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INTERNATIONAL TRADE AND STRATEGIC CHOICE OF CAPACITY*

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This paper analyzes how investment in production capacity by firms influences their decision on whether to engage in FDI or export. Firms have two options as to how to serve a foreign market: (i) to export products to that market, paying a trade cost; and (ii) to produce there by engaging in FDI, incurring a fixed cost. We find that the range of parameters under which firms choose to export rather than to engage in FDI is greater when firms invest in capacity than when they do not. This contrasts with the result obtained when firms invest in R&D, when their investment encourages them to engage in FDI. There are cases where the mode of foreign expansion preferred by firms does not maximize joint welfare. We find that governments can get firms to adopt the right mode of foreign expansion by discouraging the other mode with a high enough fixed tax or fee.

Key words: international trade, FDI, capacity.

JEL Classification: L13, F13, D24.

Foreign Direct Investment (FDI) has spread rapidly through the world economy in the past two decades [see Mody (2004), UNCTAD (2013)]. The literature analyzing international trade has studied the reasons that lead firms to engage in FDI, e.g. reducing wage costs, breaking into foreign markets, and establishing cooperation agreements with other firms[1]. However, that literature does not analyze how the investment in capacity made by firms affects their decision on whether to engage in FDI or not[2]. The main objective of this paper is to address that issue.

A related issue is analyzed by papers that study how R&D investment by firms affects FDI. Petit and Sanna-Randaccio (1998, 2000) show that investment in R&D encourages firms to expand abroad via FDI rather than via exports. Norbäck (2001)

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(1) See Markusen (2002) for a survey of literature that analyzes the causes and consequences of strategic FDI.

(2) The literature that analyzes the investment in capacity made by firms [see for example Lu and Poddar (2005, 2009), Bárcena-Ruiz and Garzón (2007, 2010)] does not analyze how that investment affects the way in which firms serve foreign markets.

analyzes a similar issue considering that technology can be implemented at home without costs or abroad with a transfer cost. These studies have been extended by considering that there are spillovers in R&D [Sanna-Randaccio (2002)] and that investment by firms lowers production costs and raises demand for the firms' products [Lehay and Pavelin (2008)]. Bárcena-Ruiz and Garzón (2014) consider that firms may reduce their production costs by investing in R&D and by moving their plants abroad, and show that these two mechanisms are complementary. They show that investment in R&D encourages firms to engage in FDI.

In this paper we analyze whether firms engage in FDI or export considering a factor that has not hitherto been examined by the relevant literature: firms invest in capacity and may have excess capacity. There is evidence that excess capacity affects the decision making of multinational firms [see Janeba (2002)]. For example, in the European light-vehicle market many automobile companies produce in both Western Europe and some of the transitional economies in Eastern Europe. Current and predicted total capacity levels exceed production by about 4 million units, or about 25-30%.

We consider two identical countries, with segmented markets. There is one firm in each country. To serve the other country firms have two options: (i) to export products to that country, paying a trade cost; and (ii) to produce there by engaging in FDI, incurring a fixed cost. Firms have identical technologies and invest in production capacity. For the sake of simplification, we assume that the cost of the investment in capacity is zero. This enables us to focus the analysis on the cost of excess capacity or undercapacity. Both excess capacity and undercapacity, which also entails a cost, are inefficient. The advantage of investing in capacity is that the output of each firm increases with its own capacity and decreases with that of its rival. The positive effect of each firm's capacity on its output is greater than the negative effect of the rival's capacity. Thus, in equilibrium firms have excess capacity.

The results presented in the paper depend on four factors: First, the cost of excess capacity, which discourages FDI[3]; second, the trade cost paid when firms export, which encourages FDI; third, the fixed cost of engaging in FDI, which encourages exporting; and finally, the greater revenue obtained by firms when they export than when they engage in FDI if the trade cost is low enough. Depending on which of these effects dominates there are three different equilibria. If the fixed cost of engaging in FDI is high enough, in equilibrium both firms export. If that cost takes an intermediate value and the trade cost is high one firm exports and the other engages in FDI. Therefore, an asymmetric equilibrium is obtained in a symmetric model. Finally, if the fixed cost is low enough both firms engage in FDI.

To compare with the case in which firms invest in capacity, we consider a benchmark case in which they do not do so. In this case the first factor does not exist. We find that, in equilibrium, both firms export if the fixed cost of engaging in FDI is high

(3) Note that production is concentrated in one plant when firms export but takes place in two plants when they engage in FDI. With the quadratic cost of excess capacity, exporting costs firms more for a given level of excess capacity. In equilibrium, this results in less excess capacity, and a lower cost of excess capacity, when firms export than when they engage in FDI. Therefore, the choice of production capacity and the cost of excess capacity or undercapacity are affected by different modes of foreign expansion.

enough; otherwise both firms engage in FDI. By comparison we obtain that the range of parameters under which firms choose to export rather than to engage in FDI is greater when they invest in capacity than when they do not. This result contrasts with that obtained when firms invest in R&D since in that case the investment made by firms encourages them to engage in FDI[4].

We have conducted a welfare analysis to examine whether firms' mode of foreign expansion maximizes the joint welfare of the countries. We obtain that, in general, the maximum joint welfare is obtained when the two countries export (engage in FDI) if the cost of engaging in FDI is high (low) enough, and when one country exports and the other engages in FDI for the remaining value of parameters. There are cases where the mode of foreign expansion preferred by firms does not maximize joint welfare. We find that governments can get firms to adopt the right mode of foreign expansion by setting regulatory restrictions discouraging one mode of foreign expansion, e.g. penalizing FDI or exports with a high enough fixed tax or fee. Those penalties can be set in one country or in both, in which case they have to be set in a coordinated fashion by countries. It is also necessary to make side payments to get both countries to increase their welfares.

