Multinational Firms and Strategic FDI Subsidies

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Abstract

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Abstract

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1. Introduction

Nowadays, almost all large firms are multinational firms that supply their products to foreign countries, not only by exporting from parent plants in their domestic countries via their subsidiaries in foreign countries. Indeed, multinational firms employ foreign direct investment (henceforth FDI) to compete in many international oligopolistic or duopolistic markets. With increases in the number of multinationals, trade policies such as import tariffs or export subsidies have been gradually losing their effectiveness and thus governments have gradually shifted their international political attentions from trade policies to direct investment policies such as FDI subsidies (or FDI taxes). Therefore, studies on international oligopoly or duopoly must consider such changes. This paper will investigate the effects of FDI subsidies on firms' FDI levels.[1]

Early in the development of international duopoly models, many studies, following Brander and Krugman (1983) and Brander and Spencer (1984 and 1985), presented various imperfectly competitive trade models (henceforth, ICT models) which analyze the effects of export subsidies. Thus, they showed that the export subsidy is effective as a strategic trade policy and that the optimal export subsidy is not zero (positive in Cournot models and negative in Bertrand models). However, introducing FDI into the ICT models, some papers have recently established imperfectly competitive trade and foreign direct investment models (henceforth, ICTF models) and demonstrated that export subsidies lose their effectiveness as a strategic trade policy, and that the optimal subsidy is zero, in circumstances where multinational firms endogenously choose both exports and FDIs.

For examples of such ICTF models, see Janeba (1998) and Ishii (2001). Janeba (1998)

modified the third country trade model of Brander and Spencer (1985) to consider firms' choices of plant locations (through FDIs), and found that if firms can freely shift their production plants between the domestic and foreign countries, the optimal export subsidy becomes zero. Furthermore, Ishii (2001) extended the reciprocal trade model of Brander and Krugman (1983) and Brander and Spencer (1984) so as to include firms' overseas production (through FDIs), and showed that the optimal export subsidy is also zero in circumstances where firms conduct overseas production as well as domestic production and exports. [2]

Although the ICTF models are more general and realistic than the ICT models since they introduce firms' FDI (or plant locations) as well as exports, they have assumed that FDI sizes (or plant sizes) are exogenous and that governments do not adopt the FDI subsidies (or taxes). However, these assumptions are contrary to the facts. In reality, when firms choose to invest in foreign countries they also choose the quantity of FDI and some governments provide FDI subsidies. Therefore, it is necessary and useful to establish a more generalized ICTF model incorporating these features.

To investigate the issues mentioned above, in this paper I will establish a very simple generalized ICTF model, by extending the reciprocal trade model of by Brander and Krugman (1983), and Brander and Spencer (1984) (henceforth, the B-K-S ICT model) to include firms' FDI and governments' FDI subsidies. [3] Hence, the framework of the present ICTF model is almost the same as that of the B-K-S ICT model of an international Cournot duopoly, but there are some essential differences between these models as the followings.

In the B-K-S ICT model, the domestic and foreign firms have plants only in their own countries and supply products to both. By contrast, in the present ICTF model, the domestic

and foreign firms may have respectively their plants in both of their original countries and their rival's countries (henceforth, parent plants and subsidiary plants). Furthermore, while the B-K-S ICT model has examined optimal export subsidies, the present model will investigate optimal FDI subsidies. Export subsidies are used to control international commodity flows, but FDI subsidies are adopted to manage international FDI flows.

Finally, the B-K-S ICT model employs a two-stage game, but the present model will adopt a three-stage game. Since the present model includes the quantity of firms' FDI (or subsidiary plant sizes) as endogenous variables in addition to governments' subsidies and firms' outputs-exports. Taking into consideration that plant construction takes considerable time, one more stage is required to analyze optimal FDI subsidies. Then, the present model becomes a three stage game model: that is, in the first stage governments determine optimal FDI subsidies, in the second stage firms choose FDI levels, and firms decide output-exports in the third stage. Thus, the present model provide some interesting propositions of FDI subsidies that are not shown by the B-K-S ICT model.

The rest of this paper is organized as follows. Section 2 establishes a generalized ICTF model as explained above. Section 3 analyzes the firms' output-export choices. Section 4 investigates the firms' FDI determinations. Section 5 discusses the optimal FDI subsidies. Section 6 presents concluding remarks.

2. Assumptions and Basic Model

This section establishes a very simple generalized ICTF model of an international Cournot duopoly consisting of a domestic firm and a foreign firm that produce homogenous goods.

Suppose that both these firms have established parent plants in their mother countries and may construct subsidiary plants for producing the same goods in their respective rival countries. This reflects the fact that many multinational firms first establish parent plants and then begin to operate subsidiaries after engaging in export for some years. Thus, when the game begins, while firms' parent plant sizes are exogenous, their subsidiary plant sizes are endogenous.

2.1 Cost functions

Intending to be multinationals, firms must consider three different categories of cost: plant construction, production and export. Therefore, it is necessary to examine these cost functions in some detail.

Plant construction costs: The domestic and foreign firms do not pay any additional construction costs for their parent plants since these plants have been already built, but they must incur construction costs, v and v^*, for their subsidiary plants since these are newly constructed. Suppose that construction costs for the domestic and foreign subsidiary plants are twice differentiable and strictly increasing-convex functions of firms' FDI levels, k and k^*, respectively. Then, the firms' subsidiary plant construction cost functions are given by $v(k)$ (with $v'(k) > 0$ and $v''(k) > 0$) and $v^*(k^*)$ (with $v^{*'}(k^*) > 0$, $v^{*''}(k^*) > 0$), respectively, (henceforth, asterisks * express the foreign variables). Moreover, it is assumed that marginal plant construction costs satisfy $v'(0) = 0$, $v'(\infty) = \infty$, $v^{*'}(0) = 0$ and $v^{*'}(\infty) = \infty$. Although the home and foreign subsidiary plant construction costs are parameters in the third stage, these are endogenous in the second stage.

