IMPACT ANALYSIS OF HIGH SPEED RAIL ON INDUSTRIAL LOCATION: AN EMPIRICAL STUDY OF JAPAN SHINKANSEN

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ABSTRACT

Due to the rising priority and vast investment on high speed rail in infrastructure construction world widely, it has become increasingly necessary to make an appropriate assessment of the impacts on regional economy and more importantly to develop strategies and policies toward a sustainable development. This paper looks at the impacts of Shinkansen on industrial location in Japan. Differing from the previous research, we highlight the investigation of both socioeconomic factors and physical determinant through an empirical industrial location model and multivariable stepwise regressions based on statistical data. The results indicate that during the period of 1990-2000, the dominant driving force of industrial location has changed from industrial transaction interdependence to population consumption demand. The elasticity of accessibility to Shinkansen network has also shown an increasing trend from 1990 to 2000. Further expansion of Shinkansen lines would encourage the development of several industries like real estate, commerce and services, etc., hence contribute to the regional economic structure formation.

Keywords: *high speed rail, Shinkansen, industrial location, accessibility*

1 INTRODUCTION

The construction of transport infrastructure is often considered as a main factor affecting accessibility, industrial location and hence regions' growth. Due to the characteristics of safety, reliability, convenience, time-saving, environmentally friendliness, etc., High Speed Rail (HSR) has been recognized as one of the most important transport modes and been paid great priority in regional development. However, when regions and cities profit significantly from HSR, some side-effects such as over agglomeration of economy and population in some mega cities, decrease of economic potential are also generated simultaneously. With more and more HSR to be introduced or expanded in both developed and developing countries, it is becoming increasingly necessary to have a better understanding of HSR's role in economic organization, and more importantly to develop appropriate strategies and policies to reduce its side-effects on regional development.

Globally, a good deal of research has been done concerning HSR's regional impact. Nakamura et al. (1981) classified the direct and indirect impacts of Shinkansen sorted the causal links among each affecting factor through an interpretive structural modelling approach. They also developed a system dynamics model to simulate the impacts of Sanyo Line on Hiroshima City. Nakamura and Ueda (1989) analyzed the demographic change in the area with and without Shinkansen and highway services in Japan. They found that since the operation of HSR there is significant concentration of population into the main metropolitan centres, cities with HSR stations and areas having highway services. These are consistent with the findings of Vickerman (1997) who reviewed the experiences of HSR development in Europe and additionally pointed out that nearly all the HSR stations located only in major metropolitans which would probably result in the expansion of regional divergence. Reed (1991) looked at the development of HSR in USA and Europe and summarized that the impacts of HSR were reflected not only in the prosperous of HSR station periphery but also in the influence on industries such as passenger transport, construction, tourism, catering. Gutierrez (2001) evaluated the accessibility impacts of the Madrid–Barcelona–French border high-speed line by means of three indicators: weighted average travel times, economic potential and daily accessibility. Rietveld et al. (2001) discussed the experiences of Japan and France and conducted a cost-benefit analysis of the planned HSR links in The Netherland. Kantor (2008) conducted scenarios analysis of the benefits with and without the construction of HSR in the Central Valley of USA. In which, growth of population and employment, enhancement of quality of life, impact on real estate, etc. are projected. The existing research provides useful insights to the HSR's regional impact. However, most such studies either rely on theoretical abstraction and qualitative discussion, or treat the impact on the regional economy as a whole. Those comprehensive and quantitative investigations on which part of regional economic framework that HSR may affect and to what extent of the impact that HSR may contribute to are generally seldom reported.

Given this background, Shinkansen has been selected for empirical analysis because Japan was the first country in the world to construct HSR in 1964, and Shinkansen has been playing an important role in structuring the regional economy and locating industries. This paper consists of four further parts. Section 2 describes the characteristics of study area and lists out the data used for modelling. Section 3 presents an industrial location model to evaluate Shinkansen's impact on 11 major industries concerning their location choice, hence the detailed contribution to regional economic organization could be understood. Section 4 surveys the empirical results. And section 5 summarizes the paper with conclusions and discussions.

