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Agglomeration Economies and Geographical Concentration of Industries: A Case Study of Manufacturing Sectors in Postwar Japan[1]

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There have been secular changes in the location of manufacturing industries away from large metropolitan areas in Japan. Using prefectural data in five major manufacturing sectors for three periods (1960–1973, 1973–1980, and 1980–1995), this study attempts to identify the factors affecting the changing patterns of industrial concentration. We found through regression analysis of employment growth that while the "pull" to cities by agglomeration economies has been weak, the "push" by congestion of cities and increasing competition with service sectors has had pervasive impacts on the geographical dispersion of industries. *J. Japan. Int. Econ.*, September 2000, **14**(3), pp. 189–203. Faculty of Economics, Tokyo Metropolitan University, Minami-Osawa, Hachiohji, Tokyo 192-0397, Japan.

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1. INTRODUCTION

In the course of modern economic development in Japan before the 1960s, manufacturing sectors had developed primarily in Keihin (around Tokyo and Yokohama) and Hanshin (around Osaka and Kobe) industrial zones. Such geographical

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concentration of industries, however, resulted in severe congestion and environmental deterioration in these industrialized zones during the high-growth period of the Japanese economy from the late 1950s to the 1960s, which subsequently led to the dispersion of industrial locations into other areas (Fujita and Tabuchi, 1997; Fujita and Hisatake, 1998).

The theory of economic geography, pioneered by Alfred Marshall (1890) and later formalized by Paul Krugman (1991), focuses on agglomeration economies of specific industry to explain why industry tends to be concentrated in specific regions.[3] According to them, such economies arise from informational externalities among enterprises producing similar goods or services, beneficial access to the pool of skilled laborers, and the shared use of highly specialized capital inputs. Once an industry begins to develop in a certain location, further development follows as the locational advantages continue to increase. Such economies accrued from the geographical concentration of certain industries are known as the localization economies in the literature.

Industrialization is often associated with urbanization because urban areas have improved transportation and communication facilities, which attract various industries to these areas (Henderson and Kuncoro, 1996). Transactions between enterprises producing parts and those engaged in final production processes, as well as exchange of knowledge and information between them, would confer another locational advantage to urban areas (Jacobs 1969). Such economies arising from the diversity of industries and their interactions are another type of agglomeration economies known as the urbanization economies.[4]

The agglomeration economies cannot explain why geographical dispersion has been more pervasive than concentration in many industries in postwar Japan. There are two possible explanations. First, both localization and urbanization economies have been at work but weak in Japan, despite the importance of interenterprise transactions of parts and intermediate products through subcontracting. Second, there might have been strong forces that induce relocation of industries from traditional centers to peripheral and rural areas. While Kanemoto (1994) argues that higher wages in urban areas tend to induce relocation of labor-using industries away from cities. Hatta and Tabuchi (1994) and Dekle and Eaton (1999) emphasize the role of higher land prices in urban areas. Fujita and Tabuchi (1997) suggest that comparative advantages of manufacturing industries in Tokyo tend to be lost over time in favor of the service industries. Further, Kanemoto *et al.* (1996) empirically demonstrate that the advantages associated with the agglomeration economies are outweighed by the disadvantages associated with congestion, once the city size exceeds a certain limit.[5]

[3] See Fujita and Thisse (1996) for a survey of recent literature on the economics of geography.

[4] To explore the empirical significance of the localization and urbanization economies, a number of empirical studies have been conducted in the United States (Ciccone and Hall, 1996; Glaeser *et al.*, 1992; Henderson, 1986; Henderson *et al.*, 1995).

[5] Nakamura (1985) obtains an interesting finding that the development of light industries is influenced by the urbanization economies and that of heavy industries is conditioned by the localization economies in Japan.

This study attempts to explain changes in industrial concentration for three distinct periods (i.e., 1960–1973, 1973–1980, and 1980–1995) by using prefectural data. Five two-digit manufacturing industries were chosen: metal product, general machinery, electric machinery, transportation equipment, and precision instrument industries. The same industries are chosen in a similar study by Henderson *et al.* (1995) in the case of the United States. These industries are not only leading industries in the postwar development of Japanese economy (Fujita and Tabuchi, 1997) but also industries heavily dependent on interenterprise transactions of parts and intermediate products. We will consider the roles of both the "pull" factors associated with the two agglomeration economies and the "push" factors associated with the congestion of urban areas and increased factor prices in the determination of industrial location. We will also examine changing patterns of the impacts of these variables over time.