Production costs: While unit production costs, C and C^*, of the firms' parent plants are both

independent of FDI levels since these are already constructed when the game begins, unit production costs, c and c^*, of the domestic and foreign subsidiary plants depend on their FDI levels, k and k^*, respectively. It is assumed that unit production costs, $c(k)$ and $c^*(k^*)$, of the subsidiaries are respectively twice differentiable, strictly decreasing (due to scale merits, for example) and convex (due to decreasing scale merits) functions, that is, $c'(k) < 0$, $c^{*'}(k^*) < 0$, $c''(k) > 0$ and $c^{*''}(k^*) > 0$. Moreover, it is assumed, for simplicity, that these unit production costs, C, C^*, c and c^*, are respectively independent of the facilities' outputs in the third stage and different from each other, due to differences between the factor prices in two countries and production technologies in production facilities. However, it is not necessary to assume that these unit costs are all equal to unity across all production facilities.[4]

Export Costs: Export costs (G and G^*) of the domestic and foreign firms consist of transportation costs, selling costs, official transaction costs and so on. It is supposed that these are respectively twice differentiable and strictly increasing functions, i.e., $G(T)$ with $G'(T) > 0$ and $G^*(T^*)$ with $G^{*'}(T^*) > 0$, where T and T^* are exports of the domestic and foreign parent firms, respectively. It is plausible to assume that average export costs decrease for the entire positive range of exports due to scale merit, but it is not certain whether marginal export costs increase or decrease for the entire positive range of exports. Therefore, we here make no assumption as to whether marginal export costs are always increasing or decreasing.[5]

As is soon shown, the assumption that marginal export costs are variable plays an important role when multinational firms decide their plant sizes and exports. If export costs

are also constant in addition to the constant marginal production costs, then exports and FDI are perfectly substitutive for each other. That is, if marginal export costs are larger than marginal production costs of subsidiary plants, then firms conduct only overseas production and do not export goods, and *vice versa*. Therefore, variable marginal export costs are necessary to ensure co-existence of firms' exports and overseas production.

2.2 Demand functions

Suppose that the domestic and foreign markets are segregated from each other. While the firms supply goods produced by their parent firms to both countries, they sell goods produced by their subsidiaries only in the rival country. Then, each firm has two routes to supply its products to its rival country, i.e., exports and overseas production. The assumption that the subsidiaries do not export their products back to the parent countries may seem to be strict at first sight, but it is not so in a homogenous good model, from both empirical and theoretical points of view.[6]

Thus, the domestic and foreign inverse demand (twice differentiable) functions are given respectively by $p(Z) = p(X + T^* + Y^*)$ with $p'(Z) < 0$ and $p^*(Z^*) = p^*(X^* + T + Y)$ with $p^{*'}(Z^*) < 0$, where p and p^* are respectively the home and foreign prices, X and T (X^* and T^*) are respectively domestic sale and export of the domestic (foreign) parent plant, and Y (Y^*) is output (= sale) of the domestic (foreign) subsidiary plant.

2.3 Political instruments

As instruments for controlling the firms' FDI flows, this paper concentrates on the FDI subsidies, because they are generally regarded as more useful and appropriate than any other political instrument for controlling the firms' FDIs. Of course, though it is not so

difficult to incorporate other policy instruments, such as tariffs, export subsidies and so on, into the model, the effects of these policies on FDI flows have been already analyzed in many papers. It is assumed that the home and foreign governments provide, respectively, per-unit FDI subsidies, s and s^*, for out-flow FDI and per-unit FDI subsidies, s_k and s_k^*, for in-flow FDI. Of course, the negative FDI subsidies imply the FDI taxes. Let us call s, s_k, s^* and s_k^*, respectively, the domestic out-flow FDI subsidy, the domestic in-flow FDI subsidy, the foreign out-flow FDI subsidy, and the foreign in-flow FDI subsidy, henceforth.

It is also assumed that the domestic and foreign governments choose their FDI subsidies so as to maximize their own welfare in the first stage and keep them constant thereafter. Hence, all FDI subsidies, s, s_k, s^* and s_k^*, are regarded as parameters by the domestic and foreign firms in the second and third stages.

2.4 Firms' profits

Under the assumptions and features presented in the previous subsections, profits of the domestic and foreign firms, Π and Π^*, are defined as:

$$\Pi = \{p(Z)X + p^*(Z^*)T - C(X+T) - G(T)\}$$
$$+ \{p^*(Z^*)Y - c(k)Y - v(k)\} + (s+s_k^*)k, \qquad (1)$$

and

$$\Pi^* = \{p^*(Z^*)X^* + p(Z)T^* - C^*(X^*+T^*) - G^*(T^*)\}$$
$$+ \{p(Z)Y^* - c^*(k^*)Y^* - v^*(k^*)\} + (s^*+s_k)k^*, \qquad (2)$$

where $Z = X + T^* + Y^*$ and $Z^* = X^* + T + Y$ are total sales (= consumption) in the

domestic and foreign countries. In (1) (and (2)), the first and second terms braced by { } are, profits of the domestic (foreign) parent firm and subsidiary, respectively, and the last term is revenue from the governments' FDI subsidies.[7]

The domestic and foreign firms in a Cournot industry act non-cooperatively to maximize their own profits, and the domestic and foreign governments determine their FDI subsidies so as to maximize their own national welfare, as defined in section 5. This paper will solve these problems recursively using the method of backward induction.[8]

3. Optimal Output-Export Choices in the Third Stage

In the third stage, both the domestic and foreign firms make output-export decisions. The domestic (foreign) firms' control variables are output X (X^*), exports T (T^*) of the parent firm and output Y (Y^*) of the subsidiary, respectively. Since firms in a Cournot industry act non-cooperatively, the domestic (foreign) firm chooses X, T and Y (X^*, T^* and Y^*) so as to maximize its profit of (1) ((2)), given the foreign (domestic) firm's output-export levels and all other exogenous variables.

