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Abstract

The purpose of this paper is to investigate the influence of a third country on the location of foreign direct investment (FDI). We focus on two determinants of FDI location. The first is the number of firms located in the third country. The second is the magnitude of demand for the good that the investing firm produces. We construct a three-country model, where two of the three countries are potential host countries and one has a geographic advantage in exports to the third country. Using this framework, we show that when the number of firms in the third country is sufficiently large, the farther (more distant) country is always the location of the plant. Furthermore, when the market size of the third country is large, it is possible for the nearer country to be the host country. In addition, we find that when the governments of the potential host countries use taxes or subsidies to attract FDI, the location of the firm investing is qualitatively the same as that without tax competition. However, the range over which the nearer country can attract the investing firm when tax competition is introduced is wider than otherwise. Finally, we reveal that when two potential host countries form a union that imposes a coordinated tax, the aggregate welfare of the union under the coordinated tax policy is higher than that under tax competition. However, conflict between the two countries may occur when the number of rival firms in the third country is neither too small nor too large.

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Key words: transport costs, tax competition, regional coordination.

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1 Introduction

In the foreign direct investment (FDI) literature, we often observe that conditions in the host countries have an effect on the locations of the invested plant. For example, studies have found that the weighted GDP of the host countries, the resource endowments in the host countries, and the distance between the host countries all impact on the location of FDI [1]. In addition to conditions in the host country, an investing firm often considers the conditions in countries neighboring the host country when determining the location of its plant. The purpose of this paper is to investigate the effects of the neighboring country's conditions on FDI location.

Consider, for example, FDI in Singapore and Hong Kong, countries that have attracted much FDI from many foreign countries. One of the reasons why FDI has flowed into these areas could be to provide good access to other countries. At the same time, we can see that the number of competitive firms in neighboring countries was relatively small. However, in recent years, the number of firms able to compete against FDI firms in Singapore and Hong Kong has increased in some neighboring countries, including China, Thailand, and Malaysia, in conjunction with economic development in those neighboring countries. Furthermore, the market size of the neighboring countries has also increased with economic development. It is then likely that economic conditions, such as the number of competitive firms and market size of the neighboring countries, influences FDI in Singapore and Hong Kong. The point is that the conditions of the neighboring countries must affect the flows of FDI to Singapore and Hong Kong, and this has the potential to affect the structure of production and the pattern of trade. Therefore, examination of the influence of neighboring countries on FDI location is both interesting and important.

In this paper, we focus on two determinants of FDI location arising in a third country. The first is the number of firms located in the third country. We assume that these firms in the third country are able to access the market in which the investing firm is active. The investing firm then faces competition with rival firms in the third country, and the degree of competition depends on the number of rival firms. When the competition between the investing firm and the rival firms is intense, the profit of the investing firm is lower. Now suppose that there are two potential host countries, where one potential host country is nearer to the third country. We can then say that the accessibility to the third country is not symmetric between the two host countries. The investing firm then selects that location which provides it with greater profit. In the case where the investing firm selects the nearer host country, the competition between the investing firm and the rival firms becomes more intense than where the investing firm selects the other host country. Therefore, the existence of rival firms where accessibility to the third country is not symmetric for the two host countries affects the location of FDI.

[1] Head et al. (1995), Head and Mayer (2004), Baltagi et al. (2007), and Blonigen et al. (2007) have shown that the conditions of each host country affect the location of FDI.

The second determinant of FDI location is the size of the market in the third country for the good that the investing firm produces. Suppose that the market in the third country is large. The investing firm can then increase its profit by locating in a country with good access to this market because it allows the firm to save on transportation costs for its good. Therefore, the plant could be located in a country near the large market. However, the investing firm also faces intense competition if the plant is located in the nearer country. This is because if the investing firm chooses that country with good access to the large market, it will face more intense competition with rival firms, though the investing firm can provide its products to other countries with lower transport costs. When the investing firm recognizes this trade-off, it may decide to locate in the country with good access to the large market if the number of competing firms is small. However, increasing the number of competing firms can lead the investing firm to locate its plant in a country that does not have such good access to the large market as a means of avoiding the intense competition entailed.

Along with competition between firms, competition between governments attempting to attract FDI can also affect its location. Some governments, for example, may attempt to attract FDI to their own country. For the governments of countries that are not near large markets to attract FDI, one policy is to offer a subsidy to the investing firm. This creates competition between governments wanting to attract the investing firm, and a "race to the bottom" arises through the intense competition in subsidies between the governments. In order to avoid this, some governments impose an alternative policy of a coordinated tax between countries. The question that arises here is whether a coordinated tax is an appropriate policy. In spatially large economic areas, accessibility to the third country is not symmetric between the potential host countries. Therefore, examining whether a coordinated tax is appropriate where accessibility is not symmetric between the host countries is important.

In this paper, we study the effects of rival firms in a third country and tax competition on the location choice of FDI where the accessibility of the potential host countries to a third country is not symmetric and there are n firms in the third country. In addition, we investigate the effect of a coordinated tax for the potential host countries. We construct a three-country model, where two of the three countries are potential host countries. The FDI investing firm then chooses a location for its plant from the two potential host countries, of which one has better accessibility in having a geographic advantage for export to the third country. We can interpret this setup as applying to an economy that is either a custom union of several countries or a very large country. We should note that in the third country, although there is a market, there are competitive rival firms [2]. Using this framework, we show that when the number of firms in the third country is sufficiently large, the farther country is always the location of the plant. Furthermore, when the market size of the third country is large, it is possible for the nearer country to be the host country. These results imply

[2]Haufler and Wooton (2010) consider an oligopolistic industry in a two-country model of tax competition where the two countries are not symmetric with regard to population (the size of the markets) and show that a larger country can attract more firms.

that the distance between countries, the presence of rival firms in the third country, and the size of demand in the third country determine the location of FDI.

In addition, we find that when the governments of the potential host countries use a tax (subsidy) to attract the investing firm to their own country, the firm's location choice is qualitatively the same as that without tax competition. However, the range within which the nearer country can attract the firm when there is tax competition is wider than it would be otherwise; that is, introducing tax competition provides the nearer country with an instrument to attract FDI. Furthermore, when tax competition is possible, the nearer country can attract the firm by offering a subsidy if the number of firms in the third country is small, while the farther country can attract the firm when the number of firms in the third country is large. Under tax competition, whether the governments of both potential host countries impose tax or subsidy is ambiguous.

