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Location power of the corporation tax and the interest rate in the globalized economy

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Location power of the corporation tax and the interest rate in the globalized eco

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1 Introduction

It would not take a long time for a firm to determine factory's location when the firm's production activity was almost confined in a country. While, in the globalized economy a firm takes a series of steps to decide factory's location since spatial range of a firm's production activity is expanded to a large geographical area in which several countries are contained. Nowadays, as a firm plans to establish a new factory, it faces the issue of country selection and site choices within the selected country. To decide factory's location a firm proceeds location determination processes deliberating various location factors. Especially, the corporation tax and the interest rates of countries are important location factor in the early stage of the location determination process since they decisively affect the firm's profits.

In addition, in globalized economy a new mechanism begins to work in firm's production management, the function of the transfer price of intermediate goods: Many manufacturing firms fragment production process into several blocs and scatter the fragmented blocs across countries¹. Thus, intermediate goods produced by each factory are moved between the factories which are located in different countries. In the movement of these goods the transfer price is utilized². Because the firm can measure each factory's profit by using the transfer price and estimate each factory's profit contribution to the firm. While, the country in which factory locates can charge the corporation tax on the factory's profit that is grasped by the transfer price.

It may be said that in the global economy, location power of the corporation tax rate and the interest rate, which did not exercise in the pro-global era, should be accurately examined as a location factor and the function of the transfer price is important to be analyzed much more by scholars. The primary purpose of the present paper is to clearly show the location power of the corporation tax rate and the interest rate through the function of the transfer price. To clearly verify that the corporation tax and the interest rate have the power to shift the factory's location, it is the appropriate way to analyze their locational power in a specified model and clearly show how they change the factory's location in a spatial area. To this end, this paper constructs a simple location

¹ Shi-Yan (1995) analyses the mechanism of spatial departure of fragmented production processes.

² The transfer price has been extensively studied by Hirshleifer (1956) and Eden (1985).

determination model based on the traditional location theory and uses a numerical simulation method. Based on a constructed model, the paper, first, analyzes the location power of the corporation tax rate, which is determined by the government. Secondly, the interest rate, which is manipulated the central bank, is incorporated into the model, and the location power of the interest rate is examined. In these examinations the gradient dynamics is adopted because this method, generating a chaotic phenomenon on the three dimensions sphere, can provide useful information about firm's location problem in a large geographical area³.

The paper is organized as follows: The next section introduces the assumptions and the framework of the analysis. And the profit function of a firm is derived. Section 3 explains that when a firm builds a new factory, the first thing the firm does is to set up a location prospective area in a large geographical area. To introduce the location prospective area a chaotic phenomenon is utilized. In section 4 the location power of the corporation tax and the interest rate are examined: This examination clarifies how changes of these rates alter the factories' location pattern. Section 5 concludes the analysis.

2. Derivation of profit function of a firm

2.1 A role of the transfer price in the movement of intermediate goods

First of all, this subsection explains a role of the transfer price in movement of intermediate goods between factories belonged into a multinational firm.

Suppose that a firm produces final goods in two production processes, the first process and the second process. As shown in Figure 1, the factory 1, which is assigned to the first process, manufactures intermediate goods in home country. The intermediate goods are transported from the factory 1 to the factory 2 in the foreign country by using the transfer price. The factory 2 composes final goods by using the transported intermediate goods and sells them in foreign country.

By using the transfer price of the intermediate goods, the revenue and profit of the factory 1 which arises from selling the intermediate goods to the factory 2 are derived. Similarly, the cost and profit of the factory 2 which arises by purchasing the intermediate goods are also derived by the transfer price. The firm managing these two factories can measure each factor's profit and estimate its contribution to the firm's profits. While, the home and the foreign country charge the corporation tax on the profits of the factory 1 and 2 which can be grasped by the taxation authority with the transfer price. The role of the transfer price is crucially important for both the firm's production management and the government's financial manipulation.

³ Puu (1998) uses the gradient dynamics to analyze the factory's location in the two dimensions. This paper uses the same gradient dynamics in three dimensions.