The rest of the paper is organized as follows. Section 1 presents the model. Section 2 analyzes the case in which firms invest in capacity. Section 3 considers a benchmark case in which firms do not invest in capacity. Section 4 compares the two cases, Section 5 undertakes a welfare analysis and Section 6 concludes.

1. The model

Consider two identical countries denoted by A and B. There is one domestic firm in each country: firm 1 in country A and firm 2 in country B. Firms produce a homogenous product. To serve the other country, firms have two options: to export products to that country or to produce there by engaging in FDI. If firm i engages in FDI it keeps its plant in its home country and sets up a new plant in the foreign country, thus incurring a fixed cost K, where $K < \bar{K}$ [5]. If firm i (i =1,2) exports, it has only one plant, which is in its home market. Firms incur a trade cost to export the product: the cost of shipping each unit of output between the two countries is denoted by t, where $t < 0.3$[6].

The markets are segmented and the inverse demand functions in the two markets are given by:

$$p_A = 1 - q_{1A} - q_{2A}, \; p_B = 1 - q_{1B} - q_{2B}, \qquad [1]$$

(4) When firms invest in R&D, they invest more if they engage in FDI, and thus reduce production costs further, than if they export. Thus, investment in R&D encourages FDI. However, exporting by firms is encouraged when they invest in capacity. Firms have two plants under FDI and have only one plant when they export. With the quadratic cost of excess capacity, exporting costs firms more than FDI for a given excess of capacity. This leads exporting firms to have less excess capacity (and thus a lower cost of excess capacity), which results in more exporting in equilibrium.

(5) $\bar{K} < min\{5916068 + 7161556t + 3907074t^2)/29575937, 338/1849\}$; this ensures that firms do not make a loss in any case if they engage in FDI.

(6) With no loss of generality we assume that $t < 0.3$ to simplify the presentation of results.

where p_A (p_B) is price of the product in market A (B) and q_{iA} (q_{iB}) denotes the output that firm i sells in market A (B), $i = 1, 2$.

Firms have the same technology, represented by the cost function $C(x_i, q_i)$, where q_i and x_i are the output and the capacity level (i.e. the plant size) of firm i, respectively. Following Nishimori and Ogawa (2004), Lu and Poddar (2005) and Bárcena-Ruiz and Garzón (2007, 2010)[7], we specify the cost function as follows. If firm i exports, its cost function is given by:

$$C(x_i, q_{iA}, q_{iB}) = m(q_{iA} + q_{iB}) + \gamma(q_{iA} + q_{iB} - x_i)^2, \; i = 1, 2. \qquad [2]$$

If firm i engages in FDI, its cost function is given by:

$$C(x_i, q_{iA}, q_{iB}) = m(q_{iA} + q_{iB}) + \gamma(q_{iA} - x_{iA})^2 + \gamma(q_{iB} - x_{iB})^2, \; i = 1, 2. \qquad [3]$$

These cost functions show that both excess capacity and undercapacity would be inefficient. When quantity equals capacity ($q_i = x_i$) the marginal production cost of firm i is m. With no loss of generality we assume that $m = 0$. Let γ denote the extent to which the quantity produced by firm i (q_i) is affected by its choice of capacity (x_i).

When firm i exports the total profit of serving the two markets is given by:

$$\pi_i = p_A q_{iA} + p_B q_{iB} - t q_{iL} - \gamma(q_{iA} + q_{iB} - x_i)^2, \; i = 1, 2, \qquad [4]$$

where $L = B$ if $i = 1$, and $L = A$ if $i = 2$.

When firm i engages in FDI its total profit from serving the two markets is given by:

$$\pi_i = p_A q_{iA} + p_B q_{iB} - \gamma(q_{iA} - x_{iA})^2 - \gamma(q_{iB} - x_{iB})^2 - K, \; i = 1, 2. \qquad [5]$$

As usual, social welfare in each country comprises the domestic consumer surplus, CS, and the producer surplus of domestic firms, PS. Specifically, we assume that the welfare of country j is given by:

$$W_j = CS_j + PS_j, \qquad [6]$$

where $CS_j = (q_{1j} + q_{2j})^2/2$ and $PS_j = \pi_j$, $j = A, B$.

The objective of this paper is to analyze the strategic choice of capacity made by firms in an international duopoly under quantity competition when they choose whether to engage in FDI in a foreign country or to export there. To that end we propose a three stage game with the following timing: In the first stage firms simultaneously and independently decide whether to export products to the other country or to engage in FDI there. In the second stage, given the decision taken in stage one, firms simultaneously decide their capacities. Finally, in the third stage, after observing the capacity choices, firms choose quantities simultaneously and independently in the two markets. We solve the game by backward induction from the last stage to obtain a subgame perfect equilibrium. To simplify the exposition of results we assume with no loss of generality that $\gamma = 1$[8].

(7) Vives (1986) assumes that firms pay a penalty only when they produce over the capacity level.

(8) It can be shown that the main results of the paper hold if it is assumed that γ is different from 1.

Given that there are two firms that may export or engage in FDI, we consider three cases: both firms choose to serve the other country by exporting (denoted by *EE*); both firms choose to engage in FDI in the other country (denoted by *FF*); and one firm chooses to export and the other chooses to engage in FDI (firms are denoted respectively by *EF* and *FE*).

