FDI Spillovers with Product Differentiation

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Abstract

Based on Symeonidis (2003)'s duopoly model with product differentiation, this paper discusses how FDI spillovers that decreases the quality difference between vertically differentiated products of the home and foreign firms affects the home firm's decision on plant location and how endogenizing spillovers makes difference from the exogenous spillovers. This paper shows that endogenizing spillovers with a quadratic spillover-prevention cost function makes FDI more likely. Related with intellectual property right of the home firm, this paper focus on the role of the two exogenous variables, (1) parameter of spillover-prevention cost function and (2) degree of spillovers when no prevention effort is made, both of which may be lower when the foreign government enforces stricter intellectual property protection. In the model, the welfare of the foreign country is always higher with FDI than with exports. This paper shows that the second exogenous variable mentioned above is positively related to the unit trade cost, and that so is the level of spillovers in the endogenous case. About this relationship, some evidence from cross-country data is provided.

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1 Introduction

One reason why many (developing) countries want foreign companies to enter their markets by foreign direct investment (FDI) rather than exports is that they expect technology transfers from the foreign to the domestic companies, which are more likely to occur with FDI than exports. Such technology transfer, known as FDI spillovers, has been discussed either theoretically or empirically by many economists.[1] However, only a portion of spillovers, i.e. spillovers decreasing rival's production costs, and its determinants are the main focus of the study, at least in the theoretical literature.

Aitken and Harrison (1994, 1999) show that the entry by the foreign firm has two aspects. One is FDI spillovers, and the other is an effect of increasing competition; an decrease in output of the each domestic firm increases its average cost, even if its average cost curve is shifted downward. They argue that these opposite effects make empirical studies of FDI spillovers harder. Whether the level of spillovers is exogenous or endogenous is another issue to be addressed. Grünfeld (2006) develops a three-period duopoly model. It is assumed that a firm's marginal cost depends on R&D investments by itself and the rival firm in case of FDI, and that FDI spillovers gets larger as its own R&D investment gets larger. He shows that for the firm entering the foreign market, weak and strong R&D investment effects favor exports while medium-sized investment effects favor FDI.

The purpose of this paper is to explore another possible FDI spillovers that affects rival's product quality rather than its costs of producing an identical product. In the article, an duopoly model based on that of Symeonidis (2003) in which goods are vertically and horizontally differentiated. This paper consider the case when the products of the home and foreign firms are vertically differentiated and the former has higher quality than the latter. In the model, FDI spillovers are supposed to decrease the quality difference between the two products. Moreover, this article discusses the two cases; (1) exogenous spillovers: the level of spillovers is given to the both firms, and (2) endogenous spillovers: it is determined by the home firm with costs.

Besides extending varieties of FDI spillovers, the contributions of this work are twofold. One is to provide a framework to examine the relationship of intellectual property right (IPR) in the FDI host country with the home firm's decision on plant location, i.e. FDI vs. exports. The foreign country's IPR policy may affect the degree of FDI spillovers and thus the home firm's decision. The other contribution is to show that the level of FDI spillovers is proportional to the unit trade cost. The home firm incurs the trade costs, including tariff, when it chooses exports. This article shows a clear relationship between these two policy instruments for the foreign country.

[1] See Blomström and Kokko (1998) about discussions on various kinds of FDI spillovers and their channels (linkages of firms in the same or different industries, for instance). Görg, and Pisu (2008) use firm-level panel data of U.K. manufacturing industries in the 1990s with treatments of FDI-spillover channels to find substantial differences between exporting/non-exporting domestic firms in the benefits of spillovers.

This paper shows that with a quadratic spillover-prevention cost function, endogenizing spillovers makes FDI more likely than the exogenous case. Related with the IPR of the home firm, this paper focus on the role of the two exogenous variables, (1) parameter of spillover-prevention cost function and (2) degree of spillovers when no prevention effort is made, both of which may be lower when the foreign government enforces stricter intellectual property protection (IPP). In the model, the welfare of the foreign country is always higher with FDI than with exports. This paper shows that the second exogenous variable mentioned above is positively related to the unit trade cost, and that so is the level of spillovers in the endogenous case. About this relationship, some evidence from cross-country data is provided.

The rest of the article is arranged as follows. Section two develops the model of FDI spillovers with product differentiation, first the exogenous case and next the endogenous case. Section three provides the base of the welfare analysis of the FDI host country. Using the framework of Section three, Section four explores the relationship of the host countries IPR policy with the FDI spillovers. Section five concludes the article.

2 Model

This paper develops a model based on Symeonidis (2003), who compares Cournot and Bertrand equilibria when goods are vertically and horizontally differentiated and a firm's R&D investment changes the quality of its own product and others. Consider two countries, home and foreign, and a home firm plans to enter the foreign market either by exports or FDI. Assume that to export products to the foreign country, the home firm must pay trade costs, which is an incentive for the home firm to perform FDI. After the decision on plant location, the home firm competes with a foreign firm by quantity with a differentiated product.