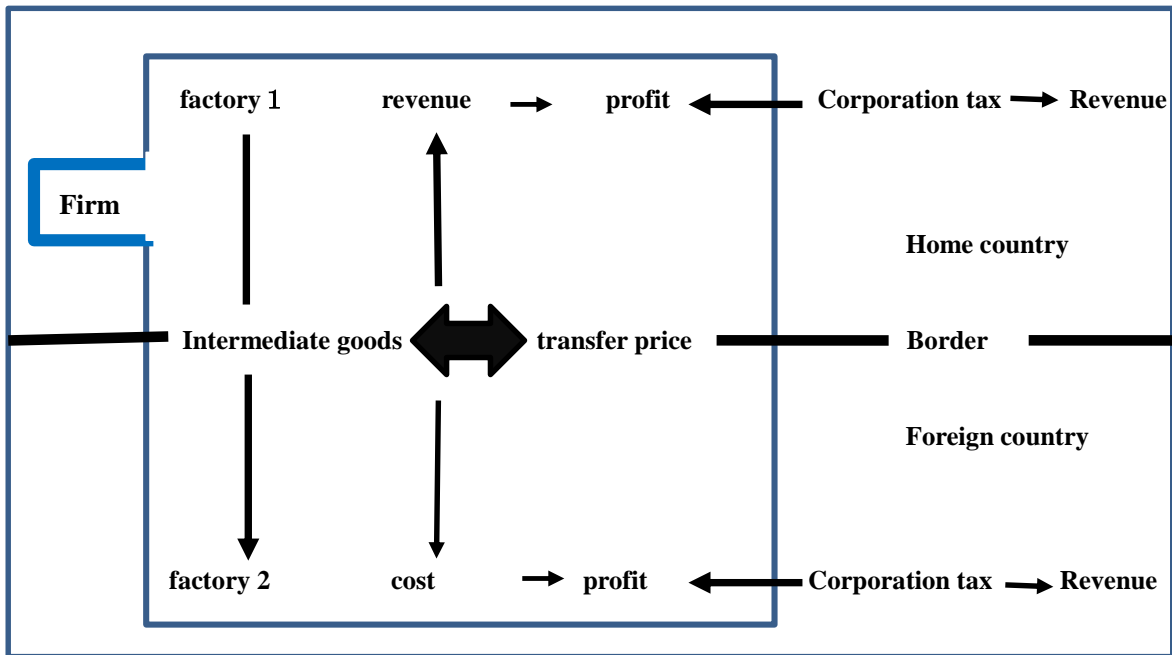


Figure 1 A role of the transfer price in the movement of intermediate goods

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2.2 Assumptions and framework of analysis

2.2.1 Roles and linkages of factories of a multinational firm

In order to analyze the location power of the corporation tax rate and the interest rate this subsection introduces the fundamental assumptions and framework according to the traditional location theory⁴.

A firm produces finished goods by using two production processes, the first and the second process. The first process is conducted by factory 1 which is in the home country. The factory 1 manufactures intermediate goods, mq . The second process is assigned to

⁴ The basic framework is constructed according to Weber (1909) and Puu (1998).

the factory 2 which locates in the foreign country. The factory 2 composes final goods by using the intermediate goods.

The intermediate goods produced by the factory 1 are transported to the factory 2 by the transfer price mp . The factory 2 uses one unit of the intermediate goods to produce one unit of final goods. The factory 2 sells the finished goods to the market place in the foreign country. There is no tariff in the movement of the intermediate goods between the two factories.

The factory 2 is in the position of the monopoly in the market. Thus, the factory 2 can determines the supply quantity of the final goods at the market. This factory decides the quantity in order to maximize *the factory's* profit. On the other hand, the factory 1 decides the transfer price of the intermediate goods in order to maximize the *firm's* profits.

The corporation tax rates of the home and the foreign country are represented by t and t^* , respectively. The interest rates of the home and the foreign country are indicated by r and r^* . At the first stage of the analysis the interest rates are not incorporated into the consideration for the simplification. The effects of the interest rates will be examined at the second stage of the analysis.

2.2.2 Derivation of the profit function of the factory 1

The profit of the factory 1, Y_1 , is given by equation (1),

$$Y_1 = (1 - t)[mp * mq - C(mq) - F_1] \quad (1)$$

where $C(mq)$ is cost function of the factory 1 and F_1 is fixed cost.

The cost function $C(mq)$ is derived on the basis of the following assumptions. The factory 1 uses two different kinds of materials m_1, m_2 to produce the intermediate goods. And the factory 1 needs lubricating oil m_3 to operate machines. The materials m_1, m_2 and oil m_3 are produced at points M_1, M_2 and M_3 which are identified by coordinates (x_1, y_1) , (x_2, y_2) , and (x_3, y_3) , respectively. These materials are transported to the factory 1 located at point L which is indicated by (x, y) . Freight rates of the materials m_1, m_2 are denoted by t_m , and the rate of the oil m_3 is given by t_e . The intermediate goods are transported from the factory 1 to the factory 2 which locates at the market at point $M_4, (x_4, y_4)$. The freight rate of the intermediate goods is t_g . Mill prices of these materials and oil are assumed to be given for the simplicity, and these prices are denoted by p_1, p_2 , and p_3 .

Figure 2 illustrates the geographical relationship between the factory 1, the factory 2, the market and points of the three materials. The territory of the home country is shown

by the oval curve. The foreign country is assumed to be a kind of city country for simplicity. The city country is indicated by the black square in Figure 2.