2. Firms invest in capacity

Next we solve the second and third stages of the game when both firms invest in capacity.

2.1. Both firms export

In the third stage, given the production capacities chosen by the firms, each firm chooses the output sold in each country to maximize its profits given by [4]. Solving these problems results in the following:

$$q_{1A} = (2(6x_1 - x_2) + 5(1+3t))/35,\ q_{2A} = (2(6x_2 - x_1) + 5(1-4t))/35,$$
$$q_{1B} = (2(6x_1 - x_2) + 5(1-4t))/35,\ q_{2B} = (2(6x_2 - x_1) + 5(1+3t))/35. \qquad [7]$$

From [7], it results that the output of each firm increases with its own capacity and decreases with the capacity of its rival. Moreover, the positive effect of each firm's capacity is greater than the negative effect of the rival's capacity. In the second stage, given [7], firms simultaneously choose the capacities that maximize their profits given by [4]. Solving these problems the following first order conditions are obtained:

$$x_i = 36(10 - 5t - 4x_j)/361,\ i \neq j;\ i, j = 1, 2. \qquad [8]$$

It is easy to see from [8] that capacities are strategic substitutes. Thus, if one firm chooses a greater capacity the other firm reacts by reducing its capacity. From [8] we obtain the following result. Let *d* (*f*) denote the domestic (foreign) market of each firm.

Lemma 1. When both firms export, in equilibrium the investment in capacity of each firm, the output sold by each firm in the domestic and foreign markets, the profit obtained by each firm, the consumer surplus and welfare in each country are,

$$x^{EE} = \frac{36(2-t)}{101},\ q_d^{EE} = \frac{35+33t}{101},\ q_f^{EE} = \frac{35-68t}{101},\ \pi^{EE} = \frac{2(1083-1083t+2821t^2)}{10201},$$
$$CS^{EE} = \frac{1225(2-t)^2}{20402},\ W^{EE} = \frac{9232-9232t+12509t^2}{20402}.$$

As there is a transport cost *t*, each firm sells more in the domestic market than in the foreign market ($q_d^{EE} > q_f^{EE}$). Both firms choose overcapacity ($q_d^{EE} + q_f^{EE} < x^{EE}$): outputs are strategic substitutes, so each firm seeks to gain market share at the expense of its rival. According to [7], output by each firm increases with its own capacity and decreases with that of its rival. Thus, given that capacities are strategic substitutes, both firms behave aggressively in the second stage. This implies that in equilibrium both firms choose overcapacity.

It is easy to see from Lemma 1 that when the two firms export the excess capacity of each firm, $q_d^{EE} + q_f^{EE} - x^{EE} = (-2 + t)/101$, becomes less negative as transport cost t increases. In this case excess capacity decreases with transport cost t because both $q_d^{EE} + q_f^{EE}$ and x^{EE} decrease with t[9], but the dominant effect is that on x^{EE}, which results in a reduction in investment capacity.

2.2. *Both firms engage in FDI*

When both firms engage in FDI, they simultaneously choose the outputs for sale in the two markets in the third stage to maximize their profits given by [5]. Solving these problems the following is obtained:

$$q_{1A} = (8x_{1A} - 2x_{2A} + 3)/15,\ q_{2B} = (8x_{2B} - 2x_{1B} + 3)/15$$
$$q_{1B} = (8x_{1B} - 2x_{2B} + 3)/15,\ q_{2A} = (8x_{2A} - 2x_{1A} + 3)/15. \qquad [9]$$

As when both firms export, each firm's output increases with its own capacity and decreases with that of its rival. In the second stage, given [9], firms simultaneously choose their capacities to maximize their profits given by [5]. Solving these problems the following first order conditions are obtained:

$$x_{iA} = 16(3 - 2x_{jA})/97,\ x_{iB} = 16(3 - 2x_{jB})/97,\ i \neq j;\ i, j = 1, 2. \qquad [10]$$

As above, capacities are strategic substitutes. From [5], [9] and [10] the following result is obtained.

Lemma 2. When firms engage in FDI in the foreign market, in equilibrium the investment in capacity by each firm in the two plants, the output sold by each firm in the domestic and foreign market and the profit obtained by each firm, the consumer surplus and welfare in each country are,

$$x_d^{FF} = x_f^{FF} = \frac{16}{43},\ q_d^{FF} = q_f^{FF} = \frac{15}{43},\ \pi^{FF} = \frac{388}{1849} - K,\ CS^{FF} = \frac{450}{1849},\ W^{FF} = \frac{838}{1849} - K.$$

It can be shown that firms choose overcapacity when they engage in FDI ($q_d^{FF} < x_d^{FF}$, $q_f^{FF} < x_f^{FF}$) since capacities are strategic substitutes. As the marginal production cost is the same in both countries and firms do not pay transport costs, the two firms produce the same output and invest in the same capacity in the two markets.

It is easy to see from Lemma 2 that when the two firms engage in FDI the excess capacity of each firm, $(q_d^{FF} - x_d^{FF}) + (q_f^{FF} - x_f^{FF}) = -2/43$, does not vary with parameter t since firms do not pay transport costs.