The organization of this paper is as follows. Section 2 examines characteristics of changing geographical concentration of industries in Japan. Section 3 specifies the regression model. This is followed by the empirical estimation in Section 4. Section 5 concludes the paper.

2. CHARACTERISTICS OF CHANGING INDUSTRIAL LOCATIONS

To examine overall changes in the geographical concentration of industries, we constructed the Herfindahl index for 1960, 1973, 1980, and 1995, which is defined as the squared sum of the employment shares of prefectures (see Table I). It is clear that industrial concentration declined, particularly during the so-called "miraculous" or high-growth period from 1960 to 1973, with an exception of the transportation equipment industry. During this period, new technologies and production methods were rapidly introduced from abroad and long-term interenterprise subcontracting networks, called *keiretsu*, were actively established (Goto, 1982; Odagiri, 1992). Thus, we expect that both the localization and urbanization economies should work toward concentration, if they play the major roles. The fact that rapid geographical dispersion rather than concentration took place

TABLE I
Changes in Herfindahl Index of Concentration, by Industry[a]

	Metal products	General machinery	Electric machinery	Transportation equipment	Precision instruments
1960	0.141	0.086	0.137	0.083	0.275
1973	0.066	0.061	0.066	0.080	0.113
1980	0.061	0.056	0.055	0.083	0.088
1995	0.049	0.047	0.038	0.094	0.062

Source: Ministry of International Trade and Industry (1960, 1973, 1980, 1995).
[a] Herfindahl index based on number of employees at the prefectural level.

in this period strongly suggests that the agglomeration economies, even if they worked, were overwhelmed by other factors. The geographical dispersion continued thereafter in these four industries, particularly during the slow-growth period of 1980–1995. Thus, it is clear that forces pushing out industries from traditional industrial centers have been persistently at work in Japan.

The Herfindahl index of the transportation equipment industry has been largely stable for the entire periods. Since forces facilitating geographical dispersion of other industries would have worked in this industry too, it is likely that the agglomeration economies of some kind have had particularly strong impacts on the locational choice of this industry. In fact, a brief literature survey of the industrial organization in the Japanese economy suggests that the automobile industry, which is a major sector included in the transportation equipment industry, is characterized by the heavy reliance on part- and intermediate product-supplying industries (Odagiri, 1992). Furthermore, since "just-in-time" delivery of parts is required for part suppliers, the urbanization economies associated with diversity of industries are likely to play a significant role.

To obtain a clearer picture of locational changes in the manufacturing industries from the centers to the peripheries in Japan, Table II demonstrates the number of workers engaged in each of the five industries, by major industrial zone and total employment share of the four industrial zones in selected years. The four industrial zones (Keihin, Hanshin, Chukyou, and Kita-Kyushu) are located along the sea, with developed infrastructures including ports, transportation, and communication.[6]

The total employment shares of the four zones were large in 1960, ranging from 70 to 80%. Absolute empolyment increased from 1960 to 1973 almost everywhere in these industrial zones, even though their relative employment shares declined.[7] Since 1973, not only the employment shares but also the absolute employment had declined in these zones, a major exception being the Chukyou zone where Toyota is located. Particularly noteworthy is the rapid decline in the employment share in the Keihin industrial zone around Tokyo and Yokohama. In 1995 in this zone, employment share in the transportation equipment industry ranked second after Chukyou, and the shares in the metal product and general machinery industries became comparable with those in the Hanshin industrial zone.

According to a survey by the Ministry of International Trade and Industry (1980, 1995), the major reason for the locational choice of new manufacturing establishments in 1980 was the proximity to headquarter offices and supporting enterprises (accounting for 40% of the responses), followed by access to output markets and

[6] The Keihin industrial zone includes Tokyo, Kanagawa, Chiba, and Saitama prefectures; the Hanshin zone includes Osaka, Hyogo, Kyoto, and Wakayama prefectures; the Chukyouu zone includes Aichi, Gifu, and Mie prefectures; and the Kita-Kyushu zone includes Fukuoka and Yamaguchi prefectures.

[7] One may suspect that such a decline in employment shares in the major industrial zones may be explained by legal restrictions on the operation of large manufacturing establishments engaged in mass production since 1959. According to Miyao (1994), the importance of large manufacturing establishments in such large cities as Tokyo declined and they were replaced by headquarter offices and R&D laboratories.