Finally, we reveal the consequences when two countries form a union by conducting welfare analysis under tax competition and coordination of the tax. We find that when the potential host countries form the union and impose a coordinated tax, the location behavior of the FDI firm is the same as that without the tax. Whether the aggregate welfare of the union is higher under the coordinated tax policy than under tax competition is ambiguous. Furthermore, introducing the coordinated tax does not always improve welfare in both countries. To start with, if the location of FDI does not change even though the policy changes, welfare in the two host countries improves. This arises when the number of the firms in the third country is either small or large. However, when the number of the firms in the third country is intermediate, the location of FDI changes from the farther country to the nearer country when the coordinated tax policy is imposed. In this case, the nearer country can improve welfare, as the consumers in this country can save on transportation costs. However, it is possible for welfare to deteriorate in the farther country [3]. This is because consumer surplus in the farther country declines as the consumers living there have to pay transportation costs when the firm is not located there. On the other hand, the government that cannot attract FDI also does not have to provide a subsidy, and this leads to a welfare improvement in the farther country. Therefore, the effect of the policy change on the welfare of the farther country is ambiguous. More precisely, whether it imposes a tax or subsidy under tax competition determines whether the welfare of the farther country improves.

Haufler and Wooton (1999) and Ludema and Wooton (2000) are the first studies known of the effect of tax competition in the presence of transportation costs. In Ludema and Wooton (2000), there are two countries, which are perfectly symmetric [4]. Ludema and Wooton (2000) focus on the effect of economic integration (the reduction of trade costs) on the tax rate and reveal that

[3] This represents a conflict between the countries participating in the union, to which Fumagalli (2003) provides a close outcome.

[4] Although two countries are symmetric, agglomeration can emerge. This is because the agglomeration force introduced assumes that the manufacturing sector uses increasing-returns-to-scale technology and that manufacturing workers are mobile between the two countries.

it is possible that a race to the bottom does not arise. In contrast, Haufler and Wooton (1999) introduce asymmetric countries with regard to market size [5]. They show that the larger country has an advantage in attracting the firm. Subsequent to these studies, tax competition between asymmetric countries with regard to market size or market structure has generally employed models with two countries.

Studies considering third-country effects on tax competition include Fumagalli (2003), Raff (2004), Haufler and Wooton (2006), and Becker and Fuest (2010). We can possibly interpret the models in Fumagalli (2003) and Raff (2004) as third-country models in the sense that they consider that the firm can choose to locate in a third country. However, in their models, there is no market in the third country [6]. The model closest in spirit to our model is Haufler and Wooton (2006) in the sense that they also introduce a market in the third country. However, in their model, the firm decides the location of its FDI as a monopoly [7]. Our model is also conceptually close to that in Becker and Fuest (2010) in the sense that they also consider asymmetric international transportation costs in a model with three countries.

The organization of the remainder of the paper is as follows. Section 2 details the basic model. Section 3 shows the results for the locations that the firm decides under both tax competition and a coordinated tax policy. Section 4 provides the welfare analysis. We state our conclusion in Section 5.

2 The basic model

We consider an economy consisting of three countries, labeled 1, 2, and f. It is possible for countries 1 and 2 to conclude a union that can impose a coordinated policy. Each country possesses L_i (i = 1, 2, and f) units of consumers that cannot move between the countries. We interpret L_i as the magnitude or size of demand in each country. The consumers obtain utility from consumption of an agricultural good and a manufactured good, both of which are homogeneous. The preferences of the consumers residing in country i are represented by the following utility function:

$$u_i = \alpha D_i - \frac{1}{2}D_i^2 + z_i,\ i, j = 1, 2, \tag{1}$$

where α is a preference parameter, z_i is the level of consumption of the agricultural good, and D_i is the demand for the manufactured good. The consumers maximize their utility subject to the following budget constraint:

$$p_{zi}z_i + p_iD_i = w_i, \tag{2}$$

[5]In Haufler and Wooton (1999), the governments of the two countries have two policy instruments available in the form of a lump-sum tax on profits and a tariff.

[6]Fumagalli (2003) considers an economy in which there is a technological gap between the countries that are the potential host countries and there are technological spillovers from FDI. Raff (2004) compares the effect of custom unions between free-trade agreements.

[7]Haufler and Wooton (2006) is also similar to our model in the sense that they also show the effects of a coordinated tax policy between the two countries.

where w_i is the wage rate in country i, and p_{zi} and p_i are the prices of the agricultural and the manufactured goods that are sold in country i, respectively. Solving this problem derives the inverse demand function for the manufactured good as follows:

$$p_i = \alpha - D_i. \tag{3}$$

From the market-clearing condition for the manufactured good, its price is determined as follows:

$$p_i = \alpha - \frac{x_{ji} + n_f x_{fi}}{L_i}, \tag{4}$$

where x_{ji} is the supply of the good produced in country $j(= 1, 2)$ and consumed in country $i(= 1, 2)$, and n_f is the number of firms located in country f.

We now turn to the supply side. There are two sectors in the economy: an agricultural good sector and a manufacturing good sector. We assume that workers can move between the two sectors. This allows the wage rates in both sectors to equalize.

The agricultural good is produced under perfect competition. We take the agricultural good as the numeraire. In this sector, one unit of workers is required to produce one unit of the good. We assume that all countries have the agricultural good sector, and there are no transportation costs to ship the good between the countries. Since the agricultural good is the numeraire, $p_{zi} = 1$ holds in all countries. In addition, the prices of the agricultural good in all countries are equalized due to the absence of transportation costs, resulting in the wage rate in all three countries equaling 1.

The market for the manufactured good is an oligopoly, and we assume that all firms in this sector share the same technology. The firm requires s units of workers as a fixed cost and c units of workers to produce one unit of goods. In addition, shipping this good to country f incurs transportation costs, and we assume that these international transportation costs are country specific. Specifically, the international transportation costs between countries i and j are $\tau_{ij}(> 1)$, $(i, j = 1,2$, and f, and $i \neq j)$. While in most studies, symmetric international transportation costs are assumed, it is possible that the international transportation costs between countries 1 and f are not the same as those between countries 2 and f. However, while shipping between countries incurs transportation costs, shipping within countries does not. That is, $\tau_{ii} = 0$, $(i = 1, 2$, and $f)$.

We assume that in country f, n_f of firms produce the manufactured good, and there is no firm in countries 1 and 2. Now, one firm, based in country f, then considers a plant located in country 1 or 2 to penetrate the markets in countries 1 and 2. The question is which of the two countries the firm chooses as the host country.

When the operating profit of the investing firm locating in country i is denoted as π^i, π^i is shown as follows:

$$\pi^i = (p_1 - c - \tau_{1i})x_{i1} + (p_2 - c - \tau_{2i})x_{i2} + (p_f - c - \tau_{fi})x_{if}, \tag{5}$$

where x_{ji} represents supply of the good produced in country j and sold in country i. All firms decide the amount of supply to maximize profit subject to the amount of the demand from the consumers in each country. From the amount of supply of each firm and (4), we find optimal prices depending on the location pattern, as shown in the Appendix.

