Foreign direct investment and export under imperfectly competitive host-country input market

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Abstract: This paper considers production strategy of a foreign firm when the input market in the host-country is imperfectly competitive and production requires non-tradable inputs. We show that the foreign firm's strategic choice about export and foreign direct investment (FDI) affects the price of input in the host-country and provides a rationale for doing both export and FDI. So, unlike the previous works, focusing on the *exogenous factors*, we show that export and FDI may be 'complements' when the foreign firm's decision affects an *endogenous variable* in its favor. We show the impact of competition in the final goods market on our results.

Key Words: Export, Foreign direct investment, Imperfectly competitive input market
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1 Introduction

Empirical evidences show that multinationals account for a significant portion of international trade.[1] However, they often face the important choice of export vs. foreign direct investment (FDI), which has generated enormous amount of empirical and theoretical literature.

Empirical evidences suggest that FDI and export can be either substitutes or complements.[2] For a representative sample, one may look at Lipsey and Weiss (1984), Yamawaki (1991), Brainard (1997), Swenson (1999), Clausing (2000), Head and Ries (2001) and Blonigen (2001). While the possibility of substitutability between FDI and export has attracted sufficiently large amount of theoretical attention, the theoretical literature has paid little attention to explain complementarity between FDI and exports.

In an earlier contribution Caves (1971) has emphasized scale economies and cost factors in determining the choice between FDI and export. More recently, Casson (1981), Smith (1987), Horstmann and Markusen (1987a, b, 1996), Mukherjee and Broll (2001) and many others have extended this literature. However, all these papers have focused on the trade-off between the costs of doing FDI and economizing on the costs of export. Thus, these papers show that FDI and export behave like substitutes.

In contrary to the above-mentioned papers, this paper provides a rationale for doing both export and FDI at the same time and therefore, explains that these two options may act as complements. More specifically, we show that a foreign firm may do both FDI and export when the input market in the host-country is imperfectly competitive and the inputs are non-tradable.

We consider the production decision of a monopolist foreign firm in the next section. We find that if the host-country market is not sufficiently small, it is optimal for the foreign firm to do both export and FDI. But, if the market size of the host-

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country is sufficiently small, the foreign firm does only FDI. Export by the foreign firm reduces its production under FDI and creates lower demand for input in the host-country. Thus, export by the foreign firm helps to reduce the price of the inputs in the host-country. So, even if export implies higher cost of production, it increases profit from FDI by reducing input price in the host-country. However, if the host-country market is sufficiently small, this benefit from lower input price in the host-country is not enough to outweigh the negative impact of higher cost of production under export. Hence, the foreign firm does FDI when the host-country market is sufficiently small. If the host-country market is sufficiently large, the effect of lower input price in the host-country market dominates the effect of higher cost of production under export and induces the foreign firm to do both export and FDI.

Section 3 extends the basic model of section 2 to show the impact of competition in the final goods market. We consider a potential host-country firm who can compete with the foreign firm in the final goods market like Cournot duopolists. We find that the foreign firm does 'FDI only' and 'export only' if the host-country market is sufficiently small and sufficiently large respectively. But, it does both export and FDI for moderate host-country market size. Hence, competition in the final goods market increases the foreign firm's incentive for doing' FDI only' and reduces its incentive for doing both FDI and export.

Presence of the host-country firm reduces the foreign firm's power to manipulate input price in the host-country through its choice of export. If the host-country market is sufficiently large, sufficiently large demand for inputs by the host-country firm creates sufficiently high input price in the host-country and makes FDI unattractive to the foreign firm. Hence, in this situation, the foreign firm does export only. If the host-country market is very small the effect of export on host-country input price is not sufficiently large and makes 'FDI only' as the optimal decision of the foreign firm. But, for moderate market size, the effect of export on the host-country input price dominates the negative impact of higher cost of production under export and provides the rationale for doing both FDI and export.

The present paper complements the recent works of Kogut and Kulatilaka (1994), Choi and Davidson (2003) and Rob and Vettas (2003), where it has been shown that FDI and export are complements when there is uncertainty about cost of production or market demand. Kogut and Kulatilaka (1994) show that if the foreign

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firms face cost uncertainty, setting up a production facility in the foreign country creates option value and encourages the foreign firms to do both FDI and export. Choi and Davidson (2003) extends this literature to the oligoplistic market and show that the incentive for doing both export and FDI increases due to strategic reasons if the firms compete in *prices*. Contrary to the uncertainty in cost, Rob and Vettas (2003) focus on the situation where demand growth in the host-country is uncertain and provide the rationale for doing both export and FDI by a foreign monopolist.