2. STUDY AREA AND DATA

Japan is an country in East Asia consisting of 47 prefectures, with a population of 128 million in 2008 while in a comparatively small land area of 377000 km^2 (Statistics Bureau, 2010). It is the second largest economy in the world just after the United States at around 4600 billion USD GDP in 2005 (International Monetary Fund, 2006). Since most large cities and industrial zones are located linearly along the coastal plain and the population density is very high, it creates a favoured environment for rail passenger transport, which is dominated by inter-city railway mode and centred on the Shinkansen. Despite the remarkable development of airlines and highways, Shinkansen holds a 6% share of the total domestic and 16% of inter-prefecture transport volume in 2005 (Central Japan Railway Company, 2008). Spatially, since the Tokaido Line between Tokyo and Osaka for a distance of 515 km was firstly put into operation in 1964, the National Shinkansen Construction Act was introduced in 1970 intending the construction of nation-wide HSR network of about 7000 km long. By 2004, six main Shinkansen lines together with 2 Mini-Shinkansens have been completed with a total network expanded to 2460 km (Fig. 1).

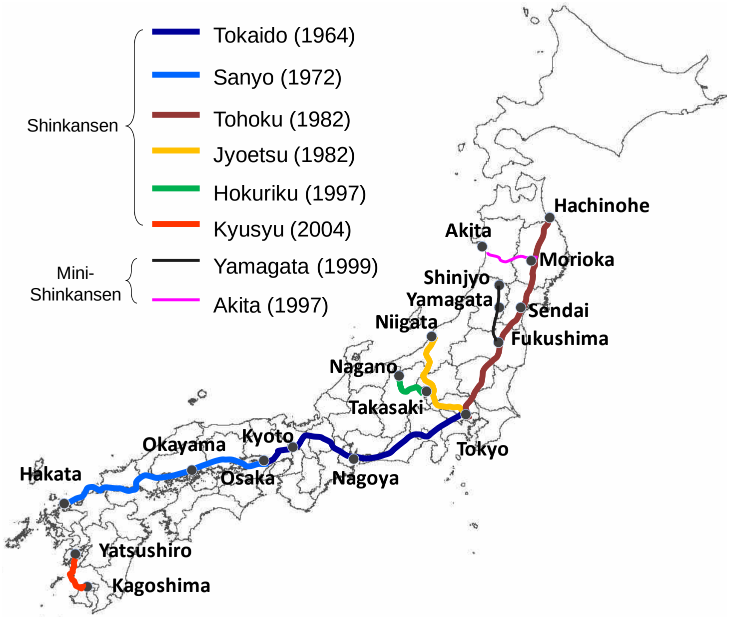

Fig.1 Study area and existing Shinkansen network by 2004

Note: figure in parentheses is the year when Shinkansen line was put into operation

To look at the change of Shinkansen's impact on industrial locations and considering the data availability, materials in 1990 and 2000 are collected from various sources at different scale. As listed out in Table 1, data include socio-economic statistics, transport time and cost, access time to Shinkansen network, etc.

3. METHODOLOGY AND MODEL SETTING

There is considerable literature on industrial location from which to develop a model of business location choice. Theoretically, it is firstly proposed by Weber (1929) who focused on the transportation cost reduction in a profit-maximizing world, and has been modified by many researchers in its level of detail, sophistication and incorporation of more complexity into the model assumptions (Moses, 1958; Greenhut, 1963; Hamilton, 1967; Greenhut and Ohta, 1973). However, comparing with such a great deal of literature on industrial location theory, empirical analysis is relatively few. One of the reasons may due to the data constraint.

Table 1 Data used in this study

Scale	Data	Year	Source
Country level	Transactions value and labour input among industries	1990, 2000	"Input-Output Tables" (Statistics Bureau, 1990, 2000)
Prefecture level	Population	1990, 2000	"Historical Statistics of Japan" (Statistics Bureau, 1996-2008)
	Number of employed persons by industries	1990, 2000	"Population Census" (Statistics Bureau, 1995, 2000)
	Inter-prefecture transport mode share	1990, 2000	"Inter-regional Travel Survey" (Ministry of Land, Infrastructure and Transport, 1990, 2000)
	Inter-prefecture travel time	1990, 2000	"JTB Timetable" (JTB, 1990, 2000)
	Inter-prefecture generalized travel cost	1990, 2000	• "Cost-benefit analysis manual for Airport Development Project" (Ministry of Transport Aviation, 1999) • "Cost-benefit analysis manual" (Road Bureau, Ministry of Land, Infrastructure and Transport, 2003 ,1999) • "Evaluation method of travel cost per unit time and per unit value (2003 price)" (Road Bureau, Ministry of Land, Infrastructure and Transport, 2003)
City level	Population	1995, 2000	"Japan City Yearbook" (Japan Association of City Mayors, 1990, 2000)
	Travel time from city center to the nearest Shinkansen station by using conventional railway	1990, 2000	"JTB Timetable" (JTB, 1990, 2000)