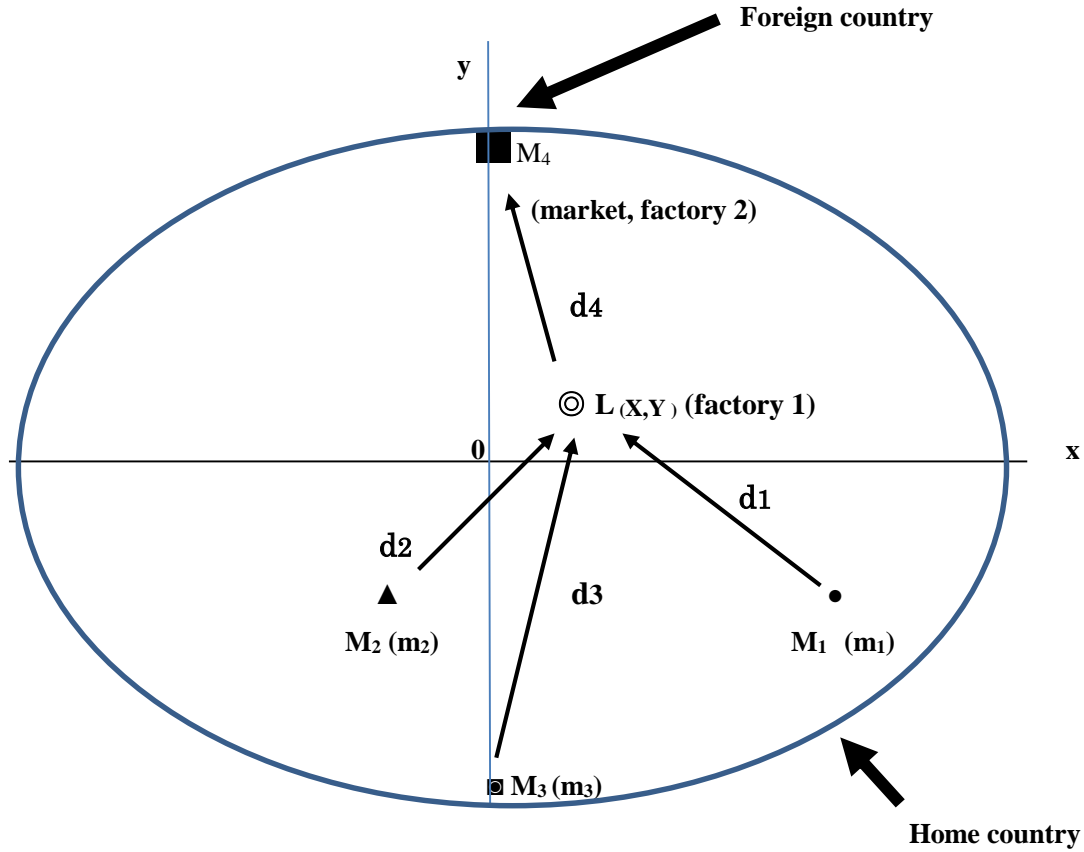


Figure 2 Location figure

The production function of the factory1 is supposed as equation (2),

$$mq = Am_1^\alpha m_2^\beta \quad (2)$$

where A , α and β are parameters and they are defined as $A > 0$, $0 < (\alpha + \beta) < 1$.

And the distances between the material places, M_i ($i=1, 2, 3$) and the factory1, L , are represented by d_1, d_2, d_3 , respectively:

$$d_1 = ((x - x_1)^2 + (y + y_1)^2)^{0.5} \quad (3a)$$

$$d_2 = ((x + x_2)^2 + (y + y_2)^2)^{0.5} \quad (3b)$$

$$d_3 = (x^2 + (y + y_3)^2)^{0.5} \quad (3c)$$

The distance between the factory 1 and the factory 2 which locates at the market M_4 is given by d_4 ,

$$d_4 = (x^2 + (y - y_4)^2)^{0.5} \quad (3d)$$

Thus, the delivered prices P_i ($i=1, 2, 3$) of the two materials and the lubricating oil at the location site of the factory 1 are shown by equations (4a, b, c), respectively:

$$P_1 = p_1 + t_m d_1 \quad (4a)$$

$$P_2 = p_2 + t_m d_2 \quad (4b)$$

$$P_3 = p_3 + t_e d_3 \quad (4c)$$

And the price of the intermediate goods at location of the factory 2, DP , which is needed to calculate the revenue of the factory 1 is represented by equation (5),

$$DP = mp - t_g d_4 \quad (5)$$

Now, making use of the law of equi-marginal productivity, that is, the ratio between the productivities of the two intermediate goods should be equal to the ratio between the delivered prices of them, quantities of these materials are derived as equations (6a) and (6b): (For simplicity, α and β are assumed $\alpha=\beta=0.4$):

$$m_1 = A^{-1.25} m q^{1.25} (p_2 + t_m d_2) / (p_1 + t_m d_1)^{0.5} \quad (6a)$$

$$m_2 = A^{-1.25} m q^{1.25} (p_1 + t_m d_1) / (p_2 + t_m d_2)^{0.5} \quad (6b)$$

Quantity of oil m_3 is given by a linear function of amount of the final goods as equation (6c),

$$m_3 = m q \quad (6c)$$

From above equations, the cost function $C(qm)$ is obtained as equation (7),

$$C(mq)=2A^{-1.25}mq^{1.25} (p_1+t_m d_1)^{0.5}(p_2+t_m d_2)^{0.5} + mq(p_3+t_e d_3)+ F_1 \quad (7)$$

The profit function of the factory 1 can be rewritten as equation (8),

$$Y_1=(1-t)[mq((mp-t_g d_4)-(p_3+t_e d_3))-2mq^{1.25}A^{-1.25}(p_1+t_m d_1)^{0.5}(p_2+t_m d_2)^{0.5}-F_1] \quad (8)$$

2.2.3 The profit functions of the factory 2 and the firm

Let us derive profit of the factory 2. The profit is derived under the following assumptions: The market demand function is represented by equation (9),

$$p= a - vQ \quad (9)$$

where p is the market price of the final goods, a is the maximum reservation price and v is parameter. For simplicity a and v are assumed 600 and 1, respectively. If the cost of composing the intermediate goods to finished goods is represented by $C(Q)$ and fixed cost of the factory 2 is represented by F_2 , the profit of the factory 2, Y_2 , is represented by equation (10),

$$Y_2 = (1-t^*)[pQ - mp *mq - C(Q)-F_2] \quad (10)$$

Suppose that the composing cost $C(Q)$ is given by equation (11),

$$C(Q) = b Q(g + Q)^2/h \quad (11)$$

where parameter b , g and h are assumed 1.5, 2, and 200 for the simplicity of the calculation, respectively.

Since the factory 2 uses one unit of the intermediate goods to produce one final goods, mq can be replaced by Q . The profit function is rewritten by equation (12),

$$Y_2 = (1-t^*)[(p - mp)Q - 1.5 Q(2+ Q)^2/200 -F_2] \quad (12)$$

Since the market price of the final good, p , is a function of the quantity Q as shown by equation (9), the optimal quantity supplied at the market to maximize the profit of the factory 2 can be derived by using equation (12). The optimal supply quantity is given by equation (13),

$$Q=0.22(-206 + (582409 - 900mp)^{0.5}) \quad (13)$$

As the supply quantity Q is a function of the transfer price, mp , the profit of the factory 2 is also represented as a function of the transfer price as equation (14),

$$Y_2 = (1-t^*) [(600-(0.22(-206+(582409-900mp)^{0.5}))-mp)(0.22(-206+(582409-900mp)^{0.5})) - F_2]. \quad (14)$$

Eventually, summing up the profits of the factory 1 and 2, the firm's profits, Y , can be obtained as equation (15). The firm's profits is a function of the transfer price and location site of the factory 1.