2.3. *One firm exports and the other engages in FDI*

We assume that firm i exports and firm j engages in FDI ($i \neq j$; i, $j = 1, 2$). In the third stage firm i and firm j choose the output sold in the two markets to maximize their profits as given by [4] and [5] respectively. When these problems are solved the output of the firms as a function of their investments in capacity is obtained:

(9) Note that q_d^{EF} increases with t.

$$q_{iA} = (21 + 32t + 56x_i - 30x_{jA} + 16x_{jB})/161,\ q_{iB} = \\ = (21 - 60t + 56xi - 30x_{jB} + 16xjA)/161, \\ q_{iA} = (35 - 8t - 14x_i + 88x_{jA} - 4x_{jB})/161,\ q_{jB} = \\ = (35 + 15t - 14x_i - 4x_{jA} + 88x_{jB})/161. \qquad [11]$$

Thus, given [11], in the second stage firm i and firm j simultaneously choose their capacities to maximize their profits as given by [4] and [5] respectively. Solving these problems the following is obtained.

Lemma 3. When one firm exports and the other engages in FDI, in equilibrium the investment in capacity by each firm, the output sold by each firm in the domestic and foreign markets, the profit obtained by each firm, the consumer surplus and welfare in each country are,

$$x^{EF} = \frac{48(21-22t)}{1319},\ x_d^{FE} = \frac{8(969+1246t)}{22423},\ x_f^{FE} = \frac{8(969-73t)}{22423},\ q_d^{EF} = \frac{8211-688t}{22423},$$

$$q_f^{EF} = \frac{8211-16516t}{22423},\ q_d^{FE} = \frac{7429+9113t}{22423},\ q_f^{FE} = \frac{7429-120t}{22423},$$

$$\pi^{EF} = \frac{6(18480105-38720220t+41159152t^2)}{502790929},\ \pi^{FE} = \frac{2(2958034+3580778t+1953537t^2)}{29575937} - K,$$

$$CS^{EF} = \frac{32(1955-101t)^2}{502790929},\ CS^{FE} = \frac{(15640-7403t)^2}{1005581858},\ W^{EF} = \frac{2(116592715-122479220t+123640672t^2)}{502790929},$$

$$W^{FE} = \frac{445755912-1005581858K+11927064t+187644925t^2}{1005581858}.$$

Since a firm incurs a trade cost t when it exports products, it produces more in the domestic market than in the foreign market ($q_d^{EF} > x_f^{EF}$). And the firm that engages in FDI produces more in the domestic market than in the foreign one ($q_d^{FE} > x_f^{FE}$). For the same strategic reason analyzed in the above two cases, both firms choose overcapacity in this case ($q_d^{EF} + x_f^{EF} < x^{EF}$, $q_d^{FE} < x_f^{FE}$, $q_j^{FE} < x_j^{FE}$).

It is easy to see from Lemma 3 that when firm i exports and firm j engages in FDI the excess capacity of firm i, $q_d^{EF} + x_f^{EF} < x^{EF} = 2(-21 + 22t)/1319$, becomes less negative as t increases. And the excess capacity of firm j, $q_d^{FE} - x_d^{FE} + q_f^{FE} - x_f^{FE} = -(38 + 23t)/1319$, becomes more negative as t increases. Thus, excess capacity decreases with transport cost for the firm that exports and increases with it for the firm that engages in FDI. This is because only the firm that exports pays the transport cost and thus its excess capacity depends on parameter t. Moreover, the excess capacity of the firm that engages in FDI depends indirectly on parameter t. This firm does not pay transport costs but its investments in capacity interact strategically with those of the other.

2.4. Firms decide whether to export or to engage in FDI

The first stage of the game remains to be solved. First, we compare the excess capacities of the firms and their incomes in the different cases.

Lemma 4. In equilibrium

(i) $0>(q_d^{EE}+q_f^{EE}-x^{EE})>(q_d^{FE}-x_d^{FE})+(q_f^{FE}-x_f^{FE})$,

$0>(q_d^{EF}+q_f^{EF}-x^{EF})>2(q^{FF}-x^{FF})$;

(ii) $p_d^{EE}q_d^{EE}+p_f^{EE}q_f^{EE}>p_d^{FE}q_d^{FE}+p_f^{FE}q_f^{FE}$ if and only if $t<0.0927$, and

$p_d^{EF}q_d^{EF}+p_f^{EF}q_f^{EF}>p_d^{FF}q_d^{FF}+p_f^{FF}q_f^{FF}$ if and only if $t<0.0887$.

Proof. See Appendix

Lemma 4 shows that a firm has less excess capacity when it exports than when it engages in FDI whenever its rival exports or engages in FDI. The explanation of this result is the following: When there is no trade cost (i.e. when $t = 0$) the result depends on the cost of the excess capacity. In that case, if a firm engages in FDI its production is shared between two plants, while if a firm exports its output is produced at only one plant. Given that the cost of excess capacity is quadratic, the second option is more costly. Thus, if $t = 0$ there is more excess capacity when the firm engages in FDI since its impact on the cost of capacity is lower.

As seen in Lemmas 1 to 3, excess capacity decreases with parameter t if a firm exports and increases or does not vary with this parameter if a firm engages in FDI. Thus, as parameter t increases excess capacity increases or does not change when a firm engages in FDI, depending on whether its rival exports or engages in FDI, and decreases when the firm exports. As a result, if a firm exports it has less excess capacity than when it engages in FDI, regardless of whether the rival exports or engages in FDI. This means that in equilibrium the cost of excess capacity is greater when the firm engages in FDI than when it exports.

