Clustering Patterns in the Manufacturing Sectors of Japan

Carlos A. Carvajal[a] and Chihiro Watanabe[b]

[a]*Industrial Engineering and Management, Tokyo Institute of Technology, Japan (carlos@me.titech.ac.jp)*

[b]*Tokyo Institute of Technology, Japan*

Summary

Japan's economic clusters are characterized by their high level of diversity. In essence, Japanese economic clusters are not limited to single industries; they comprise numerous manufacturing industries and firms which cluster in specific heterogeneous economic zones, vice political boundaries. Japanese manufacturing sectors are showing an increased level of diversity, resulting in the spread of experience and knowledge among clusters, and sustained growth at the point of industrial structural transformation.

Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) proposed the creation of intellectual clusters for the purpose of promoting research and development (R&D) activities resulting in the stimulation and development of new technologies. The Ministry of Economy Trade and Industry (METI) is also proposing the industrial cluster plan with the aim to promote the local rebirth and revitalization of the Japanese industrial sector.

This paper proposes a methodological analysis which will result in the integration of the two policies currently implemented by the Japanese government. If the current policies are not coordinated and integrated, artificial firms and sectors will continue to hamper innovation and discourage competitiveness, which will ultimately result in Japan's loss of economic opportunities within Asia. In the worst case, failure to act on current economic deficiencies illuminated in this paper could cost Japan its position as an Asian economic leader.

Key words : innovativity, clustering policy, patents, technological proximity, R&D intensity

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1. Introduction

1.1 Background

Japan's concerns of its economy "hollowing out" are most likely a result of the Japanese manufacturing sector's perceived or actual need to lower costs for the purpose of maintaining profits, and, possibly, the sector's need to find and exploit additional avenues for growth in Asia's domestic market. Its close geographical proximity to East Asia places Japan in an advantageous position vis-à-vis Europe and the U.S. in terms of increasing economic influence with newly developing East Asian economic clusters such as China, Singapore, South Korea, Thailand, Malaysia, and the Philippines. Japan's advanced economic structure places Japan in the best position to develop ties with East Asian economic clusters in terms geography, and point of development.

Japan's economy expanded at an annualized rate of 7% in the last quarter of 2003[1)], with export-oriented large manufacturers providing the main thrust of growth. Interregional spillovers contributed significantly to quantitative homogeneity, arguably, a very efficient economic structure to produce development in an industrial society. Figure 1 demonstrates trends in GNP per capita (1990 fixed prices) distribution and dissemination by prefectures[2)], classified in 6 groups[3)] according to GNP per capita performance, over the period 1985-2001. Three important periods in Japan's economy played a crucial role on the performance of variables which tended to explain the economic model: the bubble economy (1987-1990); the bursting of the bubble economy (1991-1994); and the sustained stagnation period after the bubble burst (1995-to present).

Figure 1 suggests that prefectures with higher GNP per capita are surrounded by prefectures with lower GNP per capita, and this indicator decreases with distance. This phenomena results in clustering, referred to in this paper as spatial or geographic concentration of similar firms, manufacturing industries and agglomeration economies that are external to firms but internal to an industry within a geographic region (Clark, Feldman et. al., 2000). It is necessary to determine and quantify the degree to which the value of a variable in one group of the Japanese

1) According to The Economist, this is the largest expansion in 13 years, Feb. 19th 2004.

2) Japan is divided into 47 prefectures, all administrative independent, with regional offices which set and implement policies according to their own necessities. They inform the regional offices to these plans and condensed in national reports. Recently, the central government is interested on leading compatible clustering or agglomeration plans (METI, 2000).

3) This ranging method, called equal steps, is utilized by cartographers to observe characteristics of data distribution. This helps to define cut point or boundaries between categories taking difference between low and high values of a distribution and divides this difference into evenly spaced steps.

prefectures is spatially correlated to the value in neighboring regions. To the casual observer, this clustering behavior appears to develop , naturally, however, in reality, the clusters are the result of government policies which search for homogenous economic performance in the regions. Higher differences where appreciable in the 1980s, however, in the 1990s there is a clear trend of homogeneity in the GNP per capita indicator.

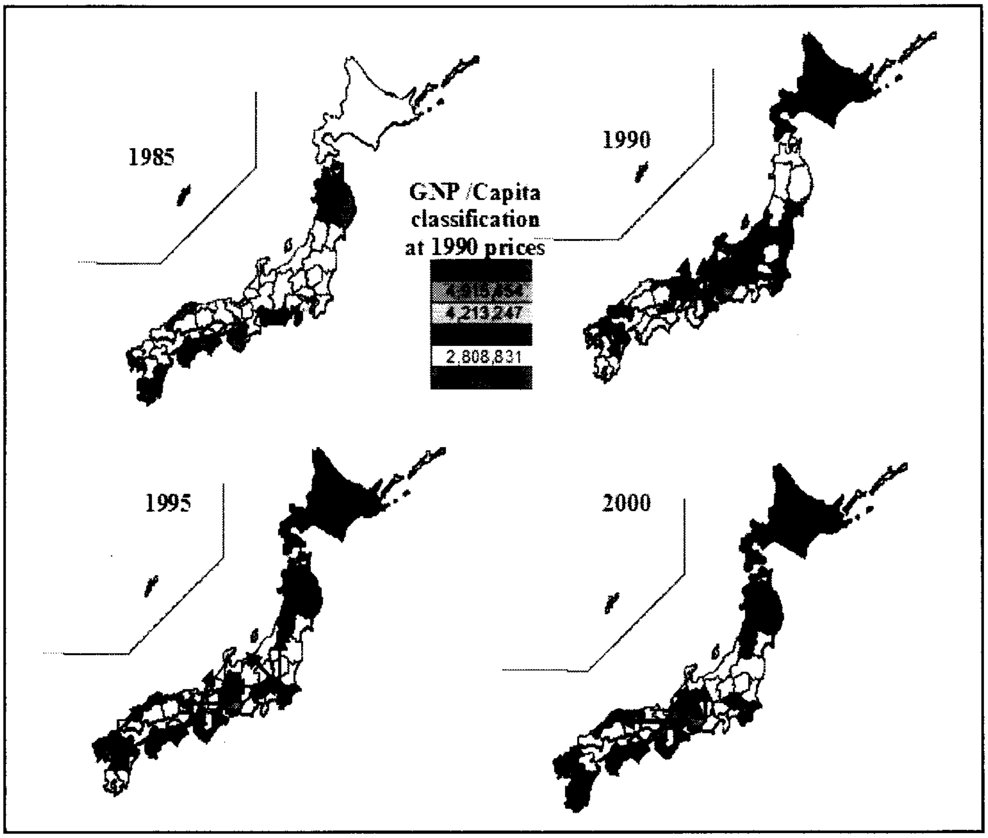


Fig. 1 : GNP per Capita Distribution and Dissemination across Prefectures (1985-2001).

Additionally, Figure 1 indicates the direction of the dissemination process by arrows. The origin of the arrows depict the possible starting point of representative knowledge that will be spilled over to neighboring prefectures and observing that intermediate regions surrounded by leading regions will leverage and speed up their growth (e.g. Shiga prefecture). This is considered due to the dynamic change in GNP per capita by geographical proximity (Aselin, 1988) and the technological proximity of geographical units (Jaffe, 1986), where spillovers could be contributors of their loss of competitive advantage.

Table 1 : Destination of Japanese Outward Direct Investment by Asian Countries and Industry (2002)

(Units : %)

	Hong Kong	Indonesia	Malaysia	Philippines	Singapore	Taiwan	Thailand	Korea	China
Food	1.72	6.48	2.11		4.55	0.76	17.28	2.50	64.59
Textile		6.29					17.90		75.81
Chemicals		69.20						8.87	21.92
Metal	0.62	1.03	0.78	1.14	12.22	0.97	28.52	20.59	34.12
Machinery		4.44	3.37	5.01	6.64	0.89	12.07	6.64	60.94
Electrical	1.61	3.57		1.86	7.49		13.27		72.20
Transport	3.15	0.12	1.45	20.41	7.82	22.56	4.54	4.49	35.44
Others	0.61	28.26	1.59			12.29	17.82	14.71	24.72
Total Mfg	0.36	2.96	3.07	9.95	22.40	0.67	7.63	5.09	47.87

Source : Ministry of Finance, Japan

In parallel, Table 1 demonstrates the target of Japanese outflows in FDI (Ministry of Finance Japan) to manufacturing sectors in Asian countries, contributing to the formation of their specific clusters in Indonesia (Transportation equipment), the Philippines (Electrical), Singapore (Chemicals and others), Taiwan (Electrical machinery), Thailand (Food, textile, chemical, transport), Korea (Metal and others) and China (All manufacturing sectors).