2.1 Consumer‘s Utility and Product Differentiation

Following Symeonidis (2003), consider the utility function of a representative consumer in the foreign country as follows;

$$U = x + y - \frac{x^2}{u_h^2} - \frac{y^2}{u_f^2} - \sigma \frac{x}{u_h}\frac{y}{u_f} + M.$$

x and y are quantities of the home and foreign firms' products. u_h and u_f are quality of the home and foreign firms' products respectively, which describe the degree of vertical differentiation. $2 \geq \sigma > 0$ captures the degree of horizontal differentiation. When σ goes to zero, the two products are totally unrelated. When σ is equal to two with $u_h = u_f$, the two products are perfect substitutes. M denotes expenditure on outside goods. Solving the consumer's maximization problem yields

the following demand function;

$$p_x = 1 - \frac{2x}{u_h^2} - \frac{\sigma}{u_h}\frac{y}{u_f},$$

$$p_y = 1 - \frac{2y}{u_f^2} - \frac{\sigma}{u_f}\frac{x}{u_h}.$$

In this paper, only the vertical differentiation is discussed. Thus, $\sigma = 2$ is assumed in the rest of the article.

2.2 FDI Spillovers

Assume that $u_h = 1$ and that $u_f = (1-q)u_h = 1-q,\ 0 < q < 1$. The second assumption implies that the home firm's product has higher quality than the foreign firm's counterpart. Suppose that if the home firm performs FDI, it results in improving the foreign firm's product by s. Assume that $q \geq s$. This inequality implies that the improved quality of the foreign firm's product will never exceed that of the home firm product. Then, the profits of the two firms in each of the location mode of the home firm are as follows.

$$\pi_h = \begin{cases} \left(1 - 2x - \frac{2y}{1-q}\right)x - (1+t)cx & \text{No FDI, i.e. Exports,} \\ \left(1 - 2x - \frac{2y}{1-q+s}\right)x - cx, & \text{FDI.} \end{cases} \tag{1}$$

$$\pi_f = \begin{cases} \left(1 - \frac{2y}{(1-q)^2} - \frac{2x}{1-q}\right)y - cy & \text{Exports,} \\ \left(1 - \frac{2y}{(1-q+s)^2} - \frac{2x}{1-q+s}\right)y - cy & \text{FDI.} \end{cases} \tag{2}$$

π_h and π_f are profits of the home and foreign firms respectively. $c > 0$ is a unit production cost, and $t > 0$ is a unit trade cost. Therefore tcx is the extra costs with exports.

From the first order conditions, quantity produced by the each firm in the each case is the following. When the home firm chooses exports (Case E),

$$x^E = \frac{(1+q)(1-c) - 2t}{6}, \tag{3}$$

$$y^E = \frac{(1-q)\{(1-2q)(1-c) + t\}}{6}. \tag{4}$$

For the outputs to be positive, $c < 1$ and $q < \frac{1}{2}$ are assumed. When the home firm chooses FDI (Case F),

$$x^F = \frac{(1+q-s)(1-c)}{6}, \tag{5}$$

$$y^F = \frac{(1-q+s)(1-2q+2s)(1-c)}{6}. \tag{6}$$

In either cases, the quality differences q or $q-s$ have positive effects on the output of the home firm while it always has a negative effect on the output of the foreign

firm. One interesting question is whether the entry of the home firm with FDI spillovers has two effects on the foreign firm's profits, pointed out by Aitken and Harrison (1994, 1999). It may be examined by comparing the outputs of the foreign firm in monopoly with duopoly. In case of monopoly, the profits of the foreign firm are $\left\{1 - \frac{2y}{(1-q)^2}\right\} y - cy$. From the first order condition, the monopoly output is $y^m = \frac{(1-q)^2(1-c)}{4}$. Therefore, the difference in outputs of the foreign firm before and after the entry of the home firm is

$$y^m - y^F = \frac{(1-c)(1-q)}{12} \left\{ \frac{2s(-4q+2s+3)}{1-q} - (1+q) \right\}.$$

Inside the curly brackets, the first term is the spillover effect, which is positive, and the second term is the increasing competition effect, which is negative. If the spillover is zero, the first term is vanished and only the second term is left. $-\frac{(1-c)(1-q)(1+q)}{12}$ is equal to the output difference with no FDI spillovers. Therefore, the second term can be interpreted as the competition effect. Aitken and Harrison (1994, 1999)'s argument is about spillovers decreasing production costs, but their argument can be applied to the spillovers improving the quality of the foreign firm's product.

To explore the effects of FDI spillovers s, a case when s is given to the both firms is discussed first. Then a case when s is endogenously determined is considered.

2.2.1 Exogenous Spillovers

Suppose that the level of FDI spillovers is s_0 and that it is given to both the home and foreign firms. By inserting the equilibrium outputs in each case to the profits (1) and (2), it is shown that $\pi_h = 2\left(\frac{x^i}{u_h}\right)^2$ and $\pi_f = 2\left(\frac{y^i}{u_f}\right)^2$, where $i = E, F$. This implies that comparing the outputs of a firm in the two cases is enough to compare the profits in the two cases. From equations (3) and (5), the equilibrium outputs of the home firm in the two cases, in order for the home firm to prefer FDI, the following inequality must hold;

$$\frac{s_0(1-c)}{2} = t_c < t. \tag{7}$$

The following lemma summarizes the results.

Lemma 1 *If the trade cost is greater than t_c, the home firm chooses FDI. Otherwise, the home firm chooses exports.*

Although equation (7) is a condition for FDI with exogenous spillovers and thus is discussed in the previous studies, it is interesting to compare this condition with the counterpart in case of endogenous spillovers.