3.1 Profit Maximization Conditions

Consider that control variables of the Cournot multinational firms in this model are not prices but quantities, such as plants, outputs and exports, and that these firms do not face any uncertainties of output and demand. Then, the home and foreign firms need not consider any quantity constraints such as output capacity constraints, as is shown in footnote (7). Therefore, concentrating on the inner solutions since the corner solutions are trivial,[9] the first-order conditions of the domestic and foreign firms for profit maximization are

respectively given by:

$$p(Z) + p'(Z)X - C = 0, \tag{3}$$

$$p^*(Z^*) + p^{*'}(Z^*)(T + Y) - G'(T) - C = 0, \tag{4}$$

$$p^*(Z^*) + p^{*'}(Z^*)(T + Y) - c(k) = 0. \tag{5}$$

and

$$p^*(Z^*) + p^{*'}(Z^*)X^* - C^* = 0, \tag{6}$$

$$p(Z) + p'(Z)(T^* + Y^*) - G^{*'}(T^*) - C^* = 0, \tag{7}$$

$$p(Z) + p'(Z)(T^* + Y^*) - c^*(k^*) = 0. \tag{8}$$

The second-order conditions are satisfied under the demand and cost conditions presented in the previous section.[10]

In these first-order conditions, (3) and (7) (or (3) and (8)) are the reaction functions of the domestic and foreign firms in choosing X and $(T^* + Y^*)$, (4) and (6) (or (5) and (6)) are the reaction functions of the domestic and foreign firms in choosing X^* and $(T + Y)$. Whether these reaction functions are depicted as downward or upward sloping curves depends on whether the products of these firms are strategic substitutes or complements. However, it is more reasonable to suppose that these products are strategic substitutes when they are homogenous. Then, as is well known, the demand functions possess the following properties: $p'(Z) + p^*(Z)X < 0$, $p^{*'}(Z^*) + p^{*'}(Z^*)(T + Y) < 0$, $p^{*'}(Z^*) + p^{*'}(Z^*)X^* < 0$ and $p'(Z) + p^*(Z)(T^* + Y^*) < 0$. Consequently, the reaction curves of the domestic and foreign firms above mentioned are all downward sloping.

3.2 Industry Equilibrium

The Cournot-Nash industry equilibrium in the third stage is given by a vector of (X, T, Y, X^*, T^*, Y^*) that simultaneously satisfies the equation system (3)-(8). However, it is easily shown that while the equilibrium levels of X, T^* and Y^* are derived by solving (3), (7) and (8), the equilibrium levels of X^*, T and Y are obtained by solving (4), (5) and (6). Thus, we may apply the Routh theorem to demonstrate stability of the industry equilibrium.

As is described in the previous section, unit production costs, C and C^*, of the domestic and foreign parent firms are parameters through this paper. On the other hand, while firms' FDI levels, k and k^*, are parameters in the third stage, these are firms' control variables in the second stage. Therefore, it is interesting to examine the effects of changes in k and k^* on the firms' output-export choices.

Totally differentiating (3)-(8) and taking account of the demand and cost functions, one derives the effects of changes in the firms' FDI levels, k and k^*, on the industry equilibrium, X, T, Y, X^*, T^* and Y^* (see Appendix 3):

$$\frac{\partial T}{\partial k} < 0,\ \frac{\partial Y}{\partial k} > 0,\ \frac{\partial X^*}{\partial k} < 0,\ \frac{\partial T^*}{\partial k} = \frac{\partial Y^*}{\partial k} = \frac{\partial X}{\partial k} = 0, \tag{9}$$

$$\frac{\partial T^*}{\partial k^*} < 0,\ \frac{\partial Y^*}{\partial k^*} > 0,\ \frac{\partial X}{\partial k^*} < 0, \text{ and } \frac{\partial T}{\partial k^*} = \frac{\partial Y}{\partial k^*} = \frac{\partial X^*}{\partial k^*} = 0. \tag{10}$$

Then, (9) and (10) provide:

Proposition 1. A rise in the domestic (foreign) firm's FDI increases output of the domestic (foreign) subsidiary, but reduces both export of the domestic (foreign) parent firm and output of the foreign (domestic) parent firm, and *vice versa*. However, it has no effect on output of the domestic (foreign) parent firm, export of foreign (domestic) parent firm or output of the foreign (domestic) subsidiary.

Furthermore, from (9) one gets the following relations (see also Appendix 3): $\frac{\partial(T+Y)}{\partial k} > 0$, $\frac{\partial(T+X+Y)}{\partial k} > 0$, $\frac{\partial Z^*}{\partial k} > 0$, $\frac{\partial(T+X)}{\partial k} < 0$, $\frac{\partial(T^*+X^*)}{\partial k} < 0$, $\frac{\partial(T^*+X^*+Y^*)}{\partial k} < 0$, $\frac{\partial Z}{\partial k} = 0$, and $\frac{\partial(T^*+Y^*)}{\partial k} = 0$. Since the effects of a change in the foreign firms' FDI are parallel to those of a change in the domestic firm's FDI, as is easily demonstrated by (9) and (10), these relations also hold even when the words "domestic" and "foreign" are interchanged. Hence, these results presented above may be paraphrased as:

Corollary 1. A rise in the domestic (foreign) firm's FDI raises domestic (foreign) firm's total overseas sales, domestic (foreign) firm's total output and foreign (domestic) consumption, but reduces domestic (foreign) parent firm's output, foreign (domestic) parent firm's output and foreign (domestic) firm's total output, and *vice versa*. However, a change in the domestic (foreign) firm's FDI has no effect on domestic (foreign) consumption and the foreign (domestic) firm's total overseas sales.

While $\frac{\partial Z^*}{\partial k} > 0$ and $\frac{\partial Z}{\partial k^*} > 0$ imply that FDI raises consumption in the host country, $\frac{\partial Z}{\partial k} = \frac{\partial Z^*}{\partial k^*} = 0$ demonstrates that FDI does not alter the consumption level of the guest country. On the other hand, $\frac{\partial Y}{\partial k} + \frac{\partial T^*}{\partial k} + \frac{\partial X^*}{\partial k} > 0$ and $\frac{\partial Y^*}{\partial k^*} + \frac{\partial T}{\partial k^*} + \frac{\partial X}{\partial k^*} > 0$ mean that FDI increases the output level of the host country, but $\frac{\partial Y^*}{\partial k} + \frac{\partial T}{\partial k} + \frac{\partial X}{\partial k} < 0$ and $\frac{\partial Y}{\partial k^*} + \frac{\partial T^*}{\partial k^*} + \frac{\partial X^*}{\partial k^*} < 0$ indicate that FDI results in a reduction of the output level of the guest country. Hence, FDI is welcomed by both consumers and the firm in the host country, but not welcomed by the firm in the guest country.

