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Abstract

This paper investigates the changing geographical pattern of manufacturing industries in Japan between 1985 and 1995 and explores factors of their geographic concentration. A regression analysis is conducted to test some hypotheses that are derived directly from early models of the New Economic Geography (NEG). Regression results indicate that the geographic concentration of Japanese manufacturing industries seems to be determined by some combination of internal economies of scale, transportation costs, and factor intensity. However, inter-industry linkages are found to be an insignificant factor of geographic concentration. As posited by the NEG theories, Japanese manufacturing industries with larger internal economies of scale and smaller unit transportation costs tend to have a higher level of geographic concentration. Japanese manufacturing data also support the Heckscher-Ohlin theory: labor- or capital-intensive industries tend to have a higher level of geographic concentration.

Keywords: new economic geography, geographic concentration, economies of scale, transportation costs, Japanese manufacturing industries

JEL classification: R11, R12, L60

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1. Introduction

Since the seminal article by Krugman (1991a), a number of studies have attempted to examine empirically the factors that determine the spatial concentration of economic activities within a framework of the new economic geography (NEG). Among these empirical studies, the following studies tested hypotheses derived directly from early models of NEG: Amiti (1998, 1999), Brulhart (2001), Brulhart and Torstensson (1996), Kim (1995), and Combes and Overman (2004).[1] They examined spatial concentration of manufacturing industries either in the U.S. or EU countries. The results were mixed, but in general they supported the NEG hypotheses.

This paper investigates the changing geographical pattern of manufacturing industries in Japan between 1985 and 1995 and explores the factors that determine their geographic concentration. We start with an estimation of the geographic concentration of manufacturing industries based on employment and establishment data at the prefecture level. We then conduct a regression analysis to test some hypotheses regarding the geographic concentration of manufacturing industries, which have been derived from early NEG models. To the authors' knowledge, no attempt has been made to test the hypotheses based on Japanese manufacturing data. In the regression analysis, we consider the following three factors of geographic concentration: internal economies of scale, transportation costs, and inter-industry

[1] Hanson (2001), Head and Mayer (2004), and Overman, et al. (2001) provided surveys of empirical studies.

linkages. In order to account for other possible sources of geographic concentration, we also consider factor intensity and industry dummies as explanatory variables.

We follow basically the approach used by Amiti (1998, 1999), which investigated the effects of scale economies, inter-industry linkages, and factor intensity on the geographic concentration of manufacturing industries for EU countries using manufacturing employment and output data from EUROSTAT and UNIDO. In addition to these factors, however, we also consider industry-specific transportation costs. Furthermore, our analysis is based on regional data rather than country data. We expect that scale economies, inter-industry linkages, and factor intensity have positive effects while transportation costs have a negative effect on the geographic concentration of manufacturing industries.

This paper is organized as follows. The next section discusses some hypotheses regarding the geographic concentration of manufacturing industries. Section 3 presents several indices that are used in our empirical analysis, while Section 4 describes the data on Japanese manufacturing industries. Section 5 conducts a shift and share analysis to examine regional growth patterns in Japan over the study period. Section 6 then tests the hypotheses of geographic concentration. The final section provides a summary of the findings and some concluding remarks.

2. Hypotheses

According to the Heckscher-Ohlin theory, a region will tend to specialize in producing goods that are intensive in the factors with which the region is relatively well endowed. It is predicted that labor-abundant regions will specialize in labor-intensive industries and export labor-intensive goods, while capital-abundant regions will specialize in capital-intensive industries and export capital-intensive goods; and thus it is expected that more factor-intensive (either labor-intensive or capital-intensive) industries have a higher level of geographic concentration.

In the Heckscher-Ohlin theory, comparative advantage, resulting from factor abundance, determines the pattern of *inter-industry* trade between regions. On the other hand, in a model of new trade theory, as advanced by Krugman (1979), internal economies of scale (i.e., economies of scale at the firm level) and the love-of-variety effect in consumers' preferences play a key role in trade. As a result, the theory predicts that regions specialize within industries, thereby bringing about *intra-industry* trade, rather than *inter-industry* trade. Suppose that firms can ship their goods freely between regions without any transportation costs. In the model, it is possible to show that even though regions are identical in every respect (i.e., identical in technology, tastes, and factor endowments), they find it advantageous to trade by specializing in different sets of varieties within industries.

By engaging in intra-industry trade, a region would reduce the number of varieties it produces, but increase the number of varieties available to its consumers. Through intra-industry trade, each firm producing a variety can reduce the average cost by expanding its production for a larger market, while the consumers can have access to more varieties. There are thus gains from intra-industry trade. There are two positive welfare effects: the decrease in prices brought about by the increased production level and the love-of-variety effect, i.e., the effect of more varieties available to consumers.

According to new trade theory, the factors of production are immobile between regions, and thus each region's market size is a given constant. Given their exogenously determined location, firms will make a decision on the varieties they want to produce. Models of NEG are also based on internal economies of scale and the love-of-variety effect in consumers' preferences. However, labor and firms are mobile, and their location and the distribution of market size are determined endogenously (Fujita, Krugman, and Venables, 1999; Krugman, 1991a, 1991b).

In models of NEG, developed by Krugman (1991a, 1991b), geographic concentration of 'footloose' manufacturing production in general depends on some combination of strong internal economies of scale, as represented by large fixed costs, low transportation costs, and a large share of manufacturing in expenditure. These models predict a core-periphery pattern of economic geography in a country, with a manufacturing core on the one hand and an agricultural periphery on the other. While these models do not ask why a particular industry within the manufacturing sector is concentrated in a particular region, and thus do not predict the pattern of regional specialization within the manufacturing sector, they suggest important factors that determine the geographic concentration of manufacturing industries, i.e., internal economies of scale, transportation costs, and market size. In his model of NEG, Venables (1996) showed also that geographic concentration of industries can be brought about by interactions between firms' location decisions that are connected through inter-industry backward (cost) and forward (demand) linkages.

Our paper considers these factors in analyzing the geographic concentration of Japanese manufacturing industries. Specifically, it conducts a multiple regression analysis to test the following hypotheses: first, manufacturing industries with larger internal economies of scale tend to have a higher level of geographic concentration; secondly, manufacturing industries with smaller transportation costs tend to have a higher level of geographic concentration; finally, manufacturing industries that have stronger inter-industry linkages tend to have a higher level of geographic concentration. In addition to these hypotheses, we also test the hypothesis predicted by the Heckscher-Ohlin theory of trade: more factor-intensive manufacturing industries tend to have a higher level of geographic concentration.

It should be noted that we do not consider knowledge spillovers and labor market pooling as other possible sources of geographic concentration. Head and Mayer (2004) argued, however, that researchers should remember the presence of these alternative sources of concentration in any empirical research that test NEG hypotheses. Rosenthal and Strange (2001) focused on these micro-foundations of agglomeration to analyze the localization of U.S. manufacturing industries at three different levels of geography (state, county, and zip code levels); they found that proxies for labor market pooling had positive effects on geographic concentration at all levels, but the results were mixed for knowledge spillovers. They also considered input sharing as another possible factor by using manufactured inputs per dollar of shipments as its proxy, but they found that it contributed to spatial concentration only at the state level. In our study, variables for inter-industry linkages are expected to capture, to some extent, the effects of input sharing.