One common feature of the above-mentioned three papers is that they focus on *exogenous factors* (either cost uncertainty or demand uncertainty) to explain the rationale for doing both FDI and export by the foreign firms. In contrast, the present paper shows that a foreign firm may prefer to do both FDI and export in a world with certainty if, by doing so, it can affect an *endogenous variable* (here input price) in its favor.

The remainder of the paper is organized as follows. Section 2 considers the basic model with a monopolist foreign firm. Section 3 extends the analysis by incorporating competition in the final goods market. Section 4 concludes.

2   Monopoly market structure

Assume that there is a foreign firm, called firm 1, who wants to sell its product in another country, called host-country. Firm 1 can sell in the host-country either through FDI or export or both. Assume that firm 1 is the monopolist producer of this product. We may think that firm 1 has developed technology for a new product and patent protection makes the firm 1 monopoly for this product. Alternatively, we may think that high entry cost prevents new firms to enter the product market and makes the firm 1 monopolist. For simplicity, we assume that there is no demand for this product in the home country of firm 1.

Assume that the input market in the home country of firm 1 is perfectly competitive, while the input market in the host-country is imperfectly competitive. For simplicity, we assume that there is a monopolist input supplier in the host-country. We further assume that the marginal costs of input production in both home and host countries are constant. While we assume it to be c in the home country, it is

assumed to be zero in the host-country, for simplicity.[3] These assumptions for the input markets may fit well if we consider the home country of firm 1 as a developed country and the host-country as a developing country. The presence of cheap labor in the developing country may be the reason for having lower cost of input production in the host-country. Further, while liberalized policy of the home country creates fierce competition in the home country input market to make it perfectly competitive, restrictive government policy of the developing country may create imperfect competition in the host-country input market.

We assume that the inputs are non-tradable. Therefore, if firm 1 wants to do export, it needs to buy inputs from its home country, and, in case of FDI, it needs to buy its input from the host-country. We assume that firm 1 needs one unit of input to produce one unit of output. Further, for simplicity, we assume that there are no other costs associated with either input or final goods production.

Perfect competition in the home country input market implies that firm 1 is able to buy input in the home country at a price c. But, it has to buy input in the host-country at a price charged by the monopolist input supplier. Assume that the input supplier in the host-country sells its inputs against a linear price, say w.[4]

We consider the following game. In stage 1, firm 1 chooses the amount of export it will do.[5] In stage 2, the monopolist input supplier in the host-country sets price for its inputs. In stage 3, firm 1 decides its amount of production in the host-country (i.e., production under FDI). Hence, our analysis allows for export and FDI by firm 1. In stage 4, market-clearing price of the final good produced by firm 1 (through export and/or FDI) is determined and profits are realized.[6] We solve the game through backward induction.[7]

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[3] One can do similar analysis by assuming same marginal costs of input production in home and host countries, while export from the home country requires a per unit transportation cost c.

[4] As an alternative specification, one may think the monopolist input supplier of this paper as the monopoly union, who sets wage to maximize union rents. For works on rent maximizing union one may refer to Booth (1995), Bughin and Vannini (1995), Vannini and Bughin (2000) and Collie and Vandenbussche (2003).

[5] Alternatively, one can assume that in stage 1, firm 1 is building its capacity for export by purchasing inputs and therefore, the per-unit cost of capacity building is c. Firm 1 cannot change its capacity level once installed.

[6] It is possible to consider a different timing of the game where the host-country supplier decides on its input price before the amount of export decided by firm 1. However, this price is not credible if the monopolist input supplier can alter its input price after firm 1's decision on export. We assume this possibility and consider the move of the host-country input supplier after firm 1's decision on export.

[7] It is trivial to see that if the host-country input market is perfectly competitive, the optimal amount of export is zero.

We have considered that firm 1 buys inputs in the home country and decides the amount of export before its dealing with the host-country input supplier and therefore, before its decision on FDI. This situation may be consistent with the previous literature assuming that the foreign firms first set up their plants in the home country for exports and then go for FDI (see, e.g., Vernon, 1966, Horstmann and Markusen, 1987b, Konishi et al., 1999 and Lin and Saggi, 1999). Later we will briefly discuss the implication of a different timing of the game where firm 1 deals with the host-country input supplier before its dealing with the home country input supplier.

