An Empirical Analysis of Agglomeration Effects on the Location Choice of Japanese Electronics Firms in China Using Provincial Data

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Abstract

In this paper, we examine the hypothesis that agglomeration has an important effect on the location choice of Japanese electronics firms in China in line with Krugman [18], Fujita and Krugman [6], Fujita, Krugman, and Venables [7] (new economic geography, in short NEG). Using the data from *Cyugoku Sinsyutsu Kigyō Ichiran 2003–2004* (Japanese enterprise investments in China 2003–2004), we estimated a location choice model of Japanese electronics firms with market potential, industrial agglomeration and traditional factors such as wage, infrastructure and policy incentives as explanatory variables. The results of this estimation show that the agglomeration effects play an important role in choices for location of Japanese electronics firms in China.

LEL classification : F23, R30, O53

Keywords : Agglomeration Effects, China, Japanese Electronics Firms, Labor Cost, Location Choice, Market Potential, NEG Model, Negative Binomial Model

1. Introduction

Japanese Foreign Direct Investment (FDI) in electronics industry in East Asia has been increasing for the last two decades, especially since the yen appreciation following the Plaza Accord in 1985. In China, Japanese FDI has been increasing since its open door policy in 1978 with remarkable peaks in the 1992–95 and 1999–2001 periods. With this as a trigger, many studies have been conducted to understand the factors that determine location choices of FDI activities using some traditional factors, such as market size, labor cost, and government policies [e.g. Zhang [29], Broadman and Sun [2], Cheng and Kwan [3], Sun et al. [23]].

Since the 1990s however, some new insights on agglomeration economies have been provided by the new research area known as new economic geography (hereafter, we use NEG) which follows the works of Krugman [18], Fujita and Krugman [6], Fujita, Krugman, and Venables [7], Hanson [11], and Fujita and Thisse [8]. In the location choice model of multinational corporations, agglomeration effect or agglomeration economy occurs because firms seek to overcome information asymmetry and business uncertainties in their host countries. Such a model has been employed by Smith and Florida [22] and Head et al. [15], [16] to understand the relationship between

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agglomeration effects and location choice of firm. Tokunaga and Ishii [26], [27] studied the factor of location choice for nine Japanese electronics firms in East Asia and found that the industry-level agglomeration had a positive effect on location choice for 1986 to 92 period. Similarly, Tokunaga and Akune [25] found that industry-level agglomeration played an important role in location choice of Japanese electronics industry for 1985 to 1999 period in East Asia. In all these models however, agglomeration effect is simply measured by the total number of foreign-funded enterprises in a country. Here, this model is extended to incorporate advances introduced Tokunaga and Akune [25] with Head et al. [16] and Chyau and Ng [4]¹.

Thus, the objective of this paper is to explore the factors guiding the new location choice of Japanese electronics firms in China. Using the provincial and firm-level panel data of Japanese electronics FDI in China from 1992 to 2003, we estimate a location choice model of Japanese electronics firms in China.

The organization of this paper is as follows. In section 2, we investigate features of the Japanese investment in the electronics industry in China. Section 3 presents our model and the data, including the provincial market potential variable. Section 4 presents the estimation results. We conclude with a summary of the major results in the final section.

2. Geographic Distribution and Location Determinants of Japanese

Electronics Firms in China

Japanese electronics FDI has been increasing since its open door policy in 1978 with remarkable peaks in the 1992–95 and 1999–2001 periods as shown in Figure 1². In 1992 the Chinese Premier, Mr. Deng Xiaoping, during his tour to the south reconfirmed China's determination to establish the Socialist-market economy as a national policy. This became a landmark for the reform and opening up policy. Second, as China entered into World Trade Organization (WTO) from 2001, there was the other small boom of Japanese FDI in China. Furthermore, as shown in Figure 2, Japanese electronics FDI is highly correlated with the exchange rate between Japanese Yen and Chinese Yuan. After the Plaza Accord in 1985, Japanese electronics industry began overseas production in China. Since yuan was devaluated against the dollar due to the dollar pegging policy of yuan (8.7 yuan/dollar) in 1994, this increased the competitiveness of Chinese exports relative to Japan and hence the attraction of Chinese market for Japanese electronics industry.

