Computer Simulation on Agglomerating Location of Home-country FDI

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Abstract—FDI enterprises from the same source country agglomerated in a region in China, i.e., a geographical agglomeration, was a main trend in recent years. An oligopoly output competition model was therefore developed between FDI enterprises and host country enterprises, with a conjectural variable introduced to weigh up the cooperation level between relevant enterprises, thus simulating and analyzing the location choice behavior of the agglomeration of home-country FDI. It was found that foreign enterprises will locate in the medium or small city which has a certain agglomeration effect when foreign investment enterprises can constitute the strategic alliance to cooperate their yield incompletely. The less degree enterprises cooperate their yield is, the bigger agglomeration effect that the location of foreign capital enterprises requests.

Index Terms—computer simulation, foreign direct investment (FDI), agglomerating of home-country FDI, investment location, emulation

I. INTRODUCTION

In 2003, China drew on foreign direct investments over 500 millions of dollar and became the biggest country to draw on foreign capital of the world. The distribution of FDI is very unbalanced in China, which concentrates primarily on the east littoral. Gathering together is the end-result of the great majority overseas-funded enterprises. In recent years the variety of FDI location also exhibits a marked characteristic, namely expands from big city to medium and small city or its suburban area, such as enterprises from Japan, Taiwan invested in peripheral regions of Dalian, Shanghai and Guangzhou City, and Korea enterprises invested in Qingdao or periphery of Tianjin City, which exhibits a marked characteristic of home-country agglomeration. For example, the agglomeration of IT industry from Taiwan in Dongguan, the electronics manufacturing base from Taiwan capital in Suzhou, "highland of Korean capital" in Qingdao and Weihai, "highland of Japanese capital" in Wuxi etc. That is, firms from the same country tend to agglomerate.

The domestic and international scholars have already noticed the phenomenon of FDI home-country agglomeration, and have started to carry the research out. Smith and Florida (1994), Head and Ries (1995) discovered the location of Japanese manufacturing enterprises in the US had strong characteristics of home-country agglomeration; Agglomeration of the Japanese enterprises in a state stimulated the latent Japanese investors to make the same location choice. Can-fei He (2003) investigated the enterprises data from Hong Kong, Taiwanese, Japan and the United States in Chinese hinterland, and discovered that these foreign capital enterprises exists marked effect of home-country agglomeration. Xu and Wang (2006) took the data of Jiangsu as sample to calculate and analyze the dynamic characteristics of home-country agglomeration coefficient HMN and general agglomeration coefficient OFN. There is less Literature on Home-Country FDI Agglomeration is less, most of which made use of positive method to demonstrate Home-Country FDI Agglomeration is less, most of which made use of positive method to demonstrate Home-Country FDI Agglomeration from the angle of industry cluster, as well as described the phenomenon and characteristics of Home-Country FDI Agglomeration. Put forward homologous policy suggestion. However the literature that there has been didn't involve the choice behavior of home-country FDI agglomeration to locate in the medium and small city.

Krugman (1991), Venables (1996) took the lead to melt the location problem into general equilibrium theory analysis, which thought the opposite strong or weak between centralized powers caused by market enlargement effect and decentralized powers caused by market competition effect would decide the spatial distribution mode of the economic activities. In order to find innate power of economic activities system and how the power to affect the spatial distribution of economic activities, Krugman thought that the space is a kind of coessential plane, manufacturing industry enterprises having increasing scale return will locate in bigger
demand market district so as to carry out scale economy and lower transportation cost. But multinational enterprises don’t face a coessential plane; the foreign capital investor will make a unique choice in the process of investigate some target locations with extrinsic nature conditions and natural endowment. More important, economic person having incomplete information in the actuality was filled with counter game each other, but monopolistic competition neglects this kind of decisive link. Fujita also admits, the new economic geography neglecting individual game analysis is really a kind of blemish. According to this, this paper follows the thought of Krugman, constructs demand function including market approaching effect and cost function including market competition effect, and builds up an two-stage oligopoly output competition model; This paper tries to analyze the behavior of the home-country FDI to locate in medium and small cities.

