

## **Agglomeration Effects and Location Choice of Japanese Electronics Firms in China: The Case of Provincial Data**

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### **ABSTRACT**

*This article examines the hypothesis related to the role of agglomeration effects on location choice behavior of Japanese electronics firms in China. According to Krugman (1991), Fujita and Krugman (1995), Fujita, Krugman, and Venables (1999), agglomeration effects play an important role on location choice behavior. Using the data of Cyugoku Sinsyutsu Kigyuu Ichiran 2003 - 2004 (Japanese enterprises investment in China 2003 - 2004), we estimate 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 variables. The result of this estimation shows that the agglomeration effects play an important role on location choice behavior of the Japanese electronics firms in China.*

### **ABSTRAK**

*Artikel ini menguji hipotesis berkaitan dengan peranan kesan penumpuan ke atas pilihan pelabur Jepun dalam syarikat elektronik di China. Mengikut Krugman (1991), Fujita and Krugman (1995), Fujita, Krugman, and Venables (1999), kesan penumpuan memainkan peranan penting ke atas keputusan bagi memilih lokasi pelaburan. Dengan menggunakan data Cyugoku Sinsyutsu Kigyuu Ichiran 2003 - 2004 (pelaburan pengusaha Jepun di China 2003 - 2004), penganggaran model pemilihan lokasi bagi pelabur Jepun dalam industri elektronik di China dianggarkan dengan potensi pasaran, penumpuan industri, dan faktor tradisional seperti upah, dan insentif dasar kerajaan sebagai pemboleh ubah bebas. Hasil kajian ini menunjukkan kesan penumpuan memainkan peranan yang penting ke atas kelakuan pelabur Jepun dalam memilih lokasi pelaburan di China dalam industri elektronik.*

## 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 and is drastically increasing during the period of 1992 - 95 and the period of 1999 - 2001. With this as a trigger, many studies of the location choices of FDI activities have been conducted in order to analyze the location factors using some traditional factors, such as market size, labor cost, and government policies [e.g. Zhang 1994), Broadman and Sun 1997, Cheng and Kwan 2000, Sun et al. 2002].

Since 1990s, some new insights of 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 (1991), Fujita and Krugman (1995), Fujita, Krugman, and Venables (1999), and Fujita and Thisse (2002). In location choice model of multinational corporations, agglomeration effect or agglomeration economies is introduced in order to overcome information asymmetry and business uncertainties for foreign investors in host countries. For example, Smith and Florida (1994), Head and Reis (1996) and Head et al. (1999) analyzed the relationship between agglomeration and industrial location. Tokunaga and Ishii (1995, 2000) studied location choice behavior of the Japanese nine electronics firms in East Asia and found that the industry-level agglomeration had a positive effect in location decisions. Similarly, Tokunaga and Akune (2003) found that the industry-level agglomeration played an important role in location choice behavior of the Japanese electronics industry for 1985 to 1999 in East Asia. However, in these studies the variable of agglomeration effect is simply measured by total number of foreign-funded enterprises in that particular country. We extend this work to combine Tokunaga and Akune (2003) with Head et al. (1999) and Jin and Tokunaga (2005).

Thus, the objective of this paper sets up the hypothesis that industrial agglomeration plays an important role in location choice behavior of Japanese electronics firms in China, and is to test this hypothesis. Using panel data of Chinese province and firm-level Japanese electronics FDI from 1992 to 2003, we estimate a location choice of Japanese electronics investment in China.

LOCATION BEHAVIOR AND LOCATION DETERMINANTS OF JAPANESE ELECTRONICS FIRMS IN CHINA

Japanese FDI in electronics industry has been increasing since its open door policy in 1978 and is drastically increasing during the 1992 - 95 period and the 1999 - 2001 period as shown in Figure 1 and this can be explained by two phenomenons. First, since in 1992, Mr. Deng Xiaoping talk during his tour to the south reconfirmed China's determination to establish the Socialist-market economy as a national policy, then his talk in 1992 became a landmark for the reform and opening up policy. Second, as China entered into World Trade Organization (WTO) from 2001, there was another 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, the Japanese electronics industry began its production in China. Since yuan was devaluated against dollar due to the dollar pegging policy of yuan (8.7 yuan/dollar) in 1994, the competition power of exports for the Japanese electronics industry increased. Hence, Japanese electronics FDI has been increasing.