Assume that inverse market demand for the final product in the host-country is

$$P = a - q - x, \qquad a > c > 0 \tag{1}$$

where x and q are respectively the amount of export and FDI by firm 1.

2.1 Decision on FDI

Given the amount of export $x(\geq 0)$, decided by firm 1 and the input price in the host-country (i.e., w), firm 1 maximizes the following expression to determine its output to be produced by FDI

$$\underset{q}{Max}(a - q - x - w)q + (a - q - x - c)x. \tag{2}$$

Maximizing (2) we find that the optimal output produced by firm 1 under FDI is

$$q^* = \frac{a - 2x - w}{2}. \tag{3}$$

It is easy to check that the second order condition for maximization is satisfied.

It is clear from (3) that $q^* > 0$ provided $a > 2x + w$, but $q^* = 0$ for $a \leq 2x + w$. Therefore, if $a \leq 2x + w$, optimal output of firm 1 is $\frac{(a - c)}{2}$.

2.2 Optimal input price in the host-country

Now, we find out optimal input price in the host-country. While choosing optimal price of the input, the monopolist input supplier internalizes the production decision of firm 1 under FDI. Therefore, demand for input is

$$\frac{(a - 2x - w)}{2}, \qquad \text{for} \qquad w < a - 2x \tag{4}$$

$$0, \qquad \text{for} \qquad w \geq a - 2x. \tag{5}$$

So, the monopolist input supplier in the host-country maximizes the following expressions to determine the price of the input:

$$Max_{w} \frac{w(a - 2x - w)}{2}, \quad \text{for} \quad w < a - 2x.[8] \tag{6}$$

Maximizing (6), we find the optimal price of the input

$$w^*_{FDI} = \frac{(a - 2x)}{2}. \tag{7}$$

We define the optimal input prices as w^*_{FDI} to imply the scenario of positive output of

firm 1 under FDI. We find that $w^*_{FDI} < a - 2x$ and $w^*_{FDI} > 0$ for $x < \dfrac{a}{2}$.[9]

2.3   Optimal amount of export

Firm 1 realizes how the monopolist input supplier in the host-country will behave for a given amount of export. Therefore, firm 1 maximizes the following expression while choosing its amount of export, x:

$$Max_{x} \frac{(a + 2x)(a - 2x) + 4x(3a - 2x - 4c)}{16}.[10] \tag{8}$$

Maximizing (8), we find that $x^*_{FDI} = \dfrac{(3a - 4c)}{6}$.[11] The second order condition for maximization is satisfied.

While $x^*_{FDI} = \dfrac{(3a - 4c)}{6} < \dfrac{a}{2}$, $x^*_{FDI} = \dfrac{(3a - 4c)}{6} > 0$ provided $a > \dfrac{4c}{3}$. Since,

$c < \dfrac{4c}{3}$, it implies that optimal amount of export is zero for $a \in (c, \dfrac{4c}{3})$. But, for

$a > \dfrac{4c}{3}$, optimal amount of both export and FDI are positive.

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[8] There is no demand for input if $w > a - 2x$.

[9] Note that input price in the host-country cannot be less than 0.

[10] The problem (8) is relevant for $x \leq \dfrac{a}{2}$, while the problem faced by firm 1 is $Max_{x}(a - x - c)x$,

for $x > \dfrac{a}{2}$. However, this maximization problem $Max_{x}(a - x - c)x$ implies $x = \dfrac{(a - c)}{2}$, which

contradicts the requirement of $x > \dfrac{a}{2}$. So, in stage one, the maximization problem faced by firm 1 is

given by the expression (8). This implies that the amount of FDI is always positive.

[11] We denote the amount of export by x^*_{FDI} to imply that for these values of export, firm 1 produces

positive amount under FDI.

Following proposition summarizes the above discussion.

Proposition 1: *Assume that the foreign firm is monopolist in the host-country. The foreign firm does 'FDI only' for* $a \in (c, \frac{4c}{3})$*, but it does both export and FDI for*

$a > \frac{4c}{3}$*.*

So, even if the cost of input production is lower in the host-country but the input market is imperfectly competitive there, the foreign firm has the incentive to do export when the host-country market size[12] is sufficiently large, i.e., $a > \frac{4c}{3}$. But the foreign firm does FDI irrespective of the market size of the host-country. Therefore, the above result shows that we may expect to see foreign firms doing both FDI and if the host-country market is sufficiently large and its input market is imperfectly competitive.