$$Y = (1-t)[(0.22(-206 + (582409 - 900mp)^{0.5}))(mp - t_g d_4) - (p_3 + t_e d_3) - 2(0.22(-206 + (582409-900mp)^{0.5}))^{1.25} A^{-1.25} (p_1 + t_m d_1)^{0.5} (p_2 + t_m d_2)^{0.5} - F_1] + (1-t^*) [(600-(0.22(-206+(582409-900mp)^{0.5}))-mp)(0.22(-206+(582409-900mp)^{0.5})) - F_2]. \quad (15)$$

3 Settlement of location prospective area

3.1 Usefulness of a chaotic phenomenon

Let us derive the optimal location (X, Y) of the factory1 and the optimal transfer price by using equation (15). To derive the optimal transfer price and the location of the factory 1, the gradient dynamics is used (Puu, 1998, Ishikawa, 2009). This method is very useful because it can identify the solution point. Furthermore, even if the solution could not be specified, the area in which the solution is included is indicated by a chaotic phenomenon. The essence of the Gradient dynamics is that first, an initial value set is given to x_n , y_n , and mp_n in the following equations (16a, b, c) as a temporal solution, and obtain the second tentative values of x_{n+1} , y_{n+1} , and mp_{n+1} by calculations indicated by the three equations (16a, b, c). The same calculation is iterated until a given tentative solution can be approximately judged as the solution. If the values of $(x_{n+1}, y_{n+1}, mp_{n+1})$ in equations (16a, b, c) become approximately the same as those of (x_n, y_n, mp_n) , the values can be admitted as the solution.

$$x_{n+1} = x_n + j * \partial Y / \partial x, \quad (16a)$$

$$y_{n+1} = y_n + j * \partial Y / \partial y, \quad (16b)$$

$$mp_{n+1} = mp_n + j * \partial Y / \partial mp, \quad (16c)$$

where j is the width of a step and n shows the number of the calculation. And $\partial Y / \partial x$, $\partial Y / \partial y$, and $\partial Y / \partial mp$ are given by the following equations (17a, b, c),

$$\begin{aligned} \partial Y / \partial x = & 0.18[-t_g x (299.4 - 0.5mp) / d_4 + (299.4 - 0.5mp) (-t_g(x / d_4) - t_e(x / d_3)) - \\ & - A^{-1.25} (299.4 - 0.5mp)^{1.25} t_m [\{ (p_2 + t_m d_2)^{0.5} / (p_1 + t_m d_1)^{0.5} \} (x - x_1) / d_1 + \\ & + \{ (p_1 + t_m d_1)^{0.5} / (p_2 + t_m d_2)^{0.5} \} (x + x_2) / d_2] = 0 \end{aligned} \quad (17a)$$

$$\begin{aligned} \partial Y / \partial y = & 0.18[-t_g(y-1)(299.4 - 0.5mp) / d_4 + (299.4 - 0.5mp) (-t_g((y - y_4) / d_4) - t_e((y - y_3) / d_3)) - \\ & - A^{-1.25} (299.4 - 0.5mp)^{1.25} t_m [\{ (p_2 + t_m d_2)^{0.5} / (p_1 + t_m d_1)^{0.5} \} (y + y_1) / d_1 + \\ & + \{ (p_1 + t_m d_1)^{0.5} / (p_2 + t_m d_2)^{0.5} \} (y + y_2) / d_2] = 0 \end{aligned} \quad (17b)$$

$$\begin{aligned} \partial Y / \partial mp = & 0.18[-(0.5 * mp - 299.4)] + 0.22[299.4 - 2 * 0.5mp + 0.5 t_g d_4 + 0.5(p_3 + t_e d_3) + \\ & + 2.5 A^{-1.25} (p_2 + t_m d_2)^{0.5} (p_1 + t_m d_1)^{0.5} (299.4 - 0.5mp)^{0.25}] = 0. \end{aligned} \quad (17c)$$

Let us derive the optimal location of the factory 1 and the transfer price of the intermediate goods by assigning numerical values to parameters as follows: $(x_1=3, y_1=-0.5)$, $(x_2=-3^{0.5}, y_2=-0.5)$, $(x_3=0, y_3=-1.5)$, $(x_4=0, y_4=1)$, $A=1$, $p_1=0.25$, $p_2=2$, $p_3=0.2$, $t_m=0.11$, $t_e=0.01$, $t_g=0.225$, $F_1=5000$, $F_2=2500$. Tax rates are firstly assumed to be the same in the home and the foreign country, $t=t^*=0.82$.

The calculation results derived from the gradient dynamics are shown by Figure 3. Figure 3 indicates that the optimal transfer price is approximately 442 and the optimal location site is hidden by a chaotic phenomenon⁵. Although the accurate location of the

⁵ The phenomenon shown in Figure 3 is a *chaos* or a *chaotic* phenomenon which is generated from the Cauchy Convergence in the solution derivation process. The study to identify this phenomenon

factory 1 is not identified by the appearance of a chaotic phenomenon, the chaotic phenomenon provides very an important information that the optimal location site is within the area where a chaotic phenomenon appears because phenomenon appears surrounding the optimal solution. As shown in the later subsection 4-1, if firm locates the factory 1 within this area, the firm's profit is not varied so much. When the firm locates the factory 1 at point M_1 , the profits is derived as 3307. The firm can obtain the almost same profits when the factory1 locates within the area where the chaotic phenomenon appears.