2.2.2 Endogenous Spillovers

Suppose that before deciding the plant location, the home firm may determine the degree of FDI spillovers s by itself. If perfect prevention of spillovers, i.e. $s = 0$, is

possible without any costs, it is obvious from equation (5), the equilibrium output of the home firm in case of FDI, that the home firm definitely does so. However, if lower spillovers need additional costs, an optimal value of s, which is positive, might exist.

Assume that the spillover-prevention cost function is quadratic. Then the profits of the home firm in case of FDI are

$$\left(1 - 2x - \frac{y}{1 - q + s}\right) x - cx - e(s_0 - s)^2$$

where e is a positive constant. The case of exogenous spillovers discussed first can be interpreted as the case when e is so large that s_0 is optimal for the home firm. The formulae of the profits of the home firm in case of exports and those of the foreign firms in either cases are not changed. Now the model has two periods; decision on the degree of spillovers in period one, and plant location and quantity competition in period two. Thus the model is solved by backward induction.

Period Two: Plant Location and Quantity Competition

In period two, the home firm chooses its optimal quantity associated with its optimal plant location, and the foreign firm chooses its optimal quantity. These decisions are made for a given level of spillovers with FDI, determined by the home firm in period one. This implies that the first order conditions in period two are exactly the same as those in the benchmark case, i.e. exogenous spillovers. Thus, equations (5) to (6), the equilibrium outputs of the two firms with exogenous spillovers, hold with endogenous spillovers too, although s_0 is replaced by s.

Period One: Optimal Degree of Spillovers with FDI

Substituting the equilibrium outputs of the two firms in case of FDI (equations 5 and 6) into the profits of the two firms (the second lines of equations 1 and 2) yields the profits of the two firms in period one if the home firm chooses FDI in period two;

$$\pi_h^{Period\ One} = \frac{1}{18}(1 + q - s)^2(1 - c)^2 - e(s_0 - s)^2. \tag{8}$$

$$\pi_f^{Period\ One} = \frac{1}{18}(1 - 2q + 2s)^2(1 - c)^2. \tag{9}$$

The home firm chooses s to maximize its profits (equation 8). From the first order condition, the optimal s is

$$s^* = \frac{18es_0 - (1 + q)(1 - c)^2}{18e - (1 - c)^2}. \tag{10}$$

The denominator is positive for the second order condition to hold. s^* is positive if s_0, the level of spillovers when no prevention effort is made, is large and if q, the initial quality difference between the two products, is relatively small. The lower

bound for s^* is zero due to the definition of the spillovers. One interesting result is whether s^* is higher or lower than s_0. The following result is the answer.

Lemma 2 *When the FDI spillovers is endogenous, the optimal level of spillovers is lower than the exogenous level.*

Proof $s_0 - s^* = \frac{(1+q-s_0)(1-c)^2}{18e-(1-c)^2} > 0$, because $q > 0$ and $1 > s_0$. QED.

The next question is how the level of spillovers optimally chosen by the home firm affects its plant location.

Home Firm's Plant Location with Endogenized Spillovers

For the home firm, it is important whether the maximized profits in case of FDI are larger than the profits in case of exports. Inserting s^* into equations (8) and (9) yields equilibrium profits of the two firms, denoted by π_h^* and π_f^* respectively;

$$\pi_h^* = \frac{(1+q-s_0)^2(1-c)^2 e}{18e-(1-c)^2} \tag{11}$$

$$\pi_f^* = \frac{1}{2}\left\{\frac{6e(1-2q+2s_0)-(1-c)^2}{18e-(1-c)^2}\right\}^2 (1-c)^2 \tag{12}$$

It is easily shown that the profits of the home firm with endogenized spillovers, π_h, are larger than those with $s = s_0$. If the home firm prefers FDI, the following inequality must hold;

$$\frac{(1+q-s_0)^2(1-c)^2 e}{18e-(1-c)^2} > \frac{1}{18}\{(1+q)(1-c)-2t\}^2.$$

The left hand side is the profits in case of FDI (equation 11), and the right hand side is those in case of exports, equal to the squared equilibrium output (equation 3). From the above inequality, the following expression similar with inequality (7), the condition for FDI with exogenous spillovers, is derived;

$$\sqrt{\frac{18e}{18e-(1-c)^2}}\cdot\frac{s_0(1-c)}{2} + \left(1-\sqrt{\frac{18e}{18e-(1-c)^2}}\right)\cdot\frac{(1+q)(1-c)}{2} = t_c^* < t. \tag{13}$$

If the trade cost t is higher than t_c^*, the home firm chooses FDI. Otherwise, it chooses exports. One might ask how endogenizing spillovers change the condition for FDI from the case when the spillovers are exogenous. The following result is the answer.

Proposition 1 *With a quadratic cost function of FDI-spillover prevention, endogenizing spillovers decreases the threshold of the trade cost with exports, t, for FDI.*

Proof Suppose that the claim is true, i.e. $t_c^* < t_c$. This inequality is changed to $\frac{(1+q)(1-c)}{2} > \frac{s_0(1-c)}{2} = t_c$. The second inequality holds because $1+q > s_0$ as in the proof for Lemma 1. QED.

Proposition 1 implies that endogenizing spillovers makes FDI more likely. Making the level of spillovers lower than s_0 causes some extra costs for the home firm. However, the opportunity to choose the level of the spillovers freely gives more benefits associated with FDI to the home firm.