3. Indices used in the Empirical Analysis

As a measure of the geographic concentration of a manufacturing industry, we use the following index (hereafter, referred to as the CL index).

$$CL_i = \frac{1}{2}\sum_{k=1}^{K}\left|s_{ik} - s_{tk}\right|, \qquad (1)$$

where K is the total number of regions in the country, and s_{ik} and s_{tk} are, respectively, the employment (or establishment) share of region k in manufacturing industry i and the employment (or establishment) share of region k in all manufacturing industries. The index ranges from 0 to 1. If manufacturing industry i has the same geographical distribution as all manufacturing industries, i.e., $s_{ik} = s_{tk}$ for all k, then the index value will be 0. On the other hand, if industry i is concentrated in a single region k', i.e., $s_{ik'} = 1$ and $s_{ik} = 0$ for $k \neq k'$, then it will approach 1, since we have

$$CL_i = \frac{1}{2}\left(\left|1 - s_{tk'}\right| + \sum_{k \neq k'} \left|0 - s_{tk}\right| \right) \approx \frac{1}{2}(2) = 1.$$

This index is usually termed the coefficient of localization (Isard, 1960) or the coefficient of concentration (Hoover and Giarratani, 1985).

As pointed out by Ellison and Glaeser (1997), the CL index or the locational Gini coefficient, as employed by Krugman (1991b), has the problem that industries with a smaller number of establishments may appear to have a higher coefficient value, even though they are concentrated merely by chance, not by economic forces as predicted by NEG models. In order to alleviate this lumpiness problem, Ellison and Glaeser (1997) proposed the following index (hereafter, referred to as the EG index).

$$EG_i = \frac{\sum_{k=1}^{K}(s_{ik} - s_{tk})^2 - \left(1 - \sum_{k=1}^{K} s_{tk}^2\right)\sum_{j=1}^{N} z_{ij}^2}{\left(1 - \sum_{k=1}^{K} s_{tk}^2\right)\left(1 - \sum_{j=1}^{N} z_{ij}^2\right)} = \frac{G_i - \left(1 - \sum_{k=1}^{K} s_{tk}^2\right)H_i}{\left(1 - \sum_{k=1}^{K} s_{tk}^2\right)\left(1 - H_i\right)}, \qquad (2)$$

where N is the number of manufacturing plants in industry i, z_{ij} is the share of manufacturing plant j in industry i, $H_i = \sum_{j=1}^{N} z_{ij}^2$ is the Herfindahl index for industry i, and $G_i = \sum_{k=1}^{K}(s_{ik} - s_{tk})^2$ is the spatial Gini coefficient. EG_i, in essence, controls for the size distribution of manufacturing plants, as measured by the Herfindahl index. For a perfectly competitive manufacturing industry with many small firms, H_i

approaches zero and thus EG_i approaches $G_i \Big/ \left(1-\sum_{k=1}^{K} s_{tk}^2\right)$, which is proportional to and larger than G_i. This paper also employs the EG index as a measure of geographic concentration and compares it with the CL index in the regression analysis.

In Krugman (1979, 1991a, and 1991b), internal scale economies are modeled by a simple linear production function:

$$L_i = \alpha + \beta x_i,$$

where L_i is the amount of labor necessary to produce x_i of variety i, and the coefficients α and β are the fixed and marginal labor input requirement. One measure of internal economies of scale is the ratio of average costs to marginal costs. However, it is difficult to obtain average and marginal costs for each manufacturing industry. Therefore, this study uses the ratio of the number of employees to the number of establishments (average establishment size) as a measure of internal economies of scale (ES):

As a proxy for industry-specific transportation costs, we use the ratio of intermediate inputs from the transportation sector to total inputs (TR). This ratio can be interpreted as total transportation costs per unit value of output. Therefore, hereafter, it is referred to as unit transportation costs. On the other hand, to measure inter-industry linkages, we employ total (direct and indirect) backward linkage index (TBLI) and total (direct and indirect) forward linkage index (TFLI); these indices are based, respectively, on the input (or Leontief) inverse, which is derived from the ordinary demand side input-output (I-O) model and the output inverse, which is derived from the supply-side I-O model (Miller and Blair, 1985).

Suppose that $(\mathbf{I}-\mathbf{A})^{-1}$ and $(\mathbf{I}-\mathbf{B})^{-1}$ are, respectively, the input inverse and the output inverse. If the elements of $(\mathbf{I}-\mathbf{A})^{-1}$ and $(\mathbf{I}-\mathbf{B})^{-1}$ are denoted, respectively, by α_{ij} and β_{ij}, then total backward linkage and forward linkage indices for industry k will be given, respectively, by:

$$\text{TBLI} = \frac{\sum_i \alpha_{ik}}{\frac{1}{n}\sum_i \sum_j \alpha_{ij}} \text{ and TFLI} = \frac{\sum_j \beta_{kj}}{\frac{1}{n}\sum_i \sum_j \beta_{ij}}. \tag{3}$$

The backward linkage of an industry refers to the extent to which the industry's production is interconnected to those industries from which it purchases inputs; the total backward linkage index presents the relative magnitude of total output multiplier effects. On the other hand, the forward linkage of an industry refers to the extent to which the industry's production is interconnected to those industries to which it sells its output; the total forward linkage index presents the relative magnitude of total input multiplier effects.

As in Amiti (1999), we use the following index as a proxy for factor intensity (FI):

$$\text{FI}_i = \left|\text{FS}_i - \overline{\text{FS}}\right|, \tag{4}$$

where FS_i is the share of payments to a factor (either labor or capital) in value added in industry i and $\overline{\text{FS}}$ is the average share in the nation. The larger the deviation from the average factor share is, the larger the index value will be, whether the industry is labor-intensive or capital-intensive.

4. The Data

This study used manufacturing data for each prefecture for 1985 and 1995 from the Industrial Statistics, which were compiled by the Research Institute of Economy, Trade, and Industry of the Ministry of Economy, Trade, and Industry (RIETI, 1985 and 1995). The data set contains statistics on the number of establishments, the number of employees, salaries and wages, output, raw material costs, value added, and fixed assets for 155 3-digit SIC (standard industrial classification) manufacturing sectors and 47 prefectures.

The study also used the Japanese 186-sector national input-output (I-O) tables for 1985 and 1995, compiled by the same research institute (RIETI, 2000). The tables include 109 manufacturing industries. Since the sector classification for manufacturing industries employed by the I-O tables differs greatly from the one used by the Industrial Statistics, this study uses significantly reorganized I-O tables and manufacturing data from the Industrial Statistics so that the sector classifications will be the same. This resulted in the 161-sector I-O tables including 83 manufacturing industries. In the empirical analysis however, data for 80 manufacturing industries were used since in the manufacturing data from the Industrial Statistics, 3 industries did not have any activities in 1985 and/or 1995. The 80-sector 3-digit classification and the corresponding 2-digit classification are found in table 4.1. Table 4.2 presents 47 prefectures, which are grouped into 11 regions, and figure 4.1 is a map of Japan, in which three metropolitan regions- Tokyo Metropolitan Area (TMA), Tokai, and Kinki- are highlighted.

To measure the geographic concentration of a manufacturing industry and its plant-level scale economies, this study used establishment and employment data from the Industrial Statistics. The geographic concentration was measured first by the CL index in equation (1) and then by the EG index in equation (2). Since plant-level employment data was not available, the Herfindahl index, used in the EG index, was calculated based on the size distribution of a prefecture's average establishments. It should be noted, therefore, that for an industry with large variations in the size distribution within prefectures, the Herfindahl index tends to be underestimated.

The 161-sector national I-O tables were used to calculate the total backward and forward linkage indices as defined by equation (3). In addition, the national I-O table was used to measure industry-specific unit transportation costs and factor intensity; the transportation sector includes the air, sea, rail, and road transportation sectors and their ancillary sectors.

5. Regional Growth Patterns of Manufacturing Industries between 1985 and 1995: A Shift and Share Analysis

Before examining the geographic concentration of manufacturing industries during 1985-95, it would be instructive to analyze the growth patterns of regional economies over the period by using manufacturing employment data by sector. Specifically, the authors conducted a shift and share analysis to analyze regional differences in the growth pattern of manufacturing employment.[2] The sector classification used in this shift and share analysis is the 2-digit industrial

[2] For ordinary shift and share analysis, please see, e.g., Armstrong and Taylor (1985).

classification (22 industries), as presented in table 4.1. Shift and share analysis aims to examine the factors determining the growth of a region by comparing the region's growth with the growth of the nation as a whole. It decomposes the region's actual total growth into three components: the regional share component, the industry-mix shift component, and the competitive shift component.