II. BASIC MODELS

Suppose a multinational enterprise intends to invest horizontally in region A or region B of the host country, but the multinational enterprise doesn’t have complete information about A and B, and doesn’t know which the better location is for FDI. The multinational enterprise neither know the local demand, nor the local resources supply and production cost, but only can calculate rationally according to the agglomeration circumstance of local enterprises.

Generally speaking, enterprises gathering together will bring two kinds of effects: market enlargement effect and market competition effect. Market enlargement effect means that change of production distribution will cause regional market scale the same directional change, and relative change of regional market scale will cause production activities further concentrate. The market competition effect means that imperfect competition enterprises incline to choose the location of having fewer competitors. The former effect is powers to accelerate enterprises centralize; the later effect is powers to accelerate enterprises decentralize. Because market enlargement effect, along with enterprises gathering together continuously, the increment of local income level will increase; if this happens in one country, it will draw on workers of other regions in host country move into constantly; the local market is further approachable because workers consume their income at the working place. Therefore the multinational enterprise will think that market demand of region A is. Use \( q_{iA} \) represent for the yield of enterprise \( i \) (\( i = 1, 2 \ldots \)) in region A, then:

\[
Q_A = \sum_{i=1}^{n_A} q_{iA} .
\]

Because of market competition effect, competition of scrambling for consumer between enterprises will be more vigorous along with enterprises gathering together continuously; at the same time the factors cost rise because the production factors become scarce increasingly. The both cause production cost rise, so the multinational enterprise will calculate rationally that production cost is also related to local enterprises agglomeration circumstance. Because emphases of the paper don't lie in analyzing the influence of cost difference between all types of enterprise, as a result suppose whether production cost of multinational enterprise or local enterprise is all the same in the following analysis, certainly they have something to do with local regional characteristics and enterprises agglomeration circumstance.

Suppose the multinational enterprise deduces average production cost to invest in region A is:

\[
c_{iA} = \frac{n_A^2}{k_1} c .
\]

\( c_{iA} \) is production cost of enterprise \( i \) (\( i = 1, 2 \ldots \)) in region A, so expectant profits of the enterprise is:

\[
E(\pi_{iA}(q_{iA} \cdot q_{jA})) = q_{iA} p_{iA}(Q) - c_{iA} q_{iA} .
\]

First stage, the enterprise choose yield in order to make the profits biggest, the above enterprise yield competition problem can be induced to the following game theory model: \( G \langle N, S_1, \cdots, S_{n_A}, \mu_1, \cdots, \mu_{n_A} \rangle \).Among them, \( N = \{1, 2, \cdots, n_A\} \); \( S_i = [0, \infty), q_{iA} \in S_i; \mu_i(q_{iA}, q_{iA}) = E(\pi_{iA}), i = 1, 2, \cdots, n_A \).

(1) The first get reaction function \( r_i(q_{iA}) \) of enterprise \( i \)

Fix the yield of other business enterprises \( j \) in addition to business enterprise \( i \), thus solve \( q_{iA} \) to make the profits of enterprise \( i \) maximum, and namely solve the maximized problem:

\[
p_{iA}(Q) = \frac{n_A}{k_1} \alpha - b Q_A .
\]

Here \( Q_A \) is for market demand, \( p_{iA}(Q) \) for product price of region A, \( a, b, k_1 \) for positive constant, \( \frac{n_A}{k_1} \alpha > \max c_{iA}, c_{iA} \) for average production cost of enterprise \( i \). Therefore the enterprise market demand in region A is positive related with enterprises number of region A. The more enterprises number is, the bigger market demand of region A is. Use \( q_{iA} \) represent for the

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The first rank condition is:
\[
\frac{dE(\pi_{i,\lambda})}{dq_{i,\lambda}} = \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c - \sum_{j \neq i} q_{j,\lambda} \right) q_{i,\lambda} - \frac{n_1^2}{k_1^2} c q_{i,\lambda}.
\] (5)

It contains thus a kind of assumption that oligarchies always believe that the rivals would keep the constant yield in Cournot model. Because oligarchies depend mutually, therefore sometimes this kind of conviction seems not to be true. Zang Bolun put forward that the mutually dependence between oligarchies makes oligopoly market attain a similar monopoly agreement equilibrium in "monopoly competition theory". Terna put forward the concept of "tacit understanding to conspire", Stigle negated the inevitability that oligopoly market appears to conspire in "oligopoly theory", and thought it is hard to keep conspiracy from dynamic view. Bosna put forward that the oligopoly market generate advantageous market characteristics to conspire on the foundation of Stigle theory.