3 Welfare of the Foreign Country

The focus of the study is now moved to the welfare of the FDI host country. First, with a common definition of welfare, some important points that the foreign government must consider are shown. Then, as a policy instrument, the importance of the intellectual property right (IPR) is discussed.

3.1 Surpluses, Welfare, and Foreign Firm's Preference

The welfare of the foreign country is defined as the sum of the consumer surplus and the profits of the foreign country. The consumer surplus is derived by substituting $M = I - p_x x - p_y y$ into the utility function where I is the consumer's income assumed to be given and thus can be ignored in the analysis. When the home firm chooses exports (case E), the consumer surplus is

$$CS^E = \left\{\frac{(2-q)(1-c)}{6}\right\}^2 - \frac{(1-q)(1-c)t}{12} - \left(\frac{t}{6}\right)^2.$$

Obviously, the unit trade cost t has negative effects on the consumer surplus. However, the effect of the quality difference q is not obvious because the price of the high-quality product, i.e. the home-firm product, gets higher due to the trade cost.[2] When the home firm chooses FDI (case F), the consumer surplus is

$$CS^F = \left[\frac{\{2-(q-s)\}(1-c)}{6}\right]^2.$$

It is clear that the consumer gets the benefits of FDI spillovers making the quality difference smaller. Moreover, the effect of the trade costs, such as the second and third terms in the welfare with exports, do not appear. Therefore, the following result holds.

[2] $p_x = \frac{3-(2-q)(1-c)+t}{3}$. Thus, an increase in the trade cost raises the price of the home-firm product. The effect of quality difference on the consumer surplus,

$$\frac{\partial CS^E}{\partial q} = \frac{1-c}{36}\{-2(1-q)(1-c)+3t\},$$

can be positive or negative.

Lemma 3 *The utility of the foreign consumer is always higher when the home firm chooses FDI.*

Lemma 3 shows that the foreign consumer always prefers FDI to exports, regardless the level of FDI spillovers.

Next, the welfare in case E is

$$\begin{aligned} W^E &= CS^E + \pi_f^E \\ &= CS^E + \left[\frac{(1-q)\{(1-2q)(1-c)+t\}}{6}\right]^2 \\ &= \frac{(1-c)^2\{(2-q)^2+(1-q)^2(1-2q)^2\}}{36} \\ &\quad -\frac{(1-c)(1-q)(1+4q)t}{36}. \end{aligned} \tag{14}$$

On the other hand, the welfare in case F is

$$\begin{aligned} W^F &= CS^F + \pi_f^F \\ &= CS^F + \left\{\frac{(1-q+s)(1-2q+2s)(1-c)}{6}\right\}^2 \\ &= \frac{(1-c)^2[\{2-(q-s)\}^2+\{1-(q-s)\}^2\{1-2(q-s)\}^2]}{36}. \end{aligned} \tag{15}$$

Comparing W^E and W^F yields the following result.

Lemma 4 *The welfare of the foreign country is always higher when the home firm chooses FDI.*

Proof The first term of W^F is larger than that of W^E due to FDI spillovers s. The second term of W^E is negative. QED.

Lemma 4 implies that with this formula of the welfare of the foreign country, the loss of the consumer surplus due to the trade costs compared to the gain in the profits of the foreign firm is so high that the foreign government always prefers FDI to exports. Moreover, Lemmas 3 and 4 show that the preferences of the foreign government and consumer for the location of the home firm are the same.

Therefore, the next question is what condition is for the foreign firm to prefer FDI, because if it is satisfied, every agent in the foreign country gets better off. The condition is derived from a inequality $\pi_f^F > \pi_f^E$;

$$s(1-c)\cdot\frac{2s+3-4q}{1-q} = t_f > t.$$

The following lemma summarizes the result.

Lemma 5 *If the trade cost is lower than t_f, the foreign firm prefers FDI. Otherwise, it prefers exports.*

Thus, it is important for the foreign government how to choose policy variables such as the trade cost t and FDI spillovers s to maximize the welfare and at the same time to satisfy the above inequality. Tariff is directly related with the trade cost. However, under the WTO rule, it is very difficult to raise the tariff rate. In this paper the tariff is not discussed as a policy by the foreign government unless the trade liberalization is effective. On the other hand, FDI spillovers is related with how much IPR is protected in the foreign country. For instance, brand image and product design of the home-firm product are kinds of product quality easily imitated by the foreign firm, if no intellectual property protection (IPP) exists. About the effect of the IPR policy, first the case of exogenous spillovers is discussed. Then the analysis on the endogenous spillovers follows.

3.2 IPR policy with Exogenous Spillovers

Suppose that the level of FDI spillovers s_0 is controlled by the foreign government through its IPR policy, and the level is given even to the home firm. If the degree of IPP is high, s_0 is low and otherwise. The foreign government must solve the following two problems: (1) to induce FDI by the home firm, equation (7) must hold (Lemma 1), and (2) to make the foreign firm better off, $t_f \geq t$ (Lemma 5). This implies that the foreign government's problem is to maximize the welfare subject to $t_c \geq t \geq t_f$ before the home firm chooses its plant location.

Figure 1 shows the solution for the foreign government's problem. In the figure, the exogenous spillovers, s_0, is on the horizontal axis, and the unit trade cost, t, is on the vertical axis. A straight line from the origin shows (s_0, t) with which the home firm is indifferent between exports and FDI. If (s_0, t) is below this line, the home firm prefers exports. Otherwise the home firm prefers FDI. On the other hand, a quadratic line from the origin shows (s_0, t) with which the foreign firm is indifferent between exports and FDI. If (s_0, t) is below this line, the foreign firm prefers FDI. Otherwise the home firm prefers exports.