Next, we survey about geographic distribution of Japanese electronics FDI in China. As can be seen, Figure 2 shows that many Japanese electronics firms locate in coastal provinces such as Shanghai, Jiangsu, Guangdong, Tianjin, Beijing, Fujian, and Liaoning. Furthermore, we calculate two location quotients (LQ) in Table 1 in order to analyze the spatial patterns of Japanese electronics manufactures in the Chinese province in more detail. Japanese Location Quotient 1

Figure 1. Japanese electronics FDI in China and Exchange Rate (1981–2003)

Figure 2. Spatial distribution of new plants for Japanese electronics manufactures in China from 1992 to 2003

Table 1 Location quotients of Japanese Electricity Industry Investment in China

	LQJ1	LQJ2
Beijing	1.74	1.43
Tianjin	1.04	0.78
Hebei	0.49	0.70
Inner Mongolia	0.29	0.50
Liaoning	2.00	1.05
Jilin	0.16	0.31
Heilongjiang	0.11	0.27
Shanghai	2.36	0.65
Jiangsu	1.35	1.25
Zhejiang	0.54	1.09
Anhui	0.27	0.77
Fujian	0.48	1.18
Jiangxi	0.21	1.22
Shandong	0.87	0.62
Henan	0.20	0.57
Hubei	0.25	0.95
Hunan	0.06	0.50
Guangdong	1.05	1.86
Guangxi	0.15	0.79
Chongqing	0.23	0.25
Guizhou	0.35	0.99
Shaanxi	0.53	1.74

Note: Japanese Location Quotient 1 (LQJ1) = provincial percentage of Japanese electronics manufacturers/provincial percentage of all electronics manufactures

Japanese Location Quotient 2 (LQJ2) = provincial percentage of Japanese electronics manufacturers/provincial percentage of all Japanese manufactures

Figure 3. Motivations of Japanese electronics industry investment in China

Source : Basic Survey of Foreign Business Activity, NO.6 and NO.7, by the Ministry of Economy, Trade and Industry (METI), Japan.

(LQJ1) is defined as provincial share of Japanese electronics manufacturers divided by provincial share of all electronics manufactures. Japanese Location Quotient 2 (LQJ2) is also defined as provincial percentage of Japanese electronics manufacturers is divided by provincial percentage of all Japanese manufactures. According to this LQJ1, Shanghai is 2.36, Liaoning is 2.00, Beijing is 1.74, Jiangsu is 1.35, Guangdong is 1.05, and Tianjin is 1.04. Japanese electronics manufactures favor Shanghai, Liaoning and Beijing. Among Japanese manufactures, the highest share of the electronics manufactures is Guangdong according to LQJ2. As mentioned above, the coastal provinces have been the most favorable locations for Japanese electronics manufactures.

Next question is motivations of FDI for Japanese electronics industry in China. That is, what are the location determinants of Japanese electronics firms in China? To understand this, we consider survey data. According to the results from the surveys for foreign business activity of Japanese firms conducted by the Ministry of Economy, Trade and Industry (METI) in Japan, the main motivations of Japanese electronics industry investment in China are to (i) expand market size, (ii) keep low production cost, (iii) reduce production cost, and (iv) keep business relationship as shown in Figure 3. Thus, we can adopt the important location factors of (1) the local market of their products, and (2) labor cost. Furthermore, we can adopt an important factor of (3) good economic environments for Japanese firms in China. Finally, we can adopt the most important location factor of (4) agglomeration effect in order to test the hypothesis that industrial agglomeration plays an important role in location choice behavior of Japanese electronics firms in China as above mentioned.