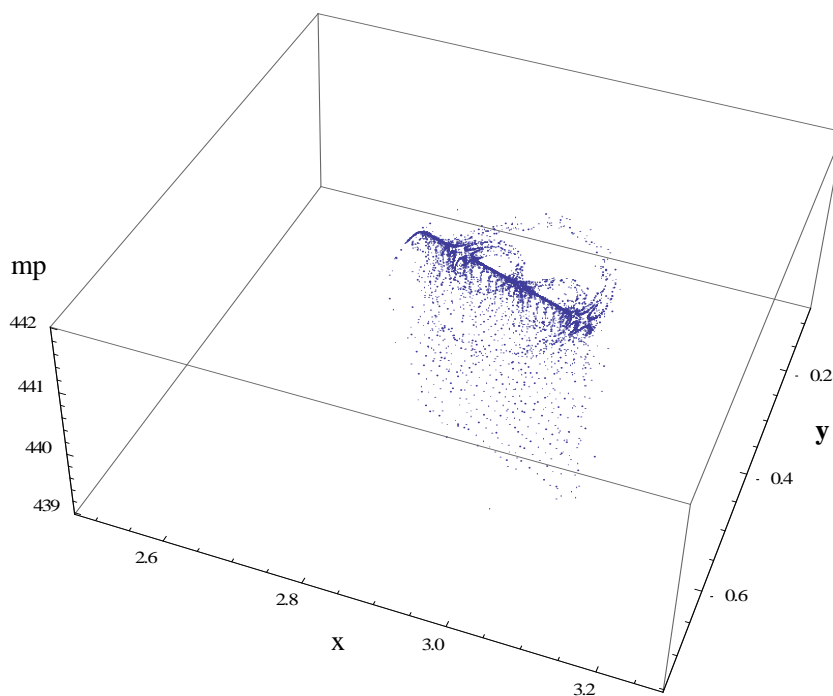


Figure 3 Appearance of a chaotic phenomenon

3-2 Formation of location prospective area

As figure 3 shows, the optimal price can be fixed at 442. While, the accurate optimal location site of the factory 1 can't be settled. The firm can, however, set up a kind of a *location prospective area* by referring the chaotic phenomenon because chaotic phenomenon generates around the optimal point. As explained above, if the manufacturer locates the factory 1 within the range of the chaotic phenomenon, profits of the firm is not far reduced from the optimal level. It could be, thus, that the firm achieves a kind of the targeted profit. The area where a chaotic phenomenon appears is considered as a

is not conducted in this paper because this problem does not make any obstacle to logical development. This interest issue is going to be discussed elsewhere.

Location Prospective Area (LPA, hereafter) for the factory 1.

In addition, it could be said that even if the optimal locational site is identified, the firm may be unable to lay the factory 1 at the site by various reasons such as weak ground, high land values, protracted bargaining, surrounding production circumstance or living environment in real life. In this case, the firm needs to explore the second-best locational site around the area in which the optimal site exists and they set up a locational prospective area. The first step of the firm's location determination process, therefore, is to set up the LPA.

3.3 Firm's profits and revenues of countries in different corporation tax rates

In the situation as shown in Figure 3, profits of the firm and revenues of the two countries are indicated in the first row of Table 1. The each column of Table 1 shows the transfer price, size of LPA, price of the final goods, firm's profits and country's tax revenue.

When the corporation tax rates of the two countries are reduced from 0.82 to 0.27, the LPA and the transfer price can be derived in the same way. The second row of Table 1 indicates the transfer price, LPA, price of the final goods, firm's profits and country's tax revenue in this case.

Table 1 Variation of transfer price and firm's profits due to change of tax rates

tax rates	$t=t^*=0.82$	$t=t^*=0.27$	$t=0.70, t^*=0.82$
transfer price	442	442	417
position of LPA	small area around M_1	large area around M_1	small area around M_1
price of final goods	551	551	545
sale amount	49	49	55
firm's profits	3307	13417	5869
Y_1	2968	12040	5293
Y_2	339	1377	576
tax revenue, home	13525	4453	12350
tax revenue, foreign	1544	509	2624

By the comparison of these two results, it is found that as far as the corporation tax rates of the two countries are the same, the reduction of tax rates does not change the transfer price. And the reduction of the tax rates widens of the size of LPA. This implies that the wide LPA gives the firm with wide options in the determination of factory's location.

The third row of Table 1 shows the results of the calculation when the combination of the tax rates of the two countries is $(t=0.7, t^*=0.82)$. It is interesting to know that the *reduction* of the corporation tax rate of the home country *lowers* the transfer price and increases the revenues of the foreign country.

4 Location power of the corporation tax and the interest rate

4.1.1 Assumptions for examination of the location power of the corporation tax rates

Squeezing the scope of the analysis to the firm's location problem, let us analyze the effects of the corporation tax rate on the factory's location and the transfer price. This analysis is conducted in the following assumptions: the freight rate of the lubricating oil, t_e , is increased from 0.01 to 0.5725. The corporate tax rate of the foreign country is fixed at 0.82, while, the rate of the home country is reduced from 0.8 to 0.65, and then 0.6. The factory's location and the transfer price are derived for these three different tax rate combinations $(t=0.8, t^*=0.82)$, $(t=0.65, t^*=0.82)$ and $(t=0.6, t^*=0.82)$. The obtained result shows how the corporation tax rate exercises its power on the factory's location.

4.1.2 Location of factory when the corporation tax rate is relatively high

Figure 4A shows the LPA when the corporation tax rate of the home country is relatively high, the corporation tax rates combination $(t=0.8, t^*=0.82)$. The LPA is formed near point M_1 , and the transfer price is determined at 437. As the LPA is a linear which leads to point M_3 , the firm locates the factory 1 at a place on this linear range and it can obtain almost same targeted profits which can be estimated 3681. The transfer price and the firm's profits are indicated in the first row of Table 2.