It is clear from the above discussion that if the cost of input production in the home country is zero then input price in the host-country and the optimal amount of production under FDI is zero. But, the qualitative result of the above proposition holds for any positive cost of input production in the home country.

2.4   Implications on the host-country input price

Now, we examine how the input price in the host-country is affected by the output decision of firm 1. This will help us to understand the rationale for different entry strategies of firm 1.

Let us consider the values of $a \in (c, \frac{4c}{3})$. Here, firm 1 does 'FDI only' and the input price in the host-country is $\frac{a}{2}$, which is lower than c for all $a \in (c, \frac{4c}{3})$. Since, the market demand in the host-country is sufficiently low, the optimal total output and therefore, the demand for input is sufficiently small. So, even if firm 1 produces the entire amount through FDI, it does not create much demand for input in the host-

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[12] Here the intercept term of the demand function is used as a proxy of the market size.

country. This lower demand for input generates lower input price in the host-country since the marginal cost of input production is lower in the host-country.

Next, consider the values of $a > \dfrac{4c}{3}$. Here, firm 1 does both export and FDI and the input price in the host-country is $\dfrac{2c}{3}$, which is positive and less than c. So, if $a > \dfrac{4c}{3}$, we find that even if the equilibrium input price in the host-country is lower compared to the input price in the home country, firm 1 produces positive amount under export. The reason for this is the following. If $a > \dfrac{4c}{3}$ and firm 1 does 'FDI only', the input price in the host-country is $\dfrac{a}{2}$, which is greater than the input price in the host-country when firm 1's optimal export is positive, i.e., greater than $\dfrac{2c}{3}$. The positive amount of export by firm 1 reduces input price in the host-country and increases profit of firm 1.

Now, we discuss the implication of an alternative move of the game. We have assumed in our analysis that firm 1 decides the mount of export before its production decision under FDI. Alternatively, firm 1 could deal with the host-country input supplier and decide the amount under FDI before it deals with the home country input market and decides the amount of export. However, it is easy to understand that, in this situation, the input supplier in the host-country has no incentive to reduce its input price below c, which will be the input price in the home country. But, as we have shown above, firm 1 could reduce the input price in the host-country below c, if it decides the amount of export before its production decision under FDI. So, given that firm 1 has the choice to decide whether to deal with the host-country input supplier before or after its dealing with the home country input market, firm 1 will consider the move of the game assumed in our analysis, i.e., it will first decide the amount of export and then will decide the amount under FDI.

2.5   Implication of the fixed costs of FDI

To show the strategic effects of export and FDI through host-country input markets we have abstracted our analysis from other aspects of FDI such as the fixed costs of

doing FDI. The implication of the fixed costs of FDI on our result is very easy to understand. Sufficient amount of fixed cost of FDI requires the product market to be sufficiently large for having FDI. We have seen that firm 1 does 'FDI only' when the host-country market is sufficiently large. This results hold if the fixed cost of doing FDI is not sufficiently high. But, for significant amount of fixed costs of FDI, it will reduce firm 1's incentive for FDI and will encourage it to do export. In this situation, firm 1 does 'export only' for very small market size, does 'FDI only' for moderate market size and does both export and FDI for relatively large market size.

The above observation makes the following proposition immediately.

Proposition 2: *(a) If fixed costs of FDI never prevent firm 1 to do FDI, Proposition 1 holds.*

(b) If fixed costs of FDI prevent firm 1 to do FDI for very small amounts of market size, it does 'export only' for very small market size, does 'FDI only' for moderate market size and does both export and FDI for relatively large market size.

3   Duopoly market structure

In the previous section we have seen that imperfectly competitive host-country input market may provide the rationale for doing both FDI and export by the same foreign firm. Now, we examine the implications of competition in the final goods market on our result.

To consider the implications of competition in the final goods market, we assume that there is a potential entrant in the host-country firm, called firm 2, who can produce a homogeneous product and compete with firm 1 like Cournot duopolists. As before, firm 1 can do either FDI or export or both.

The specifications for the input markets are similar to the previous section. Further, we assume that both firms need one unit of input to produce one unit of output. Since, our purpose is to focus on the role of competition in the final goods market, we abstract our analysis from any other costs faced by the entrant, i.e., firm 2.

We consider the following game. In stage 1, firm 1 chooses the amount of export it will do. In stage 2, the monopolist input supplier in the host-country sets the

price for its inputs. In stage 3, firm 2 decides whether to enter or not.[13] In stage 4, firm 1 and firm 2 simultaneously decide their amount of production in the host-country. In stage 5, market-clearing price of the final goods is determined and profits are realized. We solve the game through backward induction.