TABLE II
Changes in Number of Workers and Employment Share, by Major Industrial Zone[a]

	Year	Metal products	General machinery	Electrical machinery	Transportation equipment	Precision instruments
Keihin	1960	160	211	322	167	90
	1973	246	302	502	272	111
	1980	198	253	427	241	103
	1995	161	222	400	191	65
Hanshin	1960	111	185	143	91	14
	1973	189	237	204	122	26
	1980	161	207	191	87	22
	1985	159	196	205	72	22
Chukyou	1960	41	84	46	81	11
	1973	89	150	99	200	12
	1980	88	136	105	204	16
	1995	102	168	152	269	13
Kitakyushu	1960	19	29	10	13	6
	1973	33	51	27	21	1
	1980	28	44	21	19	1
	1995	32	34	48	27	1
Total of four zones	1960	331	509	521	352	121
		(77)	(70)	(78)	(71)	(80)
	1973	557	740	832	615	150
		(66)	(64)	(60)	(63)	(59)
	1980	475	640	744	464	139
		(64)	(62)	(56)	(62)	(54)
	1995	469	620	805	559	101
		(58)	(57)	(46)	(61)	(51)

Source: Ministry of International Trade and Industry (1960, 1973, 1980, 1995).

[a] One thousand employees. Numbers in parentheses show the employment share in the entire economy.

availability of labor. In 1995, both proximity to headquarter offices and related enterprises and availability of space, which was a newly added item, were considered equally important. These results indicate that, in addition to proximity to related offices and enterprises, congestion and increasing wage and land values are also important in the locational choice of industries.

3. SPECIFICATION OF REGRESSION MODEL

Following Glaeser *et al.* (1992) and Henderson *et al.* (1995), we assume that a competitive firm employs labor (N_t) up to the point where the equality of the marginal product of labor with the real wage rate (w_t) holds:

$$A_t F'(N_t) = w_t, \tag{1}$$

where A_t refers to multiplicative production efficiency parameter at time t and $A_t F'(N_t)$ is the physical marginal product of labor. Solving Eq. (1) for N_t under the assumption of Cobb–Douglas form of production functions and taking difference in logarithm, we obtain

$$\ln(N_t/N_0) = -a \ln(w_t/w_0) + a \ln(A_t/A_0), \tag{2}$$

where a is a positive parameter and subscript 0 refers to the base period. Following Glaeser *et al.* (1992), the growth rate of production efficiency is assumed to depend on the localization economies (LE_0), urbanization economies (UE_0), and other conditions (OC_0) at the initial period. Thus Eq. (2) can be rewritten as

$$\ln(N_t/N_0) = -a \ln(w_t/w_0) + aG(LE_0, UE_0, OC_0). \tag{3}$$

We assume that the G function can be approximated by log-linear form.

We include the extents of congestion and ratio of service sectors as additional explanatory variables because we expect that congestion would reduce the availability of favorable land for factories, offices, and residential areas, whereas the competition with service sectors would affect the efficiency of manufacturing sector either through the effect of complementary relationships with manufacturing sector or through the effect on availability of land, labor, and other factors of production.

Based on these considerations, we specify the following empirically estimable function using prefectural data:[8]

$$\begin{aligned}\ln(N_{ijt}/N_{ij0}) = {} & \alpha_0 + \alpha_1 \ln(N_{ij0}) + \alpha_2\, SHARE_{ij0} + \alpha_3 \ln(W_{ijt}/W_{ij0}) + \alpha_4\, UE_{i0} \\ & + \alpha_5\, SERVICE_{i0} + \alpha_6 \ln(CONG_{i0}) + \alpha_7\, ROAD_{i0} \\ & + \alpha_8\, LSIZE_{ij0} + \Sigma\beta_k\, (Region\ dummy_k) + \varepsilon_{ijt},\end{aligned} \tag{4}$$

where N_{ijt} shows the number of workers in the ith prefecture in the jth industry during the tth period, whereas N_{ij0} pertains to the number of workers in the based period, so that the left-hand side corresponds to the growth rate of employment in the jth industry; α_s and β_s are regression parameters; and ε represents an error term. Strictly speaking, regression parameters can differ across industries and change over time. For simplicity, we do not formally indicate such differences and changes. Since the common unobservable factors would affect the error terms