When taken together, proposition 1 and corollary 1 show that if the governments can

manage the firms' FDI levels by changing the FDI subsidies, they can use the FDI subsidies as strategic policies to control firms' market shares and revenues. So, in the next section, we will investigate whether governments can control firms' FDI levels by these means.

4. Optimal FDI Decisions in the Second Stage

In the second stage, the Cournot domestic and foreign firms non-cooperatively choose their FDI levels, k and k^*, so as to maximize their own profits, given the governments' FDI subsidies determined in the first stage, the rival's FDI level in the second stage, and the firms' expected third-stage optimal output-export. Although the plant construction cost functions, $v(k)$ and $v^*(k^*)$, are both strictly increasing and convex, neither the domestic nor foreign firms encounter any financial constraints and can freely choose the optimal levels of k and k^*.

Therefore, taking into consideration that conditions (3)-(8) hold in industry equilibrium of the third stage, the first-order conditions for maximizing domestic and foreign firms' profits in the second stage are given respectively by:

$$\frac{\partial \Pi}{\partial k} = p^{*'}(Z^*)\frac{\partial X^*}{\partial k}(T+Y) - c'(k)Y - v'(k) + (s+s_k^*) = 0, \qquad (11)$$

and

$$\frac{\partial \Pi^*}{\partial k^*} = p'(Z)\frac{\partial X}{\partial k^*}(T^*+Y^*) - c^{*'}(k^*)Y^* - v^{*'}(k^*) + (s^*+s_k) = 0. \qquad (12)$$

And, the second-order conditions are $\frac{\partial^2 \Pi}{\partial k^2} < 0$ and $\frac{\partial^2 \Pi^*}{\partial k^{*2}} < 0$, respectively. Then, the inner solution of k and k^* holds under the demand and cost functions mentioned in the previous sections. (11)

The Cournot-Nash industry equilibrium in the second stage is given by k and k^* satisfying (11) and (12) simultaneously. Though there might be a possibility of multiple industry equilibrium, uniqueness is assumed in this section. However, taking account of (9) and (10), it is easily shown that $\frac{\partial^2 \Pi}{\partial k^* \partial k} = 0$ and $\frac{\partial^2 \Pi^*}{\partial k \partial k^*} = 0$ hold at the industry equilibrium. Therefore, these equations and the firms' second-order conditions satisfy the conditions for local stability of the industry equilibrium in the second stage.

As is obvious from (11) and (12), both the industry equilibrium FDI levels, k and k^*, depend on the out-flow and in-flow FDI subsidies, s, s^*, s_k and s_k^*, determined by the domestic and foreign governments in the first stage. So, let us examine the effects of changes in the FDI subsidies on the industry equilibrium FDI levels.

Differentiating (11) and (12) totally, one can obtain the effects of changes in s, s_k^*, s^* and s_k on the industry equilibrium levels of k and k^*:

$$\frac{\partial k^*}{\partial s} = \frac{\partial k^*}{\partial s_k^*} = 0, \quad \frac{\partial k}{\partial s} = \frac{\partial k}{\partial s_k^*} = -\frac{1}{\left(\frac{\partial^2 \Pi}{\partial k^2}\right)} > 0, \tag{13}$$

and

$$\frac{\partial k}{\partial s^*} = \frac{\partial k}{\partial s_k} = 0, \text{ and } \frac{\partial k^*}{\partial s^*} = \frac{\partial k^*}{\partial s_k} = -\frac{1}{\left(\frac{\partial^2 \Pi^*}{\partial k^{*2}}\right)} > 0. \tag{14}$$

Therefore, these results are summarized as the following proposition:

Proposition 2. In the industry equilibrium of the second stage, the domestic (foreign) firm's FDI increases as the domestic (foreign) out-flow FDI subsidy and the foreign (domestic) in-flow FDI subsidy, but is independent of the foreign (domestic) out-flow FDI subsidy and the domestic (foreign) in-flow FDI subsidy.

This proposition shows that even if a single FDI subsidy policy is useless, a coadjutant FDI subsidy policy become effective. For example, neither the domestic nor foreign governments can manage the rival firm's FDI by changing only their out-flow FDI subsidy, but they can control both of the domestic and foreign firms' FDI levels by mixing the out-flow and in-flow FDI subsidies appropriately. Moreover, this proposition, together with proposition 1, also demonstrates that the governments can use FDI subsidies as tools to implement strategic policies, by combining them.

5. Optimal FDI Subsidy Determinations in the First Stage

In the first stage, the domestic and foreign governments non-cooperatively and simultaneously decide their FDI subsidies, $(s,\ s_k)$ and $(s^*,\ s_k^*)$ so as to maximize their own welfare. Therefore, it is crucially important what kinds of welfare functions are adopted by the governments in determining optimal FDI subsidies. This section considers two types of welfare functions. One is ordinary social surplus that is sum of consumer surplus, producer surplus and government surplus (= government FDI subsidies), and the other is extended social surplus that adds the labor employment assessment.[12]

Since FDI affects labor employment in both the domestic and foreign countries, it is quite natural that the governments consider these effects when determining their optimal FDI subsidies. Generally, in-flow (out-flow) FDI is regarded as an instrument to increase (decrease) labor employment, and then some countries suffering from a considerable amount of unemployment are apt to give positive in-flow subsidies and to impose negative subsidies (taxes) on out-flow FDI. However, as far as I know, no papers have examined whether such

the FDI subsidy policies are always appropriate. Therefore, it is useful and important to analyze the optimal FDI subsidies based on the two types of welfare functions and to examine the differences between these optimal FDI subsidies.[13]

5.1 Optimal FDI Subsidies without Considering Labor Assessment

In this subsection we investigate optimal FDI subsidy policies in a case where the governments do not assess labor employment and regard the social welfare as the welfare functions. Such the case is conceivable when perfect employment is achieved and/or the effect of FDI on labor employment is negligibly small.