Recently most researchers either apply a multinomial logit model in industrial location study which is commonly used in transportation mode choice analysis (Hansen, 1987; Pearmain et al., 1991; McQuaid et al., 1996), or use statistical methods by reducing complex decisions to an algorithm form involving a limited number of explanatory factors such as characteristics of specific industry, locality and importance of connections with other areas and industries, agglomeration economies (Porter, 1990; Storper, 1995; Leitham et al., 2000). In this study, rather than analyzing Shinkansen's impact on industrial location through defining the explanatory variables neglecting those most important determinants such as transaction correlation among industries in different regions, and population's consumption demand from neighboring areas, we follow the works of previous studies (e.g. Nakamura et al., 1983; Sumitomo Trust Business Research Institute, 1991) as a base since they considered the factors above, and incorporate the accessibility to Shinkansen network as another important driving force. In modelling, we use the number of employed persons to represent the size of each industry in location choice. Through a stepwise estimation which manages to avoid multicollinearity in selecting the most significant variables, a logarithm-type multivariable stepwise regression model is proposed as follows.

$$\ln(\mathrm{EMPL}_i^k) = \alpha^k \ln(\mathrm{InterD}_i^k) + \beta^k \ln(\mathrm{ConsD}_i^k) - \gamma^k \ln(\mathrm{AT}_i) + C^k \quad (1)$$

where EMPL_i^k is the number of employees of a specific industry k in prefecture i; InterD_i^k is a function of industrial interdependence, which indicates the interaction influence of industries in other areas on the industry k in prefecture i; ConsD_i^k is consumption demand from neighboring areas on the products or services offered by industry k in prefecture i; AT_i is a weighted average access time of prefecture i to Shinkansen network, which to some extent reflects the difficulty of an area to profit from Shinkansen. It is assumed that the larger AT_i is the more difficult prefecture i is to attract employees from other industries and areas. C^k is a constant.

In detail, the explanatory variable InterD is defined by Eq. (2)-(4). ConsD and AT is expressed by Eq. (5) and (6) respectively.

$$\mathrm{InterD}_i^k = \sum_m \theta^{mk} (\sum_j \mathrm{EMPL}_j^m \cdot \mathrm{PL}_{ji}^{mk}) \tag{2}$$

where θ^{mk} denotes the employment correlation between industry m and k; EMPL_j^m is the number of employees of k's relevant industry m in neighboring prefecture j; PL_{ji}^{mk} is the probability of industry m of prefecture j in choosing prefecture i to trade with industry k, which is further defined by a logit-induced model.

$$\mathrm{PL}_{ji}^{mk} = \frac{\mathrm{EMPL}_i^k \exp(\lambda^{mk} \cdot \mathrm{GC}_{ji})}{\sum_j \mathrm{EMPL}_i^k \exp(\lambda^{mk} \cdot \mathrm{GC}_{ji})} \tag{3}$$

where λ^{mk} is a distance decay parameter when industry m trades with k. In this paper, the value of λ is given as 1.0, which is indicated by most literatures on accessibility study (Frost and Spence, 1995; Gutierrez, 2001); GC_{ji} is the weighted average generalized transport cost from prefecture j to i, which is measured by

$$\mathrm{GC}_{ji} = \sum_{n \in N} s_{ji}^n \cdot (F_{ji}^n + \omega^n \cdot t_{ji}^n) \tag{4}$$

where n denotes transport mode, which means airway, highway and railway (conventional railways and Shinkansens) in this study; s_{ji}^n is the modal share of n in the total transport from prefecture j to i; F_{ji}^n is transport fare of mode n from j to i in JPY; t_{ji}^n is travel time of mode n from j to i in minute; ω^n is time value of mode n in JPY/min.