Lemma 4 also shows that a firm obtains more revenue by exporting than by engaging in FDI if trade cost t is low enough, whenever its rival exports or engages in FDI; otherwise the firm obtains more revenue by engaging in FDI. The intuition behind this result is the following. First, the cost of excess capacity is greater when a firm engages in FDI than when it exports. This cost does not decrease with t in the former case but does do so in the latter. Second, a firm has to incur a trade cost only when exporting to the foreign market. Since the first effect is stronger than the second, with a low enough trade cost a firm sells more total output and thus obtains more revenue when it exports than when it engages in FDI.

Let K^* denote the value of K such that $\pi^{EF}-\pi^{FF}>0$ if $K>K^*$, and let K^{**} denote the value of K such that $\pi^{FE}-\pi^{EE}>0$ if $K<K^{**}$. The values of K^* and K^{**} are defined in the Appendix. Solving the first stage of the game, the following result is obtained.

Proposition 1. In equilibrium, if $K \geq max\{K^*, K^{**}\}$ both firms export; if $K^* < K \leq K^{**}$ one firm exports and the other engages in FDI[10]; finally, if $K < K^*$ both firms engage in FDI.

(10) When $K^{**}< K \leq K^*$ there are two equilibria: in one of them both firms export and in the other one both firms engage in FDI. It can be shown that the second equilibrium Pareto dominates the first.

Proof. See Appendix

From [4] and [5] we have that there are four factors that affect the results. The first factor is due to the cost of excess capacity. As seen in Lemma 4, there is greater excess capacity, which results in greater cost, when firms engage in FDI than when they export, which encourages exporting. The second factor is the transport cost, which is paid only when firms export, which encourages FDI. The third factor is the fixed cost of setting up a new plant, K, which is paid only when firms engage in FDI, thus encouraging exporting. Finally, the fourth factor is the revenue of the firms. As Lemma 4 shows, that revenue is greater when firms export than when they engage in FDI if the transport cost is low enough.

Taking into account the above factors we find that when parameter K is great enough ($K \geq max\{K^{*}, K^{**}\}$) the first, third and fourth factors outweigh the second one and thus in equilibrium the two firms export. When parameter K is low enough ($K < K^{*}$) the first and third factor weaken (in fact, the third factor may encourage FDI) and the second factor becomes more important. Thus, in equilibrium the two firms engage in FDI. Finally, when $K^{*} < K \leq K^{**}$ the factors encouraging the firms to export are strong enough only if one firm chooses to export (since in that case t is great enough and K takes an intermediate value); as a result, one firm exports and the other engages in FDI.

3. Benchmark case

As a benchmark case, we consider that firms do not invest in capacity. Let K^{B} denote the value of K such that $\pi^{FE} - \pi^{EE} = 0$ for $K = K^{B}$, where the value of K^{B} is relegated to the Appendix.

Proposition 2. In the benchmark case, in equilibrium if $K \geq K^{B}$ both firms export, otherwise both firms engage in FDI.

Proof. See Appendix

To focus on how investment in capacity by firms affects results, we first disregard the fixed cost K. It is easy to see that in equilibrium both firms then engage in FDI since only the second and fourth factors in the last section hold. As the marginal production cost is the same in both countries and FDI implies saving transport costs, both firms prefer FDI to exporting[11]. However, if a fixed cost of setting up a new plant in the other country is considered, then there is a factor in favor of exporting. In that case, it is found that if the fixed cost of engaging in FDI is great enough ($K \geq K^{B}$) in equilibrium both firms export, otherwise both firms engage in FDI. Therefore, when firms do not invest in capacity the asymmetric equilibrium does not arise.

As shown in Section 5, governments could agree to charge firms a high enough fee to prevent them from choosing to export. This would get both firms to choose to engage in FDI.

(11) It is easy to see that the revenues of the firms are greater if they engage in FDI: $p_d^{EE} q_d^{EE} + p_j^{EE} q_j^{EE} < p_d^{FE} q_d^{FE} + p_j^{FE} q_j^{FE}$ and $p_d^{EF} q_d^{EF} + p_j^{EF} q_j^{EF} < p_d^{FF} q_d^{FF} + p_j^{FF} q_j^{FF}$.

4. Comparison of results

Next we compare the equilibria obtained when firms invest in capacity with those found in the benchmark case.

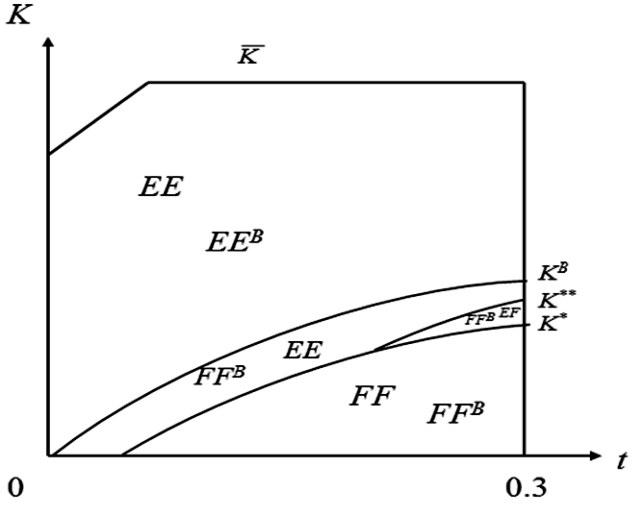
Proposition 3. In equilibrium, the range of parameters under which firms choose to export rather than engaging in FDI is greater when firms invest in capacity than when they do not.