These two lines divided (s_0, t) field into three regions; for the foreign government, the most favorable region is the area between the two lines where both the home and foreign firms prefer FDI. Thus, (s_0, t) should be in this region. The next question is for a given trade cost, what is the level of spillovers that is most favorable to the foreign government. Equation (15), the welfare with FDI, implies that the higher s_0 is, so is the welfare. Therefore, the foreign government should set the level of spillovers at the maximum for a specific level of the trade cost. The following result shows the level of FDI spillovers optimal for the foreign government.

Proposition 2 *Suppose that the foreign government may determine the level of FDI spillovers. Then, for a given level of the unit trade cost, say* t_0*, the level of* s_0 *maximizing the foreign welfare is* $s_0^{Max} = \frac{2t_0}{1-c}$.

Proof (t_0, s_0^{Max}) is on the straight line in Figure 1, which implies that with (t_0, s_0^{Max}), the home firm is indifferent between FDI and exports. If $s_0 > s_0^{Max}$, the

home firm chooses exports. If $s_0 < s_0^{Max}$, the foreign government may raise the welfare by raising s_0. QED.

Proposition 2 shows a clear relationship of the level of spillovers with the unit trade cost; if the trade cost decreases due to trade liberalization or other factors, the level of spillovers must decrease proportionally. That is, a decrease in the unit trade cost forces the foreign government to endorse more IPP to attract FDI. Such a case, however, is not desirable for the foreign government because lower spillovers implies lower foreign welfare, but the foreign government must accept it.

3.3 IPR Policy with Endogenous Spillovers

How about the case of endogenous spillovers? In Figure 2, the straight line from the origin labeled "Exogenous" is the threshold line for the home firm in Figure 1, which, as Proposition 2 shows, gives the maximum level of FDI spillovers for a given trade cost in the exogenous case. Another straight line labeled "Endogenous" is the threshold line for the home firm in the endogenous case. Because the "Endogenous" line is located below the "Exogenous" line, for a given level of trade cost, a higher level of spillovers can be chosen by the home firm. Therefore, this is a graphical expression of Proposition 1.

Related with the location of the two straight lines, the following result is about the maximum level of FDI spillovers the foreign government may set through its IPR policy; in Figure 2, s_0^{Max} is the maximum in the exogenous case and $s_0^{Max'}$ is the maximum in the endogenous case.

Lemma 6 *The maximum level of spillovers at which the home firm may choose FDI is higher in the endogenous case than in the exogenous case.*

Proof From equation (13), $s_0^{Max'} = \sqrt{\frac{18e-(1-c)^2}{18e}} \cdot \frac{2t_0}{1-c} + \left(1 - \sqrt{\frac{18e-(1-c)^2}{18e}}\right)(1+q)$. From equation (7), $s_0^{Max} = \frac{2t_0}{1-c}$. Suppose that $s_0^{Max'} > s_0^{Max}$, which is changed to $\frac{(1-c)(1+q)}{2} > t_0$. This inequality holds because

$$\frac{(1-c)(1+q)}{2} > \frac{(1-c)}{2}q > \frac{1-c}{2}s_0^{Max} = t_0.$$

The last inequality in the above line holds because the level of spillovers is assumed not to exceed the initial quality difference. QED.

However, Lemma 6 does not imply that the home firm does choose higher level of spillovers in the endogenous case than in the exogenous case. As Lemma 2 shows, the home firm's optimal level of spillovers is lower than that in the exogenous case. Figure 3 describes how the home firm determines the level of spillovers endogenously for a given trade cost. A straight line labeled "s^*" gives the optimal level of spillovers. As Figure 3 shows, $s^*(t_0)$ is lower than not just $s_0^{Max'}$ but s_0^{Max},

the level of spillovers chosen by the foreign government in the exogenous case.[3] The following proposition summarizes the result.

Proposition 3 *In the endogenous case, the home firm chooses the level of spillovers lower than that in the exogenous case, even though the maximum level of spillovers the home firm may accept is higher in the endogenous case.*

Proof From equation (10) and $s_0^{Max'} = \sqrt{\frac{18e-(1-c)^2}{18e}} \cdot \frac{2t_0}{1-c} + \left(1 - \sqrt{\frac{18e-(1-c)^2}{18e}}\right)(1+q)$,

$$s^*(t_0) = \sqrt{\frac{18e}{18e-(1-c)^2}} \cdot \frac{2t_0}{1-c} + \left(1 - \sqrt{\frac{18e}{18e-(1-c)^2}}\right)(1+q).$$

Suppose that $s^*(t_0) < s_0^{Max} = \frac{2t_0}{1-c}$. This inequality is changed to

$$s_0^{Max} = \frac{2t_0}{1-c} < q < 1+q,$$

which holds as in the proof for Lemma 6. QED.

In the endogenous case, the IPR policy by the foreign government may affect another variable besides s_0. That is, the parameter of the spillover prevention function, e. For instance, stricter IPP may reduce costs of lawsuits against piracy or other IPR violations. In Figure 3, a decrease in e shifts "Endogenous" line rightward while it shifts s^* line leftward. A lower e makes spillover prevention easier, which makes FDI more likely but induces more aggressive spillover prevention by the home firm.

