepsilon}$ is a random component.
6. In this study 'cluster' is the term designated as an agglomeration of industries with relatively substantial positive (negative) adjusted employment growth rates.
7. The permutation is 'conditional' in the sense that the value y^*_{ri} is maintained constant and the remaining values are randomly permutated over the geographical and technological locations.
8. ORD and GETIS (1995) and ANSELIN (1995) also suggest the Sidák correction of individual significant levels. However, this approach only holds for the variable to be multivariate normal.
9. Only the values of significant local Moran statistics for the counties considered as the centers of the growth clusters (two wards in Nagoya-shi and two counties in West Mikawa) are shown in Table A2 in Appendix because of space constraints for this paper. But the complete results are available from the authors upon request.
10. The results based on a threshold value of d=120 is reported since the estimation result of the FAR model specified in the endnote 5 indicates a relatively larger value of the maximum likelihood than those based on the other thresholds around d=120. An analogous value of the threshold on the size of the linkage is used as before, i.e.,

f=0.01.

11. The complete results of the values of the local Moran are available from the authors upon request.
12. Based on the Bonferroni bound, even in the core of the positive growth cluster, only transportation and its technologically proximate industries are judged to be significant and most of the services are not significant.

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Table. 1. *Number of significant local Moran statistics for the 13 districts in the Nagoya metropolitan area (d=40)*

Code	District	Number of significant statistics based on the extensive spatial weights				Number of significant statistics based on the geographical spatial weights			
		HH	LH	LL	HL	HH	LH	LL	HL
1	Gifu			8	3				
2	Seino								
3	Chuno						1		
4	Tono					3	3		
5	Nagoya-shi	1	2	71 (3)	30 (2)			122 (17)	62 (9)
6	West Owari	1		1	7			10 (2)	19 (2)
7	East Owari	4	1	1					
8	Chita	2							
9	West Mikawa	57 (21)	17 (1)			86 (45)	25 (12)		
10	East Mikawa	3							
11	Hokusei								
12	Chusei								
13	Nansei								
	Total	68 (21)	20 (1)	81 (3)	40 (2)	89 (45)	29 (12)	132 (19)	81 (11)

Note: The cord number for identifying the location of the districts corresponds to that in Fig. 1. The values in parentheses show the number of significant statistics at the 5% Bonferroni pseudo-significance level.

Table. 2. *Number of significant local Moran statistics for the 13 districts in the Nagoya metropolitan area (d=120)*

Code	District	Number of significant statistics based on the extensive spatial weights				Number of significant statistics based on the geographical spatial weights			
		HH	LH	LL	HL	HH	LH	LL	HL
1	Gifu			8	3			5	10
2	Seino	1			1				
3	Chuno	4	1						
4	Tono		1						
5	Nagoya-shi	2	2	65 (1)	23 (3)			120 (8)	54 (4)
6	West Owari	3		2	5			8	14 (1)
7	East Owari	7	4						
8	Chita	3							
9	West Mikawa	44 (12)	12 (2)			84 (32)	25 (8)		
10	East Mikawa	6 (4)	3			6 (2)	5 (1)		
11	Hokusei		2	1	6			1	2
12	Chusei			7	4				1
13	Nansei								
	Total	70 (16)	25 (2)	83 (1)	42 (3)	90 (34)	30 (9)	134 (8)	81 (5)

Note: The cord number for identifying the location of the districts corresponds to that in Fig. 1. The values in parentheses show the number of significant statistics at the 5% Bonferroni pseudo-significance level.

APPENDIX: ADDITIONAL TABLES

Table A1. *List of industries and the corresponding industry classifications*

JSIC code	Industries based on Japan Standard Industrial Classification (JSIC)	Industries based on the classification of the input–output table of the Chubu region
E	Construction	Construction
F-12	Manufacture of food	Food
F-13	Manufacture of beverages, tobacco, and feed	
F-14	Manufacture of textile mill products	Textile
F-15	Manufacture of apparel and other finished products	
F-16	Manufacture of lumber and wood products	Lumber
F-17	Manufacture of furniture and fixtures	Furniture
F-18	Manufacture of pulp, paper, and paper products	Pulp and paper
F-19	Printing and allied industries	Printing
F-20	Manufacture of chemical and allied products	Chemical
F-21	Manufacture of petroleum and coal products	Petroleum and coal
F-22	Manufacture of plastic products	Plastic
F-23	Manufacture of rubber products	Rubber
F-24	Manufacture of leather tanning, leather products	Leather
F-25	Manufacture of ceramic, stone, and clay products	Ceramic
F-26	Manufacture of iron and steel	Iron and steel
F-27	Manufacture of non-ferrous metals and products	Non-ferrous metals
F-28	Manufacture of fabricated metal	Fabricated metal
F-29	Manufacture of general machinery	General machinery
F-30	Manufacture of electrical machinery	Electrical
F-31	Manufacture of transportation equipment	Transportation
F-32	Manufacture of precision instruments and	Precision
G	Electricity, gas, heat supply, and water	Utilities
H	Transport	Transport
I	Wholesale and retail trade	Wholesale and retail
J	Finance and insurance	Finance and insurance
K	Real estate	Real estate
L	Services	Information and communications Education and research Medical, health care and welfare Business services Personal services Public services Information and communications

Note: The industry codes are based on the JSIC as of 1984.