[8] The following data sources are used: The number of workers, wage rates, and the number of establishments from Ministry of International Trade and Industry (1960, 1973, 1980, 1995); the ratio of service sector from Management and Coordination Agency (1959, 1974, 1979); total usable area from Ministry of Home Affairs (1960, 1973, 1980); and total distance of major roads from Ministry of Construction (1960, 1973, 1980).

across industries, seemingly unrelated regression methods were employed in the estimation of the above functions for each period.[9]

In our specification, the impact of localization economies (LE_0) is assumed to be captured by the initial employment level, $\ln(N_0)$. To represent localization economies, Henderson *et al.* (1995) include the share of the number of workers engaged in the industry under investigation in the total number of workers in each area. We consider that absolute employment is a better proxy for the localization economies than employment share because the localization economies arise from the absolute size of the industry rather than from the relative size of the industry compared with other industries. If the coefficient of $\ln(N_0)$, α_1, is significantly positive, geographical concentration of industry increases over time. Since Henderson *et al.* (1995) regress $\ln(N_t)$ on $\ln(N_0)$, the coefficient of unity in their specification is equivalent to the coefficient of zero in our specification. Note that if large base-period employment partly captures congestion specific to the particular industry (e.g., decreased availability of favored land and required labor), α_1 can be negative even if the localization economies are present.

SHARE refers to employment share of particular industry. For the sake of comparison with Henderson *et al.* (1995) who argue that *SHARE* captures the effect of localization economies, we include *SHARE*, even though we do not attach a clear meaning to this variable.

An increase in wage rates represented by $\ln(w_t/w_0)$ is expected to have a negative effect on employment growth. Glaeser *et al.* (1992) assume that growth rates of wage rate are the same across regions in the same economy, so that the first term is supposed to be constant. In our estimation, we retain this variable explicitly because it is unreasonable to assume that local labor markets have been perfectly integrated. Henderson *et al.* (1995) regress $\ln(N_t)$ on $\ln(w_t)$. They seem to assume, using equation (1), that N_t depends on w_t. Thus, their specification is different from ours in the use of $\ln(w_t)$ rather than $\ln(w_t/w_0)$.

UE stands for a proxy for the urbanization economies or the extent of the diversification of manufacturing industries in a prefecture, which is measured by

$$UE_{i0} = [1 - \Sigma(N_{im0}/N_{i0})^2].$$

That is, the diversification is measured by 1 minus the Herfindahl index of concentration of the mth manufacturing industry in the ith prefecture. In constructing this index, we included 21 two-digit manufacturing industries. The large *UE* in absolute terms, the larger would be the diversification of industries in a particular prefecture. Thus, if the urbanization economies have played a role, α_4 is expected to be positive.

[9] Ideally, we should include variables representing neighborhood effects from adjacent prefectures. According to a recent study of Dekle and Eaton (1999), such effects are not so strong in the manufacturing sector of Japan.

SERVICE exhibits the ratio of service sector employment to employment of the manufacturing sector.[10] If the service sector and the manufacturing sector are complementary arising from market and nonmarket linkages, α_5 will be positive. If the comparative advantage of the manufacturing sector is lost in favour of the service sector in urban areas, α_5 will be negative. We expect that, to the extent that the comparative advantage of service sector increases over time, this variable is likely to have negative effects on the growth of manufacturing employment.

As a measure of urban congestion, we used the ratio of number of workers engaged in manufacturing industries to total usable area for residence, factories, commerce, and farming (*CONG*).[11] If the major motives for locating new establishments in less urbanized areas are to avoid the urban congestion and to seek cheap land and labor, the coefficients of this variable (i.e., α_6) will be negative.

We added two more explanatory variables to control for the effects of other characteristics of the prefecture, which may be related to industrial development. The first is the ratio of total distance of major roads managed by the prefectural and central governments to total area of prefecture (*ROAD*), which is assumed to measure the density of highway networks and, hence, reflect the development of social infrastructure. The second is the ratio of large manufacturing establishments employing more than 300 workers in each industry (*LSIZE*). The large establishments may be more self-reliant in producing major parts and intermediate products by themselves, so that the availability of parts and intermediate products supplied by other industries may become less relevant for the locational choice. The direct effect of this variable on employment growth, however, is not clear. We also used five locational dummies to control for the effects of unobservable location-specific factors, such as local market conditions.[12]

4. ESTIMATION RESULTS

We estimated the regression functions for three periods separately: the high-growth period of 1960–1973, the adjustment period of 1973–1980, and the slow-growth period of 1980–1995. Sample size is, in principle, 47 except for the first period in which Okinawa prefecture is not included.[13]

[10] The service sector corresponds to the tertiary sector consisting of the wholesale, retail, finance, insurance, real estate, transportation, communication, electricity, gas, and other service industries.