Propositions 2 and 3 shows that whether the FDI spillovers are exogenous or endogenous, the level of spillovers is positively related to the unit trade cost. Figure 4 provides some evidence by examining cross-country variations of strength of IPP and tariff. In Figure 4, the horizontal axis is simple-average tariff rate of non-agriculture products of each of 41 developing/emerging countries.[4] The vertical axis is Intellectual Property Score calculated by Lesser (2002), who shows that IPP measured by the index has positive significant effects on inward FDI and imports. A higher IP Score means stricter IPP. Consistent with the model of this article, the IP score is negatively related with the tariff rate.

4 Conclusions

This paper extends Symeonidis (2003)'s duopoly model with product differentiation to discusses how FDI spillovers that decreases the quality difference between

[3] In Figure 3, the threshold line for the foreign firm is omitted; it is assumed that $(t_0, s^*(t_0))$ is right to the threshold line, i.e. with $(t_0, s^*(t_0))$, the foreign firm prefers FDI.

[4] The samples consist of 16 Central and South American and Caribbean countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Paraguay, Peru, Uruguay), 15 African countries (Botswana, Cameroon, Egypt, Ghana, Kenya, Malawi, Mauritius, Morocco, Namibia, Nigeria, South Africa, Senegal, Tunisia, Zambia, Zimbabwe), and 10 Asian and Middle Eastern countries (China, India, Indonesia, Jordan, Malaysia, Pakistan, Philippines, Republic of Korea, Thailand, Vietnam).

vertically differentiated products of the home and foreign firms affects the home firm's decision on plant location and how endogenizing spillovers makes difference from the exogenous spillovers. This paper shows that endogenizing spillovers with a quadratic spillover-prevention cost function makes FDI more likely than the exogenous case. Related with the IPR of the home firm, this paper focus on the role of the two exogenous variables, (1) parameter of spillover-prevention cost function and (2) degree of spillovers when no prevention effort is made, both of which may be lower when the foreign government enforce stricter IPP. In the model, the welfare of the foreign country is always higher with FDI than with exports. This paper shows that the second exogenous variable mentioned above is positively related to the unit trade cost, and that so is the level of spillovers in the endogenous case.

This study may be extended in several ways. First, to examine the effect of market structure, an oligopoly model with $m \geq 1$ homogeneous or a small number of heterogeneous foreign firms is possible options. Especially with heterogeneous (foreign) firms, effects of joint venture may be discussed. Second, to discuss the home country's or world welfare and a policy game among countries, introducing the home government and/or home market is another research agenda. Third, developing the empirical analysis in Figure 4 is another direction of research. For instance, tariff is not the only factor of the unit trade cost, so the robustness of the result should be examined more.

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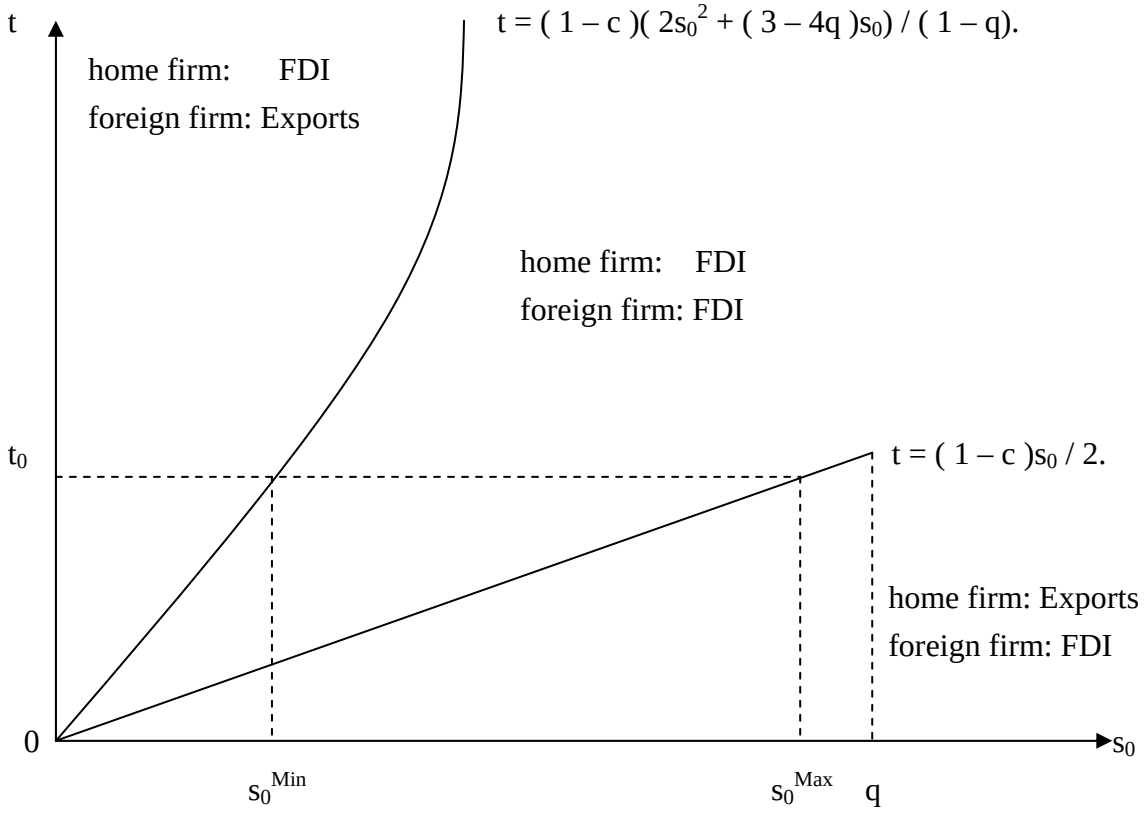