Paradoxically, these sectors showing high FDI in foreign Asian countries presented a dynamic clustering index (see Figure 2 and Figure 3) in Japan. This analysis suggests, that Japan is focusing on quantitative homogeneity, resulting in steady economic growth in all geographical regions at the same time, which lead to decreasing the clustering index. Japan struggles to control the variables which increase knowledge spillover between regions; by procuring heterogeneity to leverage innovative capacity, and by intensifying registered knowledge and creativity; normally, this activity is typically observed by the registration trend in patents.

2. Analytical Framework

2.1 Dynamics of Technology Intensive Manufacturing Sectors

The behavior of clusters in manufacturing sectors by means of clustering of employees and firms, show a tendency to disperse the employees (knowledge is embodied on persons) and firms (less clustering coefficient[4)]) chiefly in electrical machinery, transportation equipment, general machinery, chemical, food, and fabricated metal products (i.e. high and medium technology intensity sectors) which account for more than 60% of establishments, employees, and shipment value; according to Japan Statistical Book (1980-2003). The Japanese clustering process is shown on Figure 2 and Figure 3.

Looking at the clustering trend in electrical machinery (Figure 2), it can be seen that it is in a dramatic decline, even after a production decrease in 1995 to present. A similar decreasing trend can be observed by the correlation between the number of firms and clustering index. As demonstrated in Figure 3, the five above mentioned sub-sectors, out of 22 sub-sectors, according to the 2 Digits ISIC classifications, are knowledge intensive.

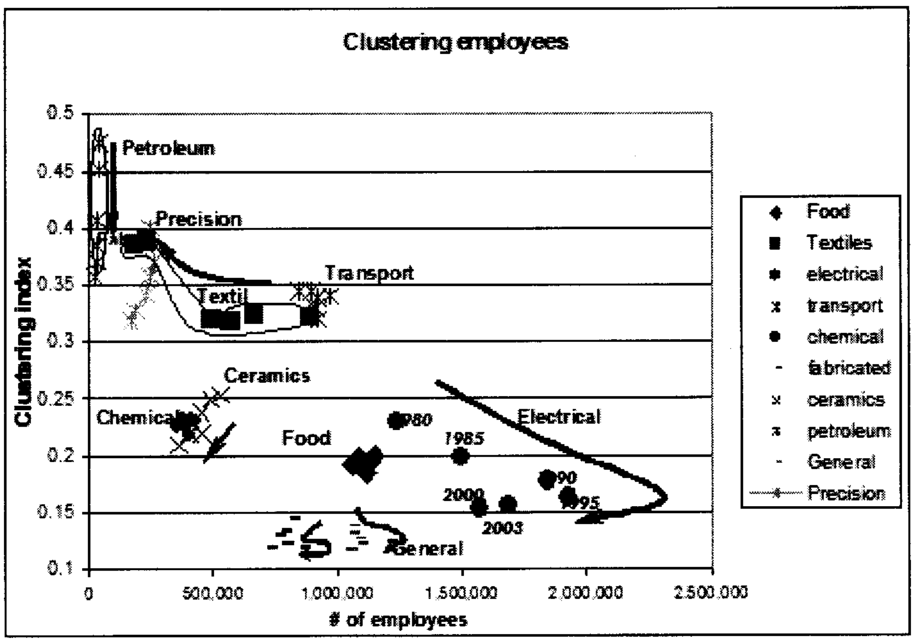


Fig. 2 : Clustering Trends of Japanese Manufacturing Sector (based on employees).

4) Clustering or agglomeration coefficient is defined $Ak_b = \frac{1}{2}\sum_{n=1}^{R}\left|\frac{a_{b,n}}{A_b} - \frac{t_n}{T}\right|$, where b is the sub sector in the manufacturing industry, $a_{b,n}$ is the number of employees in sub sector b in region n, A_b is the national number of employees in region n, t_n is the total number of employees in region n and T is the national number of employees in the manufacturing sector. When $A_{k \to} 0$ the industry is proportionally spread across regions and when $A_{k \to} 1$ the industry is concentrated in few/small regions.

Figure 2 and Figure 3 prove that according to the indicator defined, manufacturing industries have spread across the country, diminishing the clustering performance which stimulates quantitative homogeneity. However, diminishing the strength of spillovers, where location affects competitive advantage through its influence on productivity, especially on productivity growth, and proximity, arising from the co-location of firms, customers, suppliers, and other institutions, amplifies the pressure to innovate and upgrade (Porter, 2000). Japan needs a system in which it can create an atmosphere of, heterogeneity which is influenced by competitive pressure, peer pressure, and constant comparison, all occurring in geographically concentrated clusters. The importance of these clusters rises with the sophistication of competition and the simultaneous rise in knowledge and innovation intensity. In sum, the incidence of clusters tends to increase with economic development.

Analyzing this phenomena in Japan, the proposed plans by MEXT and METI are expected to promote economic revitalization through innovation by promoting itself as a nation based on creativity in science and technology, as well as promoting technological development (support to R&D oriented ventures) directly linked to increasing industrial competitiveness (formation of industrial clusters).

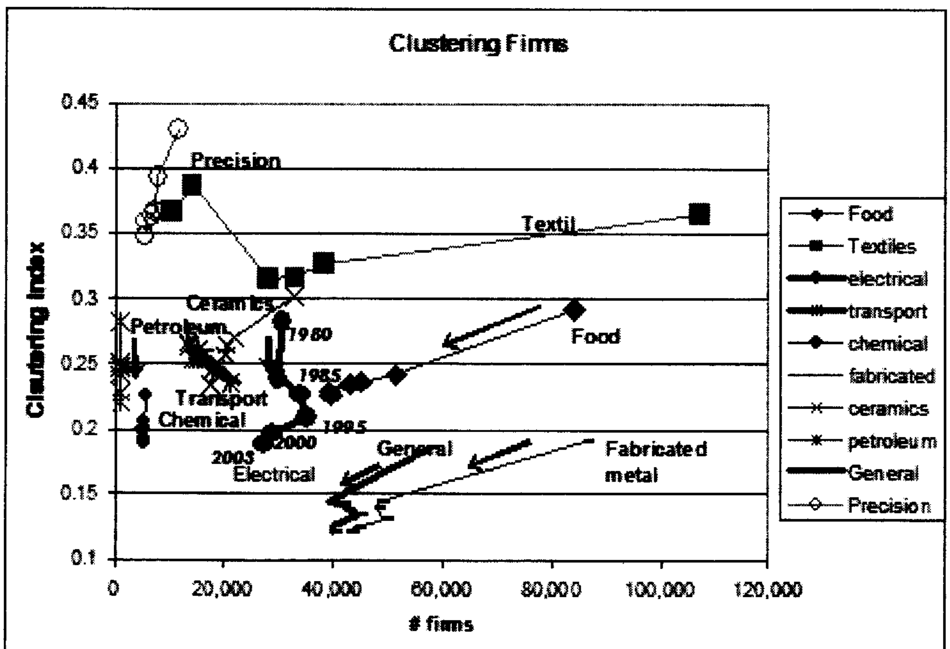


Fig. 3 : Clustering Trends of Japanese Manufacturing Sector (based on firms).

The analysis of this paper will support and allow these two plans to co-evolve in a complementary way since factors composing the "black box of innovativeness" (Watanabe and Carvajal, 2004), could be analyzed in a more empirical approach in order to stimulate synchronized clusters where they are necessary. Japan's challenge will be to develop attractive economic clusters focused on the benefits of diversity, and to form flexible ties with East Asian economic clusters.

2.2 Industrial and Intellectual Plans for Economic Revitalization

Many papers have attempted to analyze the dynamics that support the decision in regional innovation systems and the role of universities, R&D intensive firms, and governments as indispensable actors in the formation of networks (Furman (2002), Acosta (2003), Acs (2002), Agrawal (2003)). Since two plans are being developed at regional level, later, this paper argues that a more disaggregated analysis should be made (i.e. analyze smaller units than regions; in this case prefectures or areas), measuring the technology intensity within manufacturing sectors, analyzing the technological distance between prefectures and including the constraints of geographical positions; and finally, estimate the economic performance of these units. Technology stock and R&D investment as inputs for registered patents, together with value added of production, localization of labor and the dynamics of the firms of every sector (e.g. new firms, existing and abolished) will then create an environment which will allow for constructive decisions to be made on which manufacturing sectors should be promoted in specific prefectures.