[11] In the regression analyses unreported here, we also used land sale price as a measure of availability of land. Since land transactions are infrequently made and the prices differ greatly, depending on location and other unobservable differences, the land price data are unreliable. Thus, we used a more direct measure of congestion in our study.

[12] We used Hokkaido-Tohoku, Kanto, Koshinetsu-Hokuriku, Tokai-Kinki, and Chugoku-Shikoku dummies, while using Kyushu-Okinawa as a base of comparison. In addition to three regional dummies, Henderson *et al.* (1995) used distance from the business centers and employment in all other manufacturing to control for contemporaneous industry demand conditions as well.

[13] Prefectural data were unreported where only one or two enterprises existed. Thus, we actually used data of 44–45 prefectures in the case of the precision machinery industry.

TABLE III
Determinants of Employment Growth: High-Growth Period (1960–1973)[a]

Explanatory variable	Metal products	General machinery	Electric machinery	Transportation equipment	Precision instruments
Intercept	0.10	−0.04	0.14	−0.11	−0.27*
	(1.13)	(−0.58)	(1.26)	(−1.21)	(−2.13)
$Ln(N_0)$	−0.02**	0.00	−0.04**	−0.02**	−0.00
	(−3.16)	(0.67)	(−8.41)	(−3.04)	(−0.70)
SHARE	−0.15	−0.34**	0.16	0.08	−0.98*
	(−0.59)	(−2.75)	(1.43)	(0.75)	(−1.90)
$Ln(w_t/w_0)$	0.06	0.33	−0.57	−0.44	0.18
	(0.13)	(1.20)	(−1.63)	(−1.11)	(0.58)
UE	0.17*	−0.02	0.14	0.26**	0.08
	(2.19)	(0.27)	(1.06)	(2.56)	(0.63)
SERVICE	0.02	0.05	0.47**	0.12	0.53**
	(0.34)	(0.89)	(4.23)	(1.39)	(4.48)
Ln[CONG]	−0.01*	−0.02**	−0.02	−0.02**	−0.02**
	(−1.74)	(−2.50)	(−1.45)	(−2.64)	(−2.50)
ROAD	−0.10	0.06	0.04	−0.14	0.18
	(−1.42)	(0.94)	(0.36)	(−1.44)	(1.31)
LSIZE	0.05	−0.01	−0.02	0.44	−0.03
	(0.05)	(−0.05)	(−0.11)	(0.80)	(−0.05)
Kanto	0.05*	0.05**	−0.11**	0.06*	−0.11**
Dummy	(2.31)	(2.55)	(−2.87)	(2.03)	(−2.88)
Tokai-Kinki	0.04*	0.02	−0.15**	0.06*	−0.17**
Dummy	(1.84)	(1.29)	(−3.69)	(2.00)	(−4.32)
Hokkaido-Tohoku	−0.01	0.02	−0.01	0.03	0.07**
Dummy	(−0.50)	(1.42)	(−0.36)	(1.29)	(3.05)
Koshinetsu-Hokuriku	0.02	0.02	−0.11**	0.05	−0.09**
Dummy	(0.92)	(1.10)	(−3.22)	(1.56)	(−2.39)
Chugoku-Shikoku	0.00	0.01	−0.10**	0.03	−0.15**
Dummy	(0.13)	(1.66)	(−3.74)	(1.14)	(−4.73)
Adjusted R^2	0.58	0.38	0.80	0.38	0.47

[a] Explanatory variables pertain to 1960.
* Significance at the 5% level.
** Significance at the 1% level. Asymptopic z values are in parentheses.

The estimation results are shown separately, by period, in Tables III to V. The fit of regression functions is reasonably good in terms of the adjusted R^2, except in the adjustment period when the oil shocks took place and cross-sectional variations in the dependent variables were small.