According to the standard classification, we consider 11 major industries in our study. These are 1) agriculture, forestry and fishery, 2) mining, 3) manufacturing, 4) construction, 5) electric power, gas and water supply, 6) transport and communication, 7) commerce 8) finance and insurance, 9) real estate, 10) services, 11) public administration. Table 2 shows a transactions value matrix in Input-Output table. For a specific industry p, the necessary labor input from the relevant industry m, φ_{mp}, can be calculated as $(x_{mp}/X_m)\times\mathrm{EMPL}_m$ (Table 3). And the share of labor input from each industry m to p, which is the employment correlation coefficient (θ_{mp}) stated in Eq. (2), equals $\varphi_{mp} / \sum_{m \in k} \varphi_{mp}$ as shown in Table 4. It indicates the dependence of industry p on m. The larger θ_{mp} is, the more important industry m is in p's production process.

As for ConsD, it is assumed to have a positive effect on industrial location, and defined as

$$\mathrm{ConsD}_i^k = \sum_j \mathrm{POP}_j \cdot \mathrm{PL}_{ji}^k \tag{5}$$

where POP_j is the population of prefecture j; PL_{ji}^k is the probability of population of prefecture j in choosing prefecture i to consume the products or services offered by industry k, which is similar with the definition in Eq. (3).

Table 2 Transactions value in I-O table

Input \ Output	1	2	…	p	…	k	Total output	No. of employees
1	x_{11}	x_{12}	…	x_{1p}	…	x_{1k}	X_1	EMPL_1
2	x_{21}	x_{22}	…	x_{2p}	…	x_{2k}	X_2	EMPL_2
…	…	…	…	…	…	…	…	…
m	x_{m1}	x_{m2}	…	x_{mp}	…	x_{mk}	X_m	EMPL_m
…	…	…	…	…	…	…	…	…
k	x_{k1}	x_{k2}	…	x_{kp}	…	x_{kk}	X_k	EMPL_k
Total input	X_1	X_2	…	X_p	…	X_k		

Table 3 Labor input matrix among industries

Input \ Output	1	2	…	p	…	k
1	φ_{11}	φ_{12}	…	φ_{1p}	…	φ_{1k}
2	φ_{21}	φ_{22}	…	φ_{2p}	…	φ_{2k}
…	…	…	…	…	…	…
m	φ_{m1}	φ_{m2}	…	φ_{mp}	…	φ_{mk}
…	…	…	…	…	…	…
k	φ_{k1}	φ_{k2}	…	φ_{kp}	…	φ_{kk}
Sum	$\sum_{m\in k}\varphi_{m1}$	$\sum_{m\in k}\varphi_{m2}$	…	$\sum_{m\in k}\varphi_{mp}$	…	$\sum_{m\in k}\varphi_{mk}$

Table 4 Employment correlation coefficient

Affecting industries	Industries be affected 1	2	…	p	…	k
1	θ_{11}	θ_{12}	…	θ_{1p}	…	θ_{1k}
2	θ_{21}	θ_{22}	…	θ_{2p}	…	θ_{2k}
…	…	…	…	…	…	…
m	θ_{m1}	θ_{m2}	…	θ_{mp}	…	θ_{mk}
…	…	…	…	…	…	…
k	θ_{k1}	θ_{k2}	…	θ_{kp}	…	θ_{kk}
Sum	1	1	…	1	…	1

City population is used as the weight for the calculation of AT. And due to the data limitation, only the access time by using conventional Japan Railways (JR) is considered.

$$\mathrm{AT}_i = \sum_z (\mathrm{POP}^z \cdot t^z_{\mathrm{JR}}) \Big/ \mathrm{POP}_i \tag{6}$$

where POP^z is the city population of z in prefecture i; $t_{\mathrm{JR}}{}^z$ is the travel time from city z to the nearest Shinkansen station by using JR.

