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Abstract

In Japan, the manufacturing has become geographically dispersed in the 1990s, when the import has drastically increased after the historic exchange rate appreciation. This suggests the possibility that regional input-output linkages are undermined by import penetration. The regression results indicate the decline of industrial concentrations, particularly those previously established near large output absorbers. This paper also finds that local knowledge spillovers and availability of immobile specialized labor affect regional growth. These imply that the geography matters for industrial locations rather through the supply of inputs, especially non-tradable inputs, than through the demand for tradable outputs.

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1. INTRODUCTION

The import share has risen in many countries, as barriers to border-crossing transactions have substantially been removed. The geographical distribution of industries within a country is likely to be affected by increased flows of foreign goods because import penetration tends to undermine input-output linkages among domestic industries. In the last decade, the industrial location has become substantially more dispersed across regions in Japan. Therefore, this paper examines Japan's changing industrial geography after the historic yen appreciation in 1985.

The effects of international trade on internal geography have been theoretically explored, but empirical investigations have been limited. Fujita, Krugman and Venables (1999) construct an insightful model, of which the testable implication includes that the employment growth must be lower after trade liberalization in regions with previously stronger input-output linkages among regional industries.[1] This paper is inspired by econometric specifications by Hanson (1998) on the case of Mexico, where industries are dispersed from concentration in Mexico City and foreign trade is drastically liberalized.

The purpose of this paper is threefold. First, this paper empirically investigates the relationship between internal geography and international trade, focusing on the role of inter-industry linkages. The effect of regional industrial composition, rather than general urban agglomeration, is emphasized, since import penetration affects internal geography through weakening input-output linkages among regional industries. By combining *Census of Manufacturers* data with *Input-Output Table* data, this paper constructs a relatively direct, region-industry specific index for vertical linkages.

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[1] By explicitly incorporating inter-industry linkages, the models developed in Fujita, Krugman, and Venables (1999) extend the one-sector model by Krugman and Livas-Elizondo (1996), which focuses on the effect of consumers on giant metropolis. Both of these models are in the abstract framework of two-region country, but the testable implications empirically survive for multi-region settings in the real world.

Second, this paper examines the effects of regional non-tradable sectors and immobile factors on manufacturing employment in the region. This issue is critical because some goods are non-tradable and labor is immobile even when many products are traded globally. In defining vertical linkages for each manufacturing industry, this paper includes not only other manufacturing industries, but also regional non-manufacturing industries and final demand components. This paper also considers the effects of non-tradable inputs, such as local knowledge spillovers and regional availability of immobile specialized labor. As will be reported later, the supply of non-tradable inputs considerably affect regional growth, while the manufacturer's advantage of locating close to output absorbers becomes less relevant.

Third, to complement accumulated evidence on the effect of NAFTA and EU (e.g. Hanson (1998) and Paluzie et al. (2001)), the investigation of Japanese experiences will be required. Although Japan has not been involved in any free trade agreement, the imports began to rapidly rise after the historic yen appreciation triggered by the 1985 Plaza Accord.[2] During around the same period, the geographical distribution of manufacturing becomes more dispersed in Japan. Therefore, as explained in the next section, the experience of Japan after 1985 could be served as an example of rapidly opening/integrating economies simultaneously experiencing internal geography changes.

The rest of this paper is organized as follows. Section 2 briefly describes long-run trends of economic geography in Japan. Section 3 introduces empirical model. Section 4 reports estimation results. Finally, Section 5 concludes.

2. A BRIEF DESCRIPTION OF JAPAN'S ECONOMIC GEOGRAPHY

This section describes the long-run trends in geographical distribution of manufacturing industries in

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[2] Formally, Japan has recently concluded the Economic Partnership Agreement with Singapore, but its quantitative impact on Japanese industries is minor and we should view its implication as rather symbolic.

Japan, relates them with international trade, and explains our motivations for focusing on the Japanese case after 1985.

First, the manufacturing has become more evenly distributed across regions in Japan, especially in the 1990s. The cross-regional variation of manufacturing employment during 1965-2000 is shown in Figure 1.[3] After a relatively stable geographical distribution in the 1980s, Japanese manufacturing has become more dispersed after around 1990. This decline of cross-regional standard deviation in the 1990s is not due to the decline of the total/average employment because the standard deviation divided by the mean, omitted from Figure 1, also decreased.[4] This finding motivates us to examine the relationship between internal geography and international trade since increasing import penetration is simultaneously observed around the same period, as we explain below.

Second, Japan's imports began to rapidly increase after 1985. As shown in Figure 1, imports of manufactured products, which had been limited and stagnant before 1985 partly due to protectionist measures, exploded mainly triggered by the unprecedented yen appreciation after Plaza Accord in 1985.[5] The import share is generally on the rising trend after 1985 in many industries.[6] During the same period, Japanese manufacturing has become deeply integrated with neighboring Asian developing economies also through foreign direct investment, relocating production sites, for example, for unskilled-labor intensive final assembly lines. Such a drastic change in international

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3 Although declining concentration was also observed in the 1970s, the change in the last decade is larger (growth rate: 22%>19%).

4 Gini coefficient of regional manufacturing employment also decreased during the 1990s. The cross-section variance of input-output linkage variables, defined in the next section, also slightly decreased during our sample period. Calculated results will be available upon request.

5 The change in relative import price (import WPI/domestic WPI) of two-digit industries is as large as 17–48% in 1985-86, while changes in other years, except in oil shocks, are less than nine percent. The real effective exchange rate of yen had been also stable until 1985, but recorded large appreciations in the late 1980s and in the early 1990s. On the other hand, the evaluation of tariff changes in this context is difficult since protections are often provided by non-tariff measures.

6 The growth of import share for each industry is reported in Appendix Table AII.

trade must have non-negligible impact on domestic industries.[7] Some local economies dependent on import-competing industries or on concentration of small-sized subcontractors for final assembly manufacturers are reported to experience frequent plant shutdowns and increasing layoffs.[8] These episodes must be confirmed by econometric analysis.

Thirdly, the year 1985 also appears one of the major turning points for internal economic geography in Japan. The Japan's economic geography before 1985 seems characterized by the convergence among the three largest industrial centers.[9] As a result of this convergence shown in Figure 1, these three prefectures end up with approximately equal number of manufacturing employment (one million people for each) at 1985.[10] The major factors behind this convergence may include the urban congestion, such as continuously rising land prices.[11]

After 1985, however, the three largest industrial centers have begun to diverge. The largest manufacturing center in Japan is now Aichi, which is famous for its home base of the world-competitive large auto manufacture Toyota and for various supporting mechanical industries. On the other hand, Tokyo shifts heavily toward service industries, such as financial services.[12]

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7 During 1985-90, employment in import-competing manufacturing industries was often easily shifted to non-tradable service industries, which expanded due to the domestic bubble boom. In the 1990s after the burst of the bubble, the rise of overall unemployment is the serious issue in Japan.