3. A Model of Location choice and Model Specification

3.1 Model

Recent empirical studies of Japanese firm location focused on agglomeration economy in East Asia and China include Fukao and Yue [9], Togo and Arikawa [24], Belderbos and Carree [1], He [13], Tokunaga and Akune [25], and Wakasugi [28]. Fukao and Yue [9] found that localization economies had a positive effect and urbanization economies had a negative effect on location choice behavior of the Japanese electronics industry and Togo and Arikawa [24] found that agglomeration and industrial estate had a positive effect on location decisions in the Malaysian electronics industry. In China, He [13] found that agglomeration economies derived from the clustering of manufacturing and foreign investment activities influenced the location of foreign manufacturers. These studies indicate the importance of agglomeration economies in location choice. Thus, we would like to extend these results by looking in more detail. Wakasugi [28] found that factors related to human resources are more important than the 'hard' factors in attracting foreign firms

to invest in China, using conditional logit model.

We model the location decision of Japanese manufacturing as a negative binomial model. First, we assume that a rational Japanese manufacturer i would choose a Chinese province j for its branch only if this firm maximizes its profits (π_{ij}). As we cannot observe the profit directly, we further assume that the number of greenfield manufactures in each province (y_j) is a function of the observable location characteristics (x_j) of that province. Following Tokunaga and Akune [25] and Coughlin and Segev [5], we can express the negative binomial model (Greene [10])³ as follows:

$$\ln E(y_j) = \beta' x_j + \varepsilon_j \quad (1)$$

where y_j is the number of location for Japanese manufactures in province j per year, β' is a parameter vector, x_j is a provincial characteristics vector, and ε_j is a disturbance vector. The density function of y_j can be represented as

$$f(y_j | x_j) = \frac{\theta^\theta (e^{\beta' x_j})^{y_j} \Gamma(\theta + y_j)}{\Gamma(y_j + 1) \Gamma(\theta) (e^{\beta' x_j} + \theta)^{\theta + y_j}} \quad (2)$$

We use equation (2) to estimate the parameter β . Because equation (2) is a nonlinear equation, maximum likelihood is employed in estimation.

3.2 Data Sources and Model Specification

The data employed in this paper are disaggregated firm-level Japanese FDI data which come from a “*Cyugoku Sinsyutsu Kigyō Ichiran 2003–2004*” (A view of Japanese Overseas Affiliates in China 2003–2004) which is compiled by the 21st Century China Research Institute. Our estimation data is new Japanese plants location data established from 1992 to 2003 (372 pooling data), following the view that Japanese electronics FDI has been increasing after Mr. Deng Xiaoping’s 1992 speech during his tour to the south. In location choice model of plants for each province in China, the dependent variable is the number of Japanese manufacturing establishments in each province in China.

We obtain data of the provincial characteristics in China from Comprehensive Statistical Data and Material on 50 Years of New China (from 1992 to 1998), China Statistical Yearbook 1999–2003 (National Bureau of Statistics People’s Republic of China), and China’s Association of Development Zones. In this model, the independent variables are given in Table 2.

1. *Market potential* Market potential is considered as an important determinant as shown in Figure 3. Market potential (lnMP) measures both demand potentials and economies of scale. Recently some new studies are analyzing the effects of market potential on the location of foreign firms [e.g. Redding and Venables [20], [21], Head and Mayer [14]]. They provide evidence that the geography of market access and supply access is statistically significant and quantitatively important. Since there is quite differences in the area of provinces in China, with mean 305,630 square kilometers, and standard deviation of 37.41, we divide provincial market potential and GDP by the area of corresponding province, and use the logarithm of provincial market potential divided by area, lnMP as the market potential variable⁴.

2. *Wage* In China, wage rate (WAGE) is highly ranked in Figure 3. As the wage rate is an important factor for Japanese investment for electronics industry in China, we assume that the real wage is an important determinant. We use logarithm of provincial average real wages of staff and workers (lnWAGE) as wage variable.