METI's Industrial Cluster Plan proposed 16 clusters in coordination with its regional bureaus of economy, trade and industry; in which each regional division acts as an independent entity. However in the case of MEXT's Intellectual Plan, the analysis is based on the concentration of R&D dynamics, concentrating instead in the fields of nanotechnology, manufacturing technology and IT. (See Table 2).

The following analysis allows a classification of prefectures with the main purpose of defining clusters in a more empirical basis :

(i) Productivity : Chiefly manufacturing and production centers,
(ii) Innovativeness : R&D centers, and
(iii) Innovativity : R&D centers and production centers.

Will Industrial Cluster and Intellectual Cluster Plans co-evolve? Concentration on manufacturing in Tokyo and Osaka is not due to inadequate infrastructure in other prefectures, but to highly centralized federal government initiatives and institutions Processes for formulating regional plans did not take into account the need for equilibrium between the scientific and technological aspects of the local system of innovation, and the production characteristics of the regions.

Table 2 : Comparison of Industrial and Intellectual Clustering Plans

	METI	MEXT
Cluster Plan	Industrial	Intellectual
Participation	5000 enterprises, 200 universities Bureaus of Economy and Industry	Local government enterprises
Goals	Higher productivity, induce innovation Development of new businesses	Induce innovation, regional science, technology and intellectual prop.
Contents	Government circles, seminars Promotion of exchange and cooperation	Cooperative activities, promoting joint researches, holding forums
Number of projects	19 Projects	13 Clusters (15 Regions) 19 Areas
Proxies Measured	Number of firms, number of employees value added of production	Universities, R&D centers
Missing proxies in the analysis	Technological distance	Patents, R&D investment technology stock
Evolution	Technology intensive, productivity	Knowledge intensive, innovativeness
Co-evolution	Innovativity	
Future Development	Increasing the density of industry-university-government networks Promotion of international inter-cluster exchange Creation of diversified industrial clusters	Select very high potential regions of a unique R&D field Promote several industry-academy-government programs
Current State	Exploratory, formation	Germinal period

In the previous section we dealt with the Japanese industrial sector, by following its growth and transformations through time. However, as in most cases of such an industrial boom, the latter were activated from specific prefectural leading poles, which due to their location or other characteristics, had the advantage to lead -and benefit more from- this industrial development process. No others have been created in addition to the metropolitan areas of Tokyo, Osaka and Nagoya, all geographically lying in the Pacific industrial belt of Japan. Consequently, differences in both the development level and the structure of the manufacturing industry among the previously mentioned areas, and the rest of Japan, were created, and to a certain extent still exist today.

While investigating the scale and the exact geographical patterns of emerging development through the industrial development process concentration, we searched for initial conditions and changes in the structure of the Japanese manufacturing industry, in both prefectural and sectoral dimensions, examining empirically the manufacturing industry in each of the 47 administrative prefectures of Japan.

The industrial cluster plan intended to deal with the changes in the international competitive environment, since the collapse of the Keiretsu[5] (Ohsono, 1995). Without being neglected by the authors, this highlights the importance of this structure in the resurgence of Japan from 1970s, however, the outdated and degenerated economic and social conditions which justified the postwar system have disappeared (Kiribuchi, 1999). Thus the postwar system can no longer cope with these structural problems and the Japanese potential growth rate has been effectively limited.

The *Keiretsu* or relationship between big and small and medium sized (SMEs) firms, during 2003, (the most recent year for which statistics are available), show that small and medium-sized enterprises comprised 99.4 percent of all establishments in Japan. These 80,000-plus businesses employed 71.5 percent of the workers in the manufacturing sector. In terms of industrial shipments, SMEs accounted for 51.4 percent of the total value and 55.9 percent of the value added. These statistics illustrate very clearly the significant contributions of small and midsized firms to Japan's manufacturing sector and their importance in the economy as a whole. These operations, contrary to the predictions of economists both within and without Japan, did not wither away as the economy matured. Quite the opposite, they became deeply intertwined within the production networks and innovative activities of Japan's most competitive industries.

Figure 4 shows the distribution of cluster plans for both MEXT and METI, developed by ministerial regional offices.

Japan's economic clusters are characterized by their high level of diversity. They are not single-industry clusters; they comprise numerous industries and firms, clustering primarily in metropolitan areas to form heterogeneous economics zones and as showed in Figure 4. These plans contribute to increase such diversity, which means a more disaggregated analysis should be made to find complimentary smaller geographical units (See appendix for more detailed Japanese prefectural information). Those clusters are also marked by an upward trend in the level of diversity (i.e. agglomeration of different manufacturing sectors). Such diversity contributes to knowledge spillovers and promotion among clusters and sustained growth at the point of industrial structural revitalization.

5) Keiretsu are corporate groupings characterize by bonds of cross share-holding between members, shared access to capital through a member bank, and to shared services, such as distribution and shipping, and vertical integration within industries and sectors, including so-called "tied subcontractors" who received most of their business from a single large customer. This structure is particularly common in manufacturing industry.

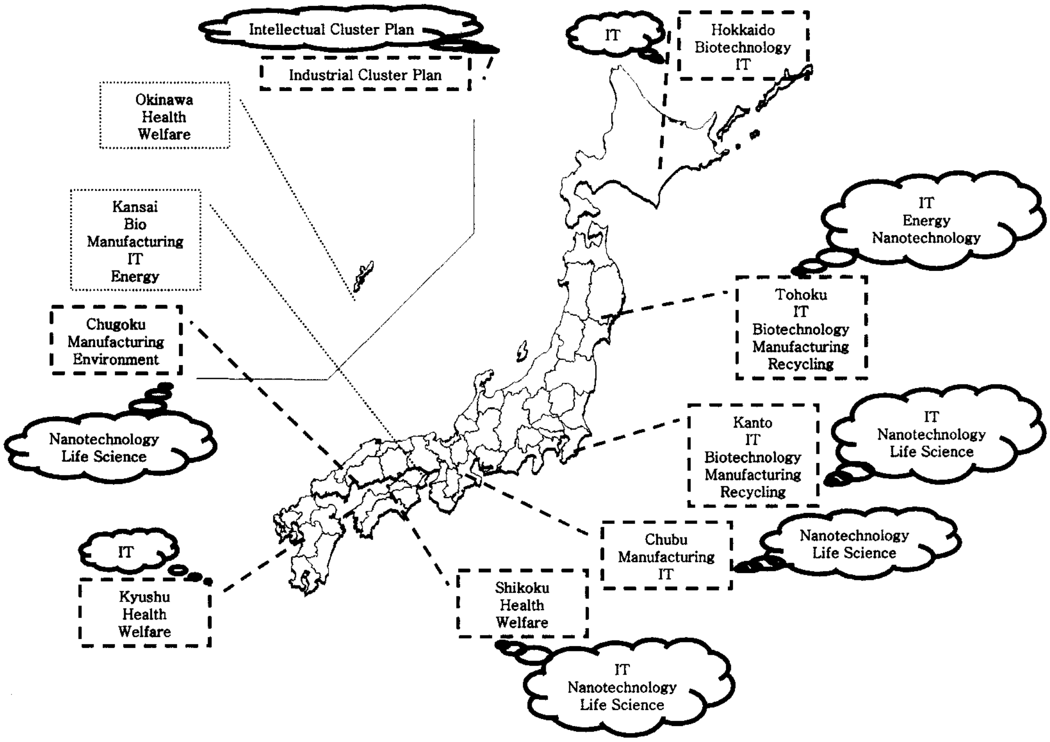


Fig. 4 : National Distribution of Clustering Plans

2.3 Patents as Proxies for Clustering of Regional Economies

Provided that the generation of patents[6] is governed by the flow and stock of R&D and they are represented by R&D investment and technology stock, respectively (Griliches, (1984), the number of patents registrations (P) can be represented by the following equation:

$$P = f(t, R, T)$$

where P : number of patents registration, R : R&D investment, T: technology stock, t : time trend representing successive diminution behavior, since generation of patents depend on novel and innovative activities and diminish as time goes.