8 The impact of intense import competition on regional employment is often reported in Japanese media. For example, some industry associations demand safeguard measures to the government. Relocations of large manufacturers to Asian developing countries threaten the accumulated technological capability based on long-term supply networks among regional subcontractors.

9 These three prefectures continue to occupy one-quarter to one-third of total manufacturing employment in 47 prefectures.

10 The Japan's geography with three equally sized industrial centers differs from the Mexican experience, where Mexico City is the sole dominant industrial concentration. This difference, however, does not make Japan's geography uninteresting, since it has drastically changed and the testable implications of the theory remain applicable. The intense import competition is not a candidate for the convergence during this early period since domestic markets were generally closed and since the yen exchange rate was stably at the depreciated level.

11 During this period, manufacturing employment in the other smaller prefectures, omitted from Figure 1, continued to grow until early 1990s, except only in years hit by oil shocks.

12 Even if firms in manufacturing industries remain in Tokyo, they are usually no longer involved in production process but specialized in headquarter function. The employment captured by *Census of Manufacturers*, shown in Figure 1, is defined as the aggregate employment in manufacturing plants, excluding headquarter offices, sales branches and research laboratories.

Osaka, of which the unemployment rate is now among the highest in Japanese regions, is in a difficult adjustment from stagnant production activities.[13] Divergent trends are observed also among smaller prefectures.[14] The experience of such different evolutions under active international trade suggests a critical role of regional industrial structure, rather than the general dispersion trend from urban congestion.[15]

Motivated by these observations, this paper examines the evolution in Japanese regions after 1985 and relates it with regional inter-industry linkages. Since the import penetration does not necessarily affect employment instantaneously, and since total manufacturing employment in Japan turned from expansion to shrinkage at around 1990, this paper mainly focuses on the regional/industrial variations of employment decline in the 1990s.[16]

3. AN EMPIRICAL MODEL

This section formalizes the specification and explains variables used for regressions. First, consider the profit function Π with standard properties and differentiate it with respect to wage. By Hotelling's Lemma, the labor demand is given by

$$L_{rjt} = -\frac{\partial \Pi\left(w_{rjt}, p_{jt}, z_{rjt}\right)}{\partial w_{rjt}} \qquad (1)$$

,where L and w are employment and wage, respectively. The output price is expressed by p. Other factors affecting the profit are captured by z. The subscript r and j index the region (r=1, 2,…, R) and

13 According to the most recent *Employment Structure Survey* (Shugyo Kozo Kihon Chosa in Japanese), the unemployment rate in Osaka is nine percent while the national average is five percent at September 2002.

14 For example, among the relatively large prefectures following the three centers, Kanagawa and Saitama remains relatively active in manufacturing, Hyogo declines, while Shizuoka expands.

15 Compared with the earlier period, the urban congestion is now less serious, as population inflows into largest cities nearly ceased and land prices have dropped significantly since early 1990s after the burst of real estate bubble.

16 The timings of changes in economic geography and in foreign trade do not necessarily coincide. In the case of Mexican states, Hanson (1998) finds that the breakup of dense manufacturing concentration in Mexico City had already begun before the start of trade liberalization.

the industry (j=1, 2, …, J) at time t, respectively.

To evaluate the evolving geographical concentration of industries across regions, we must distinguish unobserved region-specific factors, such as natural resources and resident amenity. Since these region-specific effects are not likely to change dramatically over time, we focus on the growth rates. This paper estimates the following log-linear specification.[17]

$$\Delta \ln\left(\frac{L_{rjt}}{L_{jt}}\right) = \alpha + \beta_0 \ln INP_{rj,t-1} + \beta_1 \ln OUT_{rj,t-1} + \gamma \ln WAGE_{rj,t-1} \\ + \delta_0 \ln IIA_{rj,t-1} + \delta_1 \ln SCL_{rj,t-1} + \delta_2 \ln DIV_{rj,t-1} + \delta_3 \ln SIM_{rj,t-1} + \varepsilon_{rjt} \tag{2}$$

The error term is expressed by ε. All variables are defined relative to the national average of the corresponding industry, as explained below. Taking deviations from national averages eliminates common factors in z and leaves all variables region-industry specific. To avoid the simultaneity problem, all the explanatory variables are one-period lagged. Thus, this paper specifies the relative employment growth as a function of initial conditions of the region-industry relative to the national average of the industry.[18]

The definition of the variables is explained as follows. First, *WAGE* is defined as relative to the industry's national wage. The negative sign is expected in the labor demand function.

$$WAGE_{rj} = w_{rj} / w_j \tag{3}$$

The wage variable is also supposed to partly reflect urban congestion, such as high land prices and costly commuting.[19]

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17 This type of specification is standard in analyzing changing economic geography. See Hanson (1998) and Mano and Otsuka (2000), for example.

18 Various factors in neighboring regions or in closely-related other regions might also affect labor demand in the region. Industry-specific dummy variables, α, partly control for trade costs. Trades between neighboring regions are not necessarily less costly depending on road development and on real geography (e.g. high mountains). Later, we will use road data and regional block dummies.

19 Although the wage should be defined after controlling for regional price differences, we skip this process due to the limit of data availability. Previous studies, including Hanson (1998), also follow this definition. Although our wage variable still partly captures urban congestion effects, the perfect adjustment of real wage makes other geography-related variables totally unnecessary.

Next, to capture the inter-industry linkages, we define the two indices,

$$INP_{rj} = R\sum_{h\neq j}\left(\frac{X_j^h}{X_j}\right)\left(\frac{Q_{rh}}{Q_h}\right)$$
$$OUT_{rj} = R\sum_{h\neq j}\left(\frac{X_h^j}{X^j}\right)\left(\frac{Q_{rh}}{Q_h}\right) \qquad (4)$$

,where X_k^h, X_j and X^j denote the intermediate transaction from industry *h* to industry *k*, total input supplied to industry *j*, total output from industry *j*, respectively.[20] (Q_{rh}/Q_h) is the region *r*'s share in industry *h* in terms of output/shipment. Thus, these indices are weighted averages of vertically linked upstream and downstream industries within a region.[21] The multiplication by *R* (total number of regions) standardizes the average across regions as one.

Compared with the intermediate expenditure rate (= $(Q_j - ValueAdded_j)/Q_j$), this definition excels in that rich matrix-format information from Input-Output Table is exploited.[22] As far as the author knows, no previous studies have explored the relationship between domestic geography and international trade squarely through the input-output linkage, which the theory assigns the pivotal role of translating international trade into domestic geography.[23]

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[20] This definition closely follows that by Dumais et al. (1997). Several notes should be in order. First, we use shipment share, instead of employment share, to avoid possible simultaneity and to be more consistent with I-O transactions values. Second, we omit linkages between neighboring regions. Although introducing gravity-type weights is a possible solution, actual economic costs of transportation depend on road development. Since the highway network in Japan seems to have Tokyo as the hub, transactions between neighboring regions are not necessarily inexpensive. We will discuss road-based trade cost index and regional block dummies in the next section.