Proof. See Appendix

The result shown in Proposition 3 is illustrated in Figure 1. As shown in Proposition 1, there are four factors that affect decisions concerning foreign expansion by firms. However, in the benchmark case the first effect is not present. It is easy to show that $\bar{K} > K^B > \max\{K^*, K^{**}\}$.

When $K < K^*$ the two firms engage in FDI regardless of whether they invest in capacity or not since the factors that favor FDI dominate in both cases. When $K^* < K < K^{**}$, t is high and K takes an intermediate value. In that case both firms engage in FDI in the benchmark case and only one firm engages in FDI when they invest in capacity. The effects of the second and the fourth factors dominate that of the third in the benchmark case, whereas the effects of the second and the fourth dominate that of the first and the third only for one of the firms when they invest in capacity. When $K^B > K > \max\{K^*, K^{**}\}$ both firms engage in FDI in the benchmark case and export when they invest in capacity. In the former case the effects of the second and the fourth factors dominate while in the latter case those of the first and the third dominate. Finally, when $K > K^B$, K is so high that both firms export in both cases.

Figure 1: Comparison of results



Source: Own elaboration.

5. Welfare analysis

In this section we analyze some policy implications of the paper. A welfare analysis is presented below, to find the mode of foreign expansion of firms preferred by the countries, taking into account their joint welfare. Let K_1 denote the value of K such that $W^{FF} - W^{EE} > 0$ if $K > K_1$, let K_2 denote the value of K such that $W^{EE} - W^{EF} > 0$ if $K > K_2$, and let K_3 denote the value of K such that $K^{EF} - K^{FF} > 0$ if $K > K_3$. The values of K_1, K_2 and K_3 are defined in the Appendix. By comparing the welfare obtained by the countries in the different cases, the following result (illustrated in Figure 2) is obtained.

Proposition 4. In equilibrium, the maximum joint welfare is obtained when both countries export if $K > \max\{K_1, K_2\}$, when both countries engage in FDI if $K < \min\{K_1, K_3\}$, and when one country exports and the other engages in FDI for the remaining values of the parameters.

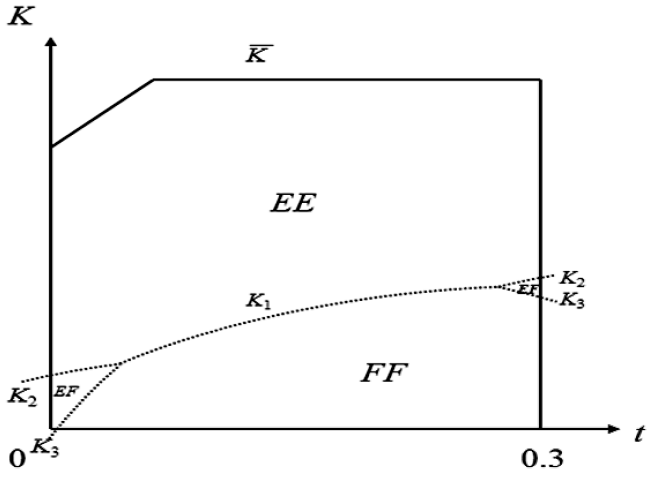
Proof. See Appendix

It can be shown (see Appendix) that the greatest joint consumer surplus of the two countries is obtained when both firms engage in FDI and the lowest when both export: $2CS^{FF} > CS^{FE} + CS^{EF} > 2CS^{EE}$. Although there is a greater excess of capacity when firms engage in FDI (see Lemma 4), the transport cost implies that the output of the firms is lower when they export. Note that the fixed cost K does not affect the consumer surplus but does affect the profit of the firms. Thus, in the top part of Figure 2 ($K > \max\{K_1, K_2\}$) joint welfare is greater when both firms export since the cost of engaging in FDI is high; note that as t increases this cost becomes relatively lower. In this area, although the greatest consumer surplus is obtained when both firms engage in FDI, the greater profits obtained by the firms when they export has a greater effect on joint welfare. Note that a greater consumer surplus implies more competition in the product market and thus less profits for the firms. It can be shown that when $K = 0$ the firms obtain greater profits when they engage in FDI unless transport costs are low enough. When the cost K is low enough ($K < \min\{K_1, K_3\}$), i.e. in the bottom part of Figure 2, joint welfare is greater when both firms engage in FDI due to the fact that in that case both consumer surplus and producer surplus are greater; note that as t increases this cost becomes relatively higher. Finally, there are two zones in which joint welfare is greater when one firm engages in FDI and the other exports: in one zone K and t are low, in the other t and K are high.

Next we analyze whether the mode of foreign expansion preferred by the firms (see Proposition 1) maximizes joint welfare (see Proposition 4). We also analyze whether countries can influence the decisions of the firms. We want to focus on these decisions in order to prevent policy measures from distorting the output of the firms. Thus we assume that the two countries agree to set up lump sum fees or taxes.