3.1   Decision on FDI

Given the amount of export $x(\geq 0)$ and the input price in the host-country (i.e., w), firm 1 maximizes the following expression to determine its output under FDI:

$$\underset{q_q}{Max}(a - q_1 - q_2 - x - w)q_1 + (a - q_1 - q_2 - x - c)x . \qquad (9)$$

Maximizing (9) we find that the optimal output of firm 1 under FDI is

$$q_1 = \frac{a - 2x - q_2 - w}{2} . \qquad (10)$$

It is easy to check that the second order condition for maximization is satisfied.

Given the amount of export of firm 1 and the input price in the host-country, firm 2 maximizes the following expression to determine its optimal production:

$$\underset{q_2}{Max}(a - q_1 - q_2 - x - w)q_2 . \qquad (11)$$

Maximizing (11), we find that the optimal output of firm 2 is

$$q_2 = \frac{a - x - q_1 - w}{2} . \qquad (12)$$

It is easy to check that second order condition for maximization is satisfied.

Solving (10) and (12), we get the optimal outputs of firm 1 under FDI and the optimal outputs of firm 2 are respectively

$$q_1^* = \frac{(a - 3x - w)}{3} \qquad \text{and} \qquad q_2^* = \frac{(a - w)}{3} . \qquad (13)$$

It is clear from (13) that $q_1^* > 0$ provided $a > 3x + w$, but $q_1^* = 0$ for $a \leq 3x + w$. Therefore, optimal output of firm 2 is $\frac{(a - x - w)}{2}$ for $a \leq 3x + w$.

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[13] Since there is no technological difference between the firms and firm 2 has no other costs except the

3.2 Optimal input price in the host-country

While choosing the optimal input price, the monopolist input supplier in the host-country internalizes the production decisions of the firms as given in (13). Therefore, the demand for inputs in the host-country is

$$\frac{(2a - 3x - 2w)}{3}, \qquad \text{for} \qquad w < a - 3x \tag{14}$$

$$\frac{(a - x - w)}{2}, \qquad \text{for} \qquad w \geq a - 3x \tag{15}$$

$$0, \qquad \text{for} \qquad w \geq a - x. \tag{16}$$

The host-country input supplier maximizes the following expressions to determine its input price, given the amount of export decided by firm 1:

$$\underset{w}{Max} \frac{w(2a - 3x - 2w)}{3}, \qquad \text{for} \qquad w < a - 3x \tag{17}$$

$$\underset{w}{Max} \frac{w(a - x - w)}{2}, \qquad \text{for} \qquad w \geq a - 3x.^{14} \tag{18}$$

Maximizing (17) and (18), we get the optimal prices of the inputs are respectively

$$w^*_{FDI} = \frac{(2a - 3x)}{4} \qquad \text{and} \qquad w^*_0 = \frac{(a - x)}{2}. \tag{20}$$

We define the optimal input prices as w^*_{FDI} and w^*_0 to imply the scenario of positive output of firm 1 under FDI and no output of firm 1 under FDI.

It is easy to check that $w^*_{FDI} < a - 3x$ provided $x < \frac{2a}{9}$ and $w^*_0 \geq a - 3x$ provided $x \geq \frac{a}{5}$, where $\frac{a}{5} < \frac{2a}{9}$. Hence, the input prices in the host-country are w^*_{FDI} for $x \leq \frac{a}{5}$ and w^*_0 for $x \geq \frac{2a}{9}$. But, for $x \in (\frac{a}{5}, \frac{2a}{9})$, the input price in the host-country depends on the relative profitability of the input supplier for w^*_{FDI} and w^*_0.

We find that if $x \in (\frac{a}{5}, \frac{2a}{9})$, it is optimal for the input supplier to charge w^*_{FDI} (w^*_0)

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costs of input, it is trivial that firm 2 will always enter the market in equilibrium.
[14] Because there is no demand for input if $w > a - x$.

provided $x^2 - ax + \dfrac{a^2}{6} > (<)0$. We get that $x^2 - ax + \dfrac{a^2}{6} = 0$ for $x = \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$, which

is between $\dfrac{a}{5}$ and $\dfrac{2a}{9}$.

We summarize the above discussion in the following proposition.