Figure 1 Unit Trade Cost and Exogenous FDI Spillovers

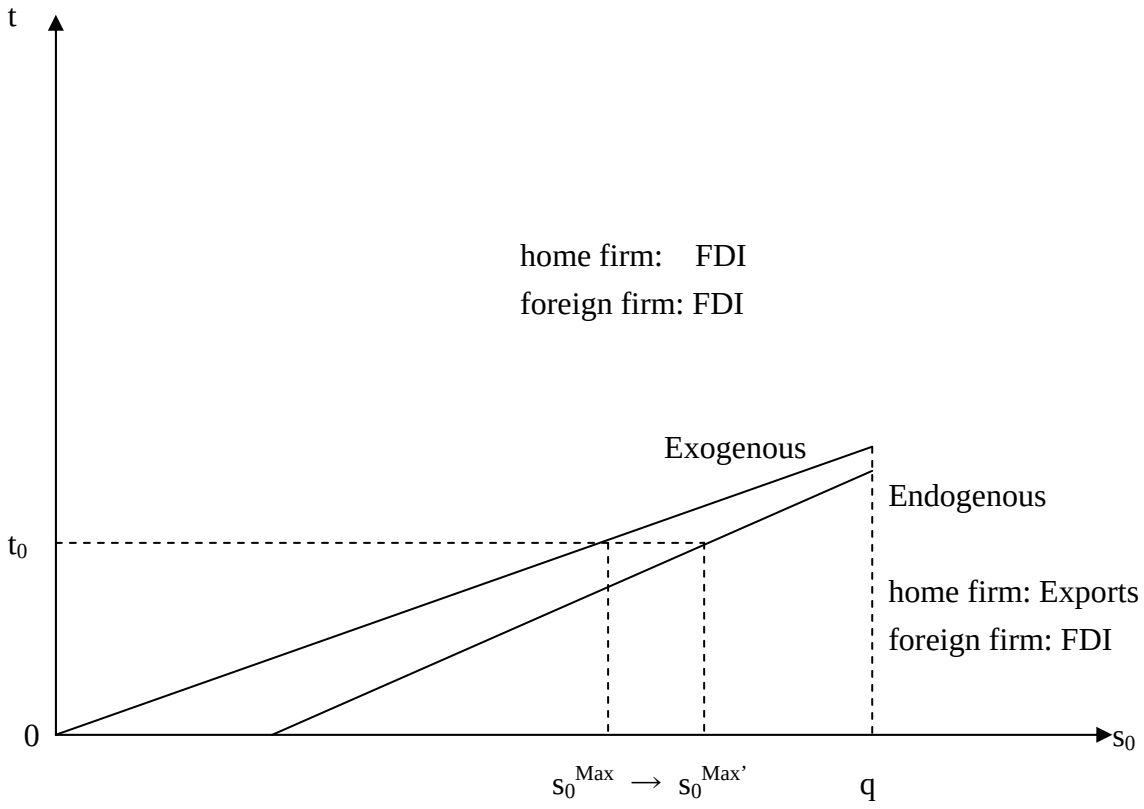


Figure 2 Maximum FDI Spillovers: Exogenous and Endogenous Cases.