Adopting the same notations and functions as in previous sections, the domestic social welfare, W, is given by:

$$W = \{\int_0^Z p(\theta)d\theta - p(Z)Z\} + \Pi - sk - s_k k^*, \tag{15}$$

where the first term, $\{\int_0^Z p(\theta)d\theta - p(Z)Z\}$, is the domesic consumer surplus, the second term, Π, is the domestic firm's profit, the third term, sk, is the domestic subsidy payment for out-flow FDI, and the last term, $s_k k^*$, is the domestic subsidy payment for in-flow FDI. The domestic government chooses the domestic out-flow and in-flow subsidies, s and s_k, so as to maximize the domestic social welfare defined by (15). Of course, negative s (s_k) implies a tax on out-flow (in-flow) FDI.

Considering that (13) and (14) hold at the industry equilibrium in the second stage, the first-order conditions for maximizing domestic social welfare in the first stage are given by:

$$s\frac{\partial k}{\partial s} = 0, \tag{16}$$

and

$$p'(Z)(T^* + Y^*)\frac{\partial Z}{\partial k^*} + \frac{k^*}{\left(\frac{\partial k^*}{\partial s_k}\right)} + s_k = 0, \tag{17}$$

Then, assuming, for simplicity, that the second-order conditions are satisfied in the neighborhood of the equilibrium, the optimal domestic out-flow and in-flow subsidies, denoted by s^e and s_k^e, are given respectively by the solutions to the first-order conditions of (16) and (17).

Since $\frac{\partial k}{\partial s} > 0$ holds (see (13)), one obtains from (16):

$$s^e = 0. \tag{18}$$

Thus, the optimal domestic out-flow FDI subsidy is zero. On the other hand, form (17) one gets:

$$s_k^e = -p'(Z)(T^* + Y^*)\frac{\partial Z}{\partial k^*} - \frac{k^*}{\left(\frac{\partial k^*}{\partial s_k}\right)}. \tag{19}$$

Considering $p'(Z) < 0$, $\frac{\partial Z}{\partial k^*} > 0$ and $\frac{\partial k^*}{\partial s_k} > 0$ (see (10) and (14)), the first term of (19) is positive, but the second term is negative. Therefore, the optimal domestic in-flow FDI subsidy is positive or negative as the first term is larger or smaller than the absolute value of the second term.

There are several cases in which the optimal domestic in-flow FDI subsidy, s_k^e, becomes positive. One occurs when (i) domestic in-flow FDI, k^*, is very small. For example, if k^* □0 holds, then (19) reduces to $s_k^e \neq -p'(Z)T^*\frac{\partial Z}{\partial k^*} > 0$. This is the most typical case that is often observed at the beginning of FDI. Furthermore, s_k^e also becomes positive when at least one of the effect of a change in the domestic in-flow FDI subsidy on the domestic in-flow FDI,

$\frac{\partial k^*}{\partial s_k}$, a slope of the domestic demand curve, $p'(Z)$, the effect of a change in the domestic in-flow FDI on domestic consumption, $\frac{\partial Z}{\partial k^*}$, and total supply of the foreign firm in the domestic county, $(T^* + Y^*)$, is very large.

The same reasoning as just employed in obtaining (18) and (19) is also applied to the optimal foreign FDI subsidies, because the decisions of optimal domestic and foreign FDI subsidies are symmetrical to each other. Therefore, from (18) and (19) one obtains the next proposition:

Proposition 3: If the governments adopt ordinary social surplus as their welfare functions, (1) the optimal domestic and foreign out-flow FDI subsidies are both zero, and (2) the optimal domestic (foreign) in-flow FDI subsidy is positive when the domestic (foreign) in-flow FDI is very small and/or at least one of the effect of a change in the domestic in-flow FDI subsidy on the domestic in-flow FDI, a slope of the domestic demand curve, the effect of a change in the domestic in-flow FDI on domestic consumption and total supply of the foreign firm in the domestic county is very large, and *vice versa.*

The political asymmetry between optimal out-flow and in-flow FDI subsidies stems from the asymmetry between the effects of changes in out-flow and in-flow FDI subsidies on the firms' FDIs (see proposition 2). It is obvious from (13) and (14) that a change in s or s_k^* (s_k or s_k^*) has a positive effect on k (k^*) but has no effect on k^* (k^*). Moreover, proposition 3 shows that the optimal FDI subsidy policy is to give nothing to out-flow FDI (laissez-faire) and to give a positive subsidy to in-flow FDI when the governments do not assess labor employment. Therefore, when the governments adopt the ordinary social surplus as the welfare function, positive subsidies on in-flow FDI are appropriate, while negative subsidies (= taxes) on out-

flow FDI are not..

5.2 Optimal FDI Subsidies with Considering Labor Assessments

In the previous subsection, it is assumed that governments choose their optimal FDI subsidies without assessing labor employment. Such the assumption might be plausible when the countries enjoy full employment and/or the effects of FDI on labor employment are sufficiently small. However, in a case where the countries are worried about labor unemployment, the governments would give particular assessments to labor employment as well as ordinal social welfare when deciding their optimal FDI subsidies. This subsection examines the optimal FDI subsidies in such the case where the governments maximize extended social surplus and compares it with the optimal FDI subsidies in the case where the governments do not consider the labor employment assessments.[14]

Domestic labor employment, E, of the industry in question is sum of labor employment, L, by the domestic parent firm and labor employment, l, by the foreign subsidiary, i.e., $E = L + l$. Then, the labor employment assessment of the home government, V, is given by $V = V(E) = V(L+l)$, and it is assumed that $V(E)$ is a strictly increasing and concave function of E, that is, the marginal assessment of labor employment is positive but decreasing: $V = V(E)$ with $V'(E) > 0$ and $V''(E) < 0$.