5.1. Changes in the Structure of the Manufacturing Industry in Employment

Table 5.1 presents changes in the structure of the manufacturing industry between 1985 and 1995. Japan as a whole contracted at an annual average rate of 0.6% over the period, losing 597,000 employees altogether (from 10,967,000 to 10,370,000 employees). The textile industry recorded the largest negative growth rate at -7.8%. It lost 387,000 employees, which was the largest among 22 manufacturing industries (2-digit SIC industries), accounting for 65% of the total decrease in manufacturing employment.[3] The textile industry's employment share decreased substantially from 6.4% to 3.0% during the period. This reflects the fact that Japan had lost its comparative advantage in labor-intensive manufacturing activities, as compared to surrounding Asian countries in the late 1980s - during this period, the Japanese yen had appreciated substantially from around 250 yen to 120 yen to the U.S. dollar in line with the so-called Plaza Agreement signed in 1985.

Electrical machinery lost 96,000 employees during the period, which was the second largest reduction next to the textile industry. However, it contracted at a much slower rate than the textile industry; thus its employment share remained the same at 16.4%. The wood products industry reduced its employment by 73,000, and the iron and steel industry reduced its employment by 72,000 employees. These were, respectively, the third and fourth largest decreases in employment. In contrast, the food products, wearing apparel, publishing and printing, and plastic products industries all recorded positive employment growth rates; thus their employment shares increased over the period. In 1995, the electrical machinery industry still had the largest employment share at 16.4%, which was followed by food products (11.2%), non-electrical machinery (10.9%), metal products (8.5%), and

[3] The textile and wood products industries contracted in all regions in the period.

transportation equipment (8.3%).

5.2. *Changes in the Geographical Distribution of the Manufacturing Industry in Employment*

Table 5.2 shows the significant changes that have occurred in the geographical distribution of the manufacturing industry by region between 1985 and 1995. Among the 11 regions, 6 regions experienced negative growth rates. In particular, very large negative growth rates were recorded by the Tokyo Metropolitan Area (TMA), which includes the capital city Tokyo, and Kinki, which includes western Japan's business center Osaka. In 1985, TMA and Kinki together accounted for 41.4% of total manufacturing employment; but the share declined to 38.0% in 1995. These two regions together lost 593,000 manufacturing employees in the period, accounting for most of the employment reduction in Japan. These two regions, in fact, were the only ones that recorded a reduction in their employment shares.

North Kanto, Tokai, Chugoku, and Shikoku also contracted, but their employment shares either grew slightly or remained constant. On the other hand, the northernmost region of Hokkaido, Tohoku, Hokuriku (the region facing the Japan Sea), and the southernmost regions of Kyushu and Okinawa recorded positive growth rates and thus experienced an increase in their respective employment shares. In sum, there seems to have been a shift in manufacturing employment in this period from the two metropolitan regions of TMA and Kinki to the remote regions of Hokkaido, Tohoku, Hokuriku, Kyushu, and Okinawa, even though TMA and Kinki still accounted for 38% of total manufacturing employment. The five aforementioned northernmost and southernmost regions together increased their employment by 87,000.

It should be noted that Japan experienced both a rising and a declining trend in regional income inequality in the late 1980s and the early 1990s, which corresponds closely to the rise and collapse of the bubble economy (Akita and Kataoka, 2003). In the late 1980s, financial institutions increased the number of loans for investment in corporate shares and real estate, especially in TMA, as it became one of the major international financial and information centers in the world, following the deregulation and liberalization of the financial sector in Japan. As a result, the prices of corporate shares and real estate increased astronomically, and the resulting capital gains brought huge wealth to investors.

However, this bubble economy collapsed in the early 1990s with a drastic fall in the prices of stocks corporate shares and real estate, and the Japanese economy entered an extended period of recession. Financial institutions have suffered from a large number of bad loans as a result of excessive lending for investment in corporate shares and real estate. Geographically, the bubble period and the subsequent extended period of recession were correlated with level of wealth in the TMA. TMA's per capita GDP grew at 6.2 % during 1985-90, when the Japan's overall per capita GDP grew at the lower rate of 5.1%. However, in 1990-2000, the growth rate of TMA dropped substantially to -0.4%, while Japan's overall growth rate was 0.7%. It should be noted that Kinki's comparable figures for these two periods were 4.8% and 0.7%, respectively. Therefore, Kinki's per capita GDP grew less rapidly than the country's overall per capita GDP in 1985-2000.

5.3. Shift and Share Analysis in Employment between 1985 and 1995

Table 5.3 presents the results of the shift and share analysis for 11 regions. As mentioned above, the two metropolitan regions, TMA and Kinki, contracted at much faster rates than Japan as a whole. In 1985, they accounted for 23.1% and 18.3%, respectively, of total manufacturing employment; but their shares declined to 20.8% and 17.2%, respectively, by 1995. There are, however, notable differences in the pattern of contraction between TMA and Kinki: while the competitive-shift component was wholly responsible for the contraction of TMA, the industry-mix shift and competitive-shift components contributed equally to the contraction of Kinki.

In TMA, all but the food products industry experienced negative growth. In particular, the metal products, non-electrical machinery, electrical machinery, and transportation equipment industries, which together accounted for half of TMA's total manufacturing employment in 1985, experienced large negative growth rates (-1.2%, -1.9%, -2.3%, and -2.3%, respectively). These four industries together accounted for two-thirds of the reduction in employment due to the competitive shift effect. These industries lost 232,000 employees in the period altogether; many of these positions seem to have been relocated to other regions or abroad.

In Kinki, the textile industry accounted for 10.4% of total manufacturing employment in 1985, which is the third largest next to the non-electrical machinery and electrical machinery industries. Kinki's textile industry, in fact, was responsible for a large negative industry-mix shift, as it recorded the largest negative growth rate in Japan at -7.8%; Japan's overall growth rate during this period was -0.6%. In Kinki, the textile industry lost 111,000 employees during this period, which accounted for more than a quarter of the nation's employment reduction in the textile industry. In Kinki, the textile industry's employment share decreased substantially, from 10.4% to 5.5% during this period. On the other hand, the iron and steel, metal products, and electrical machinery industries contributed to a large negative competitive shift. They accounted for more than half of the employment reduction due to the competitive shift effect.

Tokai (which includes Aichi, famous for Toyota and its various supporting industries) also experienced similar employment reductions. However, since the transportation equipment, electrical machinery, plastic products, and metal products industries grew at 0.6%, 0.5%, 2.8%, and 0.6%, respectively, the region had a large positive competitive shift; its manufacturing employment decreased by only 36,000 employees. The region's employment share increased slightly from 17.6% to 18.2%. It should be noted that the transportation equipment industry employed 346,000 in Tokai in 1995, which was 40% of this industry's total employment in Japan. Tohoku also had a large positive competitive shift: the wearing apparel, non-electrical machinery, and transportation equipment industries contributed significantly to Tohoku's positive competitive shift, which grew at 3.7%, 1.5%, and 3.3%, respectively. The wearing apparel industry employed 135,000 in Tohoku in 1995, which was a larger number than any other region in Japan and which accounted for about 20% of the wearing apparel industry's total employment in Japan. It should be noted that the electrical machinery industry had the largest share in Tohoku, accounting for 24.7% in 1995, although it contracted slightly during the period. Tohoku as a whole grew at 0.4%, increasing its employment share from 9.5% to 10.4% during the period.