4. RESULTS

Based on the value of θ calculated from I-O table in 2000, Fig.2 shows the interdependence among the 11 industries, so that the mechanism of industrial location can be further quantitatively analyzed. Taking construction as an example, it is found that real estate and electric power, gas and water supply are the industries that heavily rely on the development of the said industry. While on the other hand, it is mainly dependent on the inputs of commerce, services, manufacturing, transportation and communication. Such a strong correlation suggests that industrial interdependence may play an important role in construction's location choice.

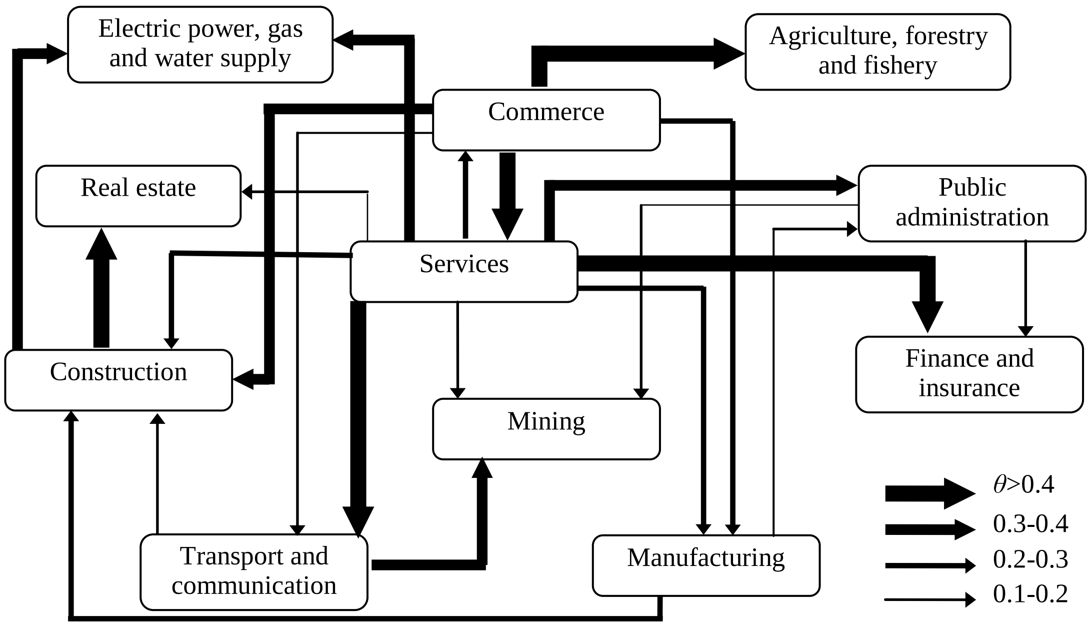

Fig.2 Interdependence mechanism among 11 industries in 2000

Note: only the value of θ larger than 0.1 is mapped.

By using Ordinary Least Square (OLS) technique, we analyze the cross-section data covering 11 industries and 47 prefectures for 1990 and 2000 respectively. The parameters of regression model are shown in Table 5, from which the following main points are identified.

- Except a low value for agriculture, forestry and fishery and mining, R^2 for most industries is high, which suggests a reasonable explanatory capability of the Eq. (1).
- In 1990, the dominant variable that influences industrial location is industrial interdependence (InterD). In 8 out of 11 industries such as construction, finance and insurance, public administration, their elasticity is as high as 0.70-0.89, which indicated that 100% increase of industrial interdependence would result in 70-89% growth of the number of employees in corresponding industry. However in 2000, the most important determinant changes to consumption demand from neighboring areas (ConsD) for over half of the industries such as real estate, transport and communication, manufacturing, in which the elasticity ranges from 0.29 to 0.85.
- Although the effect of access time to Shinkansen (AT) on industrial location is relatively small comparing with the other two explanatory variables, its elasticity at a range from -0.04 to -0.21 in most industries shows a slight increase from 1990 to 2000, which is consistent with the theoretical expectations that the more Shinkansen network is constructed, the more significant impact will be caused on regional economy, specifically the industrial location choice that this study focuses on.