[21] The effect of own industry is excluded and is instead captured by the intra-industry agglomeration, defined below as (5). The reasons for this distinction will be explained there.

[22] Although some previous studies, such as Amiti (1999) and Paluzie et al. (2001), use it as a convenient proxy, the ratio of intermediate payment is imperfect because, for example, this ratio looks at only downstream industries. We confirmed that this proxy turned out to perform poorly in our regression exercises. Hanson (1998) uses the employment share of two-digit in four-digit industry, but industries do not necessarily predominantly purchase from or supply to other four-digit industries in the same two-digit industries.

[23] Ades and Glaeser (1995) bypass inter-industry linkages in their reduced-form cross-country regressions, although they relate internal geography with external trade. Besides, they report that their finding of negative relation between foreign trade and the largest city size is not robust after controlling for the endogeneity. Hanson (1998) and Paluzie et al. (2001) devise their vertical-link

After trade liberalization, manufacturers find no longer necessary to locate near other manufacturers and/or consumers, and instead prefer locating far from geographical concentration to avoid congestion.[24] In other words, industrial concentrations established previously as optimal under closed economy are likely to turn out to be excessively concentrated after trade liberalization since inexpensive imported products partly replace trades within the region. Therefore, the coefficients on these input-output linkage variables, β, must be negative if previously established concentrations are being destroyed. We can interpret this test of changing geography by the sign of β as similar to "β-convergence" in the growth literature.[25] Since we have already found preliminary evidence for "σ-convergence," i.e. declining cross-regional variation over time as reported in Figure 1, in our case, the sign of β is regarded as informative for investigating regional changes.[26]

In analyzing vertical linkages, we must distinguish backward linkage and forward linkage from the following reasons. First, since the location with rich supply of manufactured inputs is not necessarily the location proximate to large output-absorbing manufacturing industries, the distinction is critical in economic geography. Low correlation between these two indices in the real world will be confirmed later in Japanese data. Second, since the tradability of inputs may considerably differ from that of outputs, the distinction is interesting in examining the impact of international trade changes. Manufactured outputs as final products are normally traded across national borders under

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variables, but they do not use rich information from input-output matrix.

24 Similar geographical dispersion is also observed when domestic trade costs decrease. Although we cannot directly distinguish them, our sample period is clearly characterized by drastic change in foreign trade, not by active construction of new highways in Japan. Besides, it is unlikely that new road construction significantly affects trade costs in short period like our sample period. We will add a proxy for trade costs into the regression in the next section.

25 Although, as Quah (1993) pointed out, the negative β does not necessarily mean that industries locate more evenly over time, the regression on initial conditions is a convenient specification for examining effects of various control variables. We must also note that β-convergence test in the growth literature is on the initial level and growth of exactly the same variable, while this paper relates initial level of weighted outputs in related industries with growth of employment.

26 In addition to the cross-regional standard deviation reported in Figure 1, the standard deviation divided by the mean, and Gini coefficient of manufacturing employment also decrease in the 1990s. Besides, cross-section variance of *INP* and *OUT* slightly decreased during our sample period.

free trade, while intermediate inputs into manufacturing, such as parts and components, are likely to be specially designed and still often purchased from suppliers with long-term relations/networks. If the international tradability of manufactured intermediate products increases as chains of production processes comes nearer to the final products, opening trade tends to first weaken manufacturer's linkages with output customers before linkages with input suppliers.

This paper primarily focuses on the input-output linkages among tradables, i.e. manufacturing industries to discuss the impact of import penetration, but we will also report comparable results for inputs from all other industries including non-tradables, i.e. non-manufacturing (*INP (all)*), all intermediate outputs supplied to all other industries including non-manufacturing (*OUT (ind)*), and all outputs including those absorbed by final demand such as household consumption (*OUT (all)*).

Other geography-related variables are defined as follows.[27] First, *IIA* is an index for intra-industry agglomeration, also known as Marshall-Arrow-Romer externalities.

$$IIA_{rj} = \frac{L_{rj} / L_r}{L_j / L} \tag{5}$$

This paper distinguishes the intra-industry agglomeration and the inter-industry linkages from the following reasons. First, as will be shown in Japanese data, the agglomeration of own sector does not necessarily coincide with the geographical concentration of related other industries. Second, the relative strength of intra-industry agglomeration compared with inter-industry linkages theoretically plays an important role in the geography model.[28] Finally, the focus of this paper is to investigate whether inter-industry linkages among regional industries, rather than agglomeration generally, are

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[27] If we can observe true real regional wage, the wage must be the sufficient statistics for geography and other geography-related variables are unnecessary. However, adjusting publicly available wage data by regional differences in prices and in product variety is practically impossible.

[28] In the theory model developed by Fujita, Krugman and Venables (1999), geographical concentration of particular industry is observed when intra-industry agglomeration effect is stronger than inter-industry linkage effect.

undermined during the period of increasing import penetration.

Second, *SCL* is a proxy for the economies of scale.

$$SCL_{rj} = \frac{L_{rj} / N_{rj}}{L_j / N_j} \quad (6)$$

,where *N* is the number of plants. This average plant size variable is intended to evaluate the region-industry differences in technology, especially in the degree of internal increasing returns.

Third, *DIV* is an index of industrial diversity based on the squared sum of shares of all other industries.

$$DIV_{rj} = \left[\sum_{h \neq j} \left(\frac{L_{rh}}{L_r} \right)^2 \Big/ \sum_{h \neq j} \left(\frac{L_h}{L} \right)^2 \right]^{-1} \quad (7)$$

This index, defined as the inverse, becomes larger as the employment is more evenly distributed across industries. If the diversity of industries in a region generates positive externalities through cross-fertilization of ideas, the employment in more diversified regions must grow at higher speed. Since knowledge spillover tends to be local, this regional diversity effect is expected to survive even after trade liberalization.

Finally, following Dumais, Ellison, and Glaeser (1997), this paper introduces *SIM* to measure the similarity of industries located in the same region. As firms requiring similar types of workers locate near each other, workers gain due to insurance from firm-specific shocks or from ex-post appropriation of accumulated human capital, as was pointed out by Rotemberg and Saloner (2000). Firms also gain from richer pool of specific type of labor supply in the region.[29] If this type of Marshallian labor pooling is significant, the employment grows faster in the regions where industries with more similar labor requirement locate. Let me index the type of occupation (e.g.

[29] Although this index is intended to test the Marshallian labor pooling hypothesis, the same index could capture other industrial characteristics because industries require similar types of workers tend to share other industrial attributes.

professional/technical, production, and others) by *y*. The share of occupation *y* in industry j's employment is expressed by s_{yj}. Naturally, $\sum_y s_{yj} = 1$ for any industry j.

$$SIM_{rj} = \left\{ \frac{\sum_y \left[s_{yj} - \sum_{h \neq j} \left(\frac{L_{rh}}{L_r - L_{rj}} s_{yh} \right) \right]^2}{\sum_y \left[s_{yj} - \sum_{h \neq j} \left(\frac{L_h}{L - L_j} s_{yh} \right) \right]^2} \right\}^{-1} \tag{8}$$

This index is based on a sum of squared deviations of the occupation mix of the industry and the weighted average of occupation mixes of other industries located in the same region. As in other variables, we define this index relative to the national average of the industry. By taking the inverse, this index becomes larger as more similar industries are clustered nearby. After trade liberalization, this similarity effect is expected to play a larger role since each region becomes more specialized in international division of labor while regional labor remains immobile.