3. *Labor quality* Labor quality has the positive impact of location choice because Japanese firms tend to seek a higher quality labor (He [13]). We therefore use logarithm of provincial number of scientific and technical persons in state owned enterprises (lnLABQ) as labor quality variable.⁵

Table 2 Descriptions of Variables and Expected Signs

Variables	Descriptions	Expected Signs
Location choice	Number of Japanese electronics greenfield manufactures in a province, (number)	
Market potential (lnMP)	Logarithm of provincial market potential/area, (108 yuan/square kilometer)	+
Wage (lnWAGE)	Logarithm of provincial average real wages of staff and workers, (yuan)	—
Labor quality (lnLABQ)	Logarithm of provincial number of scientific and technical person in state owned enterprises, (number)	+
Infrastructure (lnINFRA)	Logarithm of provincial highway density, (kilometer/square kilometer)	+
Policy incentives (POLI)	Provincial number of special economic zones, open coastal cities and national-level development zones, (number)	+
Japanese manufactures agglomeration (lnAGGLO1)	Logarithm of (provincial number of Japanese manufactures to previous year +1), (number)	+
Electronics manufactures agglomeration (lnAGGLO2)	Logarithm of (provincial number of electronics manufacturers to previous year +1), (number)	+
Japanese electronics manufactures agglomeration (lnAGGLO3)	Logarithm of (provincial number of Japanese electronics manufacturers to previous year+1), (number)	+
Japanese electronics manufactures Keiretsu agglomeration (lnAGGLO4)	Logarithm of (provincial number of Japanese electronic manufactures invested by core firms to previous year +1), (number)	+

Note: GDP and wage are real values at 1992=100.

Table 3 Correlation Matrix of Independent Variables

	MP	WAGE	LABQ	INFRA	POLI	AGGLO1	AGGLO2	AGGLO3	AGGLO4
MP	1.000								
WAGE	0.335	1.000							
LABQ	0.135	-0.164	1.000						
INFRA	0.832	0.234	0.503	1.000					
POLI	0.290	0.432	0.349	0.425	1.000				
AGGLO1	0.615	0.442	0.512	0.687	0.725	1.000			
AGGLO2	0.554	0.118	0.774	0.760	0.664	0.829	1.000		
AGGLO3	0.561	0.525	0.353	0.573	0.755	0.895	0.729	1.000	
AGGLO4	0.443	0.554	0.208	0.439	0.595	0.718	0.538	0.870	1.000

4. *Infrastructure* The level of infrastructure is measured by logarithm of provincial highway density (lnINFRA).

5. *Policy incentives* We use provincial number of special economic zones, open coastal cities and national-level development zones (POLI) as Policy incentives variable.

6. *Agglomeration effects* If Japanese electronic firms locate close to one another in China, the industrial agglomeration helps to expand their sales and to save transportation cost, that is

agglomeration economies (Marshall [19], Krugman [18], Fujita, Krugman, and Venables [7], Fujita and Thisse [8], and Tokunaga and Ishii [27]). Hence, we set up the hypothesis that industrial agglomeration plays an important role in location choice behavior of Japanese electronics firms in China. We use four kinds of agglomeration variables: (1) Japanese manufactures agglomeration (lnAGGLO1), (2) electronics manufactures agglomeration (lnAGGLO2), (3) Japanese electronics manufactures agglomeration (lnAGGLO3), and (4) Japanese electronics manufactures keiretsu agglomeration (lnAGGLO4) in order to test agglomeration effects on the location choice at provincial level.

Table 3 reports the correlation coefficient matrix among independent variables. All correlation coefficients are lower except correlation coefficient between market potential and infrastructure.

4. Estimation Results

The results of the negative binomial estimation are presented in Table 4 for the new plant location choice model. In order to test the hypothesis that agglomeration effects play an important role in location choice of Japanese manufacturers in China, we totally considered five different variations of this model. With a few exceptions, the estimation results support the major hypotheses.