The related researches of new industry organization theory demonstrate, enterprises can provide convenience for the stability to form and keep conspiracy by some strategically behaviors. Therefore in order to avoid lacking fidelity, define a parameter \( \lambda \) to describe the expectation reflection degree of each enterprise to others.

\[ \lambda = \frac{\sum_{j \neq i} d q_{j,\lambda}}{d q_{i,\lambda}}. \] (7)

Formula (7) means the reaction that yield variety of all other enterprises reacts to enterprise \( i \), \( \lambda \) can be called supposition variable of enterprise \( i \).

Take (7) into (6) gets reaction function of enterprise \( i \) as:
\[
R_i (q_{-i,\lambda}) = q_{i,\lambda} = \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c - \sum_{j \neq i} q_{j,\lambda} \right) q_{i,\lambda} - \frac{n_1^2}{k_1^2} c q_{i,\lambda}.
\] (8)

(2) Similarly gets reaction function of enterprise \( j \) concerning enterprise \( i \)
\[
R_j (q_{-j,\lambda}) = q_{j,\lambda} = \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c - \sum_{i \neq j} q_{i,\lambda} \right) q_{j,\lambda} - \frac{n_1^2}{k_1^2} c q_{j,\lambda}.
\] (9)

(3) The intersection of the \( n \) reaction curve is game equilibrium; it can be gotten from equation group consists of reaction functions:
\[
R_i (q_{-i,\lambda}) = q_{i,\lambda} = \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c - \sum_{j \neq i} q_{j,\lambda} \right) q_{i,\lambda} - \frac{n_1^2}{k_1^2} c q_{i,\lambda}.
\] (10)

Get the solution:
\[
q_{i,\lambda}^* = \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c \right) \left(\lambda + n_\lambda + 1\right) b .
\] (11)

\[
P_\lambda = \frac{n_1}{k_1} \left(\lambda + n_\lambda + 1\right) \alpha + \frac{n_2}{k_2} c .
\] (12)

Take formula (11) and (12) into formula (5) will get:
\[
\pi_{i,\lambda} = \left(\lambda + 1\right) \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c \right)^2 \left(\lambda + n_\lambda + 1\right) b .
\] (13)

Suppose there are \((n_\lambda - 1)\) enterprises in region B originally, after the multinational enterprise entering the number becomes \(n_\lambda\), the cost of all enterprises in region B is the same. According to enterprises number of region B the multinational enterprise deduces the market anti-demand function and production cost of region B is:
\[
p_{\lambda} (Q) = \frac{n_1}{k_1} \alpha - b Q_{\lambda} .
\] (14)

\[
C_{i,B} = \frac{n_2}{k_2} c .
\] (15)

Similarly, define supposition variable of enterprise \( i \) in region B is \( \lambda' \), the multinational enterprise invests in region B will expect to acquire profits:
\[
\pi_{i,B} = \left(\lambda + 1\right) \left(\frac{n_1}{k_1} \alpha - \frac{n_2}{k_2} c \right)^2 \left(\lambda + n_\lambda + 1\right) b .
\] (16)

Second stage, FDI enterprise chooses the location. When \(\pi_{i,B} > E (\pi_{B})\), the multinational enterprise will invest in region A. Otherwise it will invest in region B.