Hokkaido and Kyushu experienced a similar growth pattern: they both recorded positive industry-mix and competitive shifts. Hokkaido had the highest growth rate in Japan at 1.3%. Most industries experienced positive employment growth. Among them, the food products industry, which accounted for 35.1% of Hokkaido's total employment in 1985, grew at 1.7%; thus its share increased to 36.3% in 1995. The metal products and electrical machinery industries also contributed to Hokkaido's employment growth, as they grew at 3.5% and 4.9%, respectively. On the other hand, in Kyushu, the electrical machinery industry grew at a relatively high rate (2.6%) and contributed significantly (almost 70%) to the region's competitive shift. Its share in the region increased significantly from 12.5% to 15.9% during the period. The wearing apparel industry also played a prominent role in the employment growth of Kyushu, as it grew at an annual rate of 2.4%. North Kanto also had positive industry-mix and competitive shifts, although its employment decreased slightly. The non-electrical machinery and transportation equipment industries grew at 1.3% and 0.9%, respectively, and thus contributed to a large positive competitive shift. These two sectors raised their employment shares to 12.4% and 9.0%, respectively, in 1995. In North Kanto, the electrical machinery still accounted for the largest share of employment at 25.1%, even though it contracted slightly during the period.

6. Empirical Evidence

6.1. Geographic Concentration of Manufacturing Industries

An analysis of the geographical distribution of manufacturing employment by prefecture in 1985 and 1995 reveals that 7 out of 47 prefectures experienced a decrease in their employment shares over the period. Except for Fukui, they are all located in TMA or Kinki, Japan's two major metropolitan regions. In particular, Tokyo, Kanagawa, and Osaka experienced large decreases in manufacturing employment. In 1985, Tokyo had the largest employment share at 8.8%, which was followed by Osaka (8.7%), Aichi (8.6%), Kanagawa (6.4%), and Saitama (5.4%). In contrast, by 1995, Aichi had become the prefecture with the largest share of manufacturing employment at 8.9%, which was followed by Osaka (7.8%), Tokyo (6.9%), Kanagawa (5.8%), and Saitama (5.3%). Tokyo, in fact, lost 245,000 employees over this period, which accounted for more than 40% of the total decrease in manufacturing employment in the period.

The geographic concentration of a manufacturing industry was measured using the CL index, as defined in equation (1), in which the geographical distribution of employment (or establishment) in the industry is compared with the geographical distribution of manufacturing employment (or establishment) in the nation as a whole. The indices for 80 industries were calculated by using employment and establishment data, and these 80 industries were ranked in descending order by the level of their geographic concentration in employment in 1985. Table 6.1 exhibits only the top 20 industries and bottom 20 industries. By comparing the listings from 1995 with 1985, 47 out of 80 industries (59%) experienced a decrease in geographic concentration when measured by employment, and 57 out of 80 (71%) experienced a decrease when measured by establishment. This is in contrast to the EU, where most industries recorded higher levels of geographic concentration in the 1980s (Amiti, 1998; and Brulhart and Torstensson, 1996).

When geographic concentration is measured by employment, the plated steel industry was the most concentrated industry in 1985, which was followed by the synthetic fiber, car and bicycle tires, china and porcelain, airplane manufacturing, pig iron and steel, clock and watch, oil products, boiler and turbine, and paper industries. However, it should be noted that out of these top 10 industries, 8 industries experienced a decrease in geographic concentration. In particular, the plated steel, synthetic fiber, china and porcelain, and pig iron and steel industries experienced sharp decreases in geographic concentration during this period. In contrast, the boiler and turbine industry experienced a significant increase in geographic concentration. A similar pattern is observed when geographic concentration is measured by establishment.

It is interesting to note that 18 out of the top 20 geographically concentrated industries in 1985 are either heavy and chemical industries or processing and assembling industries (10 industries and 8 industries, respectively), when measured by employment. Among the top 20 industries, only the paper industry and silk and spinning industry are light industries.[4] In contrast, among the bottom 20 industries in

[4] In terms of the 2-digit industrial classification, shown in table 4.1, industries from 12 through 19 are

1985, 8 industries are light industries and only 5 are heavy and chemical industries. This suggests the existence of structural differences in geographic concentration between heavy and chemical industries and other industries.

Geographic concentration was also measured by the EG index. The order of manufacturing industries in geographic concentration was changed slightly from the one based on the CL index. It should noted, however, that the EG index employs the spatial Gini coefficient, which is defined by the sum of squared differences rather than the sum of absolute differences used in the CL index. The simple coefficient of correlation between the EG index and CL index is 0.80 and 0.78 in 1985 and 1995, respectively. Among the top 20 industries in table 6.1, the chemical fertilizer, shipbuilding, and optical instrument industries recorded significant reductions in their levels of geographic concentration. As a result, these industries were no longer among the top 20 most geographically concentrated industries when measured by the EG index. In contrast, the publishing and printing industry exhibited a marked increase in the level of concentration both in 1985 and 1995.

Table 6.2 presents establishment size, unit transportation costs, and factor intensity for 80 industries. Again, only the top 20 and bottom 20 industries are included in the table (in terms of the index of geographic concentration). Except for the boiler and turbine industry and the rolling steel and steel tube industry, all top 20 industries recorded decreases in their average establishment sizes during this period. In 1985, the pig iron and steel industry had the largest average establishment size at 1,210 employees, which was followed by the synthetic fiber industry (345), the car and bicycle tires industry (218), the plated steel industry (118), and the oil products industry (84). The average establishment sizes decreased dramatically over the period. Even though the industry with the largest average establishment size was still the pig iron and steel industry in 1995, its average establishment size was 549 employees, which was less than half of the average size in 1985. The synthetic fiber and car and bicycle tires industry recorded much lower average establishment sizes of 210 and 117 employees, respectively. It should be noted that most of the top 20

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light industries (25 3-digit industries), industries from 20 through 28 are heavy and chemical industries (28 3-digit industries), and industries from 29 through 34 are processing and assembling industries (27 3-digit industries).

industries recorded decreases in both their levels of geographic concentration and average establishment sizes. In contrast, the boiler and turbine industry and the rolling steel and steel tube industry recorded increases in both their levels of geographic concentration and average establishment sizes.

The bottom 20 industries had much smaller average establishment sizes. On average, the bottom 20 industries had an average of 14 and 15 employees per establishment in 1985 and 1995, respectively; in contrast, the top 20 industries had an average of 128 and 78 employees per establishment in 1985 and 1995, respectively. This indicates a positive relationship between the level of geographic concentration and establishment size, which is a proxy for the internal economies of scale.

Though there are some exceptions, many of the top 20 industries have a larger factor intensity than the bottom 20 industries. On average, the top 20 industries had a factor intensity of 0.119 in 1985, which was much larger than the average factor intensity of 0.083 registered by the bottom 20 industries. Again, there seems to be a positive relationship between the level of geographic concentration and factor intensity, i.e., more factor-intensive industries tend to have a higher level of geographic concentration. On the other hand, there seems to be a negative relationship between the level of geographic concentration and unit transportation costs.

These relationships will be examined statistically in the next section.

6.2. Regression Results: Factors of the Geographic concentration of Manufacturing Industries

In order to examine the factors of geographic concentration for the manufacturing industries, this study utilized multiple regression analysis. Specifically, the following linear regression model was used to test the hypotheses discussed in section 2:

$$Y_{it} = \beta_1 + \beta_2 ES_{it} + \beta_3 FI_{it} + \beta_4 TR_{it} + \beta_5 TBLI_{it} + \beta_6 TFLI_{it} + e_{it}, \qquad (5)$$

where Y_{it} = index of geographic concentration for industry i in year t (dependent variable), i.e., either the CL index or the EG index,

ES_{it} = establishment size of industry i in year t (a proxy for the internal economies of scale),

FI_{it} = factor intensity of industry i in year t,

TR_{it} = unit transportation costs of industry i in year t,

$TBLI_{it}$ = total backward linkage index for industry i in year t,

$TFLI_{it}$ = total forward linkage index for industry i in year t.