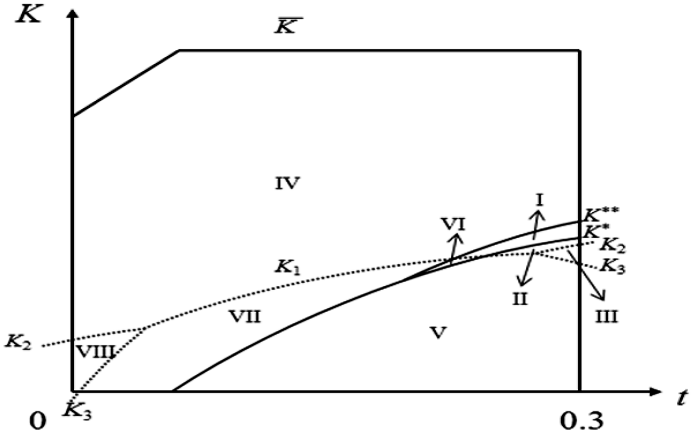
Figure 3 shows eight different zones that represent three main cases. First, we consider zones I, II and III. In these zones firms engage in FDI more than is socially desirable. In zone I only one firm exports (EF), but joint welfare is maximized if both firms export (EE). In zone II both firms engage in FDI (FF), but joint welfare is maximized if both export (EE). In zone III both firms engage in FDI (FF), but joint welfare is maximized if one firm exports (EF). In these three zones the two countries

Figure 2: MODE OF FOREIGN EXPANSION THAT MAXIMIZES JOINT WELFARE



Source: Own elaboration.

Figure 3: DIFFERENT ZONES ARISING WHEN DECIDING ECONOMIC POLICY MEASURES



Source: Own elaboration.

could agree to set up a fixed tax high enough to increase the fixed cost of engaging in FDI (in one country in zones I and III, or in both countries in zone II). The two countries should agree also to make side payments so that welfare increases in both countries. As a result, firms would adopt the mode of foreign expansion that maximizes joint welfare in these three zones.

There is a second case where the two firms take the decisions that maximize the joint welfare of the countries (zones IV and V). In this case no economic policy measures are needed. Finally, there is a case where firms export more than is socially desirable. In zone VI only one firm exports (EF), but joint welfare is maximized if both firms engage in FDI (FF). In zone VII both firms export (EE), but joint welfare is maximized if both firms engage in FDI (FF). In zone VIII both firms export (EE), but joint welfare is maximized if only one firm exports (EF). In this case the two countries could agree to set up a high enough fixed fee for exporting firms. This fixed fee should be imposed in only one country in zones VI and VIII, or in both countries in zone VII. The two countries should also agree to make side payments so that welfare increases in both. As a result, firms would adopt the mode of foreign expansion that maximizes joint welfare.

Therefore, if the governments are able to reach an agreement to set economic policy measures in a coordinated fashion, they can get firms to adopt the mode of foreign expansion that maximizes joint welfare. Those measures could be implemented by penalizing FDI or exports with a high enough fixed fee or tax, depending on the values of t and K. Such penalties can be applied in one or in the two countries. It is also necessary to make side payments to so that welfare in both countries increases.

6. Conclusions

We examine the decisions by two firms on whether to export or engage in FDI to serve a foreign country when they invest in production capacity. We show that firms overinvest in capacity and have more excess capacity when they engage in FDI than when they export.

When firms invest in production capacity the decision on whether to export or engage in FDI is affected by four factors: The higher cost of excess capacity when firms engage in FDI, the trade cost incurred when firms export, the fixed cost of investment in the foreign country when engaging in FDI, and the higher revenue obtained by firms if the trade cost is low enough. We show that there are three equilibria depending on which effects dominate. Both firms engage in FDI if the fixed cost of engaging in FDI in the foreign country is low enough. If the fixed cost takes an intermediate value and the trade cost is high, one firm exports and the other engages in FDI. Finally, both firms export if the fixed cost is high enough.

On the other hand, as a benchmark, we assume that firms do not invest in capacity. In this case both firms engage in FDI if the fixed cost of engaging in FDI in the foreign market is low enough, otherwise they export.

By comparison between the case when firms invest in FDI and the benchmark, we obtain that the range of parameters under which firms export is greater when they invest in capacity than when they do not. Therefore, investing in production capacity encourages firms to export rather than to engage in FDI. This result helps to ex-

plain foreign expansion behavior when firms invest in capacity. Moreover, this result is in contrast with that obtained in the literature on R&D investment, which highlights that R&D investment encourages FDI. Therefore, the decision by firms on whether to engage in FDI or export is affected by what firms invest in, e.g. R&D or production capacity.

In order to determine whether firms' modes of foreign expansion maximize joint welfare we conduct a welfare analysis. We find that, in general, when both countries export (engage in FDI) joint welfare is maximized if the cost of engaging in FDI is high (low) enough, and when one country exports and the other engages in FDI for the remaining value of parameters. We also obtain that there are cases where the modes of foreign expansion preferred by firms do not maximize joint welfare. However, governments can get firms to adopt the right mode of foreign expansion by penalizing the other mode with a high enough fixed fee or tax. Those penalties can be made in one country or in both, but must be coordinated between the countries. It is also necessary to make side payments so that welfare in both countries increases.

In this paper we consider how the decision on whether to export or engage in FDI is affected by the fact that firms invest in production capacity in a North-North trade framework. A natural extension is to study the decision in a North–South trade framework. We have left this task for a companion paper.

Appendix

Proof of Lemma 4

(i) $(q_d^{EE}+q_f^{EE}-x^{EE})-(q_d^{FE}-x_d^{FE})-(q_f^{FE}-x_f^{FE})=\frac{6(200+607t)}{133219}>0$, $(q_d^{EF}+q_f^{EF}-x^{EF})-2(q^{FF}-x^{FF})=\frac{4(208+473t)}{56717}>0$; *(ii)* $x^{EF}-2x^{FF}=\frac{16(71-2838t)}{56717}>0$ for $t<0.0250$;

$x^{EE}-(x_d^{FE}+x_f^{FE})=\frac{84(34-1229t)}{133219}>0$ for $t<0.0277$, $p_d^{EE}q_d^{EE}+p_f^{EE}q_f^{EE}-p_d^{FE}q_d^{FE}-p_f^{FE}q_f^{FE}=-\frac{7(-8997290188+79743224079t+186160765772t^2)}{5128970266729}>0$ if $t<0.0927$,

$p_d^{EF}q_d^{EF}+p_f^{EF}q_f^{EF}-p_d^{FF}q_d^{FF}-p_f^{FF}q_f^{FF}=-\frac{3(-3290811788+30369338713t+75700434116t^2)}{929660427721}>0$ if $t<0.0887$.