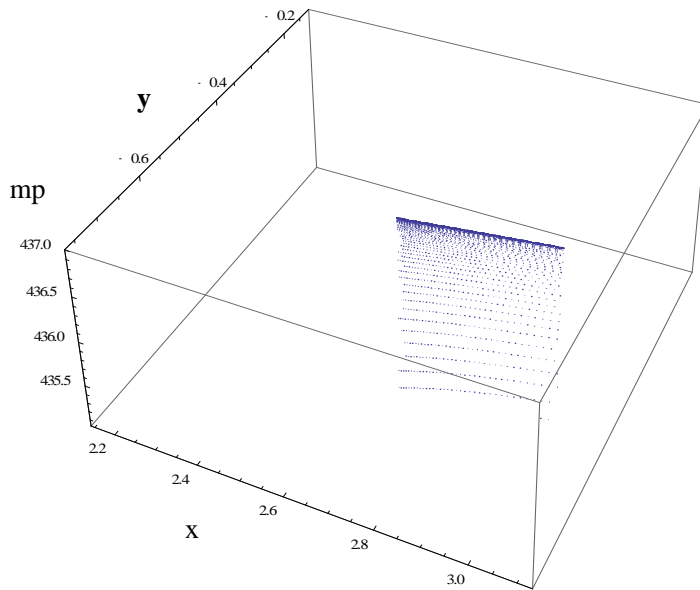


Figure 4A The LPA near the material M_1 when the tax rate is relatively high

Table 2 LPA, transfer price, and profits for the three combination of tax rates

tax rates	$t=0.8, t^*=0.82$	$t=0.65, t^*=0.82$	$t=0.6, t^*=0.82$
position of LPA	near M_1	from M_1 to point $(0.4, -1.1)$	around point $(0.4, -1.1)$
transfer price	437	411.5 ~ 412.2	407
firm's profits	3681	6726 ~ 6788	7783

4.1.3 Change of position of the LPA due to reduction of the corporation tax rate

When the corporation tax rate of the home country decreases from 0.8 to 0.65, ($t=0.65, t^*=0.82$), a large LPA is formed from point M_1 to point $(0.4, -1.1)$. Figure 4B depicts the large LPA. As shown in the second row of Table 2, if the firm locates the factory 1 at point M_1 and set the transfer price at 411.5, the firm obtains profit of 6726. While, the firm set the factory 1 at the place $(0.4, -1.1)$, the firm's profit is 6788. The difference between the firm's profits is 62 which is 0.92 percent against the firm's profit of 6726, that is, the difference of the profits is very small even if the distance between the two potential location sites is long. This implies that if the firm locates the factory 1 within the LPA, firm can drive the almost same profits. It can be said that the firm can obtains the targeted profit at every point within the LPA. And a wider LPA provides the firm with wider options in the decision of factory's location.

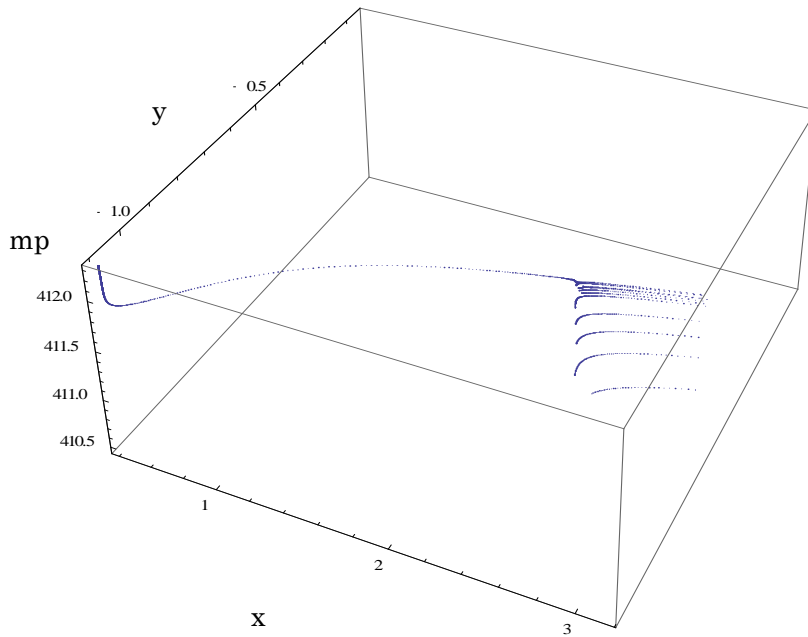


Figure 4B Expansion of LPA due to reduction of the corporation tax rate

4.1.4 Position of the LPA when the corporation tax rate is relatively low

When the corporation tax rate of the home country becomes relatively low, 0.6, ($t=0.6$, $t^*=0.82$), a LPA is formed around point (0.4,-1.1). The transfer price of the intermediate goods is determined at 407. Figure 4C shows the result of the calculation. The firm's profits are 7783 as shown in the third row of Table 2. The reduction of the corporation tax rate of the home country alters the location pattern of the factory 1 and 2.

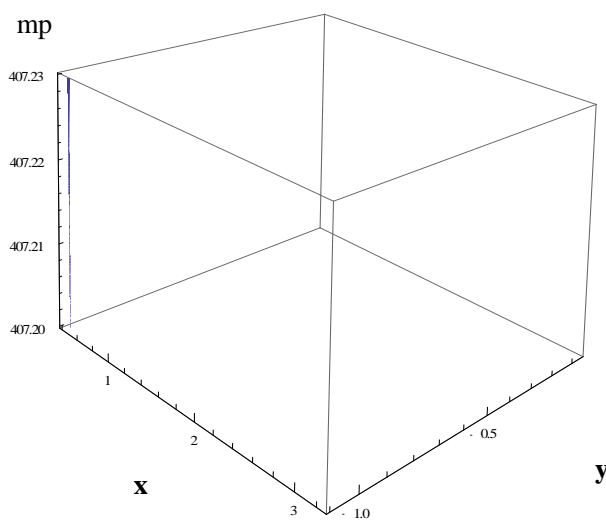


Figure 4C Shift of the LPA when the tax rate becomes relatively low

Incorporating the results derived from the case when the freight rate of the lubricating oil t_e is 0.01 into consideration, the location power of the corporation tax rate is explained as follows:

- 1) The reduction of the corporation tax rate of one country expands the LPA at the same position when the transportation cost is low. The expansion of the LPA gives a firm wider options in the determination of factory's location:
- 2) The reduction of the corporation tax rate shifts the position of the LPA from one place to another when the transportation cost is in the certain level. According to the change of position of the LPA, the firm shifts the location of the factory location. It can be said that the corporation tax rate has the location power to move the factory's location.