III. Behavior Analysis of the Home-Country FDI to Locate in Medium and Small Cities

Now we will analyze the location choice of FDI from the multinational enterprise, the conditions for the
multinational enterprise to throw FDI in region A can be shown as:

\[
\frac{(\lambda + 1)\left(\frac{n_i\alpha}{k_i} - \frac{n_i^2\beta}{k_i}\right)^2}{(\lambda + n_A + 1)^2b} > \frac{(\lambda' + 1)\left(\frac{n_i\alpha}{k_i} - \frac{n_i^2\beta}{k_i}\right)^2}{(\lambda' + n_B + 1)^2b}.
\] (17)

If \( \lambda = 0 \) , it means enterprise \( i \) think that all other enterprises would not respond to its own yield decision, obviously this is basic behavior assumption in Cournot model. However, along with FDI in China go along from sounding out stage and extending stage to the overall investment stage, investment from Taiwanese enterprises develop also from setting up a factory separately to integrate horizontally, strategic alliance, and gradually turn to group trend (Sun, 2008). Xu and Wang (2006) took the data of Jiangsu as sample, which confirmed the obvious differences of home-country FDI agglomeration effect from different source countries. Taiwanese and Japanese enterprises show a strong home-country FDI agglomeration tendency, But Hong Kong enterprises distribute too dispersive to form an obvious home-country FDI agglomeration region. The possible reason is that Taiwanese and Japanese industries have higher request to the kit product, and enterprises in these two regions all make it a rule to adopt the way of united investment stage, investment from Taiwanese enterprises to region A which agglomerative economic effect is weaker. (18)

\[
\frac{(\lambda + 1)\left(\frac{n_i\alpha}{k_i} - \frac{n_i^2\beta}{k_i}\right)^2}{(\lambda + n_A + 1)^2b} > \frac{(\lambda' + 1)\left(\frac{n_i\alpha}{k_i} - \frac{n_i^2\beta}{k_i}\right)^2}{(\lambda' + n_B + 1)^2b}
\] (17)

Sorting up formula (18) will get:

\[
n_A < n_B \cdot
\] (19)

namely the enterprise \( i \) with the same limit by a percentage point, each of its rivals will reduce its product with one by one in the aspect of pushing the market to descend product. At this time, \( \lambda = n - 1 \). formula (17) can be changed into

\[
\frac{(n_i\alpha - n_i^2\beta)}{k_i} < \frac{(n_i\alpha - n_i^2\beta)}{k_i}
\] (18)

Obviously, after lead guess variable which measures the cooperation degree among enterprises into the analysis, through above-mentioned behavior analysis of enterprise profits maximum we can get the following thesis:

Thesis 1: When the business enterprises reach to a having binding force agreement, then launch a complete cooperation, it will make multinationals transfer its investment location to the medium and small cities which have weak agglomerating effect.

But this kind of circumstance is subjected to stern control of the government anti-monopoly law on one hand; On the other hand, it is also more difficult to reach the agreement of having the binding force for the business enterprises because of the prisoner's dilemma. Thus the circumstance that enterprises completely cooperate can't almost and impossibly be carried out in practice. So the following will discuss the location choice of foreign enterprises when they carry on incomplete cooperation only.

B. When foreign enterprises carry on incomplete cooperation in region A and region B
Suppose each enterprise carry on coordination towards production, but this kind of cooperation is incomplete, namely enterprises have a certain tacit understanding cooperation but can't reach the degree of anti-monopoly laws regulation. Then \( \lambda > 0 \) , at this time where will the foreign enterprises invest in? Given relevant parameter of the demand function and the cost function, and suppose \( n_A = 10 \), \( n_B = 15 \), then profits variation of FDI is shown as Fig.1: From Fig.1 can see, if \( \lambda > \lambda' \), such as when \( \lambda' = \lambda_i \), only if \( \lambda > \lambda_i' \), foreign enterprises will agglomerate in region A which agglomerative economic effect is weaker.
Whether can region A draw on multinationals as only as $n_A < n_B$? Suppose $n_A = 3$, and when agglomerative economic effect in region A is very low, then profits variation of FDI in region A and region B is shown as Fig.2:

Figure 1. Profits variation trend of FDI

However when $n_A = 3$, namely when agglomerative economic effect in region A is very low, In spite of how the cooperation degree between the enterprises is, foreign enterprises will not locate in A.