In addition to the independent variables in equation (5), two dummy variables were used to account for possible structural differences between three types of manufacturing industries: light industries, heavy and chemical industries, and processing and assembling industries.[5] The following provides the definition of these two dummy variables.

D_1 = 1 if an industry belongs to the category of light industries; and 0 otherwise.

D_2 = 1 if an industry belongs to the category of heavy and chemical industries; and 0 otherwise.

These dummy variables are expected to account for differences in concentration between industries arising from other sources of concentration, such as natural advantages and technological externalities.

To estimate the regression model, the study utilized pooled data on the 80 manufacturing industries for 1985 and 1995. Therefore, the number of observations is 160 (n = 160). Table 6.3 presents the regression results when the CL index is used as the dependent variable. Since White's heteroscedasticity test indicated the existence of heteroscedasticity, *t*-values based on White's heteroscedasticity-corrected standard errors and covariance are presented. Results 1 and 2 are based on employment data from the Industrial Statistics, whereas Results 3 and 4 are based on establishment data. Since the pig iron and steel industry, one of the heavy and chemical industries, had an exceptionally large establishment size, as shown in table 6.2, it was regarded as an outlier. Therefore, the regression model is estimated after excluding the pig iron and steel industry. Table 6.4 presents the

[5] To see whether there is a significant structural shift between two years, we also introduced a time dummy; but the result was insignificant.

results, where the number of observations is 158, rather than 160.[6]

In all results, the coefficients associated with establishment size (ES) and factor intensity (FI) are significant at the 1% significance level. Furthermore, these coefficients are both positive, which are as predicted by the new trade theory and the Heckscher-Ohlin theory, respectively. While the coefficient associated with unit transportation costs (TR) is significant at the 1% significance level in Results 1 and 2, it is significant at the 5% level in Results 4 and 5 and at the 10% level in Result 3. However, the coefficient is negative in all results, which is concurrent with NEG theory. It should be noted that the coefficients of the total backward and forward linkage indices (TBLI and TFLI, respectively) are insignificant in all results even at the 10% significance level.

From these results, it can be concluded that the geographic concentration of manufacturing industries seems to be determined by some combination of internal economies of scale, transportation costs, and factor intensity, at least during the 1985-1995 period. However, backward and forward inter-industry linkages do not seem to be significant factors in determining the geographic concentration of manufacturing industries in Japan. In other words, manufacturing industries with larger internal economies of scale and smaller unit transportation costs tend to have a higher level of geographic concentration. Furthermore, more factor-intensive industries tend to have a higher level of geographic concentration. In contrast, the extent of inter-industry linkages does not seem to affect the level of geographic concentration.

It should be noted that both the differential intercept coefficient and the differential slope coefficient associated with establishment size (ES), as represented by the dummy variable for heavy and chemical industries (D_2), are significant at the 1% significance level in all results. Since the differential intercept coefficient is positive, while the differential slope coefficient is negative, it may be concluded that heavy and chemical industries tend to have a higher level of geographic concentration than other industries at smaller average establishment size, but their

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[6] The regression model was estimated without TBLI and TFLI since their coefficients were found to be insignificant.

levels of geographic concentration do not increase as much as other industries as average establishment size increases, *ceteris paribus*. Conversely, light industries and processing and assembling industries tend to have a lower level of geographic concentration when their average establishment size is smaller, but their level of geographic concentration increases rapidly with establishment size, *ceteris paribus*. Since the differential slope coefficient associated with factor intensity (FI), as represented by the dummy variable for heavy and chemical industries (D_2), is also negative, though not very significant, heavy and chemical industries have the same pattern for factor intensity (FI) as for establishment size (ES).[7]

The exclusion of the pig iron and steel industry generated better regression results (table 6.4), as the adjusted R^2 is much larger. For example, Result 5 has an adjusted R^2 of 0.397, which is in contrast to an adjusted R^2 of 0.297 in Result 2: Result 5 used the same regression model as Result 2 except that the former excluded the pig iron and steel industry. It should be noted that the estimated value of the differential slope coefficient associated with establishment size (ES) in Result 5 is -1.878, which is much less negative than the value in Result 2 (-3.175). Therefore, when the pig iron and steel industry is excluded, the level of geographic concentration for heavy and chemical industries appears to be more sensitive to establishment size.

When the EG index is used as the dependent variable, the adjusted R^2 is reduced considerably (table 6.5). However, the coefficients associated with establishment size, unit transportation costs, and factor intensity are still all significant at either the 1% or 5% level and have the expected signs. Therefore, the results seem to be quite robust.

7. Conclusion

This study attempted to investigate factors that determine the geographic concentration of manufacturing industries in Japan by using manufacturing data by prefecture from the Industrial Statistics and national input-output tables for 1985 and 1995. As opposed to the EU, where country data were used to analyze geographic

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[7] The differential slope coefficient for transportation costs (TR) was found to be not significant; therefore, it was removed from the corresponding terms in these regression models.

concentration, many Japanese manufacturing industries experienced a decrease in geographic concentration between 1985 and 1995. In this period, Japan underwent significant structural changes, due mainly to the rise and collapse of the bubble economy along with the rapid appreciation of the yen against the U.S. dollar. Japan as a whole experienced a marked decrease in manufacturing employment by about 600,000 employees, but most of the decrease occurred in the two metropolitan areas: the Tokyo Metropolitan Area (TMA) and Kinki. The Japanese textile industry suffered significantly from the rapid appreciation of the yen and experienced a loss of competitiveness in the world market. Textile manufacturing plants were relocated to neighboring Asian countries where labor costs were much lower, and, as a result, this industry recorded substantial employment reduction in Japan. About two-thirds of the total decrease in manufacturing employment is accounted for by the textile industry.

Despite these large structural changes during this period, the study found that the economic forces behind the geographic concentration of Japanese manufacturing industries seem to comply with NEG theories. The regression analysis indicated that, whether the CL index or the EG index was used as a measure of geographic concentration, the geographic concentration of manufacturing industries seems to be determined by some combination of internal economies of scale, transportation costs, and factor intensity. However, inter-industry linkages were found to be an insignificant factor of geographic concentration. As predicted by the theories of NEG, Japanese manufacturing industries with larger internal economies of scale and smaller unit transportation costs tend to have a higher level of geographic concentration. Japanese manufacturing data also support the Heckscher-Ohlin theory that labor- or capital-abundant regions tend to specialize in labor- or capital-intensive industries. According to the regression analysis, labor- or capital-intensive industries tend to have a higher level of geographic concentration.

The study also found that heavy and chemical industries seem to have a distinct relationship between the level of geographic concentration and internal economies of scale and between the level of geographic concentration and factor intensity. Heavy and chemical industries tend to have higher levels of geographic concentration than other industries when their establishment size or factor intensity is small, but their levels of concentration will not increase as much as other industries as establishment size or factor intensity increases.