Next, we survey about geographic distribution of Japanese electronics FDI in China. As can be seen from Figure 2, 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 (LQ1) is defined as provincial

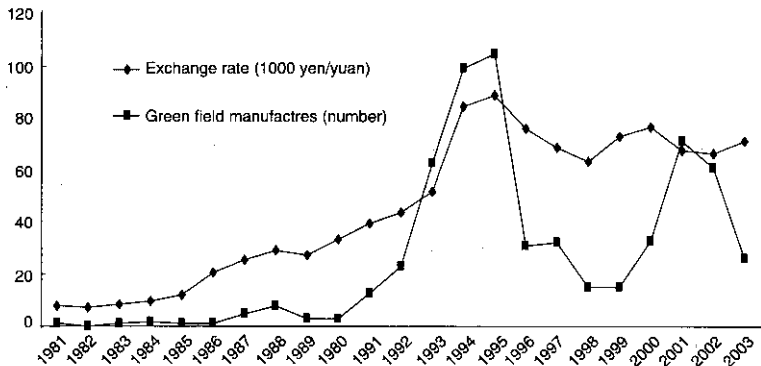


FIGURE 1. Japanese electronics FDI in China and exchange rate (1981 - 2003)]

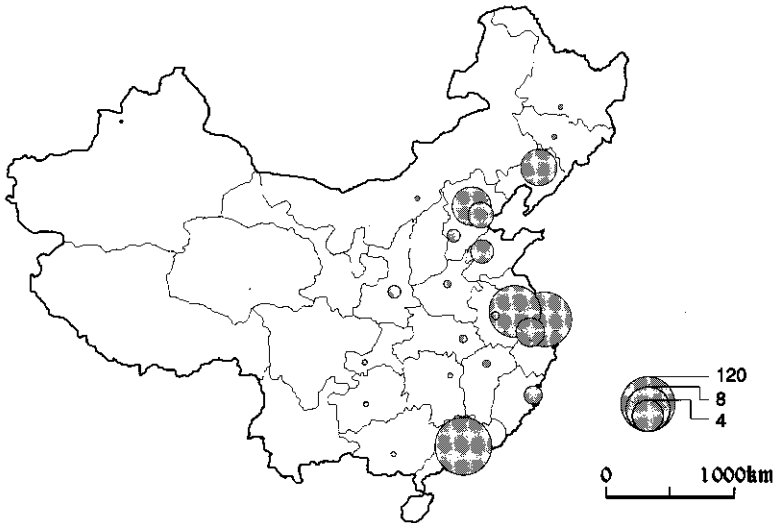


FIGURE 2. Spatial distribution of new plants for Japanese electronics manufactures

percentage of Japanese electronics manufacturers divided by provincial percentage of all electronics manufactures. Japanese Location Quotient 2 (LQJ2) is also defined as provincial percentage of Japanese electronics manufactures 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.

What are the location determinants of Japanese electronics firms in China? In order to look at these, we review the 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 (1) expand market size, (2) keep low production cost, (3) reduce production cost, and (iv) keep business relationship as shown in Figure 3. Thus, we adopt the important location factors of (1) the local market of their products, and (2) labor cost. Furthermore, we adopt an

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

important factor of (3) good economic environments for Japanese firms in China. Finally, we 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.

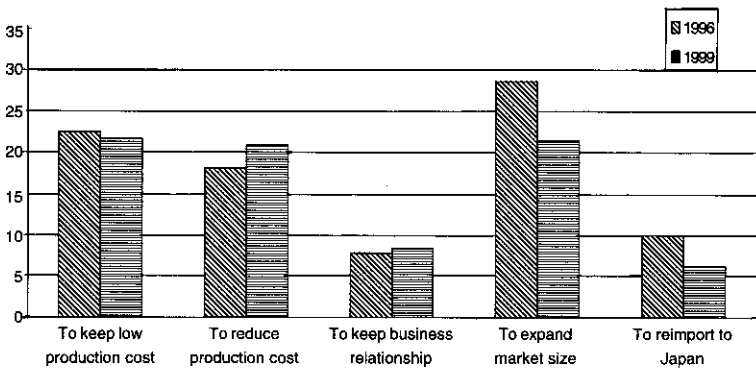


FIGURE 3. Motivations of Japanese electronics industry investment in China

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

## A LOCATION CHOICE MODEL, DATA SOURCE AND MODEL SPECIFICATION

### THE MODEL

Recent empirical studies of Japanese firms location focused on agglomeration economies in East Asia and China (see for example Fukao and Yue 1997, Togo and Arikawa 2002, He 2003, Tokunaga and Akune 2003, and Wakasugi 2005). Fukao and Yue (1997) found that localization economies had a positive effect and urbanization economies had a negative effect on location choice behavior of Japanese electronics industry and Togo and Arikawa (2002) found that agglomeration and industrial estate had a positive effect on location decisions in the Malaysian electronics industry. In China, He (2003) 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 (2005) found that factors related to human resources are more important than the 'hard' factors in attracting foreign firms to invest 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 ( $\pi_{ij}$ ). As we cannot observe the profit directly, we further assume that the number of green field manufactures in each province ( $y_j$ ) is a function of the observable location characteristics ( $x_j$ ) of that province. Following Tokunaga and Akune (2003) and Coughlin and Segev (2000), we can express in the negative binomial model (Greene, 2000)<sup>3</sup> 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,  $\beta$  is a parameter vector,  $x_j$  is a provincial characteristics vector, and  $\varepsilon_j$  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  $\beta$ . Because equation (2) is a nonlinear equation, maximum likelihood is employed in estimation.