6) In the Paper we work with the Cobb-Douglas production function at level of firms, several papers works with this approach a national level, then Previous works show that macro and micro level could be demonstrated by this function. A Meso-Level approach could be demonstrated too. (Approach by Evolutionary economists, Local level (Meso) could be even more important than micro and macro level)

This equation can be estimated by the following simple Cobb-Douglas production function[7] (Watanabe, 2000, 2003, 2004) for Japan's manufacturing industry in 47 prefectures:

$$P = Ae^{\lambda t} R^{\alpha} T^{\beta} \quad \cdots\cdots (1)$$

where A : scalar factor, ; λ : time trend coefficient; α and β : elasticities of R&D investment and technology stock, respectively.

Technology stock is measured by the following equation:

$$T_{it} = R_{i,t-m} + (1-\rho)T_{i,t-1} \quad \cdots\cdots (2)$$

where m is the lag between R&D and commercialization and ρ is the obsolescence rate of technology. This information for each respective manufacturing sector was collected from a questionnaire to Japan's major manufacturing firms undertaken in April 1990, supported by the Ministry of International Trade and Industry (Watanabe, 1996). See Appendix 3, for complete model of economic performance and inclusion of Cobb-Douglas approach and result demonstrating impact of technological proximity and geographical proximity by manufacturing sectors and economic periods in Japan.

The Japan Institute for Invention and Innovation constructed a database covering each respective manufacturing industry in each respective Japanese prefecture. The data have been classified in four-digit IPC, and then re-classified in two-digit JISIC industry and standardized to ISIC classification for further comparisons with other research. The original patents registration data base consists of 373, 761 patents of invention in manufacturing industries registered in 2000. While it is difficult to construct a database compiling the information at the prefectural level with sectoral classification, the outcome demonstrates that this is an important and invaluable source to find out more detailed differences between growth of prefectures. Then, using the information of patents by prefectures according to the IPC, in order to utilize it for this analysis, reclassification was made according to the International Standard Industrial Classification (ISIC) by industry.

Technological proximity demonstrates that the reliability of patents data is essential for this

7) Several paper have intended this approach demonstrating that patents can be represented as a function of R&D expenditure and Technology stock, the existence of assimilated spillover technology between firms and sectors which incorporates indigenous technology, the interactions between assimilation capacity, R&D intensity and sales. Then similar attempt could be done in a macro level with the existence of specialized prefectures and localized manufacturing industries. (See Watanabe, 2004; Carvajal, 2004; Caniels, 2000).

analysis (Jaffe, 1986) and a database was constructed covering each respective manufacturing industry in each respective prefecture. Many readers could question that the use of patenting is inadequate since patenting does not capture fully innovation related activities but citing Griliches (1984), there is a positive correlation between R&D investment and patents (i.e. This is know as R&D expenditure elasticity of patent applications), Empirically can be demonstrated that the sectors technologically intensive (i.e. Higher R&D intensity (OECD, 1997), present higher level of registration of patents which is a clear indicator of innovation and consequently a good proxy.

It has long been recognized that significant R&D spillovers between firms or industries occur within a nation (Griliches, 1984; Nadiri, 1993; OECD, 1997). According to Jaffe and Trajtenberg (2002), detailed information on the technological composition of firms' patents can be used to locate firms' research programs in "technology space" (See Table A-3-1 Impacts of technological and geographical proximity on Spatial Autoregressive Econometrics model) and variations across this space, "spillovers" of R&D, have measurable effects on R&D performance. Jaffe and Trajtenberg see the potentially rich detail in the classification of patents by technology-based patent class as an important issue, because it has been seen in a limited ways to spillovers across technologies, and just as with geography, there is significance in localization. Patents data offer tremendous potential for giving empirical content to the role of knowledge in the modern economy.

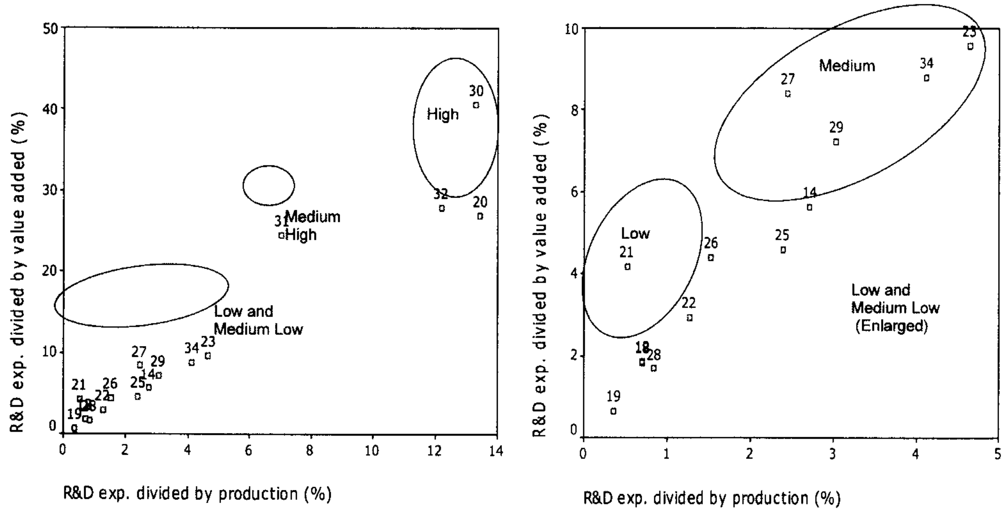


Fig. 5: Aggregate R&D Intensity in Manufacturing Sectors

Since the OECD has shown a slight difference in its classification of High (Precision instruments, Chemicals, Electric machinery), Medium (Transport, Ordinary Machinery), Low-medium and

Low technology intensity industries in the case of Japan, the classification in this paper applied the same principles of the OECD STI Scoreboard as demonstrated in Figure 5 while based on the Japanese industries performance.

In the past decade, there has been a significant change in the composition of international trade in manufactured goods. The growth rate of trade in high-technology industries has accelerated and their share in total OECD trade has increased. Figure 5 demonstrates these trends and our database constructed and reclassified in the aforementioned way represent these trends precisely. Then, analysis of concentration, technological intensity activity and innovative clusters can help to identify government strategies for industry creation or dispersion.

Low technology intensity sectors should be considered when defining clusters since they have demonstrated high level of innovation, and considerable R&D investment. Technological specialization of Japanese prefectures was associated with their productive specialization pattern, and possible technological advantages by registered patents, R&D investment and technology stock were analyzed for the definition of viable clusters.

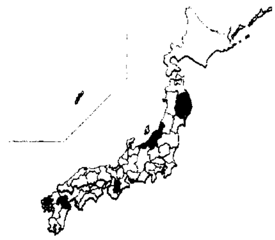
It is broadly postulated that what is important for growth is innovation, not production, and that high agglomeration in manufacturing does not necessarily mean high agglomeration of innovative activities (Audretsch and Feldman, 1996). This is one of the most sensible features to consider, without ignoring the importance of institutions to construct the networks necessary to leverage the formation of clusters, the existence of significant inter-industry differences in concentration ratios are valuable tools for identifying innovation flows in specific industrial prefectures for the creation of sectoral or firms networks. Figure 6 demonstrates the sectors within the prefectures with positive technology stock and R&D investment (α, β coefficients respectively) which means an active behavior in innovation, production activity and patents registration dynamics.

$$\ln \boldsymbol{P} = \ln \boldsymbol{A} + \boldsymbol{\lambda t} + \boldsymbol{\alpha} \ln \boldsymbol{R} + \boldsymbol{\beta} \ln \boldsymbol{T}$$

where A is scale factor; $\boldsymbol{R}$: R&D investment; $\boldsymbol{T}$: technology stock; $\boldsymbol{t}$: time trend represents successive diminution behavior, λ:coefficient of time trend.