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Figure 4.1. Map of Japan

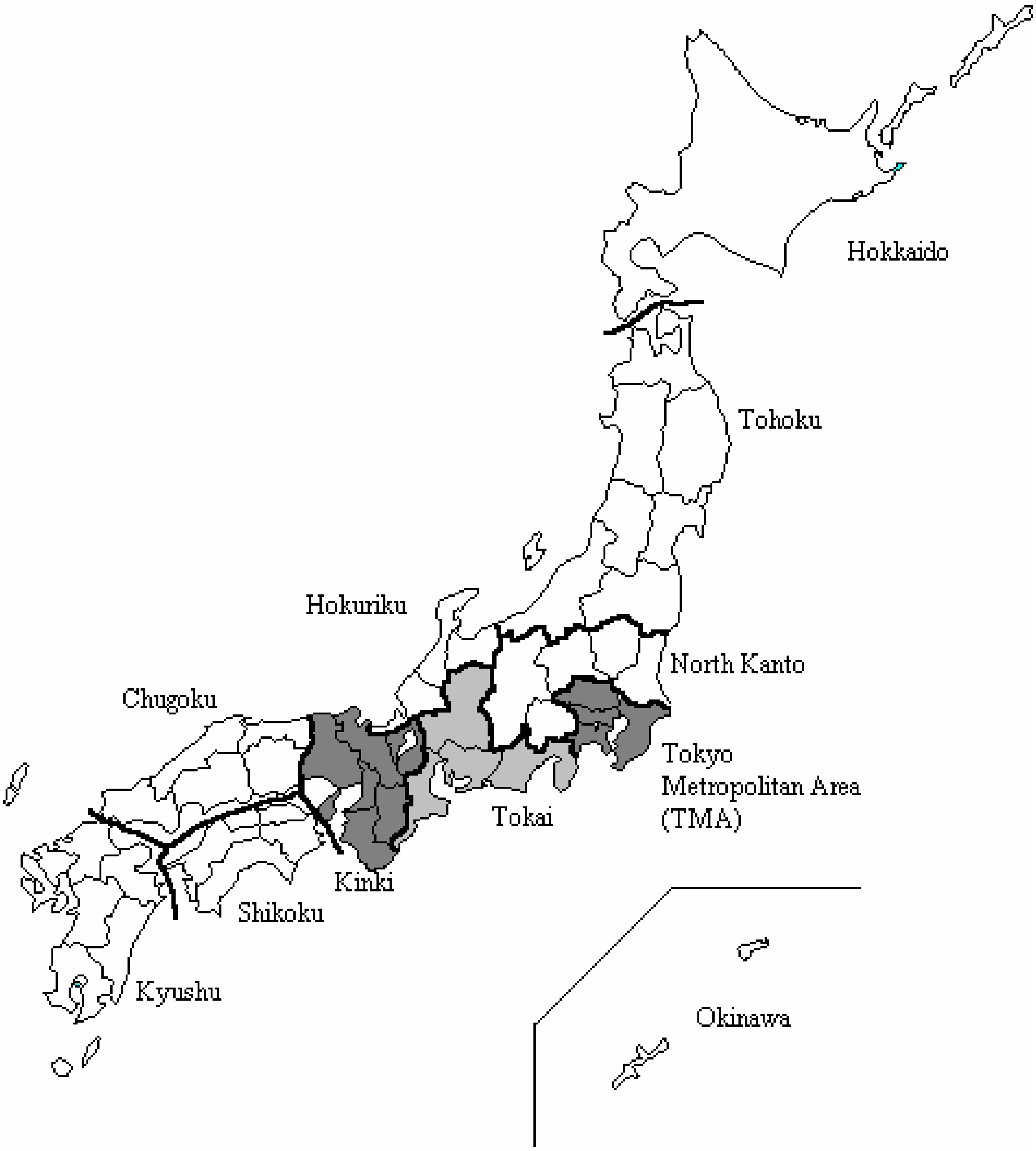

Table 4.1. Sector Classification

2-digit Industrial Classification		3-digit Industrial Classification	
12	Food products	121	Meat & diary products
		122	Marine products
		123	Vegetable products
		124	Sugar, seasoning, oil products
		126	Rice & flour milling
		127	Bread & cake
		129	Other food products
13	Beverage	131	Other beverages
		132	Alcohol beverage
14	Textile industry	141	Silk & spinning
		143	Yarning & weaving
		145	Knitting
		146	Dyeing
		147	Other textile products
15	Wearing apparel	151	Manufacturing of clothes
		152	Other clothes
		159	Other wearing apparel
16	Sawmill & wood products	161	Saw mill & plywood
		163	Other wooden products
17	Furniture & fixture	171	Furniture & fixture
18	Paper & paper products	182	Paper
		183	Paper products
		185	Paper boxes
		189	Other paper products
19	Publishing & printing	191	Publishing & printing
20	Industrial chemical	201	Chemical fertilizer
		202	Inorganic chemical products
		203	Organic chemical products
		204	Synthetic fiber
		205	Synthetic detergent & paint
		206	Medicines
		209	Other chemical products
21	Petrochemical & coal products	211	Oil products
		213	Coal products
22	Plastic products	221	Plastic products
23	Rubber products	231	Car & bicycle tires
		232	Other rubber products
24	Leather products & fur	241	Leather, fur & other leather products
		243	Leather shoes
25	Nonmetallic mineral products	251	Glass products
		252	Cement & concrete
		253	Other ceramics
		254	China and porcelain
26	Iron & steel industry	261	Pig iron & steel
		264	Rolling steel & steel tube
		265	Plated steel
		266	Cast & pig iron
		269	Other iron & steel
27	Nonferrous basic metal	271	Nonferrous metal refining
		273	Other nonferrous metals
		274	Electric wire & cable
28	Metal products	281	Other metal products
		282	Metal products for heating & kitchen

29	Nonelectrical machinery	291	Boiler & turbine
		292	Other nonelectrical machinery
		293	Construction machinery
		294	Machine tools
		297	Machinery for other products
		298	Machinery for office
		299	Other non-electrical machinery
30	Electrical machinery	301	Electrical machinery for industry
		302	Electrical machinery for households
		303	Electric bulb & lighting tools
		304	Communications equipments
		305	Computers
		306	Electronic medical & other equipments
		307	Electronic measurement instruments
		308	Electronic components & parts
		309	Other electric machinery
31	Transportation equipment	311	Automobile manufacturing
		312	Railroad vehicle manufacturing
		313	Bicycle manufacturing
		314	Shipbuilding industry
		315	Airplane manufacturing
		319	Other transportation equipments
32	Precision machinery	321	Other precision machinery
		325	Optical instruments
		327	Clock & watch
34	Other manufacturing	341	Other manufacturing
		343	Toys

Table 4.2. Classification of Regions

Region		Prefecture	
1	Hokkaido	1	Hokkaido
2	Tohoku	2	Aomori
		3	Iwate
		4	Miyagi
		5	Akita
		6	Yamagata
		7	Fukushima
		15	Niigata
3	North Kanto	8	Ibaragi
		9	Tochigi
		10	Gunma
		19	Yamanashi
		20	Nagano
4	Tokyo Metropolitan Area (TMA)	11	Saitama
		12	Chiba
		13	Tokyo
		14	Kanagawa
5	Tokai	21	Gifu
		22	Shizuoka
		23	Aichi
		24	Mie
6	Hokuriku	16	Toyama
		17	Ishikawa
		18	Fukui
7	Kinki	25	Shiga
		26	Kyoto
		27	Osaka
		28	Hyogo
		29	Nara
		30	Wakayama
8	Chugoku	31	Tottori
		32	Shimane
		33	Okayama
		34	Hiroshima
		35	Yamaguchi
9	Shikoku	36	Tokushima
		37	Kagawa
		38	Ehime
		39	Kochi
10	Kyushu	40	Fukuoka
		41	Saga
		42	Nagasaki
		43	Kumamoto
		44	Oita
		45	Miyazaki
		46	Kagoshima
11	Okinawa	47	Okinawa