Proposition 3: *(a) If* $x < \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$, *the optimal input price in the host-country is*

$w^*_{FDI} = \dfrac{(2a - 3x)}{4}$. *But, for* $x < \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$, *the optimal input price in the host-country*

is $w^*_0 = \dfrac{(a - x)}{2}$.

(b) Firm 1 does FDI if $x < \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$ *but there is no FDI for* $x > \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$.

3.3   Optimal amount of export

If firm 1 chooses $x < \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$, it realizes that input price in the host-country is

$w^*_{FDI} = \dfrac{(2a - 3x)}{4}$ but the input price in the host-country is $w^*_0 = \dfrac{(a - x)}{2}$ for

$x > \dfrac{a(\sqrt{3}-1)}{2\sqrt{3}}$. Therefore, firm 1 maximizes the following expressions while

choosing the amount of export, x:

$$\underset{x}{Max}\, \frac{(2a + 3x)(2a - 9x) + 12x(8a - 6x - 12c)}{144}, \quad \text{for} \quad x < \frac{a(\sqrt{3}-1)}{2\sqrt{3}} \qquad (21)$$

and

$$\underset{x}{Max}\, \frac{(5a - 7x - 6c)x}{6}, \qquad\qquad \text{for} \quad x > \frac{a(\sqrt{3}-1)}{2\sqrt{3}}. \qquad (22)$$

Maximizing (21) without any restriction on x, we get $x^*_{FDI} = \dfrac{(14a - 24c)}{33}$.[15] The

second order condition for maximization is satisfied.

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[15] We denote the amount of export by x^*_{FDI} to imply that for these values of export, firm 1 produces positive amount under FDI.

$x^*_{FDI} = \dfrac{(14a - 24c)}{33}$ is positive provided $a > \dfrac{12c}{7}$ and is less than $\dfrac{a(\sqrt{3} - 1)}{2\sqrt{3}}$

provided $a < \dfrac{48\sqrt{3}c}{(33 - 5\sqrt{3})}$. Hence, solution of (21) implies that for $a \in (c, \dfrac{12c}{7})$ firm

1's optimal export is zero and does under 'FDI only' but its production under export

and FDI are positive for $a \in (\dfrac{12c}{7}, \dfrac{48\sqrt{3}c}{(33 - 5\sqrt{3})})$.

Next, consider the unrestricted optimization problem of (22). Maximizing (22)

without any restriction on x, the optimal amount of export is $x^*_0 = \dfrac{(5a - 6c)}{14}$.[16]

$x^*_0 = \dfrac{(5a - 6c)}{14}$ is greater than $\dfrac{a(\sqrt{3} - 1)}{2\sqrt{3}}$ provided $a > \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})}$. Therefore,

solution of (22) implies that if $a > \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})}$ then firm 1 does 'export only'. We

find that $\dfrac{12c}{7} < \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})} < \dfrac{48\sqrt{3}c}{(33 - 5\sqrt{3})}$.

Hence, if $a \in (c, \dfrac{12c}{7})$ then we have a unique production decision of firm 1,

i.e., here firm 1 produces under 'FDI only'. If $a \in (\dfrac{12c}{7}, \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})})$, we have a

unique production decision of firm 1 where firm 1 produces positive amounts under

both export and FDI. If $a > \dfrac{48\sqrt{3}c}{(33 - 5\sqrt{3})}$, then also we have a unique production

decision of firm 1 where firm 1 does 'export only'. But we have two possibilities for

$a \in (\dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})}, \dfrac{48\sqrt{3}c}{(33 - 5\sqrt{3})})$. Here firm 1 can produce either '$x^*_{FDI} = \dfrac{(14a - 24c)}{33}$

and also positive amount under FDI' or '$x^*_0 = \dfrac{(5a - 6c)}{14}$ and nothing under FDI'.

Whether firm 1 prefers the former strategy or the latter depends on the relative

profitability of these strategies.

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[16] We denote the amount of export by x^*_0 to imply that for these values of export, firm 1 does not

produce anything under FDI.

Assume that $a \in (\dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}, \dfrac{48\sqrt{3}c}{(33-5\sqrt{3})})$. If firm 1 produces

$x_{FDI}^* = \dfrac{(14a-24c)}{33}$ and also positive amount under FDI, its profit is

$$\pi_1^{EX,FDI} = \dfrac{(9a-6c)(18c-5a)+(15a-21c)(14a-24c)}{1089}. \qquad (23)$$

But if firm does export only, i.e., $x_0^* = \dfrac{(5a-6c)}{14}$, its profit is

$$\pi_1^{EX,0} = \dfrac{(27a-38c)(5a-6c)}{784}. \qquad (24)$$

It is easy to check that (24) is greater than (23) over $a \in (\dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}, \dfrac{48\sqrt{3}c}{(33-5\sqrt{3})})$.[17]

Hence, firm 1 does only export if $a \in (\dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}, \dfrac{48\sqrt{3}c}{(33-5\sqrt{3})})$.[18]

The following proposition summarizes the above discussion.