From the optimal prices and demand functions, the profits of the firm when the firm locates in countries 1 and 2 are as follows:

$$\pi^1 = \left(\frac{a + n_f\tau_{1f}}{n_f+2}\right)^2 L_1 + \left(\frac{a-(n_f+1)\tau_{12}+n_f\tau_{2f}}{n_f+2}\right)^2 L_2 + \left(\frac{a-(n_f+1)\tau_{1f}}{n_f+2}\right)^2 L_f, \tag{6a}$$

and

$$\pi^2 = \left(\frac{a-(n_f+1)\tau_{12}+n_f\tau_{1f}}{n_f+2}\right)^2 L_1 + \left(\frac{a + n_f\tau_{2f}}{n_f+2}\right)^2 L_2 + \left(\frac{a-(n_f+1)\tau_{2f}}{n_f+2}\right)^2 L_f, \tag{6b}$$

where $a \equiv \alpha - c$. [8] We assume that $a - \tau_{1f} > 0$. When this condition holds, the firm locating in country 1 or country 2 exports the good to country f when $n_f = 0$.

For model simplicity, we assume that $L_1 = L_2 = L$. That is, countries 1 and 2 are symmetric except with regard to international transportation costs between them and country f. With regard to transportation costs, we focus on the case in which country 1 is farther from country f. That is, $\tau_{1f} > \tau_{2f}$ holds. Furthermore, we impose the condition such that the plant of the investing firm cannot locate in country f. This is because we would like to focus on the location behavior regarding FDI rather than a choice between FDI and export. In order for the investing firm not to locate in country f at any level of n_f, the following condition has to hold [9]:

$$\frac{L_f}{L} < \frac{2a(\tau_{1f}+\tau_{2f}-\tau_{12}) - (\tau_{1f}^2+\tau_{2f}^2-\tau_{12}^2)}{\tau_{1f}(2a-\tau_{1f})}.$$

[8]Denoted the profit of any firm locating in country f when the investing firm locates in country i as π_f^i, π_f^1 and π_f^2 are represented as follows:

$$\pi_f^1 = \left(\frac{a-2\tau_{1f}}{n_f+2}\right)^2 L_1 + \left(\frac{a+\tau_{12}-2\tau_{2f}}{n_f+2}\right)^2 L_2 \left(\frac{a+\tau_{1f}}{n_f+2}\right)^2 L_f,$$

and

$$\pi_f^2 = \left(\frac{a+\tau_{12}-2\tau_{1f}}{n_f+2}\right)^2 L_1 + \left(\frac{a-2\tau_{2f}}{n_f+2}\right)^2 L_2 + \left(\frac{a+\tau_{2f}}{n_f+2}\right)^2 L_f.$$

[9]This condition is derived by investigating $\pi_1 > \pi_f$ and $\pi_2 > \pi_f$. By examining these inequalities, we find the ranges of the number of the firms in country f for which $\pi_1 > \pi_f$ and $\pi_2 > \pi_f$ hold:

$$n_f > \frac{(2a-\tau_{1f})\tau_{1f}\frac{L_f}{L} - 2a(\tau_{1f}+\tau_{2f}-\tau_{12}) + \tau_{1f}^2 + \tau_{2f}^2 - \tau_{12}^2}{\tau_{1f}^2 + (\tau_{2f}-\tau_{12})^2 + \tau_{1f}^2\frac{L_f}{L}},$$

This condition implies that the firm does not locate in country f when the demand from country f is relatively small. In order to examine the location pattern of the investing firm, the profit comparison between countries 1 and 2 is examined. We define $\pi_1 - \pi_2$ as Γ, which is shown as follows:

$$\Gamma \equiv \pi^1 - \pi^2 = \frac{(n_f+1)(\tau_{1f}-\tau_{2f})L}{(n_f+2)^2}\left[2n_f\tau_{12} - \{2a-(n_f+1)(\tau_{1f}+\tau_{2f})\}\frac{L_f}{L}\right]. \tag{7}$$

It is noted that the investing firm is indifferent between locating in country 1 or country 2 when $\tau_{1f} = \tau_{2f}$. However, when τ_{1f} is not equal to τ_{2f}, it is possible for the difference not to be zero. The difference is a monotonic increasing function of n_f and negative when $n_f = 0$ [10]. From these results, we summarize the relationship between the location of FDI and the number of the rival firms in country f as follows:

Lemma 1 *It is supposed that $\tau_{1f} > \tau_{2f}$. The firm locates in the farther country if n_f is larger than $\tilde{n}_f$, and the firm locates in the nearer country otherwise, where:*

$$\tilde{n}_f \equiv \frac{[2a-(\tau_{1f}+\tau_{2f})]\frac{L_f}{L}}{2\tau_{12}+(\tau_{1f}+\tau_{2f})\frac{L_f}{L}}. \tag{8}$$

Lemma 1 states that as the number of firms in country f increases, the investing firm tends to locate in the farther country. Two factors determine the location pattern of the investing firm: the degree of competition with firms in country f and the size of demand. The competition in the nearer country is fiercer than that in the farther country when the number of firms in country f is large. Therefore, the investing firm wants to locate in the farther country to avoid the competition when the number of firms in country f is sufficiently large. However, the investing firm locates in the nearer country when it has an

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and

$$n_f > \frac{(2a-\tau_{2f})\tau_{2f}\frac{L_f}{L} - 2a(\tau_{1f}+\tau_{2f}-\tau_{12}) + \tau_{1f}^2 + \tau_{2f}^2 - \tau_{12}^2}{(\tau_{1f}-\tau_{12})^2 + \tau_{2f}^2 + \tau_{2f}^2\frac{L_f}{L}}.$$

These conditions state that when the number of firms in country f is large, the investing firm does not locate in country f. The firm does not to locate in country f under any level of n_f when the numerators of both equations are negative. It is noted that $\tau_{1f} > \tau_{2f}$.

[10]We find the following relationships:

$$\frac{\partial\Gamma}{\partial n_f} = \frac{2(\tau_{1f}-\tau_{2f})}{(n_f+2)^3}\left[(3n_f+2)\tau_{12}L + [an_f + (n_f+1)(\tau_{1f}+\tau_{2f})]L_f\right] > 0,$$

and

$$\Gamma|_{n_f=0} = -\frac{(\tau_{1f}-\tau_{2f})L_f}{4}\left[2a-(\tau_{1f}+\tau_{2f})\right] < 0.$$

It is noted that $2a-(\tau_{1f}+\tau_{2f}) > 0$ holds as we assume that $a - \tau_{1f} > 0$.

advantage with regard to access to the market in country f. Hence, when the number of firms in country f is sufficiently small, the investing firm locates in the nearer country.