Table 5.1. Changes in the Structure of the Manufacturing Industry in Employment

2-Digit Industrial Code	Name	1985 Number	1985 % Share	1995 Number	1995 % Share	Growth 85-95	Growth Rate (%)
12	Food products	1,057,915	9.6	1,164,789	11.2	106,874	1.0
13	Beverage	105,163	1.0	97,753	0.9	-7,410	-0.7
14	Textile industry	697,063	6.4	310,135	3.0	-386,928	-7.8
15	Wearing apparel	579,382	5.3	639,614	6.2	60,232	1.0
16	Sawmill & wood products	301,731	2.8	229,046	2.2	-72,685	-2.7
17	Furniture & fixture	268,802	2.5	246,273	2.4	-22,529	-0.9
18	Paper & paper products	270,079	2.5	264,753	2.6	-5,326	-0.2
19	Publishing & printing	546,794	5.0	572,678	5.5	25,884	0.5
20	Industrial chemical	342,914	3.1	342,887	3.3	-27	0.0
21	Petrochemical & coal products	28,646	0.3	24,102	0.2	-4,544	-1.7
22	Plastic products	385,967	3.5	453,569	4.4	67,602	1.6
23	Rubber products	145,492	1.3	129,457	1.2	-16,035	-1.2
24	Leather products & fur	89,392	0.8	72,324	0.7	-17,068	-2.1
25	Nonmetallic mineral products	457,501	4.2	423,717	4.1	-33,784	-0.8
26	Iron & steel industry	274,132	2.5	202,060	1.9	-72,072	-3.0
27	Nonferrous basic metal	144,901	1.3	148,284	1.4	3,383	0.2
28	Metal products	861,739	7.9	882,336	8.5	20,597	0.2
29	Nonelectrical machinery	1,156,705	10.5	1,133,887	10.9	-22,818	-0.2
30	Electrical machinery	1,799,657	16.4	1,704,067	16.4	-95,590	-0.5
31	Transportation equipment	890,320	8.1	860,506	8.3	-29,814	-0.3
32	Precision machinery	263,453	2.4	197,379	1.9	-66,074	-2.8
34	Other manufacturing	299,667	2.7	270,107	2.6	-29,560	-1.0
	Total	10,967,415	100.0	10,369,723	100.0	-597,692	-0.6

Table 5.2. Changes in the Geographical Distribution of the Manufacturing Industry in Employment

	Region	1985 Number	1985 Share	1995 Number	1995 Share	Growth 85-95	Growth Rate (%)
1	Hokkaido	211,171	1.9	240,713	2.3	29,542	1.3
2	Tohoku	1,040,682	9.5	1,078,719	10.4	38,037	0.4
3	North Kanto	1,164,761	10.6	1,158,940	11.2	-5,821	-0.1
4	TMA	2,534,297	23.1	2,160,345	20.8	-373,952	-1.6
5	Tokai	1,924,783	17.6	1,888,961	18.2	-35,822	-0.2
6	Hokuriku	366,290	3.3	368,290	3.6	2,000	0.1
7	Kinki	2,003,760	18.3	1,785,186	17.2	-218,574	-1.1
8	Chugoku	658,782	6.0	620,821	6.0	-37,961	-0.6
9	Shikoku	314,578	2.9	302,167	2.9	-12,411	-0.4
10	Kyushu	723,814	6.6	739,983	7.1	16,169	0.2
11	Okinawa	24,497	0.2	25,598	0.2	1,101	0.4
	Total	10,967,415	100.0	10,369,723	100.0	-597,692	-0.6

Table 5.3. Shift and Share Analysis in Employment by Region during 1985-95

	Total Growth (A)	Regional Share (B)	Total Shift (C) = (A) - (B) = (D) + (E)	Industry Mix Shift (D)	Competitive Shift (E)	Annual Growth Rate (%)
Hokkaido	29,542	-11,508	41,050	9,660	31,390	1.3
Tohoku	38,037	-56,714	94,751	-3,446	98,197	0.4
North Kanto	-5,821	-63,476	57,655	5,082	52,573	-0.1
TMA	-373,952	-138,112	-235,840	65,169	-301,009	-1.6
Tokai	-35,822	-104,895	69,073	-26,166	95,239	-0.2
Hokuriku	2,000	-19,962	21,962	-29,882	51,843	0.1
Kinki	-218,574	-109,199	-109,375	-47,460	-61,915	-1.1
Chugoku	-37,961	-35,902	-2,059	11,417	-13,476	-0.6
Shikoku	-12,411	-17,144	4,733	4,875	-142	-0.4
Kyushu	16,169	-39,446	55,615	9,658	45,957	0.2
Okinawa	1,101	-1,335	2,436	1,094	1,342	0.4
Total	-597,692	-597,692	0	0	0	-0.6

Table 6.1. Geographic Concentration of Manufacturing Industries

Top 20 Industries

3-Digit Code	Name	Geographic Concentration Measured by CL Index in Employment			Geographic Concentration Measured by CL Index in Establishment		
		1985	1995	Change	1985	1995	Change
265	Plated steel	0.844	0.745	-0.099	0.828	0.673	-0.155
204	Synthetic fiber	0.796	0.749	-0.047	0.742	0.634	-0.108
231	Car & bicycle tires	0.777	0.756	-0.021	0.584	0.589	0.005
254	China and porcelain	0.698	0.636	-0.062	0.637	0.595	-0.042
315	Airplane manufacturing	0.648	0.642	-0.006	0.531	0.505	-0.026
261	Pig iron & steel	0.627	0.569	-0.058	0.546	0.511	-0.035
327	Clock & watch	0.614	0.644	0.030	0.551	0.571	0.020
211	Oil products	0.611	0.596	-0.015	0.436	0.427	-0.009
291	Boiler & turbine	0.609	0.683	0.074	0.361	0.427	0.066
182	Paper	0.581	0.568	-0.013	0.573	0.545	-0.028
201	Chemical fertilizer	0.566	0.520	-0.046	0.502	0.497	-0.005
312	Railroad vehicle manufacturing	0.506	0.462	-0.044	0.344	0.376	0.032
264	Rolling steel & steel tube	0.498	0.510	0.012	0.438	0.434	-0.004
314	Shipbuilding industry	0.497	0.487	-0.010	0.481	0.472	-0.009
141	Silk & spinning	0.494	0.504	0.010	0.507	0.491	-0.016
307	Electronic measurement instruments	0.481	0.466	-0.015	0.447	0.413	-0.034
243	Leather shoes	0.473	0.487	0.014	0.520	0.516	-0.004
313	Bicycle manufacturing	0.472	0.605	0.133	0.503	0.546	0.043
241	Leather, fur & other leather products	0.469	0.482	0.013	0.481	0.490	0.009
325	Optical instruments	0.466	0.503	0.037	0.519	0.537	0.018

Bottom 20 Industries

124	Sugar, seasoning, oil products	0.254	0.217	-0.037	0.348	0.329	-0.019
232	Other rubber products	0.254	0.223	-0.031	0.329	0.285	-0.044
298	Machinery for office	0.251	0.252	0.001	0.243	0.250	0.007
269	Other iron & steel	0.245	0.261	0.016	0.191	0.187	-0.004
159	Other wearing apparel	0.215	0.231	0.016	0.174	0.190	0.016
126	Rice & flour milling	0.212	0.181	-0.031	0.281	0.280	-0.001
297	Machinery for other products	0.202	0.189	-0.013	0.218	0.186	-0.032
281	Other metal products	0.198	0.176	-0.022	0.271	0.248	-0.023
171	Furniture & fixture	0.190	0.174	-0.016	0.175	0.161	-0.014
299	Other non-electrical machinery	0.183	0.174	-0.009	0.225	0.199	-0.026
341	Other manufacturing	0.179	0.136	-0.043	0.161	0.124	-0.037
163	Other wooden products	0.177	0.210	0.033	0.148	0.208	0.060
221	Plastic products	0.174	0.166	-0.008	0.193	0.170	-0.023
301	Electrical machinery for industry	0.174	0.159	-0.015	0.189	0.149	-0.040
282	Metal products for heating & kitchen	0.170	0.160	-0.010	0.143	0.134	-0.009
294	Machine tools	0.169	0.178	0.009	0.205	0.191	-0.014
129	Other food products	0.166	0.150	-0.016	0.261	0.244	-0.017
292	Other nonelectrical machinery	0.164	0.164	0.000	0.139	0.123	-0.016
127	Bread & cake	0.135	0.145	0.010	0.217	0.201	-0.016
185	Paper boxes	0.114	0.117	0.003	0.144	0.138	-0.006