To construct these indices, this paper derives region-specific industry data from Japan's *Census of Manufacturers* (Kogyo Tokei in Japanese).[30] Detailed explanations of our data set are given in Appendix 1. The whole manufacturing is disaggregated into 21 industries at the two-digit level.[31] The total number of regions (prefectures) in Japan is 47.[32] Thus, we have 987 region-industry observations for each year.[33] To capture the long-term trend of the period with

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[30] Other variables that have been included in the regression are factor abundance and technology differential. We constructed proxies following previous studies, such as Amiti (1999) and Palzie et al. (2001), but found that they are statistically significant in no specifications.

[31] Although more disaggregated data will reveal rich information, our dependence on two-digit data is constrained by the public availability of region/industry specific data in electronic form. To analyze Japan's economic geography, previous studies also use two-digit classifications. Mano and Otsuka (2000) examine five two-digit machinery industries. Dekle (2002) depends on one-digit industry classifications. Davis and Weinstein (1999) use the data of 19 two-digit industries.

[32] The unit of region, prefecture (ken in Japanese), has much higher population density than U.S. states and is more like U.S. cities. Aggregating prefectures is not suitable here since even neighboring prefectures often differ considerably in employment growth and industrial structure.

[33] Due to the confidentiality considerations, data for some region-industry cells are not published. For computational simplicity, we assume that figures for these cells are equal to the national average. Since these unavailable cells tend to small in size, this may overestimate the impact of these tiny

increasing import penetration, we use data in 1985, 1990, and 2000.[34]

The other major data source used for this paper is *Input-Output Table*.[35] The data for *SIM* are drawn from *Input-Output Table*, of which the Employment Table disaggregates employment by occupation types. This paper combines this industry-labor requirement matrix with the region-industry employment data in *Census of Manufacturers*.[36]

The descriptive statistics are summarized in Table I. Since all the variables are defined as relative to the national average, most of the averages are around one (zero for $\Delta \ln(L_{rj} / L_j)$, which is in log difference). Substantial cross-sectional variability is evident from the table.

The correlations between variables are shown in Table II. Many variables at 1990 are negatively correlated with employment growth in the 1990s, but we must control for them simultaneously in the regressions.[37] The noteworthy finding from this matrix is that the location proximate to large output-absorbing other manufacturing industries does not coincide with the location with rich input supply from other manufacturing industries (*Corr(INP,OUT)*=0.23). Consequently, in manufacturing, we must explicitly distinguish forward linkages from backward linkages.[38]

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prefectures/industries. However, as the number of unavailable cells is quite small, the biases by this imputation on overall estimates will be small as well.

34 This choice of the sample intervals is comparable with that by Hanson (1998) as he uses data from 1980-1985 and 1985-1993. As the trend in employment during the 1990s appears almost monotonic, we combine all the years in the 1990s focusing on long-run trends.

35 Among 21 industries, the transport equipment industry has no output purchased as intermediate inputs by other manufacturing industries. To take logarithm, we add negligible 10^{-8}. To check the robustness, we also conduct regressions on the sample excluding this industry.

36 The professional/technical occupations include scientific researchers and lawyers, which are normally supposed to require college degrees. On the other hand, the production occupation is roughly corresponds to the category of production workers in *U.S. Census of Manufacturing*. Although the employment data of more disaggregated 288 occupation types are available, the broad aggregation is appropriate for our purpose because Japanese labor market is not finely segmented by occupation types.

37 This table also confirms that multicollinearity is not serious between any variables except for alternatively defined input-output link variables.

38 Since the same table also shows that *IIA* is not significantly correlated with inter-industry linkages (correlation=0.15–0.19), we must distinguish the intra-industry agglomeration from

4. EMPIRICAL RESULTS

4.1. Basic regression results from manufacturing industries

All industries are pooled with the constant term varying across industries, while we will discuss differences across industries in Appendix 2.[39] The regression results are shown in Table III.[40] The standard errors are corrected by White's heteroskedasticity-consistent estimates. The difference between two sub-periods (1985-90 and 1990-2000) is statistically significant, as the Chow Test rejects the equality of coefficients at any conventional confidence levels.[41]

First, as expected in the labor demand function, the wage is negatively related with employment growth.[42] The manufacturing escaped from high-wage regions particularly during 1985-90.[43] This wage effects may partly reflect other omitted factors related with urban congestion, such as high land prices in the period of real estate bubble.

Second, estimated coefficients on the input-output linkage variables, especially on the output linkage variable, are significantly negative in 1990-2000, while they are mostly insignificant, and the

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inter-industry linkages as well. On the other hand, if we include non-manufacturing and final demand, the distinction between input link and output link is less important, as the large presence of final consumers naturally quite often implies the large input-supplying service industries in the same region (*Corr(INP(all), OUT(all))*=0.90). This paper, however, focuses mainly on manufacturing, i.e. tradable industries, to evaluate the impact of international trade.

39 In the Appendix 2, we allow all coefficients to vary across industries while errors in the same region may be correlated.

40 To check the robustness, we will report not only the estimates of the full specification (2) but also those omitting geography variables other than input-output linkages. To eliminate all fixed effects, the inclusion of dummies is appropriate but some variables such as *DIV* vary little across industries within a prefecture. Adding 46 region dummies will also considerably lose degree of freedom. Hence, only industry-specific dummies are included. We will, however, include dummies for regional blocks, as used by Mano and Otsuka (2000) for similar Japanese data, in the next section. See Hanson (1998) for discussions of error structures in a similar specification.

41 The statistics for the restricted regression will be available upon request.

42 In Europe, Brulhart (2001) finds that 17 out of 32 industries, especially labor-intensive cost-sensitive industries, are concentrated in peripheral (low market potential) countries rather than central (high market potential) countries.