According to Table III, the coefficients of base-period employment were negative in four industries and three of them were highly significant. Henderson *et al.* (1995) obtained qualitatively the same result, even though they failed to notice the important implication of this result.[14] These findings do not support the hypothesis that localization economies have played a major role in increasing the

[14] Kim (1995) also finds reinforcing evidence in the United States that concentration occurred during the prewar period, whereas dispersion took place during the postwar period.

geographical concentration of industries during the high-growth period. A factor affecting geographical dispersion may be the consequences of locational changes in accordance with the theory of the product cycle originally postulated in Vernon (1966). This theory argues that as the industry becomes mature, the production method gets more standardized, which makes it possible to produce the product cheaply in areas where cheap unskilled labor is available. Thus, if the large base-period employment is positively correlated with the standardization of the industrial technologies, its coefficient is expected to be negative. It is of interest to note that the coefficients of base-period employment were significantly negative in those industries in which the overall employment growth rates were comparatively high possibly due to the diffusion of standardized technologies.

We have observed that manufacturing establishments were often moved from traditional industrial centers to neighboring prefectures near the centers. This is consistent with the positive and significant coefficients of Kanto and Tokai-Kinki regional dummies in the metal product and transportation equipment industries. It is important to note that in these industries, base-period employment has negative and significant effects, suggesting that employment grew less rapidly or declined in such traditional industrial centers as Tokyo and Osaka. The estimated coefficients of regional dummies indicate that the electric machinery and the precision machinery industries moved out from the Kanto and Tokai-Kinki regions.

The coefficients of the employment share of workers (*SHARE*) were positive in two industries and negative in three industries, two of them significant. There was no consistent trend and these results were difficult to interpret. In contrast, Henderson *et al.* (1995) obtained positive coefficients of this variable in the analysis of mature industries, which correspond to the five industries we analyze in this paper. They insist that localization economies strongly affect current employment of such industries. It is difficult to reconcile the markedly different results obtained from the two studies.

The effect of the urbanization economies was pronounced in the transportation equipment industry as well as in the metal product industry (but to a lesser extent). These findings indicate that significant urbanization economies operate only in certain industries, which depend on interenterprise transactions of parts and intermediate products. Similarly, Henderson *et al.* (1995) find that urbanization economies are important only for the new industries, which may depend on a variety of inputs supplied by other industries. In contrast, the employment ratio of service sector had positive coefficients in all five regression equations and two of them were significant, suggesting that manufacturing industries and service sectors were complementary in the early period of postwar development. This is reasonable if the service sectors provided support services to the manufacturing industries.

While we failed to obtain consistently negative and significant effects of wage rates, we found negative and frequently significant effects of congestion on employment growth. Thus, it is clear that the congestion of cities, together with the negative effect of base-period employment, is a major factor accounting for the

drastic reduction in the concentration of manufacturing industries in the high-growth period. In was also found that the ratio of large establishments (*LSIZE*) had negative effects in three cases. It might well have been that large establishments adopted capital-intensive production methods to save on labor or their presence deterred the development of the network of labor-intensive interenterprise cooperation involving subcontracting between enterprises.

The estimation results for the adjustment period were poor not only in terms of R^2 but also in terms of the significance and consistency of the signs of estimated coefficients, with only several exceptions (Table IV). As in the earlier period, the urbanization economies had a highly significant impact on the employment growth

TABLE IV
Determinants of Employment Growth: Adjustment Period (1973–1980)[a]