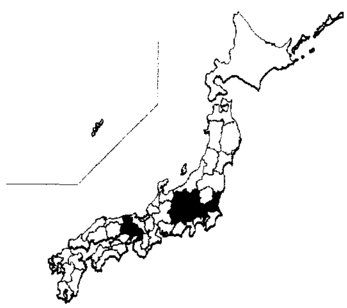
Chemicals

Prefecture	A	λ	α	β	adj. R^2	Firms change	Empl. change
Iwate	-1.895 (11.23)	0.017 (1.381)	0.741 (17.69)	0.98 (22.94)	0.995	-15.3	4
Niigata	-15.72 (1.486)	0.087 (1.196)	2.389 (2.460)	2.479 (1.481)	0.458	2	-2.5
Nara	0.094 (0.038)	0.363 (1.513)	0.665 (1.646)	0.572 (1.095)	0.381	-5.2	-7.6
Saga	-8.24 (7.43)	0.050 (1.397)	2.759 (12.54)	0.898 (3.796)	0.98	-4	-0.9
Oita	-2.253 (6.93)	-0.009 (1.177)	1.411 (20.19)	0.374 (7.82)	0.997	-3.8	-7.9



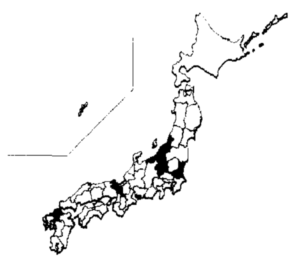
Electric machinery

Prefecture	A	λ	α	β	adj. R^2	Firms change	Empl. change
Saitama	-1.147 (2.145)	0.003 (1.498)	0.731 (15.38)	0.563 (9.859)	0.986	-6.1	-9
Tokyo	4.796 (5.629)	-0.005 (1.358)	0.500 (5.682)	0.347 (4.185)	0.896	-12.3	-20.6
Kanagawa	10.66 (92.0)	-0.02 (1.2)	-0.14 (14.2)	-0.15 (14.3)	0.986	-6.1	-9
Yamanashi	3.733 (17.90)	-0.016 (1.328)	0.233 (6.422)	0.191 (5.072)	0.93	-8.4	-10.1
Ibaraki	6.416 (365.8)	-0.002 (1.310)	0.007 (4.581)	0.076 (24.50)	0.994	-7	-8.9
Gunma	-14.95 (3.226)	0.042 (1.526)	0.872 (1.918)	2.123 (4.098)	0.81	-8.6	-6.2
Nagano	3.422 (25.7)	-0.006 (1.372)	0.530 (30.37)	0.305 (16.37)	0.996	-10	-7.8
Osaka	7.661 (26.26)	-0.011 (1.318)	0.077 (2.435)	0.111 (3.390)	0.731	-10.2	-21.2
Hyogo	-1.385 (3.628)	0.009 (1.352)	0.717 (16.79)	0.562 (12.66)	0.991	-8.1	-6.4



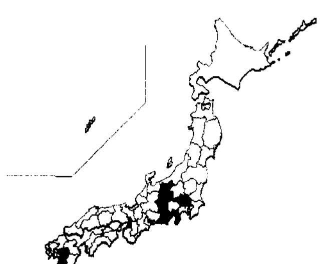
Transport machinery

Prefecture	A	λ	α	β	adj. R^2	Firms change	Empl. change
Ibaraki	0.629 (0.477)	0.012 (0.923)	0.677 (4.81)	0.342 (2.092)	0.867	-8.5	-5.3
Gunma	0.612 (3.932)	-0.006 (1.388)	0.531 (20.6)	0.423 (16.79)	0.993	-9.1	1
Niigata	-15.72 (1.481)	0.087 (1.196)	2.389 (2.46)	2.479 (1.481)	0.458	-9.9	-17.8
Kyoto	2.346 (1.377)	-0.013 (1.349)	0.125 (1.60)	0.409 (1.589)	0.844	-3.4	-10.1
Fukuoka	2.437 (51.41)	-0.003 (47.22)	0.48 (47.2)	0.208 (21.85)	0.998	-17.2	-17.9



Precision instruments

Prefecture	A	λ	α	β	adj. R^2	Firms change	Empl. change
Saitama	4.210 (5.73)	0.013 (1.511)	0.311 (2.44)	0.379 (3.363)	0.79	-8	-11.4
Tokyo	8.33 (16.68)	-0.016 (1.429)	0.189 (2.44)	0.192 (2.67)	0.642	-11	-22.5
Nagano	-0.523 (0.326)	0.034 (1.508)	1.138 (3.36)	1.019 (3.338)	0.836	-7.2	-6.1
Shizuoka	3.795 (6.008)	-0.013 (1.415)	0.675 (5.86)	0.056 (0.479)	0.889	-2.2	-7.1
Osaka	3.739 (7.994)	0.007 (1.483)	0.637 (9.29)	0.388 (6.346)	0.967	-8.8	-12.2
Kumamoto	2.038 (27.93)	0.003 (1.520)	0.653 (22.2)	0.834 (30.68)	0.996	-3.4	-13.9



Notes : [a] λ, α, β are coefficients of time trend, R&D investment and technology, respectively.

[b] Time trends t for 13 manufacturing sectors represent successive diminution behavior are estimated by means of their behavior in 1998, 1999 and 2000.

[c] Figures in parenthesis indicate t-values and firms and employment changes are indicated in percentage (%).

Fig. 6 : Comparative Analysis of Assimilation Structure in 47 Japanese Prefectures Cross-prefectural, Cross-sectoral and Time Trend Comparison.

Regarding prefectures with negative technology stock, they represent prefectures which are patent appliers but not generators and non innovators. The prefectures with positive R&D investment are prefectures active in patent registration but non-active producers or manufacturing centers within the analyzed sectors. As was shown in Figure 4, a considerably number of industries are being developed, but mainly focused on IT, nanotechnology and life science. Almost all regions focusing on the same type of clusters especially intellectual clusters that are non-compatible to industrial clusters makes these plans very willing to underestimate their potential benefits.

2.4 Manufacturing Clusters in TAMA

One example could be the denominated TAMA (Technology Advanced Metropolitan Area) region which comprises the prefectures of Tokyo, Saitama and Kanagawa. This regional industry revitalization plan proposed the relocation of dominant factories from inner city district and small and medium enterprises with product development abilities in the sectors of transport machinery and precision instruments. This project, leaded by the regional bureau of METI (Kodama, 2002) in order to respond to the intensification of global competition and changes in industrial structure, recognizes agglomeration as the source of Japan's economic dynamism and the possibility of also achieving regional economic development.

Table 3 : Characteristics of Prefectures Conforming TAMA Region

	Major industries	Developing industries	Education	Firms
Tokyo	Transportation and electrical machinery	Animation, information and communications and consumer service	Universities 114.	IBM Japan Ltd., Amway Japan Limited, Nippon Motorola Ltd., McDonald's Co., Ltd., AIC Corporation, Pfizer Pharmaceuticals Inc., Esso Sekiyu KK, EI du Pont de Nemours and Company, AXA Life Insurance Co., Ltd, etc.
Kanagawa	Electric and general machinery transport equipment, chemicals and petroleum products	Biotechnology, environment, inf/communications, medical and new manufacturing technologies	Universities 38, graduate schools 29.Kanagawa Prefecture is one of the nation's most educated prefectures; 48.8 percent of its students go on to attend university, and there are over 200,000 students at the junior college level and above. Includes Kanagawa and Yokohama National University and Kanagawa Institute of Technology.	431 foreign affiliated firms are located in Kanagawa Prefecture, including 263 HQ. 8 percent of all foreign affiliated firms in Japan, and Kanagawa Prefecture has the second highest number of foreign affiliated firms, next to Tokyo.
Saitama	Electrical, transport, chemical, and general machinery.	Environment-related, data communications, medical, biotechnology, new manufacturing technologies.	Universities 42. Seven universities in the prefecture include engineering departments. Each of these has an office for collaboration between industry and academia.	31 foreign enterprises (firms which have their head office located in Saitama Prefecture and have at least 20% foreign capital)
Gunma	Transportation machinery, electrical machinery.	New industries nanotechnology, bioscience, analog and processing/assemblyand automotive and electrical industries.	Universities 12. Universities specializing in engineering, including the Engineering Faculty of Gunma University, are engaged in research that takes advantage of the characteristics of the region.	There are 13 foreign enterprises (manufacturing industry), with 15 factories. (Excluding firms which became foreign enterprises due to M&A.) P&G, Glaxo Wellcome, Michelin Japan and Mitsuba-Walbro

TAMA spreads from the Tokyo Tama region across Saitama and Kanagawa. The region is situated on the periphery of the clustered network of Tokyo area, and comprises a number of clusters based on regional cities and on industrial parks. Table 3 explains the characteristics of the prefectures conforming this region. In Table 3, one prefecture not included in the TAMA region (i.e Gunma), has an increasing potential to participate in the expansion of the cluster based on the results empirically obtained. The area absorbed many factories relocated out of Tokyo by large firms, with new businesses emerging as spin-off of existing companies, and as a consequence, electrical machinery, transport machinery and precision machinery clusters were created.

However, because TAMA clusters have developed only since the period of the bubble economy, manufacturing centers are dispersed with decreasing clustering pattern (See Figure 3). According to METI (2002), the area lacked the diverse basic technology and the capacity for a flexible response in terms of both quantity and quality, which has been achieved in Tokyo and Osaka. Additionally, large firms with their R&D and manufacturing facilities with high technology intensity from the Tokyo area are expected to locate into the TAMA area.