There are many enterprises in the region which agglomerative economic effect is high, the home-country, scale, actual strength of the enterprises are different greatly, The cooperation efficiency between enterprises is lower than that in the region which agglomerative economic effect is weaker. For making the analysis simple, and not lose the generality, Suppose $\lambda > 0$, because the numbers of enterprises in region A and region B are different, So the response degree each enterprise does is different, Obviously the response degree each enterprise does in region A is higher than that in region B. Through sorting from formula (17) will get formula (20):

$$(n_A - n_B) \left( \frac{\lambda \alpha + \frac{\alpha}{k_1} - \frac{\lambda c}{k_2}}{\frac{n_A n_B c}{k_2}} - c \right) > 0$$

Suppose $n_A < n_B$, formula (20) establishes must satisfy the following:

$$\frac{\lambda \alpha + \frac{\alpha}{k_1} - \frac{\lambda c}{k_2}}{\frac{n_A n_B c}{k_2}} - c \left( n_A + n_B \right) < 0.$$ (21)

Get the solution:

$$n_A > \left( \frac{k_1 \alpha - n_B}{n_B + \frac{\lambda}{\lambda + 1}} \right) \left( \frac{n_B}{\lambda + 1} \right).$$ (22)

Namely the condition that foreign enterprise invests in region A is:

When enterprises carry on incomplete cooperation, the foreign enterprises will choose to locate in the medium or small cities having a certain agglomerative effect. The bigger $\lambda$ is, the greater gathering number of enterprises in region A that multinational enterprises request to invest in it is. The average response degree that each enterprise does in region A is higher than that in region B, but the agglomerative economic effect of region A is weaker than that of region B, The multinational enterprise weighs the both carefully to choose the investment location.

Suppose $c = 100$, $k_1 = 2$, $k_2 = 4$, then the least enterprises gathering number in region A $(\min \left\{ n_A \right\})$ change along with the enterprises number in region B is as Fig.3.

Figure 3. The least gathering number of enterprises in region A
enterprise in region B is smaller, the multinational enterprise requests a smaller agglomerative effect to locate in region A also.

Thesis 2: When the enterprises carry on coordination towards their yield, but this kind of cooperation is incomplete, which will cause the location of foreign enterprises transfer toward medium or small cities having a certain agglomerative effect, the location for the foreign enterprises invest in must request to have the lowest limit of agglomerative effect. Along with the aggregation of $\lambda$, it means that the response degree done by each enterprise in region B is getting greater and greater, the multinational enterprises request greater and greater agglomerative effect to locate in region A.

C. When enterprises in region A have a certain tacit understanding cooperation, but enterprises in region B are mutually independent

Suppose city A is smaller than city B, agglomeration economic effect in city A is weaker than it in city B, this means $n_A < n_B$. Each enterprise in city A carries on the coordination to yield. But this kind of cooperation is incomplete, namely enterprises have a certain tacit understanding cooperation but can't reach the degree that need to be controlled by anti-monopoly law, at this time $\lambda > 0$. But enterprises in city B carry on independent yield decision, at this time $\lambda = 0$. How the foreign investment enterprise will locate? Give the related parameters: $a = 100$,$c = 1$,$k_1 = 2$,$k_2 = 4$,$n_B = 15$, the result of emulation with variety of different agglomeration circumstance in city A is as Fig.4.

From Fig.4 it is obvious that when $n_A = 5$, if only $\lambda > \lambda_1$, the foreign investor will locate in city A which agglomeration effect is weaker; when $n_A = 4$, if only $\lambda > \lambda_2$, the foreign investor will just locate in city A; when $n_A = 3$, namely agglomeration effect in city A is very weak, there no foreign investor will locate in city A regardless how the cooperation degree of enterprises in city A is. From this get thesis 2.

Thesis 3: When enterprises located in the stronger agglomeration effect city make independent decision mutually, if foreign investment enterprises can constitute the strategic alliance to cooperate their yield incompletely, which will cause foreign invest enterprises to locate in the medium or small city which has a certain agglomerative effect. The region that foreign invest enterprises locate must request to have agglomeration effect of the lowest limit, the less degree enterprises cooperate their yield is, the bigger agglomeration effect that the location of foreign capital enterprises requests.