When labor employment assessment is taken into account, the domestic social welfare, W_L, is defined as:

$$W_L = \{\int_0^Z p(\theta)d\theta - p(Z)Z\} + \Pi - sk - s_k k^* + V(E), \qquad (20)$$

where the first four terms represent the ordinary social surplus and the last term is employment assessment. Moreover, considering that marginal product of labor is positive,

labor employment, L, of the domestic parent firm and labor employment, l, of the foreign subsidiary are both expressed as increasing functions of their outputs, $X+T$ and Y^*, that is, $L = L(X+T)$ with $L'(X+T) > 0$ and $l = l(Y^*)$ with $l'(Y^*) > 0$. Consequently, the domestic social welfare, W_L, is rewritten as:

$$W_L = \{\int_0^Z p(\theta)d\theta - p(Z)Z\} + \Pi - sk - s_k k^* + V\{L(X+T)+l(Y^*)\}. \qquad (20)'$$

Therefore, the domestic government chooses s and s_k so as to maximize the domestic social welfare defined as (20)'.

Assuming that the second-order conditions are satisfied, for omitting some tedious but unessential arguments to examine these conditions, the optimal domestic out-flow and in-flow FDI subsidies are obtained by solving the first-order conditions:

$$-s + V'(E)\,L'(X+T)\frac{\partial T}{\partial k} = 0, \qquad (21)$$

and

$$p'(Z)(T^*+Y^*)\frac{\partial Z}{\partial k^*} + \frac{k^*}{\left(\frac{\partial k^*}{\partial s_k}\right)} + s_k - V'(E)\{L'(X+T)\frac{\partial X}{\partial k^*} + l'(Y^*)\frac{\partial Y^*}{\partial k^*}\} = 0. \qquad (22)$$

Therefore, it is easily shown that the optimal domestic out-flow FDI subsidy, s_L^e, is negative and thus smaller than s^e since, under the conditions of (9), (10), the labor employment and assessment function, (21) presents:

$$s_L^e = V'(E)\,L'(X+T)\frac{\partial T}{\partial k} < 0. \qquad (23)$$

On the other hand, the optimal domestic in-flow FDI subsidy, s_{Lk}^e, is derived from (22) as:

$$s^{e}_{Lk} = -p'(Z)(T^{*}+Y^{*})\frac{\partial Z}{\partial k^{*}} - \frac{k^{*}}{\left(\frac{\partial k^{*}}{\partial s_{k}}\right)}$$

$$+ V'(E)\,L'(X+T)\frac{\partial X}{\partial k^{*}} + V'(E)\,l'(Y^{*})\frac{\partial Y^{*}}{\partial k^{*}}. \quad (24)$$

Therefore, one can not judge definitely sign of the optimal domestic in-flow FDI subsidy given by the right side of (24) since the first and last terms are positive, but the second and third terms are negative. The optimal dome in-flow FDI subsidy is positive as sum of first and last terms is larger (smaller) than the absolute value of sum of the second and third terms, and *vice versa.*

It is obvious, from (19) and (24), that the optimal domestic in-flow FDI subsidy, s^{e}_{Lk}, in the case where governments assess labor employment is not always larger than the optimal domestic in-flow FDI subsidy, s^{e}_{k}, in the case where governments do not assess labor employment. This is why s^{e}_{Lk} depends on effects of a change in the foreign FDI on labor employment by the domestic parent firm and by the foreign subsidiary, $L'(X+T)\frac{\partial X}{\partial k^{*}}$ and $l'(Y^{*})\frac{\partial Y^{*}}{\partial k^{*}}$. While a rise (decrease) in the domestic in-flow FDI (= the foreign out-flow FDI) increases (reduces) labor employment of the foreign subsidiary firm, $l'(Y^{*})\frac{\partial Y^{*}}{\partial k^{*}} > 0$, it reduces (increases) labor employment of the domestic parent firm, $L'(X+T)\frac{\partial X}{\partial k^{*}} < 0$. Therefore, s^{e}_{Lk} is larger (smaller) than s^{e}_{k} if and only if $| L'(X+T)\frac{\partial X}{\partial k^{*}} |$ is smaller (larger) than $l'(Y^{*})\frac{\partial Y^{*}}{\partial k^{*}}$.

Since the same reasoning as is just adopted above is also applied to the optimal foreign out-flow and in-flow FDI subsidies, s^{*e}_{L} and s^{*e}_{Lk}, the similar results as those derived from

(23) and (24) are also obtained with respect to s_L^{*e} and s_{Lk}^{*e}. Hence, from the arguments presented above, one gets the following proposition:

Proposition 4. When governments consider employment assessment, (1) both the optimal domestic and foreign out-flow FDI subsidies are negative and less than those when governments consider no employment assessments, respectively, (2) the optimal domestic (foreign) in-flow FDI subsidy is ambiguous in its sign and larger than that in the case where governments consider no employment assessments if and only if the absolute value of the effect of a change in domestic (foreign) in-flow FDI on labor employment of the domestic (foreign) parent firm is smaller than the effect of a change in domestic (foreign) in-flow FDI on foreign (domestic) subsidiary's labor employment, and *vice versa*.

A conceivable case in which the domestic government imposes a tax on its in-flow FDI occurs in circumstance where the domestic in-flow FDI, k^*, is very big and its marginal effect on labor employment of the foreign subsidiary, $l'(Y^*)\frac{\partial Y^*}{\partial k^*}$, is very small. In this case, the absolute value of sum of the second and third terms in (24) exceeds sum of the first and last terms in (24). Thus, from a theoretical point of view one cannot exclude such the case where the in-flow FDI subsidy is negative, though it is observed but rarely in the real world.

A political asymmetry between optimal out-flow and in-flow FDI subsidies also holds in the case where governments adopt social welfare defined as (20) or (20)'. However, the asymmetry here is essentially different from that in the previous subsection. Proposition 3 shows that, when governments do not consider labor employment assessments, while the government should not intervene into the out-flow FDI, it should give a positive subsidy to the in-flow FDI.