#### 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), because Japanese electronics FDI has been increasing after Mr. Deng Xiaoping's talk during his tour to the south in 1992. 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), China's Association of Development Zones. In this model, the independent variables are considered the following nine variables in Table 2.

TABLE 2. Variables and expected signs

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

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

*Domestic market potential* Market potential is considered as an important determinant as shown in Figure 3. Domestic market potential (lnMP) measures both demand potentials and economies of scale. Recently there are some new studies that analyzing the effects of market potential on the location of foreign firms [e.g. Redding and Venables (2000, 2004), Head and Mayer (2004)]. 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 305.63 thousand square kilometers, and standard deviation of 37.41, we divide provincial market potential and GDP by its area of provinces, and use logarithm of (provincial domestic market potential/area),  $\ln MP$  as market potential variable.

*Wage* In China, wage rate (WAGE) is highly ranked in Figure 3. As the wage is an important factor for opening plants of Japanese 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 ( $\ln WAGE$ ) as wage variable.

*Labor quality* Labor quality can blur the bad impact of labor cost on location choice because Japanese firms tend to seek a higher quality labor [He (2003)]. We use logarithm of provincial number of scientific and technical personal in state owned enterprises ( $\ln LABQ$ ) as labor quality variable.

*Infrastructure* The level of infrastructure is measured by logarithm of provincial highway density ( $\ln INFRA$ ).

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

*Agglomeration effects* If Japanese electronic firms locate close together in China, the industrial agglomeration helps to expand their sales and to save transportation cost, that is agglomeration economies [Marshall (1920), Krugman (1991), Fujita, Krugman, and Venables (1999), and Fujita and Thisse (2002)]. 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 as agglomeration effects: (1) Japanese manufactures agglomeration ( $\ln AGGLO1$ ), (2) Japanese electronics manufactures agglomeration ( $\ln AGGLO2$ ), and (3) Japanese electronics manufactures keiretsu agglomeration ( $\ln AGGLO3$ ) 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.

TABLE 3. Correlation matrix of independent variables

	MP	WAGE	LABQ	INFRA	POLI	AGGLO		
						1	2	3
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	0.561	0.525	0.353	0.573	0.755	0.895	1.000	
AGGLO3	0.443	0.554	0.208	0.439	0.595	0.718	0.870	1.000

## 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 are 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 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 AGGLO3. The coefficient estimate of market potential (MP) is positive and statistically significant at the 0.01 level in all cases,

TABLE 4. Results of the new plant location choice model in China (negative binominal model)

	(1)	(2)	(3)	(4)
Constant	-13.574*** (-3.08)	-5.271 (-1.05)	-3.437 (-0.68)	-9.561* (-1.91)
lnMP	0.820*** (7.37)	0.573*** (4.48)	0.700*** (6.35)	0.819*** (7.32)
lnWAGE	-1.297*** (-3.44)	-1.600*** (-4.19)	-1.746*** (-4.49)	-1.624*** (-3.79)
lnLABQ	1.371*** (5.58)	0.905*** (3.26)	0.959*** (3.69)	1.281*** (5.13)
lnINFRA	0.805** (2.09)	0.693** (1.82)	0.442 (1.14)	0.740* (1.89)
POLI	0.411*** (10.7)	0.325*** (7.25)	0.335*** (8.15)	0.408*** (10.6)
lnAGGLO1		0.411*** (3.21)		
lnAGGLO2			0.435*** (4.07)	
lnAGGLO3				0.154* (1.69)
Observations	372	372	372	372
Log likelihood	-372.48	-367.13	-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.

implying that new Japanese electronics manufactures are 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 1991).

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

significant at the 0.1 level, implying that new Japanese electronics manufactures are 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.

## CONCLUSION

In this paper, we examine the hypothesis that agglomeration effects play an important role in location choice behavior of Japanese electronics firms in China, according to Krugman (1991), Fujita and Krugman (1995), Fujita, Krugman, and Venables (1999). Using the data of *Cyugoku Sinsyutsu Kigyou Ichiran 2003 - 2004* (A view of Japanese Overseas Affiliates in China 2003 - 2004), we estimated a location choice model of Japanese electronics firms in which is 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 the 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 of Japanese electronics industry and another industry such as machinery, food processing, and transportation equipment.

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