Investigate from the dynamic angle; the high urbanized eastern littoral drew on the first batch foreign investors depending on the location advantage and the predominance of policy factors. The first foreign investment much was thrown to big cities in Fujian, Guangdong, Jiangsu, Shanghai, Shandong province and so on eastern littoral. Because home-country, scale, actual strength of the first batch foreign investment is different greatly, the product connection between the enterprises is low, the collective efficiency is low, and so it is a kind of "space-heaped" agglomerative type. Along with more than 20 years development of foreign enterprises in China, foreign enterprises have had a deeper understanding about the conditions of Chinese business enterprise, investment environment, the cooperative objects, and the investment market of China. These experiences and trial have an important function to make the industrial investment and location decision well in the future for foreign investors. So thesis 3, enterprises in the region of having weaker agglomerating effect carry on an incomplete cooperation on their yield, but enterprises in the region of having stronger agglomerating effect independence mutually, this situation is relatively kept with China’s reality.

From Fig.4 it is obvious that when $n_A = 5$, if only $\lambda > \lambda_1$, the foreign investor will locate in city A which agglomeration effect is weaker; when $n_A = 4$, if only $\lambda > \lambda_2$, the foreign investor will just locate in city A; when $n_A = 3$, namely agglomeration effect in city A is very weak, there no foreign investor will locate in city A regardless how the cooperation degree of enterprises in city A is. From this get thesis 2.

It is thus clear that, When the first batch of high urbanization and general FDI agglomerated regions turn up non-economy because of production cost and competition pressure rising, foreign investors need to re-find new locations, Or lately-entering foreign investors prepare to choose invest location, And if the home-country FDI can form a strategic alliance of collaborating and consociating production, So the peripheral medium or small cities and suburban areas around big city can satisfy the request for agglomeration economy, and then even have more charm to be the newly arisen investment.

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location because of nearing to the center city and their more perfect invest environment.

IV. CONCLUSION

This paper analyzes the behavior of the home-country FDI to locate in medium and small cities and the motivation of home-country FDI agglomeration; and put forward the strategy to attract FDI that aims at the characteristic of home-country FDI agglomeration. 1. It will cause foreign enterprises to locate in the medium or small city which has a certain agglomeration effect when foreign investment enterprises can constitute the strategic alliance to cooperate their yield incompletely. The less degree enterprises cooperate their yield is, the bigger agglomeration effect that the location of foreign capital enterprises requests. Because of making it a rule to adopt the way of collaborating and consociating production, so the peripheral medium or small cities and suburban area around such as Shanghai, Dalian, Qingdao and Guangzhou these Cities, which have better invest environment, become the important and newly arisen investment locations that Taiwanese investors, Japanese investors and Korea investors agglomerate.

2. China should pay attention to attract investment from oversea by the way of industrial agglomeration aiming at the characteristic of home-country FDI agglomeration. Along with the high speed development of Chinese economy, the improvement of infrastructure and open of information in everyplace, The strategy of foreign investors have already evolved into “The rational investment mode” under industry kit, strategic alliances and cooperation principle. The negative exterior caused by general FDI agglomeration has already exceeded or neared to straight exterior caused by its demonstrate effect since 1998, Thus not enough to affect location decision of the latent investors, Even limit the latent investor into, But the importance of home-country FDI agglomeration gradually strengthens in investor's location decision. Therefore under the gradual vigorous competition background of attracting FDI, China should change the way of attracting FDI and carry out the third generation policy of attracting FDI aiming at the characteristic of home-country FDI agglomeration. Namely satisfy foreign enterprises particular location need in activities and cluster levers, promote native location advantage by exploiting agglomeration effect. Therefore according to industrial development direction, decide the type of regional industrial agglomeration, establish feasible plan for attracting FDI, map out the concrete realm of attracting FDI, choose foreign enterprises having higher industry relation as attracting objects, and strike out spatial agglomeration characteristics in the plan geography of attracting FDI. It is not only to prevent FDI from holding back by other region with industrial agglomeration way to attract FDI, but also draw on original enterprises not having intention to invest in.

ACKNOWLEDGMENT

This paper is supported by the humanities and social sciences fund of the ministry of education in China (10YJA630103) and the major project of economic and social development in Liaoning province (2009IsIktdzian-18).

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