4.2 Location power of the interest rate

4.2.1 Derivation of firm's profit function as the interest rate is incorporated into consideration

In these days the firm's activity is organized across borders, the manufacturer recognize the interest rate has been one of the important location factors: the interest rate varies the firm's profits, and it affects firm's country selections and location choices within the selected country.

In this section the interest rates of countries are incorporated into the framework of the analysis used in the previous section. The interest rates of the home country and the foreign country are denoted by r and r^* , respectively. And the term of the firm's production activity in question is represented by T .

If firm achieves the profit indicated by equation (15) at every unit time, the firm's total profit, TY , in the term of T , TY , is given by equation (18)⁶.

$$TY = \int_0^T Y_1 e^{rt} dt + \int_0^T Y_2 e^{r^*t} dt \quad (18)$$

The equation (18) is developed as equation (19),

⁶ Incorporating other factors which are closely related to the interest rate such as construction costs of a factory 1 into consideration, the analysis will provide more comprehensive insights. Since the primary aim of this section is to just show that the interest rate has the location power, the analysis is conducted in a simplest framework.

$$\begin{aligned}
TY = & (-1/r + (1/r) \text{Exp}(rT)) (1-t) [(0.22(-206 + (582409 - 900mp)^{0.5})) (mp - t_g d_4) - (p_3 + t_e d_3)] - \\
& - 2(0.22(-206 + (582409 - 900mp)^{0.5}))^{1.25} A^{-1.25} (p_1 + t_m d_1)^{0.5} (p_2 + t_m d_2)^{0.5} - F_1] \\
& + (-1/r^* + (1/r^*) \text{Exp}(r^*T)) (1-t^*) [(600 - (0.22(-206 + (582409 - 900mp)^{0.5})) - mp) (0.22(-206 + \\
& (582409 - 900mp)^{0.5})) - F_2]. \tag{19}
\end{aligned}$$

From the profit function, the firm determines the optimal location of the factory 1 and the transfer price of the intermediate goods by the same method used in the previous section.

4.2.2 Shift of factory's location due to change of the interest rate

Let us derive the optimal location of the factory 1 and the transfer price of the intermediate goods under the following assumptions.

The transportation costs of the intermediate goods, t_g , and the lubricating oil, t_e , are assumed 0.675 and 0.01, respectively. The corporation tax rates of the home and the foreign country are fixed at 0.7 and 0.82, respectively. The term of the firm's production activity in question is firstly assumed 1.55 and then is expanded to 1.75. The interest rate of the foreign country is fixed at 0.1, and that of the home country is assumed initially 0.11 and later 0.35. The values of the other parameters are the same assumed in the previous analysis.

When the interest rate of the home country is 0.11, the LPA and the optimal transfer price are obtained by using the same method in the previous section. The calculation result is shown in Figure 5A. From the chaotic phenomenon in Figure 5A, the LPA is set up near point M_1 and the transfer price is determined at 417.6. In this case, the firm locates the factory 1 at a place within this LPA.

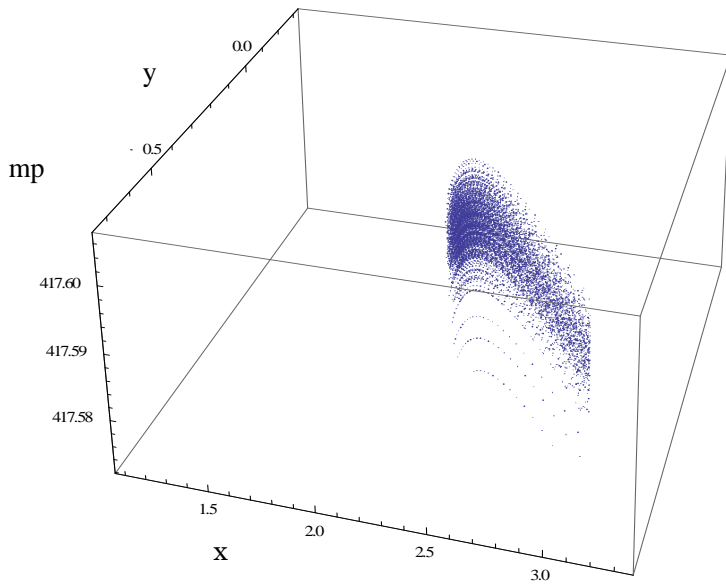


Figure 5 A Formation of the LPA near point M₁

Then, let us derive the LPA and the transfer price when the interest rate of the home country is raised to 0.35. By the same way the LPA and the transfer price are derived and they are depicted in Figure 5B. The LPA is formed near the market place M₄ and the transfer price is set at 410.4. In this case, the firm set the factory1 at a place within the LPA near the market place M₄.