Table A2. *Significant local Moran statistics for the center of growth clusters (d=40)*

Regional Industry	Local spatial statistics and associations based on the extensive spatial weights		Local spatial statistics and associations based on the geographical spatial weights	
The center of the significant LL growth cluster:				
Nakamura-ku in Nagoya-shi				
Food	0.114	LL	**0.087**	**LL**
Textile	n.s.		**0.062**	**LL**
Printing	0.134	LL	**0.112**	**LL**
General Machinery	n.s		**0.275**	**LL**
Construction	n.s		**0.436**	**LL**
Wholesale and retail	n.s.		2.357	LL
Finance and insurance	0.526	LL	0.389	LL
Real Estate	**0.068**	**LL**	0.024	LL
Transport	−0.092	HL	**−0.079**	**HL**
Education and research	n.s.		**0.172**	**LL**
Medical	−0.783	LH	**0.363**	**LL**
Business Services	**−3.652**	**HL**	**−2.579**	**HL**
Personal Services	0.469	LL	0.564	LL
Naka-ku in Nagoya-shi				
Textile	−0.296	HL	**−0.197**	**HL**
Furniture	0.087	LL	0.045	LL
Printing	0.025	LL	0.021	LL
Construction	n.s.		0.812	LL
Wholesale and retail	n.s.		3.894	LL
Finance and insurance	0.605	LL	0.463	LL
Real Estate	−1.961	HL	**−0.799**	**HL**
Transport	0.876	LL	0.825	LL
Information	2.784	LL	1.372	LL
Education and research	n.s.		−0.257	HL
Medical	−0.998	LH	0.573	LL
Public Services	0.149	LL	0.137	LL
Business Services	**−4.543**	**HL**	**−3.202**	**HL**
Personal Services	2.865	LL	3.037	LL
The center of the significant HH growth cluster:				
Okazaki-shi in West Mikawa				
Food	n.s.		**0.228**	**HH**
Textile	n.s.		**−0.120**	**LH**
Furniture	0.065	HH	**0.070**	**HH**
Chemical	0.098	HH	**0.111**	**HH**
Plastic	0.054	HH	**0.032**	**HH**
Rubber	**−0.033**	**LH**	**−0.009**	**LH**
Ceramic	0.086	HH	**0.059**	**HH**
Fabricated Metals	0.263	HH	**0.210**	**HH**
General Machinery	0.550	HH	**0.430**	**HH**
Electrical Machinery	0.233	HH	**0.163**	**HH**
Transportation	**2.378**	**HH**	**0.797**	**HH**
Construction	0.396	HH	**0.357**	**HH**

(*Table Continued*)

Table A2. *Continued*

Regional Industry	Local spatial statistics and associations based on the extensive spatial weights		Local spatial statistics and associations based on the geographical spatial weights	
The center of the significant HH growth cluster:				
Okazaki-shi in West Mikawa (continued)				
Utilities	**0.026**	**HH**	**0.021**	**HH**
Wholesale and retail	**−0.472**	**LH**	**−0.337**	**LH**
Finance and insurance	**0.084**	**HH**	0.070	HH
Real Estate	n.s.		**0.079**	**HH**
Transport	**0.417**	**HH**	**0.289**	**HH**
Education and research	**0.174**	**HH**	**0.066**	**HH**
Medical	n.s.		**0.052**	**HH**
Public Services	0.097	HH	**0.071**	**HH**
Business Services	**0.486**	**HH**	**0.390**	**HH**
Personal Services	−0.031	LH	**−0.031**	**LH**
Toyota-shi in West Mikawa				
Food	0.090	HH	**0.097**	**HH**
Textile	n.s.		**0.643**	**HH**
Plastic	**0.980**	**HH**	**0.516**	**HH**
Rubber	**0.325**	**HH**	**0.084**	**HH**
Ceramic	0.052	HH	**0.043**	**HH**
Fabricated Metals	0.848	HH	**0.790**	**HH**
General Machinery	0.926	HH	**0.821**	**HH**
Electrical Machinery	**−0.119**	**LH**	**−0.069**	**LH**
Transportation	**4.747**	**HH**	**1.731**	**HH**
Construction	**0.125**	**HH**	**0.092**	**HH**
Wholesale and retail	**1.119**	**HH**	**0.672**	**HH**
Finance and insurance	**0.457**	**HH**	**0.311**	**HH**
Real Estate	0.034	HH	**0.035**	**HH**
Transport	**1.339**	**HH**	**0.882**	**HH**
Education and research	**−0.061**	**LH**	**−0.022**	**LH**
Medical	−0.568	LH	**−0.203**	**LH**
Public Services	**0.130**	**HH**	**0.086**	**HH**
Business Services	**2.467**	**HH**	**2.101**	**HH**
Personal Services	−0.111	LH	**−0.095**	**LH**

Note: n.s. – Not significant. The significant values even at the 5% Bonferroni bound are shown in bold.