The empirical analysis is supportive, at meso-level, to this initiative of transferring many factories out of Tokyo by large firms, with new businesses beginning to catch-up and following-up; as a consequence, electric machinery, transport machinery and precision instruments clusters should be leveraged.

Further, Tokyo and Saitama were found to be highly productive with high level of innovativeness (adj. R2 0.89 and 0.98 respectively, see Figure 6), being identified as having high innovativity performance. In the case of Kanagawa, results showed it does have significance on the variables of technology stock and R&D investment but with a negative trend, this information prompted us to analyze more carefully the role of this prefecture within the project, and to consider it, mainly, as a productive center. The lack of the project in this sense is that it is neglecting important neighbors such as Gunma, Ibaraki and Nagano. Results showed a high level of innovativity (highly productive and potentially high level of innovativeness). This important result will prompt the government to establish policies in order to not affect the objective of economic revitalization sacrificing the performance of other prefectures with strong prospective.

2.5 Other Sectors

TAMA is not the only industrial and intellectual cluster that can be found by means of this analysis. Other sectors such as chemicals, precision instruments, transport machinery and ceramics could be supported with the same basis as TAMA. Figure 6 shows the different prefectures with both productivity and innovativeness potential that can be interpreted as innovativity. In these sectors, such prefectures can be proposed to be the starting point (i.e. epicenters) for the formation of intellectual and industrial clusters, and the surrounding prefectures to be the supportive structure.

According to the spatial autocorrelation analysis, the key factors for the formation of networks such as universities, firms and location constraints are statistically significant, making stronger the hypothesis of technological and geographical proximity (Carvajal et al. 2002, 2003, 2004).

Continuously applying traditional regional industry policy, underestimating the utilization of cluster theory, and developing plans with the sole objective of revitalizing the region or the industrial activity, can impact negatively in innovation and productivity of the sector by isolation of enterprises in local areas in spite of their high technology intensity.

Prefectures can be the basis to enhance economic revitalization rather than regions. Firstly, concentration of firms in specific prefectures constitutes the fundamental condition in the creation of new industries, and the strengthening and abolishment of others. Manufacturing sectors with high growth potential benefit enormously from the merits of regional clusters and start-up firms which can make the best of infrastructure, universities and other support institutions that are within these smaller geographical units such as prefectures. Tokyo, Osaka and Aichi tend to be a vortex, because of their capacity to concentrate those advantages, but some other prefectures that are not necessary neighbors of these leaders present characteristics that should be taken advantage of. Then, it is important to look for strategies whereby the advantages of some prefectures spillover neighbors and boost homogeneous development.

Using this approach will increase the competitiveness of prefectures by the formation of clusters other than biotechnology, nanotechnology and IT. Clusters will enhance a more rapid organization of manufacturing sectors in Japan and it will support the development of international manufacturing center, avoiding hollowing-out.

As described in Table 2, the proposed plans neglect fundamental concepts and indicators that have demonstrated to be accurate proxies for indicating innovation and support policies in clustering development. (e.g. registered patents, technology stock, R&D investment, technological distance and geographical distance). Additionally, these two plans should be complementary to each other and co-evolve to avoid failures in their definition to revitalize the region. The concept of innovativity demonstrates if these two plans can co-evolve or not.

Clusters are also marked by the upward trend in this level of diversity. Such diversity contributes to knowledge spillovers[8] and promotion among clusters and sustained growth at the point of industrial structural transformation. Japan's challenge will be to develop attractive economic clusters focused on the benefits of diversity and to form flexible ties with other economic clusters. (To see the current intellectual[9] and industrial[10] clusters defined see Ishikura et. al. 2003).

3. Conclusions

The lessons from Japan provide informative suggestions to enterprises under megacompetition by trans-regional technology spillovers. Japan faced homogeneity which can be argued as a negative factor for the transition to an information society. Japan's economic performance is the consequence of its enterprises, universities, research institutions, and R&D expenditure performances during the bubble economy in the latter part of the 1980s. This is when they played important leveraging roles on the impact of distance on knowledge and economic spillovers between prefectures, since the learning capability speeded it up. The implications of this research will help focus on more effective policies and improve the R&D strategy in Japanese regions, in order to increase reasonable economic growth, backing up the concept of quantitative homogeneity.

According to the OECD, there are three levels in cluster analysis national level (macro), branch or industry level (meso) and firm level (micro). This paper dealt with the first two levels, since the focus of the analysis was with specialization patterns of national, regional and prefectural level and exploring innovation trends intra-prefectural and intra-sectoral level measured by registered patents, demonstrating that industrial clusters together with intellectual clusters may transcend different geographical levels. One of the main challenges for clustering analysis is the availability of micro-level information and production statistics at cluster level, identification of a cluster in its infancy, and the measurement of international clusters. Japan is uniquely situated to take advantage of cluster analysis because information within the confines of Japan is well organized.

The cluster projects, aiming both at the acceleration of the regional development process

8) Knowledge spillovers were demonstrated in Carvajal et. al. 2004, influenced by geographical and technological distance. Knowledge spillovers demonstrated to decrease if geographical distance increases as confirmed by Caniels (2000). Using spatial econometrics (Anselin, 1988) the locational factor was found to be significant explaining 4% of the model.

9) Map Intellectual Clusters MEXT : http://www.rieti.go.jp/users/cluster-seminar/pdf/003_p_en.pd

10) Map Industrial Clusters METI : http://www.meti.go.jp/english/report/downloadfiles/gIT0201e.pd, pp. 54

and the promotion of a technology-intensity industries, constitutes one of the most ambitious plans in the history of Japan's regional development policy-making.

The cluster project, as the largest scale attempt at the deliberate stimulation of technological advance and its close relationship with regional development in Japan, will attract international attention. Up until now, there are many definitions and qualitative descriptions regarding cluster sites, however, no extensive quantitative work examined factors that could be the key for this regional development process.

Due to the agglomeration effect in clusters, the utilization of the knowledge capital of universities is stimulated, the mechanisms of competition between competing firms and a mechanism that accelerates innovations comes into play. Furthermore, innovativity is stimulated rapidly by customer needs and trends, and an environment is provided in which it is easy to obtain the need for innovations and technical opportunities. Similarly, procurement of assets required for innovations (i.e. services, machinery, etc.) are provided, and it is expected a close competition and cooperation between clusters and between firms within prefectures, then it is plausible that new technologies and products would be effectively produced, contributing greatly to prefectural growth and employment, ultimately contributing to flexible responses to changes in the environment, and strengthening the nationwide innovation system to face the Asian's challenges. Mega clusters analysis must be combined with small scale cluster approaches avoiding policies that could have unintended negative consequences on innovativity. This paper could lead industrial policy to stimulate competition in favor of a particular location; to remove obstacles, relax constraints, and eliminate inefficiencies, in order to leverage productivity growth relying on dynamic improvement.

The analysis provided in this paper is coherent with the Prime Minister's policy speech in the Diet in February 2003 that an Industrial Revitalization Corporation will be established to make fundamental revisions for special measures toward industrial reorganization and early revival of businesses through maximum utilization of the wisdom and vitality of the private sector. Science and technology will maintain strict control on general expenditures in order to achieve a nation built on the platform of scientific and technological creativity. In that way, overcoming economic stagnation due to complex structural elements, not merely for cyclical changes of the economy, but also for establishing institutions for taking up the challenges of innovating technology and launching new enterprises.

Additionally, as the Japanese industry matured, the less developed prefectures found it difficult to follow as they specialized in the more traditional living related industry. The cluster policies came up as the new METI's and MEXT's approach to cope with those regional problems.

In fact, according to METI, the cluster plan is a new strategy for the development of relatively backward regions, aiming at the creation of attractive towns in which industry, academia and residential space are closely interrelated. This originated from the need of expanding the employment opportunities in the local areas. It also help become more aggressive in attracting high-tech industries by providing the latter the necessary support at the local level and stimulate the manufacturing industries.

Finally, we would like to put in order the results of the analysis and studies made in this paper and suggestions derived from them. First, the authors collected and analyzed industry and prefectural interactions, which can be used to improve the analysis of co-location of sectors and industries. Indeed, it is obvious to those familiar with large cities and urban realities that economic interactions within these kinds of clusters are typically governed by the logic of large number and political decisions.