Explanatory variable	Metal products	General machinery	Electric machinery	Transportation equipment	Precision instruments
Intercept	−0.13	−0.04	−0.30**	−0.43*	−0.38
	(−1.24)	(−0.37)	(−2.46)	(−2.14)	(−0.98)
$Ln(N_0)$	0.01	−0.01	0.03**	0.00	−0.02
	(1.24)	(−0.93)	(4.73)	(0.07)	(−1.62)
SHARE	−0.43*	−0.16	−0.31**	−0.04	0.71
	(−2.19)	(−1.05)	(−3.78)	(−0.25)	(0.86)
$Ln(w_t/w_0)$	0.31	1.03**	−0.37	1.60**	−0.25
	(1.03)	(5.02)	(−1.51)	(7.18)	(−0.54)
UE	0.11	0.08	−0.01	0.46*	0.49
	(1.07)	(0.74)	(−0.10)	(1.92)	(1.21)
SERVICE	0.00	−0.01	0.01	0.01	0.05
	(0.10)	(−1.25)	(0.88)	(0.23)	(1.25)
L*n*[CONG]	−0.01	−0.01	−0.04**	−0.01	−0.02
	(−1.38)	(−1.20)	(−4.84)	(−0.84)	(−0.83)
ROAD	−0.12**	0.03	0.06	0.03	0.19
	(−2.32)	(0.43)	(0.79)	(0.26)	(0.74)
LSIZE	−0.74	1.24**	0.52**	0.07	0.13
	(−1.27)	(2.97)	(2.80)	(0.20)	(0.32)
Kanto	0.01	0.01	0.01	−0.03	0.05
Dummy	(0.76)	(0.85)	(0.63)	(−0.86)	(0.85)
Tokai-Kinki	0.01	0.02	0.03*	−0.02	0.02
Dummy	(0.93)	(1.27)	(1.74)	(−0.56)	(0.37)
Hokkaido-Tohoku	−0.01	0.01	0.01	−0.05*	0.06
Dummy	(−0.84)	(0.50)	(0.68)	(−2.02)	(1.19)
Koshinetsu-Hokuriku	0.02	0.01	0.04*	−0.01	0.03
Dummy	(1.20)	(0.58)	(1.98)	(−0.32)	(0.44)
Chugoku-Shikoku	0.00	0.00	0.04**	−0.06**	0.35
Dummy	(0.06)	(0.19)	(2.82)	(−2.41)	(0.73)
Adjusted R^2	0.16	0.44	0.31	0.51	0.45

[a] Explanatory variables pertain to 1973.

* Significance at the 5% level.

** Significance at the 1% level. Asymptotic *z* values are in parentheses.

of the transportation machinery industry, and the congestion was a very important factor pushing out the employment of the electric machinery industry from the traditional production centers. Two coefficients of the employment share variable were negative and significant, suggesting the declining employment growth in the prefectures where the extent of industrial specialization is high. Unexpectedly, growth of wage rates had positive and highly significant coefficients in the general machinery and the transportation equipment industries. One possible reason for such results would be the failure to control for worker skills. Another reason could be simultaneous equation bias because industrial growth may increase wage rates. Aside from these, no result seems noteworthy.

The fit of regression functions was remarkably improved for the slow-growth period (Table V). First of all, we found that the coefficients of base-period

TABLE V
Determinants of Employment Growth: Slow-Growth Period (1980-1995)[a]

Explanatory variable	Metal products	General machinery	Electric machinery	Transportation equipment	Precision instruments
Intercept	0.13*	0.12*	0.35**	0.08	0.13
	(1.69)	(1.70)	(3.95)	(0.59)	(0.75)
$Ln(N_0)$	−0.01**	−0.02**	−0.02**	−0.01**	−0.02**
	(−2.73)	(−5.02)	(−5.41)	(−2.61)	(−4.77)
SHARE	0.08	0.02	−0.02	0.18*	0.06
	(0.63)	(0.20)	(−0.44)	(1.70)	(0.25)
$Ln(w_t/w_0)$	−0.02	0.29	0.24	−0.11	−0.18
	(−0.05)	(1.41)	(0.79)	(−0.30)	(−0.56)
UE	0.03	0.09	−0.12	0.10	0.06
	(0.36)	(1.27)	(−1.42)	(0.69)	(0.36)
SERVICE	−0.03**	−0.03**	−0.00	−0.03**	−0.02
	(−3.73)	(−3.78)	(−0.47)	(−2.33)	(−0.83)
Ln[CONG]	−0.00	−0.00	−0.00	0.00	0.02**
	(−1.36)	(−0.16)	(−1.17)	(0.34)	(2.45)
ROAD	−0.02	0.06*	−0.05	0.01	−0.07
	(−0.44)	(1.74)	(−1.18)	(0.12)	(−0.79)
LSIZE	−1.27**	−0.22	−0.33**	0.21	0.44**
	(−2.53)	(−0.87)	(−3.39)	(1.51)	(4.01)
Kanto	−0.01*	−0.01	−0.02	−0.03**	0.01
Dummy	(−1.81)	(−0.65)	(−1.64)	(−2.02)	(0.31)
Tokai-Kinki	−0.01	−0.30	−0.01	−0.02	−0.00
Dummy	(−1.41)	(−0.36)	(−1.09)	(−1.46)	(−0.01)
Hokkaido-Tohoku	−0.00	0.02**	−0.02**	0.01	0.03*
Dummy	(−0.28)	(3.18)	(−2.50)	(1.16)	(2.11)
Koshinetsu-Hokuriku	−0.02*	−0.01	−0.02*	−0.02	0.01
Dummy	(−1.83)	(−0.70)	(−2.12)	(−1.09)	(0.61)
Chugoku-Shikoku	−0.02**	−0.02**	−0.02**	−0.04**	−0.03*
Dummy	(−3.01)	(−2.69)	(−2.95)	(−3.09)	(−1.92)
Adjusted R^2	0.50	0.66	0.70	0.21	0.27

[a] Explanatory variables pertain to 1980.