Table 6.2. Establishment Size, Unit Transportation Costs, and Factor Intensity

Top 20 Industries

3-Digit Industrial Code	Name	Establishment Size		Unit Transportation Costs		Factor Intensity	
		1985	1995	1985	1995	1985	1995
265	Plated steel	118.3	73.0	0.024	0.035	0.122	0.099
204	Synthetic fiber	345.3	210.3	0.036	0.031	0.086	0.065
231	Car & bicycle tires	217.9	117.0	0.024	0.018	0.071	0.074
254	China and porcelain	10.7	9.9	0.031	0.031	0.086	0.036
315	Airplane manufacturing	80.7	71.1	0.005	0.009	0.075	0.123
261	Pig iron & steel	1210.5	548.7	0.045	0.060	0.229	0.201
327	Clock & watch	51.8	44.3	0.017	0.021	0.108	0.088
211	Oil products	84.0	68.7	0.009	0.029	0.230	0.262
291	Boiler & turbine	65.2	86.6	0.031	0.023	0.016	0.002
182	Paper	63.1	69.1	0.048	0.031	0.002	0.141
201	Chemical fertilizer	35.2	26.5	0.034	0.037	0.111	0.165
312	Railroad vehicle manufacturing	26.0	21.1	0.013	0.018	0.174	0.237
264	Rolling steel & steel tube	71.9	74.4	0.017	0.014	0.191	0.007
314	Shipbuilding industry	27.3	22.2	0.019	0.018	0.215	0.120
141	Silk & spinning	72.6	40.8	0.015	0.029	0.227	0.170
307	Electronic measurement instruments	29.9	28.8	0.018	0.016	0.031	0.053
243	Leather shoes	9.7	9.6	0.017	0.029	0.004	0.078
313	Bicycle manufacturing	18.4	17.6	0.015	0.021	0.269	0.101
241	Leather, fur & other leather products	6.2	5.8	0.020	0.027	0.096	0.075
325	Optical instruments	19.4	18.7	0.010	0.020	0.045	0.135

Bottom 20 Industries

124	Sugar, seasoning, oil products	17.0	19.7	0.037	0.050	0.001	0.042
232	Other rubber products	16.3	16.9	0.019	0.021	0.041	0.080
298	Machinery for office	32.9	33.9	0.014	0.020	0.175	0.050
269	Other iron & steel	12.8	14.6	0.038	0.044	0.097	0.035
159	Other wearing apparel	7.5	7.8	0.016	0.025	0.074	0.140
126	Rice & flour milling	11.9	12.8	0.037	0.063	0.321	0.353
297	Machinery for other products	18.7	18.5	0.021	0.020	0.006	0.007
281	Other metal products	9.5	10.6	0.021	0.030	0.106	0.096
171	Furniture & fixture	6.4	6.6	0.021	0.038	0.003	0.076
299	Other non-electrical machinery	11.7	11.5	0.026	0.026	0.088	0.059
341	Other manufacturing	7.0	7.1	0.033	0.052	0.090	0.037
163	Other wooden products	5.3	5.7	0.027	0.057	0.079	0.012
221	Plastic products	14.9	16.5	0.021	0.021	0.047	0.091
301	Electrical machinery for industry	28.8	28.2	0.018	0.018	0.056	0.070
282	Metal products for heating & kitchen	9.6	10.7	0.024	0.035	0.081	0.050
294	Machine tools	12.1	10.8	0.023	0.017	0.037	0.069
129	Other food products	9.8	15.0	0.028	0.036	0.171	0.188
292	Other nonelectrical machinery	14.8	16.5	0.023	0.023	0.030	0.062
127	Bread & cake	17.4	22.4	0.025	0.039	0.065	0.105
185	Paper boxes	12.2	13.8	0.026	0.037	0.066	0.034

Table 6.3.
Regression Results
CL Index as the Dependent Variable

Based on White Heteroskedasticity-Consistent Standard Errors & Covariance

Independent Variables	CL Index Measured by Employment		CL Index Measured by Establishment	
	Result 1	Result 2	Result 3	Result 4
C	0.255 **	0.245 ***	0.230 **	0.207 ***
	(2.197)	(8.183)	(2.116)	(6.931)
D_1	0.016		0.052 **	0.039
	(0.624)		(2.058)	(1.646)
D_2	0.210 ***	0.201 ***	0.200 ***	0.184 ***
	(4.542)	(4.910)	(4.977)	(4.651)
ES	3.707 ***	3.594 ***	3.258 ***	3.078 ***
	(5.659)	(5.845)	(6.473)	(6.501)
FI	0.511 ***	0.526 ***	0.529 ***	0.544 ***
	(2.968)	(3.061)	(3.375)	(3.641)
TR	-2.189 ***	-1.985 ***	-0.898 *	-1.226 **
	(-3.642)	(-3.600)	(-1.859)	(-2.522)
TBLI	-0.023		0.005	
	(-0.208)		(0.049)	
TFLI	0.011		-0.055	
	(0.316)		(-1.605)	
D_2*ES	-3.286 ***	-3.175 ***	-2.900 ***	-2.743 ***
	(-4.877)	(-4.944)	(-5.571)	(-5.531)
D_2*FI	-0.523 *	-0.503 *	-0.456 *	-0.585 **
	(-1.828)	(-1.800)	(-1.884)	(-2.521)
Adjusted R^2	0.285	0.297	0.213	0.213
No. of observations	160	160	160	160

(Notes) * Significant at the 10% significance level
** Significant at the 5% significance level
*** Significant at the 1% significance level
t-statistics are given below coefficient values in parentheses.

Table 6.4
Regression Results
CL Index as the Dependent Variable
Excluding the Pig Iron and Steel Industry

Based on White Heteroskedasticity-Consistent Standard Errors & Covariance

Independent Variables	CL Index Measured by Employment		CL Index measured by Establishment	
	Result 5		Result 6	
C	0.225	***	0.194	***
	(7.455)		(6.384)	
D_1			0.033	
			(1.424)	
D_2	0.143	***	0.137	***
	(3.568)		(3.358)	
ES	3.722	***	3.131	***
	(6.169)		(6.674)	
FI	0.528	***	0.551	***
	(2.957)		(3.598)	
TR	-1.314	**	-0.702	
	(-2.530)		(-1.411)	
D_2*ES	-1.878	***	-1.734	***
	(-2.824)		(-3.457)	
D_2*FI	-0.603	**	-0.668	***
	(-2.143)		(-2.812)	
Adjusted R^2	0.397		0.283	
No. of observations	158		158	

(Notes) ** Significant at the 5% significance level
*** Significant at the 1% significance level
t-statistics are given below coefficient values in parentheses.
n = 158

Table 6.5
Regression Results
EG Index as the Dependent Variable

Based on White Heteroskedasticity-Consistent Standard Errors & Covariance

Independent Variables	EG Index	EG Index Excluding Pig Iron & Steel
	Result 7	Result 8
C	-0.077	-0.073
	(-1.087)	(-1.087)
D_2	0.057 ***	0.039 ***
	(4.012)	(2.839)
ES	0.656 ***	0.704 ***
	(3.075)	(3.411)
FI	0.100 **	0.102 **
	(2.021)	(2.003)
TR	-0.564 ***	-0.354 **
	(-3.121)	(-2.053)
TBLI	0.099	0.089
	(1.367)	(1.310)
D_2*ES	-0.536 **	-0.161
	(-2.516)	(-0.542)
D_2*FI	-0.140	-0.168
	(-1.300)	(-1.424)
Adjusted R^2	0.180	0.233
No. of observations	160	158

(Notes) ** Significant at the 5% significance level
*** Significant at the 1% significance level
t-statistics are given below coefficient values in parentheses.
n = 158