Next, we investigate the effect of the relative size of demand in country f, L_f/L, on the location pattern of the firm. We find that Γ is a monotonic increasing function of L_f/L if n_f is larger than the critical value denoted as $\bar{n}_f$, and a decreasing function of L_f/L otherwise. Moreover, $\pi^1 - \pi^2$ is positive if $L_f/L = 0$. The following lemma summarizes these results [11].

Lemma 2 *It is Supposed $\tau_{1f} > \tau_{2f}$ holds.*

- *When n_f is larger than $\bar{n}_f$, the investing firm locates in the farther country at any level of L_f/L.*
- *When n_f is smaller than $\bar{n}_f$, the investing firm locates in the farther country if L_f/L is smaller than $\bar{L_f}$ then, and the investing firm locates in the nearer country otherwise, where:*

$$\bar{L}_f \equiv \frac{2n_f\tau_{12}}{2a - (n_f+1)(\tau_{1f}+\tau_{2f})}.$$

As shown by this lemma, the number of competing firms in country f is crucial. When the number of firms in country f is sufficiently large, the most important thing for the investing firm is to avoid competition. Therefore, the investing firm locates in the farther country. However, as n_f is sufficiently small, the competition against the firms in country f becomes weaker, which allows the investing firm to locate in the nearer country.

When there is a possibility that the investing firm can locate in the nearer country, the investing firm locates in the nearer country if the relative size of demand from country f is sufficiently large. This is because the desire for the investing firm to locate in the nearer country dominates the desire for it to avoid competition against the firms in country f [12].

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[11] We reveal the following relationships:

$$\frac{\partial\Gamma}{\partial\frac{L_f}{L}} = -\frac{(n_f+1)(\tau_{1f}-\tau_{2f})L}{(n_f+2)^2}\left[2a-(n_f+1)(\tau_{1f}+\tau_{2f})\right] \geq (<)\ 0,$$

$$as\ n_f \geq (<) \frac{2a-(\tau_{1f}+\tau_{2f})}{\tau_{1f}+\tau_{2f}} \equiv \bar{n}_f,$$

and

$$\pi^1 - \pi^2|_{\frac{L_f}{L}=0} = \frac{2n_f(n_f+1)\tau_{12}(\tau_{1f}-\tau_{2f})L}{(n_f+2)^2} > 0.$$

[12] In addition to the basic model, we consider a model with a transport hub in country 2. The results of the model with the hub are qualitatively the same as that of the basic model. The Appendix provides the results of the model with the hub and the comparison between the model with the hub and the basic model.

3 Tax competition between countries 1 and 2

In this section, we consider tax competition between countries 1 and 2. The governments of these countries can levy a lump-sum tax on the profit of the investing firm locating in their own country. We denote the tax set by the government of country $i(=1,2)$ as t_i. The variables under tax competition are indicated by the superscript, t.

When the profit of the investing firm locating in country $i(=1,2)$ under tax competition is represented by π^{it}, $\pi^{it} = \pi^i - t_i$ holds. From this, we find the following relationship:

$$\pi^{1t} - \pi^{2t} \geq (<) 0, \ as \ t_1 - t_2 \leq (>) = \Gamma, \tag{9}$$

where Γ is shown in (7). (9) states that the investing firm is indifferent to location when $t_1 - t_2 = \Gamma$. Furthermore, the investing firm locates in the farther country when $\Gamma \geq t_1 - t_2$. The farther country (country 1) can impose a higher tax rate than the nearer country (country 2) until the difference of the tax rates reaches Γ in order for the farther country to attract the firm. Γ represents the so-called "tax premium" in Haufler and Wooton (1998).

We have already shown that this tax premium is the monotonic increasing function of n_f, and negative when $n_f = 0$. These results reveal the following relationship:

$$\Gamma \geq (<) 0 \ as \ n_f \geq (<) \tilde{n}_f. \tag{10}$$

From (9) and (10), when the number of the firms in country f is sufficiently low, the level of the tax rate that the government of the farther country imposes cannot be higher than that of the nearer country, if the government of the farther country intends that the investing firm should locate in its own country. This is because when n_f is sufficiently small, the investing firm tends to locate in the nearer country. Hence, in order for the farther country to attract the investing firm, it is required to impose a lower tax rate than the rival country. However, when the number of firms in country f becomes large, the investing firm tends to locate in the farther country in order to avoid the intense competition. As a result, the level of the tax rate that the government of the farther country imposes can be higher. Therefore, the maximum tax rate that the investing firm is willing to pay to locate in the farther country is higher as the number of firms in country f becomes larger.

3.1 Tax competition with asymmetric trade costs

The government of each host country chooses a tax rate to maximize welfare in its own country. Since we assume that in this economy, the home country of all firms is country f, the level of welfare of each host country is equal to the sum of the utility of the households living in each country and the distribution of the tax that the government imposes on the investing firm. The level of utility of each consumer in country i when the investing firm locates in country j is represented by v_i^j. Moreover, the wage rate of workers residing in country i when the investing firm locates in country j is denoted by w_i^j. When the firm locates in country 1, the levels of utility of the households in each country are as follows:

$$v_1^1 = \frac{1}{2}\left(\frac{(n_f+1)a - n_f\tau_{1f}}{n_f+2}\right)^2 + w_1^1, \tag{11a}$$

and

$$v_2^1 = \frac{1}{2}\left(\frac{(n_f+1)a - \tau_{12} - n_f\tau_{2f}}{n_f+2}\right)^2 + w_2^1. \tag{11b}$$

When the investing firm locates in country 2, the levels of utility of individuals living in each country are as follows:

$$v_1^2 = \frac{1}{2}\left(\frac{(n_f+1)a - \tau_{12} - n_f\tau_{1f}}{n_f+2}\right)^2 + w_1^2, \tag{12a}$$

and

$$v_2^2 = \frac{1}{2}\left(\frac{(n_f+1)a - n_f\tau_{2f}}{n_f+2}\right)^2 + w_2^2. \tag{12b}$$

The minimum tax rate that country i is willing to impose in order for the government of country $i (i = 1$ and $2)$ to attract the investing firm is determined by $v_i^i + (t_i/L) = v_i^j (i, j = 1$ and 2, and $i \neq j)$. When the minimal tax rate (maximum subsidy) levied by the government of country i is denoted as $\tilde{t}_i$, $\tilde{t}_1$ and t_2 are shown as follows:

$$\tilde{t}_1 = -\frac{\tau_{12}[2a(n_f+1) - \tau_{12} - 2n_f\tau_{1f}]L}{2(n_f+2)^2} < 0, \tag{13a}$$

and

$$\tilde{t}_2 = -\frac{\tau_{12}[2a(n_f+1) - \tau_{12} - 2n_f\tau_{2f}]L}{2(n_f+2)^2} < 0. \tag{13b}$$

We point out that $\tilde{t}_i$ is a tax if $\tilde{t}_i$ is positive, and $\tilde{t}_i$ is a subsidy if $\tilde{t}_i$ is negative. That is, the governments of both countries always declare that they offer a subsidy to the firm. Furthermore, we find that $\partial\tilde{t}_i/\partial n_f > 0$ [13]. This means that the policy that each government imposes becomes severer for the investing firm as the number of firms in country f increases.