On the contrary, proposition 4 indicates that, when governments assess labor employment as well, while the governments impose taxes on out-flow FDI, they should determine to give subsidies or to impose taxes on in-flow FDI, after observing carefully the effect of a change in in-flow FDI on labor employment of its parent firm and rival's subsidiary firm. There is a possibility that governments must impose taxes on in-flow FDI in circumstances where a rise in in-flow FDI causes a radical reduction in their labor employment. Therefore, it is wrong for governments always to give positive subsidies to in-flow FDI even in circumstances where they are suffering from a certain amount of labor unemployment.

6. Concluding Remarks

Establishing a generalized ICTF model of an international Cournot industry that consists of the domestic and foreign multinational firms, this paper investigates the effects of FDI subsidies on firms' FDI and the optimal FDI subsidies. Some interesting results have been obtained. However, since they have been summarized as propositions in previous sections, we do not repeat all of them, but only refer to some of their general features.

The paper shows that governments can use FDI subsidies as strategic international policies by combining appropriately out-flow and in-flow FDI subsidies. The governments cannot control the in-flow (out-flow) FDI by using only out-flow (or in-flow) FDI subsidy, but they can effectively manage one or both of the in-flow and out-flow FDIs by mixing in-flow and out-flow FDI subsidies.

Furthermore, the paper finds that optimal FDI subsidies depend on whether the governments care about labor employment. While the optimal domestic and foreign out-flow

FDI subsidies are zero when the governments neglect employment assessment, they are negative when the governments assess labor employment. And, the optimal domestic (foreign) in-flow FDI subsidy in the former case is lager than that in the latter case as the absolute value of the effect of a change in foreign (domestic) in-flow FDI on labor employment of domestic (foreign) parent firm is smaller than the effect of a change in foreign (domestic) in-flow FDI on labor employment of foreign (domestic) subsidiary firm, and *vice versa*.

It could be also shown, though this paper does not discuss it explicitly, that the FDI subsidies do not have such drastic effects on the firms' plant choices as are indicated by Markusen, et al. (1993)[8]. In the present model, since firms can endogenously choose their subsidiary plant sizes in the second stage, costs for constructing them are also firms' control variables, though these are fixed when firms decide their output-export levels in the third stage. Therefore, firms can choose their subsidiary construction costs by changing their subsidiary plant sizes when governments determine their optimal FDI subsidies. In such a case, firms would change their subsidiary plant sizes more smoothly, compared to the case in which they must drastically open or close subsidiary plants of constant size.

Of course, the present ICTF model cannot explain all aspects of multi-nationals' FDI choices and the governments' FDI subsidies. It is clearly irrelevant for some industries and policies. Therefore, in order to investigate other aspects appropriately, it is necessary to extend the model. There are several ways to extend and/or generalize the model.

The present model assumes homogenous goods, fixed sizes of parent plants, and a three-stage game of a Cournot duopoly. However, when examining the Beltrand duopoly for

example, an assumption of heterogeneous goods would be much more plausible. In order to concentrate on FDI subsidies, this paper excludes other political instruments that may have effects on the firms' FDI flows, and it also neglects some interesting issues such as transfer prices, technological transfers and technology spillovers that are specific to multinationals. It seems interesting and useful to compare the effectiveness of FDI subsidies with that of other policy instruments. Furthermore, need to be modified if a more global welfare function were introduced. However, analyses considering the modifications mentioned above will be presented in future papers.

Appendix 1.

Here we first discuss a theoretical plausibility of the assumption that, in a homogenous good model, the domestic subsidiary supplies its product only to the foreign country.

If both the domestic parent and subsidiary supply their products to the domestic and foreign countries, the domestic firm's profit is defined as:

$$\Pi = p(X+T^*+Y^*+y)(X+y)+p^*(X^*+T+Y+y^*)(T+Y) - C(X+T) - G(T) - c(k)(Y+y) - v(k) - h(y) + (s+s_k^*)k,$$

where y is the domestic subsidiary's exports, $h(y)$ is its export cost function with $h'(y)>0$, and other notations and functions are all the same as those in section 2. Then, the first-order condition of the domestic multinational firm is given by: $p'(Z)(X+y) + p(Z)-C=0$, $p''(Z^*)(T+Y)+p^*(Z^*)-G'(T)-C=0$, $p''(Z^*)(T+Y)+p^*(Z^*)-c(k)=0$, and $p'(Z)(X+y)+p(Z)-h'(y)-c(k)=0$. Hence, from (i) - (iv) one gets:

$$g'(T)+h'(y)=0. \qquad \text{(A.1)}$$

However, (A.1) is inconsistent with the assumptions of positive marginal export costs. This implies, from a theoretical point of view, that it is not possible for both the domestic parent and subsidiary to supply their products to both of the foreign and domestic countries in a homogeneous good model. Thus, considering many empirical observations of multinational firms (see footnote 6), it is reasonable to assume that the domestic subsidiary sells its products only in the foreign country and does not export them back to the domestic country. The same reasoning is also applied to the foreign multinational firm.

Appendix 2.

From (4) and (5), one gets the condition under which the domestic parent's export is

positive:

$$G'(T) + C = c(k). \tag{A.2}$$

This shows that the domestic multinational firm chooses its export T so as to equate effective unit export cost, $G'(T) + C$, to unit production cost of its subsidiary, $c(k)$. Then, one might indicate that since C and $c(k)$ are both parameters in the third stage, T becomes zero (a corner solution) if C is bigger than $c(k)$. However, since $c(k)$ is one of the control variables in the second stage, the domestic firm which intends to supply its products to the foreign country through two routes (exporting and overseas production) would decide $c(k)$ in the second stage so that it may choose positive exports in the third stage. The same reasoning applies to the foreign multinational firm.

Appendix 3.