Table 5 Estimates with cross-section data for 1990 and 2000

Industry	1990					2000				
	InterD	ConsD	AT	*C*	R^2	InterD	ConsD	AT	*C*	R^2
Agriculture, forestry and fishery		0.35**		4.86***	0.29		0.41***		2.27***	0.20
		(2.53)		(3.19)			(3.58)		(4.95)	
Mining	0.25*	0.21*		0.33	0.35	0.16*	0.29***		0.47	0.40
	(1.92)	(1.77)		(0.18)		(1.93)	(3.25)		(0.39)	
Manufacturing	0.44**	0.40**	-0.04*	0.32	0.96	0.19**	0.56***	-0.05*	1.05*	0.97
	(2.58)	(2.49)	(-1.69)	(0.49)		(2.04)	(5.36)	(-1.89)	(1.73)	
Construction	0.89***		-0.07**	1.93**	0.90	0.79***		-0.09*	2.89**	0.87
	(15.66)		(-2.37)	(2.27)		(12.52)		(-1.79)	(2.97)	
Electric power, gas and water supply	0.50**	0.35*	-0.07**	-1.99**	0.93	0.44*	0.38*	-0.06*	-1.89**	0.91
	(2.48)	(1.70)	(-2.56)	(-2.43)		(1.97)	(1.80)	(-1.69)	(-2.17)	
Transport and communication	0.39*	0.56**	-0.11***	-1.44*	0.98	0.34*	0.73***	-0.08*	-3.53***	0.97
	(1.82)	(2.47)	(-4.43)	(-2.67)		(1.98)	(4.25)	(-1.80)	(-5.21)	
Commerce	0.59***	0.31*	-0.09***	1.34**	0.98	0.45*	0.49**	-0.13**	0.15	0.98
	(3.62)	(1.84)	(-4.15)	(2.42)		(1.96)	(2.15)	(-2.46)	(0.20)	
Finance and insurance	0.72***	0.17**	-0.04***	-0.35	0.96	0.50**	0.37*	-0.04*	-2.68***	0.97
	(8.24)	(2.27)	(-2.48)	(-0.86)		(2.19)	(1.62)	(-1.32)	(-3.52)	
Real estate	0.25*	0.77***	-0.15***	-3.73**	0.89	0.18**	0.85***	-0.21***	-4.45***	0.90
	(1.76)	(4.09)	(-2.72)	(-2.47)		(1.86)	(5.58)	(-3.53)	(-3.04)	
Services	0.52***	0.38**	-0.08*	0.63	0.98	0.49**	0.47**	-0.11*	-0.30	0.97
	(3.05)	(2.15)	(-1.69)	(0.96)		(2.05)	(2.05)	(-2.38)	(-0.40)	
Public administration	0.70***		-0.09*	2.26**	0.89	0.57***		-0.14**	5.14**	0.84
	(13.82)		(-1.98)	(3.09)		(3.78)		(-1.84)	(2.36)	

Note: *significance:10% **significance:5% ***significance:1%. Figure in parentheses is *t*-value.

For a better understanding of Shinkansen's impact on industrial location, Fig. 3 illustrates the change of employee's number for 11 industries in Nagano prefecture during 1990-2000. In 1997, the Hokuriku line was opened for operation which starts from Takasaki to Nagano with 4 stations established within Nagano prefecture. Thus the access time of Nagano prefecture to Shinkansen network is expected to decrease significantly from 1990 to 2000. Due to the negative effect of AT shown in Table 5, the number of employees has increased at an annual rate of 2.7%, 2.0%, 1.1% and 0.4% respectively in those industries such as real estate, services, commerce, and public administration, for which the elasticity of AT is also relatively high.