Proposition 4: *(a) Firm 1 does 'FDI only' for $a \in (c, \dfrac{12c}{7})$.*

(b) Firm 1 does both export and FDI for $a \in (\dfrac{12c}{7}, \dfrac{12\sqrt{3}c}{(14-4\sqrt{3})})$.

(c) Firm 1 does 'export only' for $a > \dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}$.

3.4 Implications on the host-country input price

Now we examine the effects of different production strategy of firm 1 on the host-country input price.

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[17] We find after straightforward calculation that (24) is greater than (23) provided $0 < 17665a^2 - 21120ac - 62172c^2$. The right hand side of this inequality is increasing in a and positive at $a = \dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}$. So, (24) is greater than (23) over $a \in (\dfrac{12\sqrt{3}c}{(14-4\sqrt{3})}, \dfrac{48\sqrt{3}c}{(33-5\sqrt{3})})$.

Let us consider $a \in (c, \frac{12c}{7})$. Here, firm 1 does FDI only and the input price in the host-country will be $\frac{a}{2}$, which is lower than c for all $a \in (c, \frac{12c}{7})$. If firm 1 does export, it can reduce the input price in the host-country but needs to incur higher cost of production for export. When the market size is very small, the benefit from export is not sufficiently large since the input price in the host-country is already sufficiently low and therefore, here firm 1 does FDI only.

Next, consider $a \in (\frac{12c}{7}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$. Here, firm 1 does both export and FDI and the input price in the host-country is $\frac{(2a+6c)}{11}$. We find that $\frac{(2a+6c)}{11} \underset{<}{\overset{\geq}{=}} c$ for $a \underset{<}{\overset{\geq}{=}} \frac{5c}{2}$, where $\frac{5c}{2} \in (\frac{12c}{7}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$. Therefore, for $a \in (\frac{12c}{7}, \frac{5c}{2})$, the input price in the host-country is lower than the input price in the home country of firm 1, while the input price in the host-country is higher than the input price in the home country when $a \in (\frac{5c}{2}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$.

By doing both export and FDI, firm 1 can keep the input price in the host-country below the input price of the home country when $a \in (\frac{12c}{7}, \frac{5c}{2})$. This benefit induces firm 1 to do both export and FDI when $a \in (\frac{12c}{7}, \frac{5c}{2})$.

Now, consider for $a \in (\frac{5c}{2}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$. Here, input price in the host-country is higher than the input price in the home country. Anticipating this possibility, firm 1 could produce the amount of export in a way (i.e., $\frac{a(\sqrt{3}-1)}{2\sqrt{3}} + \varepsilon$, where $\varepsilon \to 0$) so that it could commit that it would not produce under FDI. But, this strategy reduces

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[18] There is a possibility that firm 1 wants to produce '$x < \frac{a(\sqrt{3}-1)}{2\sqrt{3}}$ and the corresponding amount under FDI' than doing 'export only' and producing $x_0^* = \frac{(5a-6c)}{14}$ when $a > \frac{48\sqrt{3}c}{(33-5\sqrt{3})}$. It is

the total market share of firm 1 and eliminates firm 1's incentive for producing this amount of 'export only'.[19] Since, the analysis assumed that firm 1 cannot readjust the amount of export once chosen, it can either do FDI or nothing after its decision on export. Since, the host country input price $\frac{(2a+6c)}{11}$ makes it profitable for firm 1 to produce under FDI when $a \in (\frac{5c}{2}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$, it does both export and FDI for these market sizes. Further, it is easy to understand that 'FDI only' would cause the host-country price to be higher than $\frac{(2a+6c)}{11}$ and makes this strategy unprofitable to firm 1 compared to both export and FDI. So, firm 1's optimal strategy is to produce both under export and FDI when $a \in (\frac{5c}{2}, \frac{12\sqrt{3}c}{(14-4\sqrt{3})})$.