43 The finding of insignificant wage effect in the 1990s is consistent with recent high unemployment rate.

input-link was even weakly positive, in 1985-1990.[44] In other words, the employment declined more during the 1990s in regions where larger output customers are present in the same region at the year 1990.[45] This weakening linkage with output-absorbing manufacturers appears not directly caused by general dispersion trend of population because population mobility becomes less active in the 1990s.[46]

The inter-industry linkage is destroyed with output customers, not with input suppliers, maybe because intermediate inputs into manufacturing production such as parts and components, compared with manufactured outputs as final products, are more likely to be specially designed and difficult to purchase from arms-length trades in global spot markets. The contrasting evolution of manufacturing in the three industrial center regions, introduced in Figure 1, may also partly be attributable to the relatively strong mechanical input supplier industries in Aichi, while urban population concentration in Tokyo no longer attracts manufacturing activity. We will discuss this finding again in the next sections.[47]

Third, intra-industry agglomeration, *IIA*, is significantly negative, while internal increasing returns to scale, *SCL*, seems insignificant.[48] This suggests that each industry has already been

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[44] This finding is consistent with previous results. Hanson (1998) discovers that the effect of his linkage variable becomes smaller after the trade liberalization in Mexico. Paluzie et al. (2001) finds that their linkage index has a negative effect on industry concentration in 50 Spanish provinces after Spain joined EU. Although she finds positive coefficient from five major European countries on the same variable as that by Paluzie et al. (2001), her sample period is 1976-1989 before the completion of the single market. Although they find significant effect of regional demand on regional production from Japanese prefecture data, Davis and Weinstein (1999) compare the home market effect with the factor abundance theory as the alternative hypothesis by using cross-section data at 1985.

[45] The columns (2) and (5) in Table III confirm that the output linkage is negative in 1990-2000 even if we exclude transport equipment industry, which has no outputs purchased as intermediate inputs by other manufacturing industries.

[46] The congestion effects must be rather captured by the wage term. Further, manufactured input-output linkages are not correlated with urban congestions in our sample. See low correlations between *INP/OUT* with *OUT(all)* in Table 1, for example.

[47] The discussions in this paragraph, combined with the declining cross-regional variation shown in Figure 1, also suggest that the weakening input-output linkages in our case tends to be stronger than general trend of regression toward the mean.

[48] This finding is consistent with previous studies of Japanese data (e.g. Dekle (2002) and Mano and Otsuka (2000)). Hanson (1998) also reports that relative plant size and intra-industry agglomeration

excessively concentrated in Japan while internal increasing returns are no longer significant for manufacturing in the age of networking and outsourcing.[49]

Fourth, while the industrial diversity of the region, *DIV*, significantly reduced growth during 1985-1990, this negative effect disappeared or weakly reversed in the 1990.[50] We may interpret it as an indication that the cross-fertilization of ideas becomes more critical for Japanese industries in recent years. This result is also consistent with our experience of declining regions specialized in narrow ranges of industries.

Finally, the mechanism of labor pooling appears working in the 1990s, as evidenced by significantly positive coefficient on the similarity variable *SIM*.[51] This may be consistent with the observations after opening trade. As each region becomes more specialized in more involved international division of labor, regions where industries with similar labor requirement locate close each other are more likely to grow.

By combining these findings, we can argue that specialized human skills, which tend to be immobile, and knowledge spillovers, which tend to be local, affect regional growth more significantly in recent years. As workers are quite immobile across regions even within a country, regions critically vary in terms of human capital accumulations and of activeness of cross-fertilization of ideas.[52] As trade in goods become more active around the globe, the geographical proximity matters less for transporting tradable goods, but stays important (or becomes

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are negatively or insignificantly related with employment growth in Mexico, although significantly positive estimates have been reported for the relative plant size variable in the European cases (see Amiti (1999) and Paluzie et al. (2001)).

49 The negative effect is significant both in 1985-90 and 1990-2000 for *IIA*, while it is only in 1990-2000 for *OUT*. Here, again, we must distinguish intra-industry agglomeration and inter-industry linkages.

50 Hanson (1998) finds that the industrial diversity has insignificant or negative estimate in a similar specification for Mexico.

51 Dumais et al. (1997) also report strong effect of similarity of local industries in U.S. data.

52 In spite of large variations in unemployment rates and in income levels, the inter-regional labor mobility remains quite low. According to the Census Bureau, less than half of population mobility is across prefectures in Japan. The share of inter-prefecture mobility is still much lower in employment. Similar observations are reported for Europe. See, for example, Fiani et al. (1997).

more important) for knowledge spillovers and specialized labor supply, both of which are not the typical inputs captured by strict definition of Input-Output Tables but clearly considered as non-tradable inputs. Active international trade tends to lessen the dependence on regional customers in selling tradable goods, but to rather emphasize regional non-tradable sectors and immobile factors.

This finding of significant roles played by regional non-tradable inputs also has deep policy implications. Our results show that manufacturers no longer find necessary to locate proximate to other manufacturers, but instead prefer to locate in the region where rich non-tradable inputs are available. We can interpret it as suggesting that industrial policies targeting critical industries to promote manufacturing concentrations should, after trade liberalization, be replaced by regional economic policy enhancing human capital development and information spillovers.

4.2. Alternative variables related with tradability

This paper has so far concentrated on the input-output linkages among tradables, i.e. manufacturing industries to discuss the impact of imports. The input-output linkages, however, are not contained within manufacturing. Large portions of inputs to manufacturing are supplied by service industry, while some outputs from manufacturing are absorbed by non-manufacturing industries as intermediate inputs and by household consumption. Therefore, this section compares alternative definitions of input-output linkage variables.

Table IV reports the results from alternative input-output linkage variables. All the coefficient estimates are basically robust across different specifications. While the input linkage, either defined by inputs from other manufacturing industries (*INP*) or inputs from all other industries including non-manufacturing (*INP (all)*), is found statistically insignificant, the output linkage, either defined by outputs purchased by other manufacturing industries (*OUT*), outputs purchased by all other industries including non-manufacturing (*OUT (ind)*), or all outputs including those absorbed by final demand (*OUT (all)*), is clearly significant.[53]

Consequently, the proximity advantage of locations close to output customers, including final consumers, is weakened, while the linkages with input suppliers remain unchanged. Since we find around the same coefficient estimates and significance levels for alternative definitions of output linkage variables, not only cost-sensitive manufacturers, but also households have switched to purchase products supplied from other regions. The surge of import share particularly in final consumption goods and relatively stagnant import of intermediate inputs in Japan are consistent with our results. The contrasting results between input link and output link, previously reported within manufacturing industries, are confirmed robust even if non-manufacturing sectors and final absorption are included.

We also find in Table IV that the statistical significance and magnitude of coefficient estimates for the industrial diversity of region (*DIV*) and the similarity of labor-requirement of regional industries (*SIM*) are substantially attenuated if we include non-manufacturing sectors and final demand components in defining input-output linkage variables. This contrast is rather natural because the stronger presence of service industry or of consumers in the region is supposed to be associated with more active knowledge spillovers among diversified sectors or richer accumulation of specialized human capital in the region.