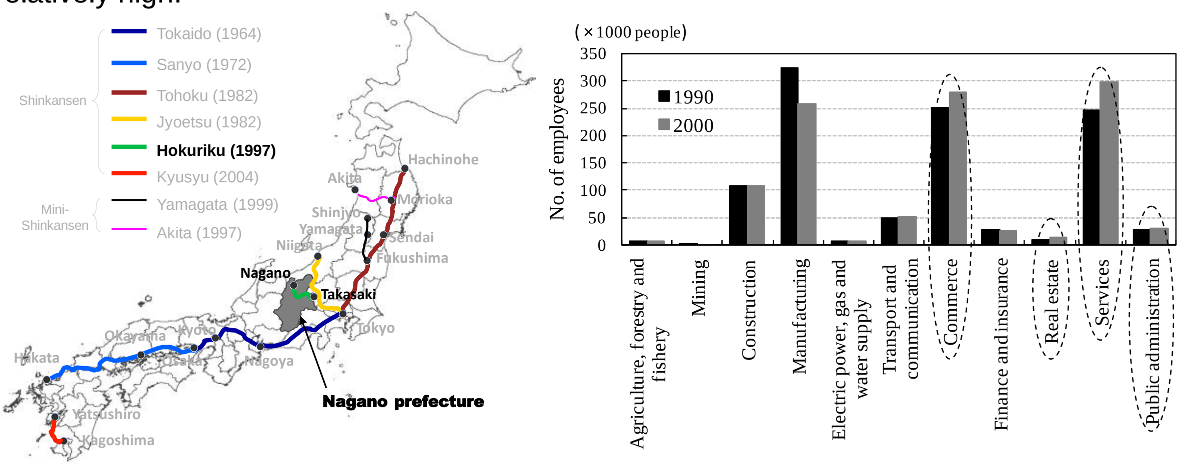

Fig.3 Number of employees for 11 industries in Nagano prefecture 1990-2000

5. CONCLUSIONS AND DISCUSSIONS

This paper has looked at the impact of Shinkansen network on regional economy, with a special focus on industrial location in Japan. We have highlighted a quantitative investigation of driving forces behind change in industry's employee number. In contrast with the previous works, the socioeconomic factors include the transaction interdependence among 11 industries cross 47 prefectures and people's consumption demand, together with the physical determinant like the accessibility to Shinkansen network have been explicitly detected in this study. Through multivariable stepwise regressions based on cross-section data, it is found that the most important variable influencing industrial location has changed from industrial interdependence to people's consumption demand in neighboring areas during the period of 1990-2000. Although the access time to Shinkansen plays a minor important role in affecting industrial location, its elasticity for most industries has shown a slight increase with the expansion of Shinkansen network from 1990 to 2000. The policy implication is that the construction of Shinkansen lines will improve the accessibility of an area and encourage the development of several industries like real estate, commerce and services, etc., hence contribute to the regional economic structure formation.

Though this paper presents an empirical model analyzing Shinkansen's regional economic impact, there still exist some limitations that need to be improved in the future work. When estimating the access time of a prefecture to Shinkansen network, only the travel time by using JR is considered. While other transport modes like private car, bus, subway etc. are not considered because of the data availability. A comprehensive estimation of the accessibility to Shinkansen is supposed to better reflect the regional difference and have more significant effect on industrial location.

In another hand, a great deal of potential uses and further studies can be derived. By using the industrial location model and through a panel data analysis, the parameters could be used for simulation of industrial location change in the scenarios with and without Shinkansen, or future projection under different socioeconomic and policy settings. The negative effects caused by Shinkansen, for example the economic potential of Osaka City has been decreasing since the opening of Sanyo Line in 1972, can also be measured for detail with a longer decade data support. Moreover, the methods presented in this study could also be applied in other regions of the world where HSR will be constructed such as the HSR project in California of USA, HSR from Beijing to Shanghai in China.

References

Central Japan Railway Company (2008). Summary of the company performance: transportation data. Available on http://english.jr-central.co.jp/company/company/achievement/transportation/index.html

Frost, M.E., Spence, N.A. (1995). The rediscovery of accessibility and economic potential: the critical issue of self-potential. Environment and Planning A, 27, 1833-1848.

Greanhut, M. (1963). Microeconomics and the space economy. Scott, Foresman, Chicago.

Greenhut, M., Ohta, H. (1975). Theory of spatial pricing and market areas. Duke University Press, Durham.

Gutierrez, J. (2001). Location, economic potential and daily accessibility an analysis of the accessibility impact of the high-speed line. Journal of Transport Geography, 9(4), 229-242.

Hamilton, F.E.I. (1967). Models of industrial location, in: R. Charley and P. Haggett, eds, Models of geography, Methuen, London.

Hansen, E.R. (1987). Industrial location choice in San Paulo, Brazil: A nested logit model. Regional Science and Urban Economics, 17, 89-108.