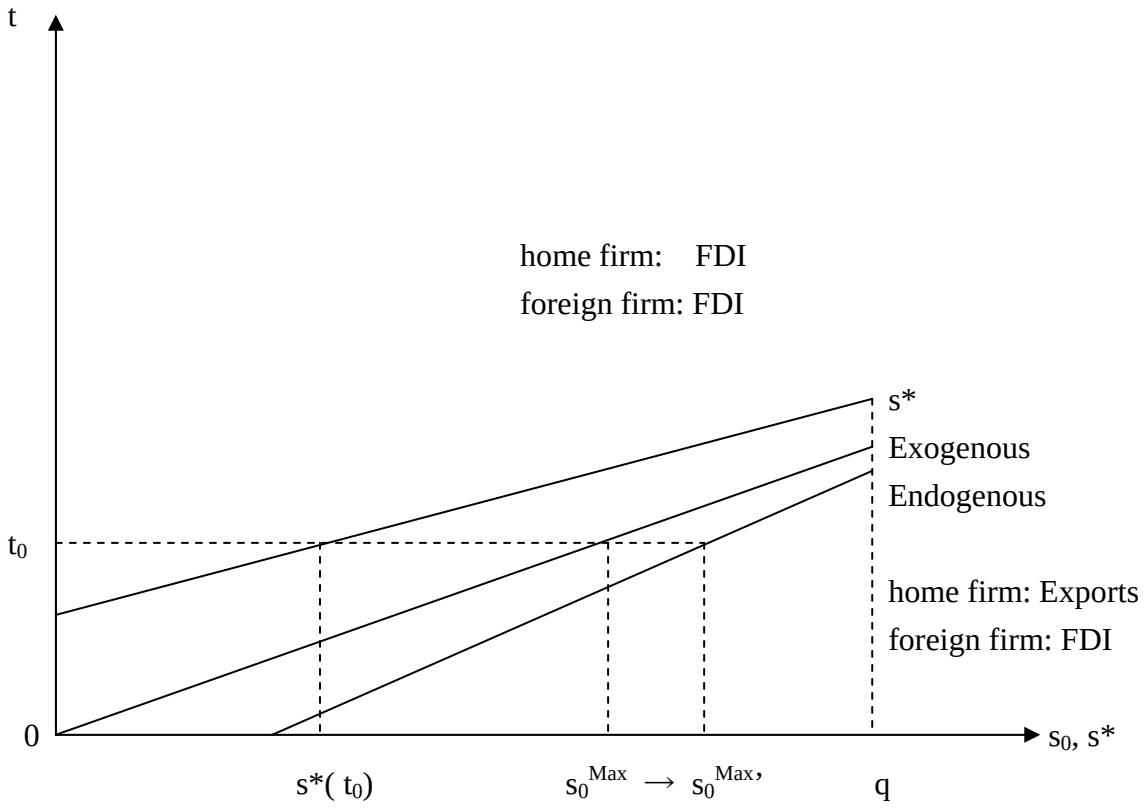
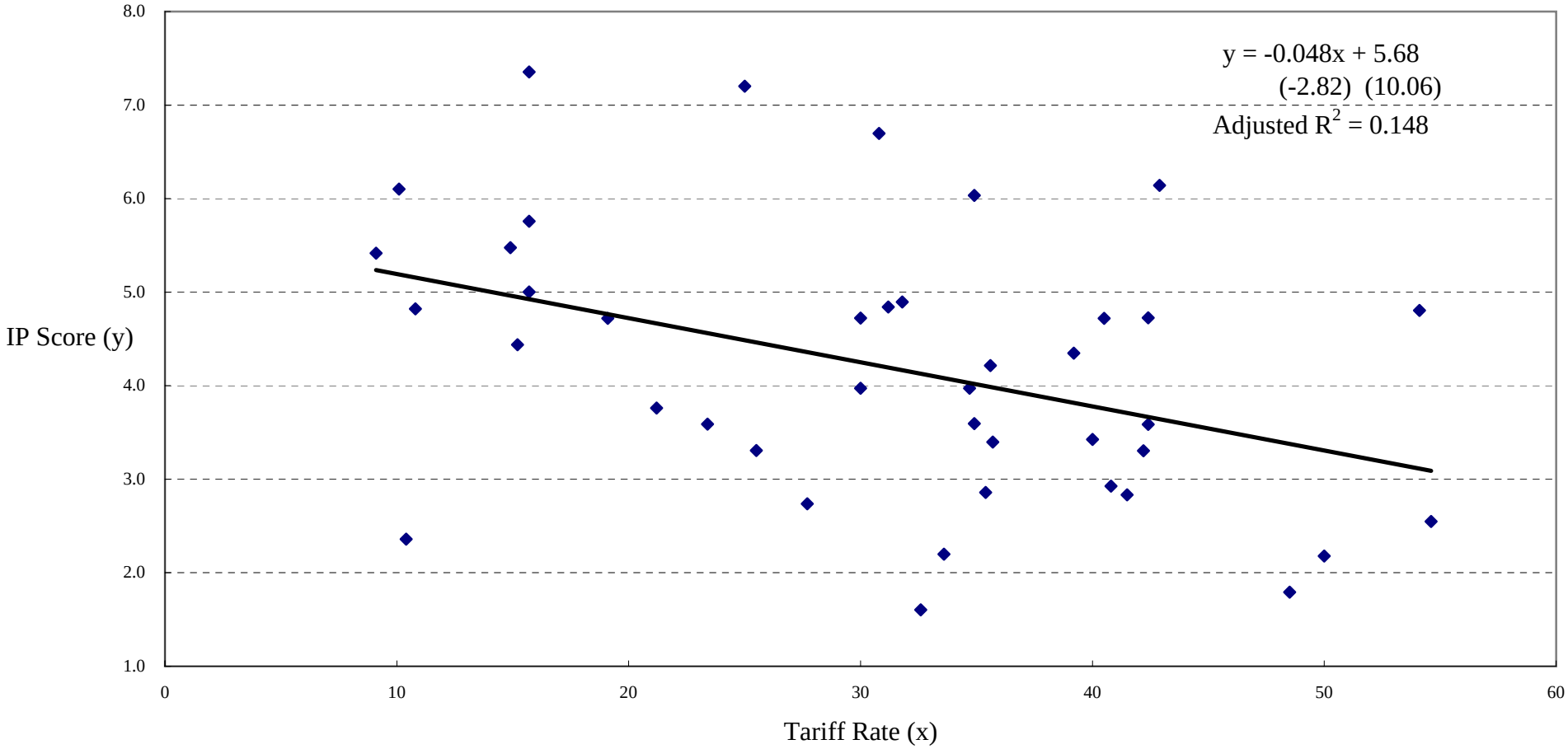


Figure 3 Endogenous FDI Spillovers for a Given Unit Trade Cost.

Figure 4 Average Non-Agriculture Tariff and Strength of Intellectual Property Protection: Cross-Country Analysis



Notes

1. Tariff rate = Simple average based on pre-aggregated HS six-digit averages. Source: WTO international trade and tariff data.
2. IP score is from Lesser (2002).
3. t-values are in parentheses.