Defining the difference between $\tilde{t}_1$ and $\tilde{t}_2$ as Δ, we find the following:

$$\Delta \equiv \tilde{t}_1 - \tilde{t}_2 = \frac{\tau_{12}n_f(\tau_{1f} - \tau_{2f})L}{(n_f+2)^2} > 0. \tag{14}$$

[13]It is shown that $\frac{\partial\tilde{t}_i}{\partial n_f} = \frac{\tau_{12}L}{(n_f+2)^3}\left[(a-\tau_{if})n_f + 2\tau_{if} - \tau_{12}\right] > 0.$

This means that the level of the tax rate that the government of the farther country imposes on the investing firm is higher [14].

We note that the investing firm locates in the farther country as long as $\Gamma > \Delta$. When this sign of the inequality holds, the tax rate such that the firm is willing to pay to locate in the farther country is higher than the difference between $\tilde{t}_1$ and $\tilde{t}_2$. Therefore, the investing firm locates in the farther country when $\Gamma > \Delta$. $\Gamma - \Delta$ is shown as follows:

$$\Gamma - \Delta = \frac{(\tau_{1f} - \tau_{2f})L}{(n_f + 2)^2} \left[n_f(2n_f + 1)\tau_{12} - (n_f + 1)\left[2a - (n_f + 1)(\tau_{1f} + \tau_{2f})\right] \frac{L_f}{L} \right]. \tag{15}$$

$\Gamma - \Delta$ is a monotonic increasing function of n_f and negative when $n_f = 0$ [15]. When we denote the level of n_f associated with $\Gamma - \Delta = 0$ as n_f^{tc}, it is said that $\Gamma - \Delta$ is negative if n_f is smaller than n_f^{tc}, and $\Gamma - \Delta$ is otherwise positive. These results are summarized in the following proposition.

Proposition 3 *Under tax competition, the investing firm locates in the nearer country if the number of firms in country f is sufficiently small, and the investing firm locates in the farther country otherwise.*

When the investing firm locates in country i, the government of country i does not have to impose $\tilde{t}_i$. Specifically, the government of the farther country imposes $t_1^* = \tilde{t}_2 + \Gamma$. Conversely, when the investing firm locates in the nearer country, the government of the nearer country imposes $t_2^* = \tilde{t}_1 - \Gamma$.

When the investing firm locates in country 1, the government of country 1

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[14] Δ has the following three natures:

$$\Delta|_{n_f=0} = 0,$$

$$\frac{\partial \Delta}{\partial n_f} = -\frac{\tau_{12}(\tau_{1f} - \tau_{2f})L(n_f - 2)}{(n_f + 2)^3} \geq (<)\ 0\ as\ n_f \leq (>)\ 2,$$

and

$$\frac{\partial^2 \Delta}{\partial n_f^2} = \frac{2\tau_{12}(\tau_{1f} - \tau_{2f})L(n_f - 4)}{(n_f + 2)^3} \geq (<)\ 0\ as\ n_f \geq (<)\ 4.$$

When the number of firms in country f is zero, $\tilde{t}_1 = \tilde{t}_2$. $\tilde{t}_1 - \tilde{t}_2$ increases as n_f increases until n_f reaches 2. When n_f exceeds 2, the difference become smaller as n_f increases.

[15] $\Gamma - \Delta$ has the following properties:

$$\Gamma - \Delta|_{n_f=0} = -\frac{(\tau_{1f} - \tau_{2f})\left[2a - (\tau_{1f} + \tau_{2f})\right]}{4} < 0, \tag{16}$$

and

$$\frac{\partial(\Gamma - \Delta)}{\partial n_f} = \frac{(\tau_{1f} - \tau_{2f})L}{(n_f + 2)^3} \left[(7n_f + 2)\tau_{12} + 2\left[an_f + (n_f + 1)(\tau_{1f} + \tau_{2f})\right] \frac{L_f}{L} \right] > 0. \tag{17}$$

imposes t_1^* shown as follows:

$$t_1^* = \frac{\tau_{12}L\left[4(\tau_{1f}-\tau_{2f})n_f^2+2(2\tau_{1f}-\tau_{2f}-a)n_f-2a+\tau_{12}\right]}{2(n_f+2)^2} - \frac{(\tau_{1f}-\tau_{2f})L_f(n_f+1)\left[2a-(n_f+1)(\tau_{1f}+\tau_{2f})\right]}{(n_f+2)^2}. \quad (18)$$

We find that t_1^* is a monotonic increasing function of n_f and negative when $n_f = 0$ [16]. These results state that the government of the farther country offers a subsidy to the firm if n_f is larger than a critical value denoted by n_f^1 [17], otherwise the government of country 1 imposes a tax on the investing firm,. The reason that the government of country 1 can impose a tax on the firm is that it can afford to impose a higher tax rate as the number of firms in country f increases. This is because the firm tends to locate in country 1 if the number of firms in country f is sufficiently large.

When the investing firm locates in country 2 (the nearer country), the government of country 2 imposes t_2^* shown as follows:

$$t_2^* = -\frac{\tau_{12}L\left[4(\tau_{1f}-\tau_{2f})n_f^2+2(\tau_{1f}-2\tau_{2f}+a)n_f+2a-\tau_{12}\right]}{2(n_f+2)^2} + \frac{(\tau_{1f}-\tau_{2f})L_f(n_f+1)\left[2a-(n_f+1)(\tau_{1f}+\tau_{2f})\right]}{(n_f+2)^2}. \quad (19)$$

Although we find that t_2^* is negative when $n_f = 0$, we cannot reveal the nature of t_2^* with regard to n_f. This means that it is ambiguous whether the government of country 2 imposes a tax or a subsidy.