Lastly consider the situation where $a > \frac{12\sqrt{3}c}{(14-4\sqrt{3})}$. Here, firm 1 does 'export only' and the input price in the host-country is $\frac{(9a+6c)}{28}$, which is greater than c for $a > \frac{12\sqrt{3}c}{(14-4\sqrt{3})}$. As market size increases, it increases the input price in the hoist-country. Since, here market size is sufficiently large, it increases the price of input significantly and reduces firm 1's benefit from FDI. As a result, here firm 1 is better off by doing export only.

3.5   Implication of the fixed costs of FDI

The implication for the existence of fixed costs of FDI is similar to section 2.5. Proposition 4 holds if fixed costs of FDI never prevent firm 1 to do FDI. But, if the fixed costs of FDI prevent firm 1 to do FDI for very small host-country market size, we will observe 'export only' for both very small and very large host-country markets. Firm 1 does 'FDI only' for moderate but relatively small market size and both export and FDI for moderate but relatively large market size.

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clear from the above discussion that this strategy is not optimal for firm 1.

3.6   Effect of competition on the production decision of firm 1

Now we are in a position to compare the effects of host-country competition on export and FDI.

Proposition 5: *(a) 'Only export' by firm 1 may be the outcome when firm 1 faces competition from firm 2 but not when firm 1 is monopoly.*

(b) Incentive for 'only FDI by firm 1' is higher when firm 1 faces competition from firm 2 compared to the situation when firm 1 is monopoly.

(c) Incentive for 'both export and FDI by firm 1' is lower when firm 1 faces competition from firm 2 compared to the situation when firm 1 is monopoly.

Proof: (a) It directly follows from Propositions 1 and 4.

(b) From Proposition 1 we find that firm 1 does FDI only provided $a < \dfrac{4c}{3}$ when it is monopoly in the host-country. But, if firm faces competition in the host-country, it does 'FDI only' when $a < \dfrac{12c}{7}$. Since, $\dfrac{12c}{7} > \dfrac{4c}{3}$, it proves the result.

(c) Proposition 1 shows that firm 1 does both export and FDI provided $a > \dfrac{4c}{3}$ when it is monopoly in the host-country. But firm 1 does both export and FDI when

$a < \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})}$ and   if   it   faces   competition   in   the   host-country.   Since,

$\dfrac{12c}{7} < \dfrac{12\sqrt{3}c}{(14 - 4\sqrt{3})}$, it proves the result.   Q.E.D.

Reasons for the above results are as follows. If there is competition in the host-country and the market size is sufficiently small, firm 1's loss of profit is higher under export compared to FDI since its marginal cost of production is higher under export compared to FDI. As a result, if the host-country market is sufficiently small,

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[19] Straightforward   calculation   shows   that   firm   1'   market   share   under   'export   and   FDI'   (i.e., $x^{*}_{FDI} + q^{*}_{1}$) is $\dfrac{(3a - 2c)}{11}$, which is greater than $\dfrac{a(\sqrt{3} - 1)}{2\sqrt{3}} + \varepsilon$.

competition in the host-country increases firm 1's incentive for FDI compared to export.

But, if the host-country market is sufficiently large, it increases the price of input significantly and reduces the incentive for FDI. Without competition in the host-country and becoming a monopolist producer, firm 1 could manipulate the amount of export and FDI in a way so that it could neutralize the effect of higher market size on the host-country input price. But, the presence of firm 2 reduces its power to manipulate the host-country input price through the choice of export. Hence, while 'export only' is not optimal without competition in the host-country, it is optimal in presence of competition in the host-country when the host-country market is sufficiently large.

So, while the presence of competition increases the incentive for 'FDI only' and 'export only', it reduces the incentive for both export and FDI.

4   Conclusion

Empirical findings have shown that export and FDI may act either as substitutes or complements. While the previous literature has mainly explained the rationale for substitutability between export and FDI, they have paid little attention to explain that export and FDI may be complements. Recent theoretical literature has paid attention to the *exogenous factors* such as cost and demand uncertainty to explain complementarity between export and FDI

The present paper focuses on the endogenous factors to explain that export and FDI may be complements. We show that if the host-country input market is imperfectly competitive and production requires non-tradable inputs, foreign firms may prefer to both export and FDI. Export by foreign firms helps to affect the input price in the host-country and increases foreign firm's profit from FDI. This strategic reason provides the foreign the incentive to do export even if it needs to face relatively higher input price in the home country.

We further show that foreign firm has the incentive to do both export and FDI even if it faces competition from a host-country firm in the final goods market.

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