Here, we show only the derivation of (10), since that of (9) is obtained by exchanging variables with and without asterisks, respectively. The effects of a change in k^* on X, T^* and Y^* are obtained by totally differentiating equations (5), (6) and (1) with respect to k^*:

$$\begin{pmatrix} \Delta_{11} & \Delta_{12} & \Delta_{13} \\ \Delta_{21} & \Delta_{22} & \Delta_{23} \\ \Delta_{31} & \Delta_{32} & \Delta_{33} \end{pmatrix} \begin{pmatrix} \dfrac{\partial T^*}{\partial k^*} \\ \dfrac{\partial Y^*}{\partial k^*} \\ \dfrac{\partial X}{\partial k^*} \end{pmatrix} = \begin{pmatrix} 0 \\ c''(k^*) \\ 0 \end{pmatrix}, \tag{A.3}$$

where $\Delta_{11} = p'(Z)(T^* + Y^*) + 2p'(Z) - G''(T^*)$, $\Delta_{12} = \Delta_{21} = \Delta_{22} = p'(Z)(T^* + Y^*) + 2p'(Z)$, $\Delta_{13} = \Delta_{23} = p'(Z)(T^* + Y^*) + p'(Z)$, $\Delta_{31} = \Delta_{32} = p'(Z)X + p'(Z)$, and $\Delta_{33} = p'(Z)X + 2p'(Z)$. Then, getting $\dfrac{\partial T^*}{\partial k^*}$, $\dfrac{\partial Y^*}{\partial k^*}$ and $\dfrac{\partial X}{\partial k^*}$ from (A.2) and substituting features of the demand functions and the second-order conditions for maximizing profits into the results, one gets (10).

Footnotes

1. As is well known, not only FDI subsidies but also trade policies such as tariffs, export subsidies and voluntary export restraints affect FDIs. However, since political instruments other than FDI subsidies have their own purposes, it is rare that they are used to control directly the FDIs. Furthermore, the effects of these policies on the FDIs have been already analyzed by many papers including Brander and Spencer (1987), Flamm and Reiss (1993), Hillman and Ursprung (1993), Konishi, Saggi and Weber (1999) and Williamson (1986). Thus, this paper concentrates on analyses of the FDI subsidies.
2. Markusen, Morey and Olewiler (1993) established a model that considers the firms' endogenous plant locations in analyzing the environmental pollution policies. However, they implicitly assumed that firms are 'footloose' as has been indicated by Motta and Thisse (1994) and that firms' plant sizes are exogenously given. However, when analyzing the multinationals that already have parent firms and intend to construct the subsidiary plants in other countries, such assumptions are not appropriate.
3. The present model also depends on Motta and Thisse (1994), Brander and Spencer (1987) and Hoel (1997). It assumes, following Motta and Thisse (1994), that both home and foreign firms have already established parent plants in their countries when the game begins. Moreover, it adopts the two types of welfare function proposed by Brander and Spencer (1984) and Hoel (1997), i.e., an ordinal social surplus excluding employment assessments and an extended social surplus including employment assessments.
4. The strictly increasing and convex plant construction cost function and the constant unit production costs are derived when the production functions of the firms are strictly increasing and concave with respect to capital stocks and homogenous of degree one with respect to other factors except for capital stocks, respectively.

5. Though detail discussions are omitted here to save spaces, increasing marginal export costs, $G^{*}(T) > 0$ and $G^{**}(T^{*}) > 0$, are necessary in the neighborhood of the equilibrium to ensure both the second-order condition of the firms' profit maximization and the stability condition of the industry equilibrium in the third stage. Moreover, it is easily shown that the increasing marginal export cost is not incompatible with the decreasing average export cost under certain reasonable conditions. Though one of the referees suggested $G^{*}(T) < 0$ and $G^{**}(T^{*}) < 0$ for all range of exports, I would not agree with this suggestion since these satisfy neither of the two kinds of condition mentioned above.

6. Some researchers have found that many subsidiaries do not export their products to the mother countries where the parent firms produce homogenous goods (see Belderbos and Sleuwaegen (1996), Blonigen (2001) and Baldwin and Ottaviano (2002), for example). Furthermore, as regards the theoretical explanation, see Appendix 1.

7. Output capacity constraints become significant in a model of Bertrant oligopoly facing demand uncertainty, for example. This is why there exists a possibility in such a model that outputs corresponding to the prices determined under demand uncertainty are smaller than the realized demand when uncertainty is resolved. However, in a Cournot oligopoly considering no uncertainty, since outputs are always equal to demand, the firms do not face any capacity constraints. With respect to capacity constraints, see Bjorksten (1994) and Bughin (1996), for example.

8. When the subsidiary plant sizes are exogenously fixed, the present ICTF model reduces to the ICTF model exploited by Ishii (2001).

9. With respect to the plausibility of the inner solution, see appendix 2.

10. The second-order condition for maximizing the domestic (foreign) firm's profit is that the

Hessian H (H*) is negative definite in the neighborhood of the equilibrium, where, adopting the notations of $D_{11} = p^{*}(Z)X + 2p^{'}(Z)$, $D_{22} = p^{**}(Z^{*})(T+Y) + 2p^{*}(Z^{*}) - G^{'}(T)$ and $D_{23} = D_{32} = D_{33} = p^{**}(Z^{*})(T+Y) + 2p^{*}(Z^{*})$, H is defined as

$$\begin{pmatrix} D_{11} & 0 & 0 \\ 0 & D_{22} & D_{23} \\ 0 & D_{32} & D_{33} \end{pmatrix} .$$

And, H* is given by exchanging notations with * and those without * in H.

11. In (11), when the reasonable conditions of $\lim_{k=0} v'(k) = 0$ and $\lim_{k=\infty} v'(k) = \infty$ are adopted, a corner solution of $k = 0$ is excluded. The same reasoning is applied to (12).

12. Though one of the two referees suggested that more global social welfare should be adopted, we postponed the analyses based on such global social welfare to future studies.

13. One should note that the propositions and the corollary presented in previous sections hold without any modifications even if governments adopt either of these welfare functions, since the analytical framework of the model in the previous sections is independent of the welfare function adopted by governments.

14 For example, extending the Harris-Todaro model, Bennett and Phelps (1983), Chandra and Khan (1993), Choi and Beladi (1993), Chao and Yu (1997) have shown that unemployment in the manufacturing (or urban) sector is essential in some countries.

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