3.2 A coordinated tax

In this subsection, we assume that countries 1 and 2 form a union that imposes a coordinated tax on the firm's profit. We denote the coordinated tax rate when the investing firm locates in country i as t_i^u. The countries then distribute the proceeds from the tax as a lump-sum transfer to consumers in the country in which the investing firm locates. In this case, the equilibrium location patterns are the same as those without a tax.

The union determines the coordinated tax rate in order to maximize the welfare of the union. Denoting the welfare of the union when the firm locates in country j as V^{ju}, the definition of V^{ju} is described by $V^{ju} \equiv [v_1^j + v_2^j + (t_i^u/L)]L$. The following equations provide the welfare of the union when the investing firm

[16] Recall that $t_1^* = \tilde{t}_2 + \Gamma$. From $\frac{\partial \tilde{t}_2}{\partial n_f} > 0$, and $\frac{\partial \Gamma}{\partial n_f} > 0$, we find that $\frac{\partial t_1^*}{\partial n_f} > 0$. Moreover, from $\tilde{t}_2|_{n_f=0} < 0$, and $\Gamma|_{n_f=0} < 0$, we obtain that $t_1^*|_{n_f=0} < 0$.

[17] This critical value is associated with $t_1^* = 0$.

locates in countries 1 or 2:

$$V^{1u} = \left[\frac{[(n_f+1)a - n_f\tau_{1f}]^2}{2(n_f+2)^2} + w_1^1 + \frac{t_1^u}{L} + \frac{[(n_f+1)a - \tau_{12} - n_f\tau_{2f}]^2}{2(n_f+2)^2} + w_2^1\right]L, \tag{20}$$

and

$$V^{2u} = \left[\frac{[(n_f+1)a - \tau_{12} - n_f\tau_{1f}]^2}{2(n_f+2)^2} + w_1^2 + \frac{[(n_f+1)a - n_f\tau_{2f}]^2}{2(n_f+2)^2} + w_2^2 + \frac{t_2^u}{L}\right]L. \tag{21}$$

The welfare is an increasing function of t^u. Therefore, the union imposes the maximum tax rate that the union can levy. As a result, the tax rate that the union imposes becomes equal to the profit that the firm obtains [18]. In other words, $t_i^u = \pi^i$ holds. The difference in welfare between the two countries is as follows [19]:

$$V^{1u} - V^{2u} = -\frac{n_f(\tau_{1f} - \tau_{2f})\tau_{12}L}{(n_f+2)^2} + \Gamma = \Gamma - \Delta. \tag{22}$$

Recall that Γ is negative if n_f is smaller than $\tilde{n}_f$. It is said that when $n_f < \tilde{n}_f$ holds, the investing firm locates in the nearer country, which leads to the union obtaining greater welfare. However, if $n_f > \tilde{n}_f$ holds, Γ is positive. In this range, the investing firm locates in the farther country, which leads to the union obtaining greater welfare. Hence, whether the investing firm locating in the farther country is optimal for the union depends on n_f.

Recall that the location of the firm under tax competition is determined by $\Gamma - \Delta$. It can be stated that tax competition leads to the appropriate location pattern for the union.

4 Welfare analysis

To start with, we show the levels of welfare of a representative consumer in each country under each policy. We denote the welfare of the consumer in country i when the investing firm locates in country j when policy r as v_i^{jr}. In addition, $r = tc$ and u, where tc represents tax competition, and u is the coordinated tax. When the investing firm locates in country 1 (the farther country), the levels of welfare of the representative consumers in each country under policy r are shown as follows:

$$v_1^{1r} = v_1^1 + \frac{t_1^r}{L}, \tag{23a}$$

[18] This result is only derived in our model when we dismiss exports as a means of penetration for the good in countries 1 and 2. If the firm can choose that the plant does not locate in country 1 or 2, it may be impossible for the union to capture the profit of the investing firm through imposing a tax.

[19] It is noted that $w_1^i = w_2^i = 1$ from our normalization and $\Gamma = \pi^1 - \pi^2$ from our definition.

and

$$v_2^{1r} = v_2^1. \tag{23b}$$

When the investing firm locates in country 2 (the nearer country), the levels of welfare for the representative consumer in each country under policy r are as follows:

$$v_1^{2r} = v_1^2, \tag{24a}$$

and

$$v_2^{2r} = v_2^2 + \frac{t_2^r}{L}. \tag{24b}$$

It is noted that when $r = tc$, $t_i^r = t_i^*$, and when $r = u$, $t_i^r = t_i^u = \pi^i$.

We now investigate the effect of the formation of the union. First, we would like to discuss the location patterns of FDI. The location patterns under each policy are determined by Γ or $\Gamma - \Delta$. As we have already know that Δ is positive, $\Gamma - \Delta$ is always smaller than Γ, $\partial\Gamma/\partial n_f > 0$, and $\partial(\Gamma - \Delta)/\partial n_f > 0$. From these results, we infer two properties. The first is that the location pattern under each policy is not qualitatively different. The second property is found by examining the critical values, $\tilde{n}_f$, and n_f^{tc}, which are associated with $\Gamma = 0$ and $\Gamma - \Delta = 0$, respectively. When the union is not formed, the critical value associated with $\Gamma = 0$ is $\tilde{n}_f$. When the union is formed, we denote the critical value associated with $\Gamma - \Delta = 0$ as n_f^{tc}. We find that $\tilde{n}_f$ is always smaller than n_f^{tc}.

That $\tilde{n}_f$ is not equal to n_f^{tc} means that there is the range of n_f in which the location of the investing firm changes due to the policy change from tax competition to coordinated tax. Specifically, the policy change from tax competition to coordinated tax leads to the change in the location of the investing firm when $\tilde{n}_f < n_f < n_f^{tc}$. In this range, the investing firm moves from country 1 to country 2 as the policy changes.

First, we investigate welfare in the case in which the location of the firm does not change. Then we examine the welfare in the case in which the location of the firm changes.

4.1 The case in which the firm does not move between the countries in the union

In this subsection, we focus on the case in which the firm does not move between the countries because of the policy change. In other words, we investigate the effect of the policy change on welfare when $n_f < \tilde{n}_f$, or $n_f > n_f^{tc}$.

As long as the firm does not change its location, the level of the representative consumer's surplus does not vary. Hence, the comparison of the levels of the welfare of each country when the investing firm continues to locate in country i are described as follows:

$$v_i^{iu} - v_i^{itc} = \pi^i - t_i^*, \tag{25}$$

and

$$v_j^{iu} - v_j^{itc} = 0. \tag{26}$$

From the second equation, we conclude that the welfare of the country in which the investing firm does not locate is unaffected by the policy change.