Second, the revitalization of the economy is a critical issue that Japan is facing, and structural reforms are pointing toward that purpose. Hollowing out is a fact; changes in the number of firms, reduction of employees in the different sectors, increasing of outward FDI into the Asian community, historical desegregation of sectors within Japan, etc. are just some of the constraints against stimulating the revitalization goal. Then, exploiting the potential of innovativeness, productivity and innovativity of the prefectures and localized sectors, by means of clusters, will set the pace for the aimed objective.

Today, Japan is experiencing the same situation as in 1990s, when a hollowing out of the Japanese economy took place in the shadow of the bubble economy. This became more visible as the value of the Yen remained high and the economy stagnated. On the other hand, in Asian countries, restructuring and re-engineering measure are increasingly in traditional sectors such as textile, food, steel and important manufacturing industries, such as transport machinery, electrical machinery, chemicals and precision instruments.

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Appendix 1. Innovation and Research Projects

	Regional projects	Patents		
		First	Second	Third
1. Hokkaido	Biotech cluster	Preparations for medical, dental, or toilet purposes	Horticulture; Cultivation of vegetables, flowers,	General building constructions; Walls,
2. Aomori	Environment, energy related	Animal husbandry; Care of birds, fishes, insects;	Harvesting; Mowing	Containers for storage or transport of articles
3. Iwate	Tertiary industry, ZnO cluster Flower of Zinc	Information storage based on relative movement	Electric discharge tubes or discharge lamps	Micro-organisms or enzymes; Compositions
4. Miyagi	Food product, environment, medical, welfare, IT	Semiconductor devices; Electric solid statedevices	Magnets; Inductances; Transformers; Selection	Apparatus or devices for man folding, duplicating,
5. Akita	Ultra high density perpendicular recording media	Devices for introducing media into,	Diagnosis; Surgery; Identification	Semiconductor devices Electric solid state devices
6. Yamagata	Organics Electronic Display	Information storage based on relative movement	Semiconductor devices; Electric solid state devices	Electric digital data processing
7. Fukushima	IT, computer sciences	Processes or means, e.g. batteries, for the direct	Pistons; Cylinders; Pressure vessels in general;	Information storage based on relative movement
8. Ibaraki	Biomedical, Science Frontier (Proton accelerator)	Semiconductor devices; Electric solid state devices	Investigating or analyzing materials	General building constructions; Walls,
9. Tochigi	Electronics, semiconductor, medical, transportation equipment	Diagnosis; Surgery; Identification	Filters implantable into blood vessels; Prostheses;	Containers for storage or transport of articles
10. Gunma	Nanotechnology, ecology, bioscience, high frequency circuits, LSI	Card, board, or roulette games; Indoor games	Coin-freed or like apparatus	Compositions of macromolecular compounds
11. Saitama	Environment, data communication, medical, welfare, biotech, manuf. Tech	Pictorial communication, e.g. television	Semiconductor devices; Electric solid state devices	Optical elements, systems, or apparatus
12. Chiba	DNA research	Compositions of macromolecular compounds	Optical elements, systems, or apparatus	Investigating or analyzing materials
13. Tokyo	Mfg. industries, creating value added printing, electric and gen. machinery	Electric digital data processing	Semiconductor devices; Electric solid state devices	Pictorial communication, e.g. television
14. Kanagawa	10 regional industrial parks (manufacturing, R&D, biotech, electronics)	Electric digital data processing	Semiconductor devices; Electric solid state devices	Information storage based on relative movement

	Regional projects	Patents		
		First	Second	Third
15. Nigata	IT, plasma display, consumer robot, metal processing, medical appliances	Electrography; Electrophotography;	Lime; Magnesia; Slag; Cements; Compositions	Shaping or joining of plastics;
16. Toyama	Data communication, IT, research pharmaceutical	Fixed or movable closures for openings in	General building constructions; Walls,	Containers for storage or transport of articles or
17. Ishikawa	IT nanotechnology	Electric digital data processing	Pictorial communication, e.g. television	Woven fabrics; Methods of weaving; Looms
18. Fukui	Services	Spectacles; Sunglasses	Dynamo-electric machines	Working-up; General processes of compounding;
19. Yamanashi	Manufacturing, road cargo transportation, packaging	Semiconductor devices; Electric solid state devices	Electric digital data processing	Measuring electric variables; Measuring magnetic
20. Nagano	Electric machinery, precision, printing	Typewriters; Selective printing mechanisms,	Semiconductor devices; Electric solid state devices	Devices or arrangements, the optical operation
21. Gita	Robots, IT	Printed circuits; Casings or constructional details	Containers for storage or transport of articles or	Card, board, or roulette games; Indoor games
22. Shizouka	Optoelectronics, imaging devices	Electrophonic musical instruments	Electrically-conductive connections; Structural	Photomechanical production of textured
23. Aichi	Automotive	Card, board, or roulette games; Indoor games	Controlling combustion engines	Semiconductor devices; Electric solid state devices
24. Mie	Panel display FPD, medical biotech, pharmaceuticals	Electrically-conductive connections; Structural	Installation of electric cables or lines,	Compositions of macromolecular compounds
25. Shiga	Biotech	Semiconductor devices; Electric solid state devices	Layered products, i.e. products built-up of strata	Shaping or joining of plastics;
26. Kyoto	IT bazaar, genome, nanotechnology	Semiconductor devices; Electric solid state devices	Investigating or analyzing materials	Processes or means, e.g. batteries,
27. Osaka	Bioscience, nanotechnology	Semiconductor devices; Electric solid state devices	Pictorial communication, e.g. television	Information storage based on relative movement
28. Hyogo	Optical, medical, material science	Semiconductor devices; Electric solid state devices	Compositions of macromolecular compounds	Investigating or analyzing materials
29. Nara	Bioscience, materials	Containers for storage or transport of articles	Details, components, or accessories for machine	Preparations for medical, dental, or toilet purposes

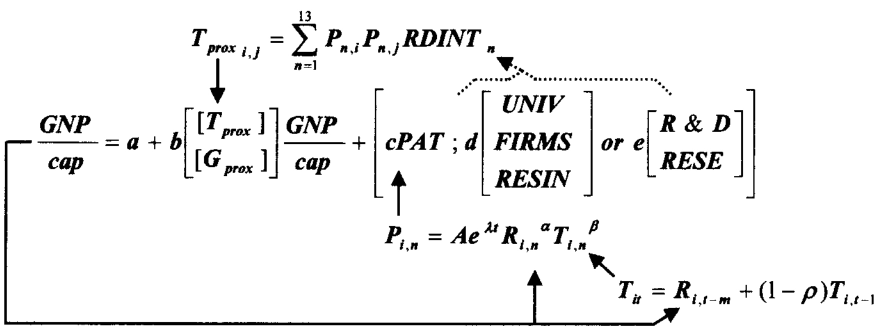
	Regional projects	Patents		
		First	Second	Third
30. Wakayama	IT	Apparatus or arrangements for taking photographs	Detergent compositions; Use of single substances	Apparatus for processing exposed photographic
31. Tottori	IT	Telephonic communication	Electric digital data processing	Devices or arrangements, the optical operation
32. Shimane	Communication, information, environment, health, welfare	Planting; Sowing; Fertilizing	Processing of harvested produce;	Soil working in agriculture or forestry;
33. Okayama	Medical devices	Harvesting; Mowing	Compositions of macromolecular compounds	Acyclic or carboxylic compounds
34. Hiroshima	Automotive	Shaping or joining of plastics;	Animal husbandry; Care of birds, fishes, insects;	Vehicles, vehicle fittings, or vehicle parts,
35. Yamaguchi	Services	Compositions of macromolecular compounds	Semiconductor devices; Electric solid state devices	Macromolecular compounds obtained otherwise
36. Tokashima	Services	Semiconductor devices; Electric solid state devices	Electric digital data processing	Devices using stimulated emission
37. Kagawa	Services	Information storage based on relative movement	Filters implantable into blood vessels; Prostheses;	Pictorial communication, e.g. television
38. Shiime	Biotech, medical	Harvesting; Mowing	Processing of harvested produce; Hay or straw	Planting; Sowing; Fertilizing
39. Kouchi	Information devices	Foundations; Excavations; Embankments;	Treatment of water, waste water, sewage, or sludge	Animal husbandry; Care of birds, fishes, insects;
40. Fukuoka	Semiconductor	Water-closets or urinals with flushing devices;	Semiconductor devices; Electric solid state devices	Sanitary equipment not otherwise provided
41. Soga	Synchrotron light	Semiconductor devices; Electric solid state devices	Preparations for medical, dental, or toilet purposes	Single-crystal growth; Unidirectional solidification
42. Nagasaki	Industrial equipment cleaning	Semiconductor devices; Electric solid state devices	Ships or other waterborne vessels;	Separation
43. Kumamoto	30% semiconductors	Semiconductor devices; Electric solid state devices	Devices or arrangements, the optical operation	General building constructions; Walls,
44. Ooita	Steel, petrochemical, semiconductor, automotive, electronics	Semiconductor devices; Electric solid state devices	Devices for introducing media into, or onto,	Macromolecular compounds obtained by reactions
45. Miyazaki	Services	Semiconductor devices; Electric solid state devices	Compositions of macromolecular compounds	Static stores
46. Kagoshima	Metal products	Semiconductor devices; Electric solid state devices	Printed circuits; Casings or constructional details	Lime; Magnesia; Slag; Cements; Compositions
47. Okinawa	IT	General building constructions; Walls,	Horticulture; Cultivation of vegetables, flowers,	Electric digital data processing