Proof of Proposition 1

i) $\pi^{EF}-\pi^{FF}=\frac{2(4967702209-214781060340t+228309816144t^2)}{929660427721}+K>0$ if

$K>K^*=-\frac{2(4967702209-214781060340t+228309816144t^2)}{929660427721}$.

ii) $\pi^{FE}-\pi^{EE}=-\frac{2(1855834937-68558256149t+63505687340t^2)}{301704133337}-K>0$ if

$K < K^{**} = -\frac{2(1855834937 - 68558256149t + 63505687340t^2)}{301704133337}$.

iii) $K^* - K^{**} = \frac{15317858681424 + 71979861993646t - 665628328653448t^2}{9483466023181921} > 0$ if

$t < \frac{17(49233831733 - 133219\sqrt{1211716874161})}{15479728573336} \approx 0.2151$.

iv) $\pi^{EE} - \pi^{FF} = \frac{2(23473 - 2002467t + 5216029t^2)}{18861649} + K > 0$ if $K > -\frac{2(23473 - 2002467t + 5216029t^2)}{18861649}$.

Benchmark case

When both firms export, by substituting $x_1 = x_2 = 0$ in [6] and using [4], the following is obtained: $q_d^{EE} = (1 + t)/3$, $q_f^{EE} = (1 – 2t)/3$, $\pi^{EE} = (2 – 2t + 5t^2)/9$. When both firms engage in FDI, substituting $x_{id} = x_{jf} = 0$ in [8] and using [5], the following is obtained: $q_d^{FF} = q_f^{FF} = 1/3$, $\pi^{FF} = 2/9–K$. When one firm exports and the other engages in FDI, substituting $x_i = x_{jd} = x_{jf} = 0$ in [10] and using [4] to [5], the following is obtained: $q_d^{EF} = q_d^{FE} = 1/3$, $q_f^{EF} = (1 – 2t)/3$, $q_f^{FE} = (1 + t)/3$, $\pi^{EF} = 2(1 – 2t + 2t^2)/9$, $\pi^{FE} = (2 + 2t + t^2)/9 – K$. Comparing the profits of the two firms the following is obtained: *(i)* $\pi^{FE} – \pi^{EE} = 4t(1 – t)/9 – K > 0$ if $K < K^B = 4t(1 – t)/9$; *(ii)* $\pi^{FF} – \pi^{EF} = 4t(1 – t)/9 – K > 0$ if $K < K^B$. Finally, it is easy to see that $K^B > \max\{K^*, K^{**}\}$

Proof of Proposition 4

For all values of t: $2CS^{FF} – CS^{FE} + CS^{EF} = \frac{457371400 + 474897307920t - 102540497777t^2}{1859320855442} > 0$; $CS^{FE} + CS^{EF} – 2CS^{EE} = \frac{63173955000 + 2307325448120t - 666118134177t^2}{10257940533458} > 0$.

$2W^{EE} – 2W^{FF} = K_1 + 2K > 0$ if $K > K_1$, where $K_1 = \frac{26908 + 17069968t - 23129141t^2}{37723298}$; $2W^{EE} – W^{EF} – W^{FE} = K_2 + K > 0$ if $K > K_2$, where $K_2 = \frac{21073488116 + 4407557600040t - 5619623601509t^2}{10257940533458}$; $2W^{FF} – W^{EF} – W^{FE} = K_3 – K > 0$ if $K < K_3$, where $K_3 = \frac{-1167207420 + 883803169784t - 1261401876437t^2}{1859320855442}$. It can be shown that $K_2 > K_1 > K_3$ for $t < 0.0746$ and for $t > 0.2749$, $K_3 > K_1 > K_2$ for $0.0746 < t < 0.2749$, and $K_1 = K_2 = K_3$ for $t = 0.0746$ and for $t = 0.2749$.

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RESUMEN

Este artículo analiza cómo la inversión en capacidad de producción influye en la decisión de realizar inversión directa en el extranjero (IDE) o exportar. Para servir a un mercado extranjero las empresas tienen dos opciones: (i) exportar productos a ese mercado, pagando un coste de transporte; y (ii) producir allí mediante (IDE), incurriendo en un coste fijo. Encontramos que el rango de parámetros bajo los cuales las empresas optan por exportar en lugar de hacer IDE es mayor cuando invierten en capacidad que cuando no lo hacen. Esto contrasta con el resultado obtenido cuando las empresas invierten en I + D, ya que en ese caso la inversión realizada por las empresas les anima a realizar IDE. Hay casos en los que el modo de expansión en el extranjero elegido por las empresas no maximiza el bienestar conjunto de los países. Mostramos que los gobiernos pueden lograr que las empresas adopten el modo correcto de expansión en el extranjero penalizando el otro modo en una cantidad fija suficientemente alta.

Palabras clave: comercio internacional, IDE, capacidad.

Clasificación JEL: L13, F13, D24.