However, with regard to the host country, the difference in the levels of tax imposed by the government and the union determines whether the policy change makes the country better off. When n_f is smaller than $\tilde{n}_f$, the investing firm continues to locates in country 2. In addition, the sign of t_2^* must be negative [20]. Therefore, when n_f is smaller than $\tilde{n}_f$, the policy change allows the welfare of the host country to improve.

Then, when n_f is larger than n_f^{tc}, the investing firm continues to locate in country 1. In this case, the government of country 1 imposes t_1^* under tax competition. We then find that $\pi^1 - t_1^*$ is positive [21]. Therefore, we can say that when n_f is larger than n_f^{tc}, the welfare of the host country is improved by the policy change.

We summarize the above discussion in the following proposition.

Proposition 4 *The aggregate welfare of the union is improved by the policy change when n_f is sufficiently small or sufficiently large.*

4.2 The case in which the firm moves between the countries in the union

When $\tilde{n}_f < n_f < n_f^{tc}$, the policy change leads to that the investing firm moves from country 2 to country 1. This then affects the level of consumer surplus as the shipping of the good between countries 1 and 2 incurs costs.

First, we investigate the effect of the policy change on the welfare of each country. We describe the following relationship:

$$v_1^1 - v_1^2 = \frac{\tau_{12}\left[2a(n_f+1) - 2n_f\tau_{1f} - \tau_{12}\right]}{2(n_f+2)^2} > 0, \tag{27a}$$

and

$$v_2^1 - v_2^2 = -\frac{\tau_{12}\left[2a(n_f+1) - 2n_f\tau_{2f} - \tau_{12}\right]}{2(n_f+2)^2} < 0. \tag{27b}$$

The policy change allows the consumers in country 1 to save transportation costs as the location of the investing firm changes from country 2 to country 1 through the policy change. This leads to an increase in consumer surplus in country 1. In addition, country 1 can obtain tax revenue from the investing

[20]Recall that $t_2^* = \tilde{t}_1 - \Gamma$. It is shown t_2^* is negative since $\tilde{t}_1$ and Γ are negative when $n_f < \tilde{n}_f$.

[21]From $t_1^* = \tilde{t}_2 + \Gamma$, it is shown $\pi^1 - t_1^* = \pi^1 - \tilde{t}_2 - \Gamma$. From the definition of Γ, $\pi^1 - t_1^* = \pi^2 - \tilde{t}_2$. Since $\tilde{t}_2$ is negative, $\pi^1 - t_1^*$ is positive.

firm. Therefore, we state that the welfare level of country 1 improves because of the policy change from tax competition to coordinated tax.

In contrast, the consumers in country 2 are the subject of the opposite effect on their consumer surplus. This is because when the investing firm moves from country 2 to country 1, the consumers in country 2 have to pay transportation costs. However, it is possible that the welfare burden of country 2 as a whole is now less as the government of country 2 does not have to offer the investing firm a subsidy. Whether the overall effect is positive or negative is then shown by examining the following equation:

$$v_2^1 - v_2^2 - \frac{t_2^*}{L} = \frac{\Gamma - \Delta}{L}. \tag{28}$$

This is negative when $\tilde{n}_f < n_f < n_f^{tc}$. This means that the policy change leads to a deterioration in the welfare of country 2. We interpret this as meaning that a conflict arises between countries 1 and 2.

We reveal the effect of the policy change on aggregate welfare in the union by investigating the sign of the following equation:

$$\begin{aligned}\left[v_1^{1u} + v_2^{1u} - \left(v_1^{2tc} + v_2^{2tc}\right)\right] L &= \left(v_1^1 - v_1^2\right) L + \pi^1 + \left(v_2^1 - v_2^2\right) L - t_2^* \\ &= -\frac{n_f(\tau_{1f} - \tau_{2f})\tau_{12}}{(n_f+2)^2} + (\pi^1 - t_2^*) \\ &= (\Gamma - \Delta) + (\pi^1 - \tilde{t}_1). \end{aligned} \tag{29}$$

The sign of first parenthesis is negative. The sign of second parenthesis is positive. It is therefore said that the effect on the aggregate welfare of the union is ambiguous.

We summarize the above results in the following proposition.

Proposition 5 *When the level of $\tilde{n}_f < n_f < n_f^{tc}$, a conflict between countries* 1 *and* 2 *emerges. In addition, it is possible that the aggregate welfare of the union deteriorates due to the policy change.*

5 Conclusion

In this paper, we investigate the effects of asymmetric international transportation costs and the existence of rival firms in a third country on the location of FDI. We show that as the number of rival firms in the third country becomes sufficiently large, the investing firm locates in the country farther from the third country to avoid the competition of rival firms. However, when the number of rival firms is not sufficiently large, it is possible for the investing firm to locate in the country nearer to the third country and thereby closer to the competition of rival firms. In this situation, the size of demand determines the location of the investing firm.

Introducing tax competition between the potential host countries shows that the pattern of the location of the investing firm is qualitatively the same as where there is no such policy. However, we reveal that tax competition widens the range where the government of the nearer country can attract FDI to its own country. That is, by introducing tax competition, the nearer country has an instrument to attract FDI. As the farther country has an advantage with regard to attracting the investing firm, the tax rate that its government levies is higher. In general, the number of rival firms in the third country determines the sign of the tax rate (a tax or a subsidy) that the farther country levies or applies when the investing firm locates in the farther country.

When the potential host countries decide to impose a coordinated tax on the investing firm as a union, the pattern of the location of the investing firm is the same as when there is no tax competition. Investigating the patterns of location of the investing firm under both tax competition and the coordinated tax policy reveals that the change in the location of the investigating firm derives from the policy change. We find that when the policy change leads the investing firm to move between countries, there could be a conflict between the potential host countries. When such conflict arises, redistribution between the countries that form the union may then be required.

6 Appendix

6.1 Appendix A

We represent the price of the good consumed in country i when the investing firm locates in country j by p_i^j. When the investing firm locates in country 1, the optimal prices are as follows:

$$p_1^1 = \frac{\alpha + (n_f + 1)c + n_f \tau_{1f}}{n_f + 2}, \tag{30a}$$

$$p_2^1 = \frac{\alpha + (n_f + 1)c + \tau_{12} + n_f \tau_{2f}}{n_f + 2}, \tag{30b}$$

and

$$p_f^1 = \frac{\alpha + (n_f + 1)c + \tau_{1f}}{n_f + 2}. \tag{30c}$$

When the investing firm locates in country 2, the optimal prices are as follows:

$$p_1^2 = \frac{\alpha + (n_f + 1)c + \tau_{12} + n_f \tau_{1f}}{n_f + 2}, \tag{31a}$$

$$p_2^2 = \frac{\alpha + (n_f + 1)c + n_f \tau_{2f}}{n_f + 2}, \tag{31b}$$

and

$$p_f^2 = \frac{\alpha + (n_f + 1)c + \tau_{2f}}{n_f + 2}. \tag{31c}$$

6.2 Appendix B

Here, the effect of the existence of a trade hub is considered. Here, the variables of the economy with the hub are presented by the superscript, h.