Appendix 2. Industries in Manufacturing

	Major industries	Developing industries
1. Hokkaido	Food, pulp/paper/paper processed goods, oil/coal products and machine equipments	Information and communication technology, biotechnology, and recycling
2. Aomori	Agriculture, forestry and fisheries, manufacturing, construction and wholesale trade	Electric machinery, general machinery and wholesale/retail trade
3. Iwate	Electricity, food, transportation, general machinery	Automobile-related, basic technology-related, research-and-development-related
4. Miyagi	Electrical machinery, food products, petroleum products, paper/pulp and metal products	High-tech industry and four key areas (food products, environment, medical and welfare and IT)
5. Akita	Electrical machinery, food products, general machinery, lumber and wood products and precision instruments	Promoting the development of advanced technological industries, resource recycling/new energy industries, research and development industries and food processing industries
6. Yamagata	Electrical machinery, general machinery, food and textiles	Organic Electro Lumine science(EL), nanotechnology and biotechnology
7. Fukushima	Electricity, chemistry, drink products, transportation and food products	Creative/environment-conscious, manufacturing, software-related and high-technology
8. Ibaraki	Machinery, electric equipment, chemicals, food products and metals	Medical/welfare, information/communications, new manufacturing technologies, environment and biotechnology
9. Tochigi	Electric machinery, transportation equipment, general machinery, chemical and beverage and cigarettes	Automobile-related, medicine and biotechnology, medical device and R &D functional integration
10. Gunma	Transportation equipment, electrical equipment, machinery, food products and beverages/feeds	New industries (nanotechnology, ecology, bioscience, analog and processing/assembly) and existing industries (automotive related and electrical equipment)
11. Saitama	Electrical machinery, transport machinery, chemical, general machinery and food products	Environment-related, data communications and images, medical and welfare, biotechnology, new manufacturing technologies and distribution and lifestyle related areas
12. Chiba	Chemical, steel, coal/petroleum, electrical machinery, transport machinery and agriculture (ranking second in Japan in crude productivity)	Working to form bases for creation of new industries, foster research and development businesses, and advance existing industries. Active projects include Kazusa DNA Research Institute and Tokatsu Techno Plaza.
13. Tokyo	Transportation and telecommunications, wholesale/restaurant business/retail sales, finance/insurance, publication/printing and electrical apparatus manufacture	Animation, information and communications and consumer service
14. Kanagawa	Electric equipment, transport equipment, general equipment, chemicals and petroleum products	Biotechnology, environment, information/communications, medical and welfare and new manufacturing technologies
15. Nigata	Electric machines, food products, metal products, general machines and chemical (In the order of the sales amount of shipped products)	Housing manufacturing, everyday life and culture-related, environment and energy-related and new manufacturing technology-related

	Major industries	Developing industries
16. Toyama	Aluminum, machinery manufacturing, pharmaceuticals and plastics	IT, biotechnology and deep sea water related industries are considered new growth areas and the prefecture is promoting these industries.
17. Ishikawa	Machinery and electronic equipment, textile, food, IT and service	IT, machinery and electronic equipment, food and service
18. Fukui	Electric machines, textile products, chemicals, precision and plastics	High-tech industries, laboratories and IT service industries
19. Yamanashi	Electric appliances, machinery, foods, precision instruments and transport equipment	Electric appliances, machinery, foods, precision instruments and transport equipment
20. Nagano	Electric machine, general machine, food and tourism	Health/welfare, environment and education
21. Gita	Textile products, ceramics, metals/cutlery, plastic products and machinery	Health/welfare, environment, culture/exchange, education and high technology
22. Shizouka	Transportation equipment, musical instruments, electric machinery, chemical engineering and food	Optoelectronics, medical services, functional food and physical distribution
23. Aichi	Transport machinery, general machinery, electrical equipment, steel and textiles	Aerospace, data communications, fine ceramics, electronics, biomedical and other advanced industries
24. Mie	Machine tools for transportation, liquid crystal, semiconductor, petrochemistry and tourism	Information and communication, medical/health/welfare, ocean, environment and tourism
25. Shiga	Electrical equipment, general equipment, transport equipment, chemicals and plastics	Environmental industry, health industry, biotechnology industry and IT industry
26. Kyoto	Electric equipment, transportation equipment, precision instruments, textile and chemical engineering	Information, environment, health and welfare and biotechnology
27. Osaka	Metal products, electrical appliances, machine equipment, textile products and plastic products	Biotechnology-related, information and communication-related, environment-related and health and welfare-related
28. Hyogo	Wholesale/retail, services, manufacturing, construction and transport/communications	Commerce, services and other tertiary industries
29. Nara	Electrical machinery, food products, metal products, general machinery, and plastics	Industrial concentrations of machine tools, integrated circuits (IC), and electrical machinery and devices with the latest technology
30. Wakayama	Petroleum, chemical, steel, machinery and beverage/feed industries	Beverage/feed, petroleum, apparel, steel and metal industries
31. Tottori	Electrical equipment, electronics and food products	Information/communications, IT services, environment and recycling and biotechnology
32. Shimane	Electrical machinery, iron and steel, general machinery, food and ceramic/sand and stones	Environment/energy, IT, health/welfare/safety, and industrial sawn timber (materials, parts and manufacturing technology)

Appendix 3



Source : Watanabe, et al. (2004).

Fig. A-3.1 : Scheme of the Model Depicting Interacting Dynamism between Regional Economies

Table A-3.2 : Spatial Autocorrelations for Analyzed Manufacturing Sectors in Japan showing Impact of Technological Proximity.

	Constant	T_{prox}	PAT	UNIV	FIRMS	R&D	adj. R^2
Chemicals	0.143 (2.85)	0.045 (1.93)		0.62 (4.14)		0.263 (2.85)	0.530
Electrical machinery	0.042 (0.94)	0.038 (2.03)		0.601 (4.71)	0.409 (5.16)		0.644
Transport machinery	0.098 (2.31)	0.059 (3.16)	0.094 (1.80)	0.476 (5.20)		0.240 (3.43)	0.619
Precision instruments	0.081 (1.60)	0.053 (2.54)	0.135 (1.46)	0.503 (3.66)	0.135 (1.53)	0.133 (1.43)	0.619

Source : Watanabe, et al. (2004).

Table A-3.3 : Spatial Regression Model for Japanese Prefectures and Impact of Geographical Proximity

		B1 Intercept	B2 UNIV	B3 PAT	B4 R&D	B5 RESEAR	B6 RESINS	B7 FIRMS	B8 Locational	Adj R^2
1985	Beta t-statistic	0.05 1.65***	0.45 1.68**	0.19 0.89	0.02 0.13	-0.11 -1.42***	-0.015 -0.09	0.22 1.56**	0.40 2.51^	0.75
1990	Beta t-statistic	0.08 2.15*	0.36 1.53***	0.36 1.87**	-0.04 -0.39	-0.08 -0.84	-0.009 -0.13	0.15 1.59**	0.41 2.71^	0.78
1995	Beta t-statistic	0.09 2.506^	0.30 1.29***	0.46 2.41^	0.05 0.571	-0.11 -0.87	-0.05 -0.80	0.1 1.01	0.40 2.63^	0.75
2000	Beta t-statistic	0.10 2.63^	0.26 1.21	0.54 3.02^	0.02 0.16	-0.07 -0.47	-0.07 -0.93	0.05 0.59	0.38 2.47^	0.73

Notes : ^ 98% Conf. * 95% Conf. ** 90% Confi. *** 80% Conf.
Source : Carvajal, et al. (2004).