For some traditional location factors, the coefficient estimates for the real manufacturing wages variables (WAGE) are negative and statistically significant at the 0.01 level in all cases. This result suggests that new Japanese electronics manufactures tend to choose locations with a low real wage cost. The coefficient estimates for the labor quality variables (LABQ) are positive and statistically significant at the 0.01 level in all cases, implying that new Japanese electronics manufactures are inclined to choose locations of high quality labor forces. The coefficient estimates of infrastructure (INFRA) are also positive and almost statistically significant at the 0.1

Table 4 Results of the new plant location choice model in China (Negative Binominal Model)

	(1)	(2)	(3)	(4)	(5)
Constant	-13.574*** (-3.08)	-5.271 (-1.05)	-10.562** (-2.37)	-3.437 (-0.68)	-9.561* (-1.91)
lnMP	0.820*** (7.37)	0.573*** (4.48)	0.488*** (4.62)	0.700*** (6.35)	0.819*** (7.32)
lnWAGE	-1.297*** (-3.44)	-1.600*** (-4.19)	-1.147*** (-3.24)	-1.746*** (-4.49)	-1.624*** (-3.79)
lnLABQ	1.371*** (5.58)	0.905*** (3.26)	0.686*** (2.587)	0.959*** (3.69)	1.281*** (5.13)
lnINFRA	0.805** (2.09)	0.693** (1.82)	0.512 (1.33)	0.442 (1.14)	0.740* (1.89)
POLI	0.411*** (10.7)	0.325*** (7.25)	0.072 (1.19)	0.335*** (8.15)	0.408*** (10.6)
lnAGGLO1		0.411*** (3.21)			
lnAGGLO2			1.357*** (6.39)		
lnAGGLO3				0.435*** (4.07)	
lnAGGLO4					0.154* (1.69)
Observations	372	372	372	372	372
Log likelihood	-372.48	-367.13	-351.48	-363.92	-371.01

Note: 1. Numbers in parentheses are z-values.

2. * denotes significant at 0.1 level, ** denotes significant at 0.05 level, and *** denotes significant at 0.01 level.

level. Furthermore, the coefficient estimates of Policy incentives (POLI) are also positive and almost statistically significant at the 0.01 level.

Next, we examine the hypothesis that market potential and industrial agglomeration play an important role in location choice of Japanese manufacturers in China. Both market potential and industrial agglomeration variables are positive and statistically significant at the 0.01 level except AGGLO4. The coefficient estimate of market potential (MP) is positive and statistically significant at the 0.01 level in all cases, implying that new Japanese electronics manufactures tend to choose locations with wider provincial's market potential since large market access gives opportunities to use domestic scale economies and consequently low cost of production (Krugman [18]).

The coefficient estimate of Japanese manufactures agglomeration (AGGLO1) is positive and statistically significant at the 0.01 level, suggesting that new Japanese electronics manufactures tend to choose locations favored by Japanese manufactures. The coefficient estimate of electronics manufactures agglomeration (AGGLO2) is positive and statistically significant at the 0.01 level, implying that new Japanese electronics plants tend to choose locations favored by electronics manufactures. The coefficient estimate of Japanese electronics manufactures agglomeration (AGGLO3) is positive and statistically significant at the 0.01 level, implying that new Japanese electronics plants tend to choose locations favored by Japanese electronics manufactures. The coefficient estimate of Japanese electronics manufactures keiretsu agglomeration (AGGLO4) is positive and statistically significant at the 0.1 level, implying that new Japanese electronics manufactures tend to choose locations where there are keiretsu's plants of Japanese electronics firms.

Thus, we find that market potential and industrial agglomeration effects play an important role in location choice of Japanese manufacturers in China.