Suppose that country 2 is the hub country. Therefore, when the consumers in country 1 purchase the manufactured good produced in country f, the good must be transported via country 2. Therefore, the transportation cost paid by consumers in country 1 is the sum of the transportation costs between countries 2 and f, and those between countries 1 and 2. That is, $\tau_{1f}^h = \tau_{2f} + \tau_{12}$ holds. In this case, the difference between the profit when the investing firm locates in country 1 and when the firm locates in country 2 is as follows:

$$\pi^{1h} - \pi^{2h} = \frac{(n_f+1)\tau_{12}L}{(n_f+2)^2}\left[2n_f\tau_{12} - \{2a - (n_f+1)(2\tau_{2f}+\tau_{12})\}\frac{L_f}{L}\right]. \quad (32)$$

The sign of the bracket on the right-hand side (RHS) determines the sign of the difference.

We show that the difference has the following properties:

$$\frac{\partial(\pi^{1h} - \pi^{2h})}{\partial n_f} = \frac{2\tau_{12}L}{(n_f+2)^3}\left[(n_f^2 + 4n_f + 2)\tau_{12} + (an_f + n_f + 1)\frac{L_f}{L}\right] > 0,$$

and

$$\begin{aligned} \pi^{1h} - \pi^{2h}|_{n_f=0} &= -\frac{\tau_{12}}{4}\left[2a - (2\tau_{2f}+\tau_{12})\right] \geq (<)\ 0 \\ & \quad as\ 2a - (2\tau_{2f}+\tau_{12}) \leq (>)\ 0. \end{aligned}$$

The first equation indicates that $\pi_1 - \pi_2$ is an increasing function of n_f. The second indicates that $\pi_1^h - \pi_2^h|_{n_f=0} > 0$ always holds when $2a - (2\tau_{2f}+\tau_{12}) < 0$. In this case, the investing firm always locates in the farther country. However, as we assume that $2a - (2\tau_{2f}+\tau_{12}) > 0$, we dismiss this case.

On the other hand, when $2a - (2\tau_{2f} + \tau_{12})$ holds, there is a critical value with respect to the location of the investing firm. In this case, the investing firm locates in the farther country if n_f is larger than $\bar{n}_f^h$, otherwise the investing firm locates in the nearer country, where:

$$\tilde{n}_f^h \equiv \frac{[2a - (2\tau_{2f}+\tau_{12})]\frac{L_f}{L}}{2\tau_{12} + (2\tau_{2f}+\tau_{12})\frac{L_f}{L}}.$$

We note that $\tilde{n}_f^h$ is an increasing function of L_f/L. Therefore, it is said that the smaller is L_f/L, the larger is the range over which the investing firm locates in the farther country.

Using these results, we find that the behavior of the location of the investing firm does not change essentially, even though there is a hub country. We summarize as follows.

Lemma 6 *It is supposed that $\tau_{1f} = \tau_{2f} + \tau_{12}$. The firm locates in the farther country if n_f is larger than $\bar{n}_f^h$, otherwise the firm locates in the hub country.*

Next, we investigate the effect of L_f on the location of the investing firm, as shown by the following:

$$\begin{aligned} \frac{\partial(\pi_1^h - \pi_2^h)}{\partial(L_f/L)} &= -\frac{(n_f+1)\tau_{12}L}{(n_f+2)^2}\left[2a - (n_f+1)(2\tau_{2f}+\tau_{12})\right] \geq (<)\ 0, \\ & \quad as\ n_f \geq (<) \frac{2a - (2\tau_{2f}+\tau_{12})}{2\tau_{2f}+\tau_{12}} \equiv \bar{n}_f^h, \end{aligned} \tag{33}$$

and

$$\pi_1^h - \pi_2^h|_{(L_f/L)=0} = \frac{2n_f(n_f+1)\tau_{12}^2 L}{(n_f+2)^2} > 0.$$

The following lemma summarizes the implications of these equations.

Lemma 7 *It is supposed that $\tau_{1f} = \tau_{2f} + \tau_{12}$.*

- *When n_f is smaller than $\bar{n}_f^h$, the investing firm locates in the farther country at any level of L_f/L.*
- *When n_f is larger than $\bar{n}_f^h$, the investing firm locates in the farther country if L_f/L is smaller than $\bar{L}_f^h$, otherwise the investing firm locates in the nearer country, where:*

$$\bar{L}_f^h \equiv \frac{2n_f\tau_{12}}{2a - (n_f+1)(2\tau_{12}+\tau_{12})}.$$

In this case, we also find that the location behavior of the investing firm does not change, even though there is a hub country.

We now compare the location behaviors of the investing firm in the basic model and the model with a trade hub:

$$\tilde{n}_f - \tilde{n}_f^h = -\frac{2a(\tau_{1f}-\tau_{2f}-\tau_{12})}{(\tau_{1f}+\tau_{2f})(2\tau_{2f}+\tau_{12})} \geq (<)\ 0\ as\ \tau_{1f} \leq (>) \tau_{2f}+\tau_{12} = \tau_{1f}^h,$$

and

$$\bar{L}_f - \bar{L}_f^h = \frac{2n_f\tau_{12}(\tau_{1f}-\tau_{2f}-\tau_{12})L}{[2a-(n_f+1)(\tau_{1f}+\tau_{2f})][2a-(n_f+1)(2\tau_{2f}+\tau_{12})]} \geq (<)\ 0\ as\ \tau_{1f} \geq (<) \tau_{2f}+\tau_{12} = \tau_{1f}^h.$$

These results reveal that whether the range over which the investing firm locates in the farther country widens or not is determined by the difference between τ_{1f} and τ_{1f}^h. Regarding n_f, the existence of the hub allows the range in which the investing firm locates in the farther country to be wider when $\tau_{1f} > \tau_{1f}^h$. This is because the degree of competition against firms in country f is greater when $\tau_{1f} > \tau_{1f}^h$.

As to the relative size of demand, the existence of the hub leads to a situation where the range in which the investing firm locates in the farther country is wider when $\tau_{1f} < \tau_{1f}^h$. This is because the degree of competition against the firms in country f is smaller when $\tau_{1f} < \tau_{1f}^h$.

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