* Significance at the 5% level.

** Significance at the 1% level. Asymptotic z values are in parentheses.

employment were all negative and highly significant. This, coupled with similar evidence from the high-growth period, is prima facie evidence that the localization economies did not facilitate the geographical concentration of industries in Japan. Unlike the high-growth period, the estimated coefficients of regional dummies indicate that the location of manufacturing industries tends to move to more distant areas such as Hokkaido, Tohoku, and Kyushu (default area). These observations support the validity of the product cycle hypothesis that the standardization of products and production methods in the later stages of industrial development leads to further decentralization of the locations of manufacturing industries.

Second, we found that none of the coefficients of the urbanization economies was significant. In all likelihood, this is partly due to the improvements of communication and transportation networks that have significantly reduced the reliance of the manufacturing enterprises on the supply of parts and intermediate products from their neighborhoods. This finding is consistent with the finding of Henderson *et al.* (1995) that urbanization economies are unimportant in mature industries, to the extent that the metal product and transportation equipment industries in Japan have become mature over time.

Henderson *et al.* (1995) advocate the product cycle hypothesis in view of their finding that production decentralizes to smaller, more specialized cities in the case of mature industries. This conclusion is derived primarily from the absence of the impact of *UE* variable and the positive effects of *SHARE* variable. In contrast, we reached qualitatively the same conclusion from the coefficients of base-period employment and regional dummies, as well as the existence of and subsequent disappearance of the urbanization economies in the metal products and transportation equipment industries.

Third, it is found that, in contrast to the estimation results of the high-growth period, all the coefficients of the ratio of service sector were negative and three of them were significant. These results imply that the competition with the service sector induced the relocation of manufacturing industries in the 1980s and the early 1990s. This interpretation is also consistent with the product cycle hypothesis because it indicates that as the manufacturing sector becomes mature, it loses comparative advantage vis-à-vis other fast-growing industries in large cities.

Unfortunately, consistent and significant coefficients across the five equations were not obtained for wage, congestion, and road density variables. The ratio of large establishment had negative and significant coefficients in two cases and positive and significant coefficient in another case. Though slow, downsizing of large enterprises has been taking place in Japan and the negative effects of large establishments are consistent with such trend.

5. CONCLUDING REMARKS

This study attempted to identify the factors affecting the locational choice of major manufacturing industries for the periods from 1960 to 1995 in Japan by

using prefectural employment data. First of all, we found that, except for the transportation equipment industry, there have been persistent trends toward the diversion of industrial locations. Regression analysis confirmed that the base-period employment generally had negative effects on the subsequent growth of employment, which denies the pervasive effects of the localization economies in the context of postwar Japanese development.

In our view, it was the product cycle hypothesis that can most consistently explain the geographically outward movements of industrial centers over time. We also obtained a strong indication that the urbanization economies affected the locational choice of the transportation equipment industry and, to a lesser extent, the metal product industry as well. These findings are consistent with the casual observation that these industries have relatively strong backward or forward linkages with other industries. It is also worth pointing out that the effects of the urbanization economies seem to have disappeared at the prefectural level during the recent slow-growth period, when communication and transportation infrastructures were improved.

In the economic analysis of geography, more attention should be paid to the effects of congestion and other negative consequences of urbanization on the choice of industrial location. Indeed, if the localization and urbanization economies work without arousing countervailing forces, the industrial concentration will tend to continue without interruption. Our analysis clearly indicates that congestion and strengthened competition with the service sector associated with urbanization are the strong built-in forces that deter the continuous concentration of manufacturing industries in urban areas.

Finally, we would like to emphasize that in order to grain further insights into the roles of the urbanization economies, the localization economies, and the economic forces formulated by the theory of the product cycle, more down-to-earth, microlevel case studies will be indispensable. Without such studies, it will be difficult to explain the differences in patterns of locational choice of industries between Japan and the United States.

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