International Monetary Fund (2006). World economic outlook database: country comparisons. Available on http://www.imf.org/external/pubs/ft/weo/2006/02/data/index.aspx

JTB (1990, 2000). JTB Timetable. JTB Publishing (in Japanese).

Japan Association of City Mayors (1990, 2000). Japan City Yearbook. First Key press (in Japanese).

Kantor, S. (2008). The economic impact of the California high-speed rail in the sacramento/central val ley area. Available on http://www.cahighspeedrail.ca.gov/images/chsr/20081003135956_HSRCentralValleyReportFINAL-2.pdf

Leitham, S., McQuaid, R.W., Nelson, J.D. (2000). The infuence of transport on industrial location choice: a stated preference experiment. Transportation Research Part A, 34, 515-535.

Moses, L.N. (1958). Location and the theory of production. Quarterly Journal of Economies, 72, 259-272.

McQuaid, R.W., Leitham, S., Nelson, J.D. (1996). Accessibility and location decisions in a peripheral region of Europe - a logit analysis. Regional Studies, 30, 589-598.

Ministry of land, Infrastructure, Transport and Tourism (1990, 2000). Inter-regional travel survey. Available on http://www.mlit.go.jp/seisakutokatsu/jyunryuudou/download.html (in Japanese).

Ministry of Transport Aviation (1999). Cost-effectiveness analysis manual for airport development project, Institution for Transport Policy Studies (in Japanese).

Nakamura, H., Hayashi, Y., Kuniyuki, K., Makitani, H. (1981). Analyzing the effects of Shinkansen using a system dynamics model - findings from a case study of Sanyo Shinkansen. Transportation and Economy, 41(4), 33-45 (in Japanese).

Nakamura, H., Hayashi, Y., Miyamoto, K. (1983). A land use-transport model for metropolitan areas, Papers in Regional Science, 51(1), 43-63.

Nakamura, H., Ueda, T. (1989). The impacts of Shinkansin on regional development. Proceedings of World Conference of Transport Research, Vol. 3, Yokohoma, Japan, 95-109.

Porter, M. (1990). The competitive advantage of nations. Macmillan, London.

Pearmain, D., Swanson, J., Kroes, E., Bradley, M. (1991). Stated preference techniques: A guide to practice, 2nd ed., Steer Davies Gleave, London.

Rietveld,P., Bruinsma, F.R., Delft, H.T., Ubbels, B. (2001). Economie impacts of high speed trains. Experiences in Japan and France: expectations in The Netherlands. Available on ftp://zappa.ubvu.vu.nl/20010020.pdf

Reed, J.S. (1991). High speed rail related development in Europe and in the United States. Conference of Station Areas Development for High Speed Rail, Taipei.

Road Bureau, Ministry of Land, Infrastructure and Transport (2003). Evaluation method of travel cost per unit time and per unit value in 2003 price. Available on http://www.mlit.go.jp/road/ir/iinkai/1pdf/s1-56.pdf (in Japanese)

Road Bureau, Ministry of Land, Infrastructure and Transport (2003). Cost-benefit analysis manual. Available on http://www.mlit.go.jp/road/ir/ir-council/hyouka-syuhou/1pdf/s1-1.pdf (in Japanese).

Storper, M. (1995). The resurgence of regional economies, ten years later: the region as a nexus of untraded interdependencies. European Urban and Regional Studies, 2, 191-221.

Statistics Bureau (1990, 2000). Input-Output Tables. Statistics Bureau of Ministry of Internal Affairs and Communications.

Statistics Bureau (2010). Japan Statistical Yearbook. Available on http://www.stat.go.jp/english/data/nenkan/index.htm

Statistics Bureau (1996-2008). Historical Statistics of Japan. Available on http://www.stat.go.jp/english/data/chouki/index.htm

Statistics Bureau (1995, 2000). Population Census. Available on http://www.stat.go.jp/english/data/kokusei/index.htm

Sumitomo Trust Business Research Institute (1991). Survey report on land use plan of Mega-cities. (in Japanese).

Vickerman, R. (1997). High-speed rail in Europe: experience and issues for future development. The Annals of Regional Science, 31(1), 21-38.

Weber, A. (1929). Alfred Weber's theory of the location of industries, translated by C. Ffiedrich, University of Chicago Press, Chicago.