Although we have so far assumed that trading manufactured goods is costless, transportation costs cannot be neglected even within a country. Hence, next, this paper controls for trade costs of manufacturing.[54] Since measuring all trade costs is empirically impossible, this paper defines the

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53 This confirms that our finding of weakening linkage with output customer is stronger than general dispersion trend from urban congestion because locations with large output-absorbing other manufacturers, *OUT*, are not necessarily locations with large population, which is highly correlated with *OUT(all).*

54 The distance to major ports/airports may be another proxy candidate for trade costs. However,

trade costs *TRC* by the following proxy.

$$TRC_{rj} = \left\{ \frac{T_r}{\sum_r \left[\left(\frac{L_{rj}}{L_j} \right) T_r \right]} \right\}^{-1} \tag{9}$$

, where T is the ratio of land used as roads in the total area of each prefecture.[55] Since the road transportation occupies the largest share in shipping goods in Japan compared with air, railroad and water transports, this inverse measure is supposed to capture actual transport cost variations. As the denominator is the weighted-average over regions for each industry, this index is region- as well as industry-specific.[56] As an alternative proxy for trade costs, this paper also introduces dummy variables for regional blocks, which aggregate 47 prefectures into nine blocks, to take account of the trade facilitating effects of geographical proximity and of local cultural similarity.

The regression results including the road-based trade cost in logarithm or regional block dummies, reported in the last two columns of Table IV, confirm that previous findings are robust even after trade costs are considered. Besides, the negative impact of manufacturing trade costs is found significant.[57] Combined with discussions of non-tradable inputs, this result provides additional evidence for the critical role of tradability on regional manufacturing.

5. CONCLUDING REMARKS

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locations of major ports/airports tend to coincide with industrial concentrations. Actually, in our sample, most major ports/airports are located in the prefectures nearly overlapped with the Pacific Industrial Belt in Japan.

55 Compared with total distance of roads in kilometer, the measure of land area used for roads in terms of square kilometer is better in capturing actual transportation capacity.

56 This weighting follows that by Hanson (1998), where he uses geographical road distance from state capital to the nearest U.S. border in Mexican states.

57 The distinction of trade cost effect from industrial agglomeration, however, is empirically difficult because locations with low trade costs naturally attract industry concentrations. The statistical significance of output linkage decreases when trade costs are included. For regional block dummies, some of them are statistically significant, though omitted from the table to save space.

This paper has examined the changing economic geography in Japan during 1985-2000. The findings of this paper have not necessarily reject other alternative interpretations, for example, relating observed changes with the spread of information technology, but have provided evidence at least consistent with the prediction based on geography and trade.

Although regional transactions of manufactured final products turned to matter less, the role of geography does not necessarily diminishes as the country becomes more open. Specific human skills or diversified ideas accumulated and exchanged within a region affect the industrial location even after global free trade in goods realizes.

Appendix 1 Description of data

All the data in *Census of Manufacturers* are downloaded from the web page of the Japan's Ministry of Economy, Trade and Industry. The employment (L) is the number of employees. The wage (w) is defined as the total wage payment divided by L. We aggregate apparel (14) and textile (15) because of the change in the industry classification during our sample period. The ordnance industry (33) is merged into the general machinery industry (29). As a result, we have 21 two-digit industries. Since the unit of region we use is the prefecture (ken in Japanese), we have data for 47 regions.

The inter-industry transaction data (X) are drawn from the 90 Sector Table in Japan's *Input-Output Table* (1990 Input-Output Benchmark Table compiled by the Management and Coordination Agency). We aggregate I-O sectors to match two-digit industries. The non-manufacturing sectors are disaggregated into ten sectors and ten service industries, while final demand is disaggregated by Gross Prefectural Domestic Expenditure data into the following four components: private final consumption, government final consumption, private investment, and public investment.

To calculate region shares for *INP* and *OUT*, the shipment values (Q), derived from *Census of Manufacturers*, are used for 21 manufacturing industries, while the prefecture-level data for 1990 fiscal year in *Annual Report on Prefectural Accounts 2001*, complied by Cabinet office, are used for nine non-manufacturing sectors (except education-research) and all four final demand components. The Gross Prefectural Domestic Product by kind of Economic Activity, defined in terms of value-added is used for nine non-manufacturing sectors because gross output data are not available for Tokyo. For the education and research sector, region shares are calculated in terms of numbers of full-time teachers in all universities and colleges, derived from *Basic Survey on School Education* by the Ministry of Education and Science. The data for calculating regional shares of the ten service industries are derived from 1989 *Survey of Service Industries* by Census Bureau.

The industry-specific occupation type data (s) are derived from Industry-Occupation Table of Employment Matrix in *Input-Output Table* (Appendix Table 7 in Data Report (2) of 1990 Benchmark Table). From nine occupation types, we pick up the following two occupations: (1) professional or technical occupations (Occupation Classification Code No.1), and (2) mining/production/construction workers and apprentices (No.9). The other seven occupation categories aggregated here as "other" are managerial (No.2), clerical (3), sales (4), service (5), security (6), agricultural, forestry, or fishing (7), and transportation or communication (8). In formulating *SIM*, we include all manufacturing industries as well as construction industry and service industry. The region-specific employment data for these non-manufacturing industries are drawn from *Population Census of Japan* (Kokusei Chosa in Japanese) compiled by the Statistics Bureau, the Management and Coordination Agency.

The data for roads are at April 1990, derived from *1991 Road Statistics Annual* by the Ministry of Construction. All roads, including those managed by local authorities, are covered.

The dummy variables for regional blocks is defined by the classification in *Inter-regional Input-Output Tables* by the Ministry of Economy, Trade and Industry, where Japan is divided to the nine blocks (Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa).

The import and export data, used for Appendix Table AII, are also derived from *Input-Output Table* (1985, 1990 and 1995 Benchmark Tables by the Management and Coordination Agency and 1999 Updated Table by the Ministry of Economy, Trade and Industry) because usual foreign trade data from Custom Clearance Statistics is not compatible with domestic industry classification. The 1999 Updated Table, published in 2002, is the most recent Input-Output Table at the time of this research. The growth rate shown in Appendix Table AII is the average of growth rates of three intervals (1985-1990, 1990-1995, and 1995-1999). Since the three industries (beverage, tobacco, and feed (2), furniture and fixture (17) and leather and fur products (24)) are not identified in the 1999 Table due to industry classification changes, the growth rate averaged over 1985-1990 and 1990-1995 are shown for these industries.

Appendix 2 Industry results

The panel regressions reported in the main text constrained all the coefficients except the constant term to be equal across all industries. The impact of geography, however, is likely to differ depending on the industry. Consequently, we allow all the coefficients to vary across industries.

$$\begin{aligned}\Delta \ln\left(\frac{L_{rj}}{L_j}\right) &= \alpha_j + \beta_{0j} \ln INP_{rj} + \beta_{1j} \ln OUT_{rj} + \gamma_j \ln WAGE_{rj} \\ &\quad + \delta_{0j} \ln IIA_{rj} + \delta_{1j} \ln SCL_{rj} + \delta_{2j} \ln DIV_{rj} + \delta_{3j} \ln SIM_{rj} + \varepsilon_{rj}\end{aligned} \tag{A1}$$

Since the error terms in different equations may be correlated because the region-specific shocks affect different industries located in the same region in the same direction, we assume that

$$E(\varepsilon_{rj}\varepsilon_{sh}) = \sigma_{jh} \qquad \text{for } r = s$$

$$\text{zero} \qquad \text{otherwise} \qquad \text{(A2)}$$

This structure of error terms (A2) requires us to estimate 21 equations of (A1) as a system by seemingly unrelated regressions (SUR). The results from SUR estimation for 1990-2000 are summarized in Appendix Table AI.[58] For *OUT*, nine out of 21 industries have negative coefficients statistically significant.[59] On the other hand, only three industries have significantly negative estimate for *INP*.[60] Besides, the combination of negative *OUT* and positive *INP* is observed in three industries, while the opposite combination is in no industry.