5. Conclusion

In this paper, we examined the hypothesis that agglomeration effects play an important role in location choice behavior of Japanese electronics firms in China, according to Krugman [18], Fujita and Krugman [6], Fujita, Krugman, and Venables [7]. Using the data of *Cyugoku Sinsyutsu Kigyō Ichiran 2003-2004* (A view of Japanese Overseas Affiliates in China 2003-2004), we estimated a location choice model of Japanese electronics firms using market potential, industrial agglomeration, and traditional factors such as wage, infrastructure, and policy incentives as explanatory variable. From the results of this estimation, we found that agglomeration effects play an important role in location choice behaviors of Japanese electronics firms in China.

In order to examine these issues in more detail, further studies are required. One is a further study of agglomeration effects using data of city in China. Another possible study is a comparative study among Japanese electronics industry and other industries such as machinery, food processing, and transportation equipment.

Endnotes

1. Jin and Tokunaga [17] found that agglomeration effects of Chinese food manufactures and Japanese keiretsu had positive effects on location decisions of the Japanese food industry in China.
2. The database of Japanese electronics industry investment in Chinese provinces is from *Cyugoku Sinsyutsu Kigyō Ichiran 2003-2004* (Japanese enterprises investment in China 2003-2004).
3. See Greene [10]. The density function of y_i can be represented as follows: Let $\beta'x_j = \ln \lambda_j$ and $\varepsilon_j = \ln u_j$, equation (1) can be written as $\ln E(y_j) = \ln \lambda_j + \ln u_j$ (A.1). Then the distribution of y_i conditioned on x_i and u_i (i.e., ε_i) remains Poission with conditional mean and variance μ_i ,

$$f(y_j | x_j, u_j) = \frac{e^{-\lambda_j u_j} (\lambda_j u_j)^{y_j}}{y_j!}.$$

As the unconditional distribution $f(y_j | x_j)$ is the expected value of $f(y_j | x_j, u_j)$, the density function of y_i is

$$f(y_j | x_j) = \int_0^\infty \frac{e^{-\lambda_j u_j} (\lambda_j u_j)^{y_j}}{y_j!} \frac{\theta^\theta e^{-\theta u_j} u_j^{\theta-1}}{\Gamma(\theta)} du_j = \frac{\Gamma(\theta + y_j)}{\Gamma(y_j + 1) \Gamma(\theta)} r_j^{y_j} (1 - r_j)^\theta,$$

where $r_j = \frac{\lambda_j}{\lambda_j + \theta}$. (A.1)

The distribution has conditional mean λ_j and conditional variance $\lambda_j(1 + (1/\theta))\lambda_j$.

Substituting $\lambda_j = e^{\beta x_j}$ into equation (A.1), we have the density function of y_i

$$f(y_j | x_j) = \frac{\theta^\theta (e^{\beta x_j})^{y_j} \Gamma(\theta + y_j)}{\Gamma(y_j + 1) \Gamma(\theta) (e^{\beta x_j} + \theta)^{\theta + y_j}}. \quad (A.2)$$

4. Enlightened from Harries [12], we define market potential for province j as:

$$MP_j = \sum_{i=1}^n \exp_i / d_{ij}$$

where $\exp_i$ is per capita annual living expenditure of Urban Residents by province j . d_{ij} is the distance from provincial i to province j , for $i \neq j$.

For $i = j$, following Head and Mayer [14], We assume that the distance from a region to itself is obtained using a simple geographical approximation and that each region is approximated as a disk all production concentrates at the center and consumers are uniformly distributed throughout the rest of the area. The average distance between a producer and a consumer is then given by

$$d_{ij} = \int_0^R r \frac{2r}{R^2} dr$$

where R denotes the radius of the disk, and $\frac{2r}{R^2}$ is the density of consumer at any given distance r to the center. We obtain:

$$d_{ij} = \frac{2}{3} R = \frac{2}{3} \sqrt{A/\pi}$$

where A is the area of the region.

5. We used the provincial number of scientific and technical person in state owned enterprise as labor quality variables due to data availability, but there is a negative correlation between real wage and labor quality variables, we want to improve it as future work.

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