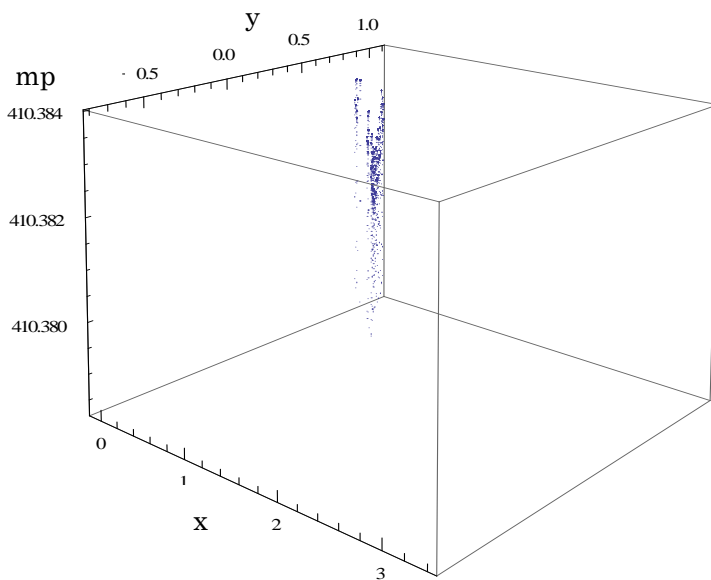


Figure 5B Shift of the LPA due to change of the interest rate

Comparison of Figure 5A and 5B indicates that when the interest rate of the home country is changed from 0.11 to 0.35, the location of the factory 1 shifts from point near M_1 to a place near M_4 . The increase of the interest rate changes the factory's location and transfer price: It can be said that the interest rate clearly exercises the locational power.

Table 3A shows the position of LPA, transfer price, and profits. It is noteworthy that since the interest rate of the foreign country is lower than that of the home country, the factory 1 does not locate at the market place where the factory 2 exists. They just co-exist across border between the countries. Although this location pattern seems an agglomeration, they do not make an agglomeration at the market place⁷.

Table 3A LPA, transfer price, and profits for the two combination of interest rates

T=1.55		
r	0.11	0.35
r*	0.1	0.1
Position of LPA	near M1	nearM 4
transfer price	417.6	410.6
firm's profit	9806	12005

4.2.3 Shift of factory's location by expansion of the term of production activity

Suppose that the term of the production activity in question is expanded from 1.55 to 1.75. Let us analyze the effects of the term expansion on the factor's location. To this end, the interest rate of the home country is reassumed back to 0.11. By applying the same method used in the previous sections, the result by calculations is obtained, Figure 6 shows it. Firm's profit is shown in Table 3B.

Comparing Figure 6 with Figure 5A, it is shown that by the expansion of the term of the production activity, the position of the LPA is shifted from point near M_1 to that near the market place M_4 , and the transfer price is slightly raised from 417.6 to 418.4. That is, when the term of production activity is relatively short, the firm set the factory 1 at point near M_1 : While, when the term is relatively long, the factory 1 locates at a place near the market M_4 . It can be said that the location of the factory 1 is influenced from the term of the production activity.

⁷ The location pattern that manufacturing factories co-exist across border can be identified at the border between Marisa and Singapore. Some Japanese manufacturing firms locates their factories across border. The intermediate goods of them are moved between them by using the tariff price which is related with the transfer price in a sense, but its concept is different from the transfer price.

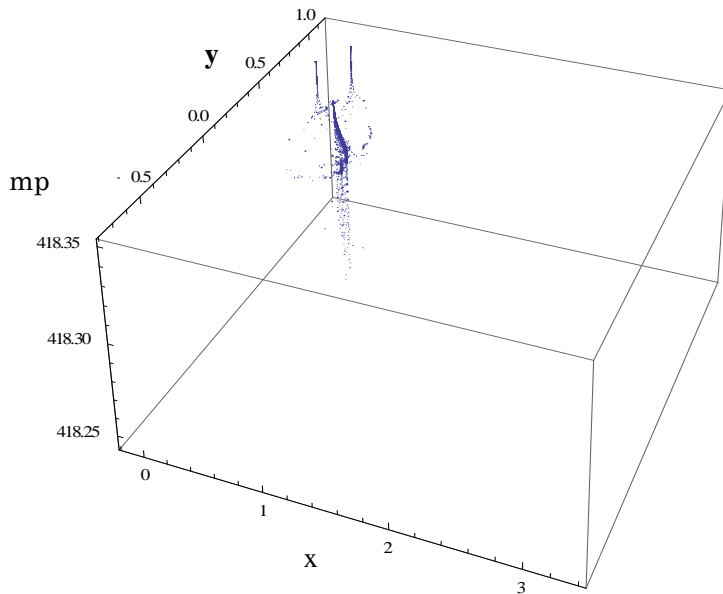


Figure 6 Shift of locational prospective area by expansion of activity term

Table 3B LPA, transfer price, and profits for the longer production period

T=1.75	
r	0.11
r*	0.1
position of LPA	near M4
transfer price	418.35
firm's profit	11171

5 Concluding remarks

In the time which economic activity has expanded on a global scale, the function which did not attract attention so much begins to act with importance in firm's manufacturing activity, and some economic factors start to influence firm's location selections: The function of the transfer price of the intermediate goods is used when a firm moves the intermediate goods between a firm's factories; and the corporation tax rate and the interest rates play an important role in firm's country selections and the location selections within the selected country.

The paper analyzed the locational effects of the corporation tax and the interest rates on the factory's location incorporating the function of the transfer price of the intermediate goods into consideration. The results of the analysis are summarized as follows: 1) the reduction of the corporation tax rate of one country widens the LPA when

the transportation cost is low. The large LPA gives a firm wider options in the determination of factory's location. 2) when the transportation cost is relatively high, the change of the corporation tax rate of one country moves the position of the LPA from one place to another. This means that the change of the corporation tax rate moves the factory's location. 3) the change of the interest rate of one country also affects the LPA and varies the factor's location from one place to another. It is said from the above analyses that the change of these rate alters the location pattern of factories: The corporation tax rate and the interest rate become to have the more location power to move factory's location as the globalized economy progresses.

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