Appendix Table AII shows that the growth rate of import share averaged over these nine industries is considerably higher than that averaged over all industries.[61] Therefore, the declining vertical linkage is related with import penetration because the output link is particularly undermined in industries with rapidly rising import shares.

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58 Complete estimation results for individual industries will be available upon request.

59 There is only one industry with positive coefficient on *OUT*, but that industry is heavily regulated and protected by various measures.

60 Among them, the food industry can be interpreted as an outlier because this industry appears to be strongly affected by domestic regulations and import protections.

61 The relative import price (import WPI/domestic WPI) exhibits little variability across industries in our sample. The region-specific trade data are not generally available, since the data from *Interregional Input-Output Tables* are available only for broadly aggregated nine regional blocks.

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TABLE I
SUMMARY STATISTICS

	Average	St. Dev.	Max	Min
$\Delta \ln(L_{rj} / L_j)$ (1985-1990)	0.044	0.218	1.419	–2.279
$\Delta \ln(L_{rj} / L_j)$ (1990-2000)	0.076	0.257	2.103	–1.324
INP	1.000	1.101	6.431	0.016
INP (all)	1.000	1.230	9.792	0.068
OUT	1.000	1.232	10.570	0.006
OUT (industries)	1.000	1.295	13.342	0.082
OUT (all)	1.000	1.237	12.203	0.088
IIA	1.016	0.836	10.987	0.027
SCL	1.114	0.611	6.063	0.140
DIV	0.770	0.195	2.105	0.364
SIM	1.165	1.106	29.685	0.040
WAGE	0.892	0.183	1.570	0.056

(Notes)

1. "Average," "St. Dev.," "Max," and "Min" are the unweighted average, standard deviation, maximum and minimum among all industries/prefectures. All variables are defined as relative to the national average of the industry. See text for abbreviations.
2. All the values except $\Delta \ln(L_{rj} / L_j)$ are those at 1990, while $\Delta \ln(L_{rj} / L_j)$ is the log difference between years.

TABLE II
CORRELATION BETWEEN VARIABLES

	L	*Wage*	*INP*	*INP (all)*	*OUT*	*OUT (ind)*	*OUT (all)*	*IIA*	*SCL*	*DIV*	*SIM*
L	1										
Wage	–0.28	1									
INP	–0.23	0.53	1								
INP(all)	–0.25	0.47	0.87	1							
OUT	–0.07	0.20	0.23	0.24	1						
OUT(ind)	–0.26	0.52	0.81	0.89	0.24	1					
OUT(all)	–0.25	0.51	0.82	0.90	0.23	0.99	1				
IIA	–0.43	0.38	0.19	0.19	0.19	0.16	0.15	1			
SCL	–0.23	0.33	0.14	0.04	0.16	0.01	0.03	0.51	1		
DIV	–0.17	0.31	0.48	0.37	0.12	0.28	0.29	0.35	0.15	1	
SIM	0.04	0.04	0.10	–0.03	0.02	0.02	–0.00	0.00	0.03	0.00	1

(Notes)

1. All variables are in logarithm form, while "L" in this table denotes the relative employment growth [$\Delta \ln(L(r, j)/L(j))$]. See text for other abbreviations.
2. All the variables except "*L*" are those at 1990, while "*L*" is the growth between 1990 and 2000. Shown is the correlation for each variable across all regions/industries combined.

TABLE III

REGRESSION RESULTS

Variables	(1) 1985-90	(2) 1985-90	(3) 1985-90	(4) 1990-2000	(5) 1990-2000	(6) 1990-2000
INP	0.0274 (0.0120)	0.0167 (0.0117)	0.0189 (0.0114)	–0.0104 (0.0123)	–0.0131 (0.0124)	–0.0132 (0.0134)
OUT	–0.0234 (0.0132)	–0.0149 (0.0135)	–0.0160 (0.0135)	–0.0295 (0.0129)	–0.0284 (0.0132)	–0.0183 (0.0137)
WAGE	–0.2459 (0.0639)	–0.2348 (0.0663)	–0.3279 (0.0592)	–0.0647 (0.0690)	–0.0741 (0.0734)	–0.2055 (0.0838)
IIA	–0.0556 (0.0144)	–0.0575 (0.0146)	-----	–0.1175 (0.0167)	–0.1150 (0.0169)	-----
SCL	0.0193 (0.0268)	0.0083 (0.0276)	-----	0.0023 (0.0225)	0.0004 (0.0228)	-----
DIV	–0.0778 (0.0288)	–0.0589 (0.0288)	-----	0.0582 (0.0345)	0.0583 (0.0354)	-----
SIM	0.0011 (0.0094)	–0.0026 (0.0095)	-----	0.0277 (0.0138)	0.0278 (0.0142)	-----
R^2	0.1738	0.1759	0.1266	0.2670	0.2709	0.1590

(Notes) The dependent variable is the region-industry employment growth rate relative to the national average of the industry. Industry-specific fixed effect dummy variables are included in the regression. White's hetroskedasticity-consistent standard errors are in parentheses. The columns (2) and (5) are results from the sample excluding the transport equipment industry.

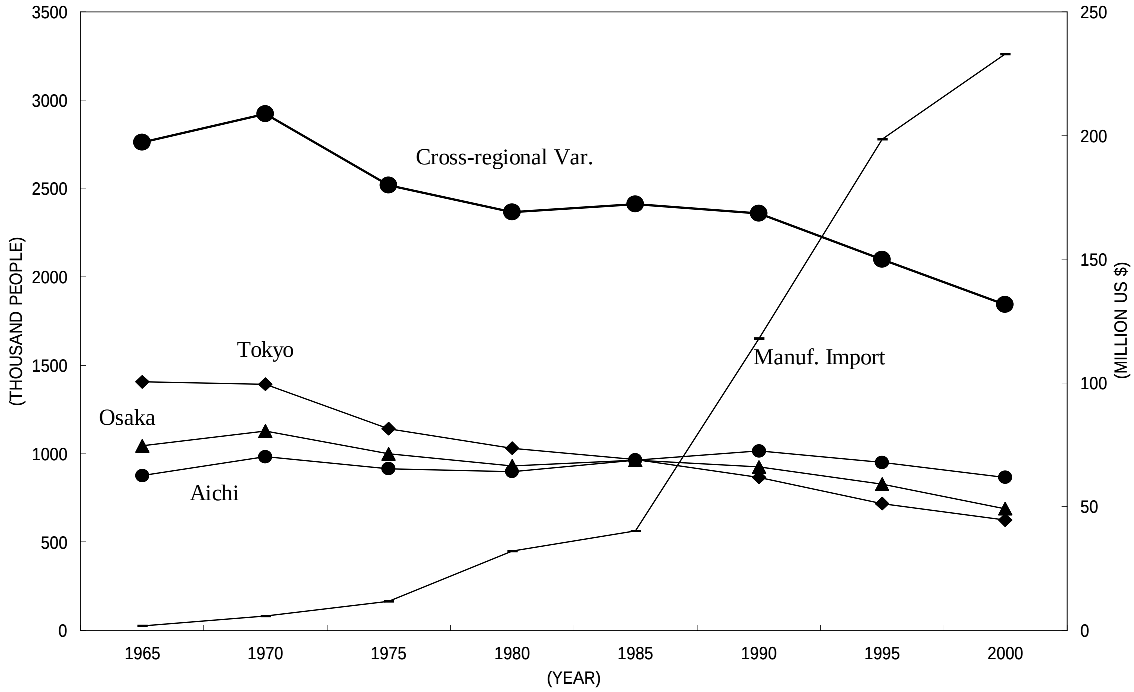
TABLE IV

ALTERNATIVE SPECIFICATIONS

	(1)	(2)	(3)	(4)	(5)	(6)
INP(manf)	–0.0104 (0.0123)	–0.0021 (0.0141)	–0.0008 (0.0140)	--------	–0.0016 (0.0125)	–0.0168 (0.0127)
INP (all)	--------	--------	--------	–0.0144 (0.0212)	--------	--------
OUT(manf)	–0.0295 (0.0129)	--------	--------	--------	–0.0186 (0.0126)	–0.0400 (0.0145)
OUT (ind)	--------	–0.0467 (0.0170)	--------	--------	--------	--------
OUT (all)	--------	--------	–0.0505 (0.0172)	–0.0381 (0.0242)	--------	--------
WAGE	–0.0647 (0.0690)	–0.0583 (0.0676)	–0.0587 (0.0677)	–0.0599 (0.0657)	–0.0362 (0.0659)	–0.0456 (0.0678)
IIA	–0.1175 (0.0167)	–0.1139 (0.0164)	–0.1150 (0.0165)	–0.1145 (0.0166)	–0.1205 (0.0168)	–0.1211 (0.0169)
SCL	0.0023 (0.0225)	–0.0055 (0.0238)	–0.0036 (0.0233)	–0.0039 (0.0226)	–0.0052 (0.0224)	0.0015 (0.0248)
DIV	0.0582 (0.0345)	0.0383 (0.0342)	0.0394 (0.0343)	0.0439 (0.0343)	0.0731 (0.0352)	0.1151 (0.0401)
SIM	0.0277 (0.0138)	0.0176 (0.0138)	0.0149 (0.0140)	0.0142 (0.0139)	0.0190 (0.0135)	0.0271 (0.0140)
TRC	--------	--------	--------	--------	–0.0692 (0.0179)	--------
R^2	0.2670	0.2699	0.2708	0.2712	0.2777	0.2881

(Notes) The sample period is 1990-2000. The column (1) is reproduced from the column (4) in Table III for comparison. The column (6) includes dummies for regional blocks. As in Table III, industry dummies are included, and hetroskedasticity-consistent standard errors are in parentheses.

Figure 1 Japan's regional employment and imports 1965-2000



(Notes) The manufacturing employment for the three largest prefectures is measured in thousand people on the left vertical scale. The cross-regional variation (the standard deviation across all 47 prefectures), after multiplied by ten, is also measured on the left scale. The Japan's manufactured import is measured in million U.S. dollars on the right vertical scale.

Appendix TABLE AI

SUMMARY RESULTS FROM SUR ESTIMATION 1990-2000

	INP	*OUT*	*Wage*	*IIA*	*SCL*	*DIV*	*SIM*	R^2
12. Food manufacturing	(−)		(+)					0.18
13. Beverage, Tobacco & Feed	(+)	(−)			(−)		(−)	0.27
14+15. Apparel & Textile		(−)						0.16
16. Timber & Wooden products			(−)	(+)	(−)		(+)	0.47
17. Furniture & fixture	(+)	(−)		(−)	(+)			0.40
18. Pulp & Paper products				(−)		(+)	(+)	0.11
19. Printing & Publishing		(−)					(−)	0.19
20. Chemical products	(+)		(−)	(−)	(+)	(+)	(+)	0.45
21. Petroleum & Coal products	(−)			(−)	(+)			0.53
22. Plastic products		(−)		(−)		(+)	(+)	0.59
23. Rubber products				(−)	(+)		(+)	0.17
24. Leather & Fur products		(+)				(−)		0.15
25. Ceramic, Stone & Clay products		(−)		(−)				0.27
26. Iron & Steel					(+)		(+)	0.23
27. Nonferrous Metals	(+)	(−)	(+)	(−)				0.49
28. Metal products		(−)		(−)	(+)			0.41
29. General Machinery			(−)	(−)	(+)			0.57
30. Electric Machinery	(−)			(−)	(+)	(+)		0.70
31. Transportation Equipment			(−)		(+)			0.31
32. Precision Instruments		(−)	(+)			(+)		0.50
34. Miscellaneous manufacturing				(−)	(+)			0.24

(Notes)
Shown are the sign of coefficients estimated by Seemingly Unrelated Regression (SUR). Only the estimates significant at the 5% significance level are present. The numbers followed by abbreviated industry names are industry classification codes. The ordnance industry (33) is merged into the general machinery industry (29).

Appendix TABLE AII

INDUSTRY IMPORT SHARES

Industry	Import Share at 1985	Growth Rate of Import Share (1985–1999)
12. Food manufacturing	7.06	35.00
13. Beverage, Tobacco & Feed	3.61	56.22
14+15. Apparel & Textile	8.50	48.82
16. Timber & Wooden products	10.55	36.19
17. Furniture & fixture	2.67	55.81
18. Pulp & Paper products	4.31	3.27
19. Printing & Publishing	0.57	4.70
20. Chemical products	7.99	10.52
21. Petroleum & Coal products	13.01	–0.50
22. Plastic products	1.01	49.02
23. Rubber products	5.32	34.57
24. Leather & Fur products	13.11	78.97
25. Ceramic, Stone & Clay products	2.41	24.33
26. Iron & Steel	1.85	12.99
27. Nonferrous Metals	25.18	–0.75
28. Metal products	1.08	32.55
29. General Machinery	2.97	33.31
30. Electric Machinery	4.33	56.64
31. Transportation Equipment	2.92	36.58
32. Precision Instruments	11.75	33.39
34.Miscellaneous manufacturing	12.88	33.61
Average (all 21 industries)	6.81	22.69
Average (with negative *OUT*)	6.31	33.79

(Notes)

All figures are in terms of percentage. The growth rate is expressed by averages over intervals 1985-90, 90-95 and 95-99. The last row corresponds to the average over the nine industries with significantly negative coefficient on the output linkage variable estimated by SUR.