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Abstract

This paper provides an analysis of how a firm's decision to serve a foreign market by exporting or by engaging in foreign direct investment (FDI) affects firm productivity, when productivity is endogeneous as a function of training. The main result of our paper is that, with endogeneous productivity, exporting results in lower productivity than does FDI, but exporting may result in higher or lower employment and output than does FDI. We also show that FDI has lower employment, higher training, higher wages and higher productivity than does production for the home market. A further interesting and unexpected result of our model is that exporting results in the same level of training and productivity as does production for the home market. However, under the same demand conditions, the exporting firm employs less labour for foreign production than for home production and, consequently, output for the foreign market is lower than output for the home market. In addition, we investigate the firm's decision to serve the foreign market by exporting or by engaging in FDI and determine parameter values for which either regime is chosen.

JEL classification: F22, F23
Bank classification: International topics; Labour markets; Productivity

Résumé

Les auteures analysent comment la décision d’une firme de s’engager sur un marché extérieur par la voie de l’exportation ou d’un investissement direct à l’étranger influe sur sa productivité, lorsque celle-ci est déterminée de façon endogène par la formation. L’étude révèle que, si la productivité est endogène, les entreprises exportatrices sont moins productives que les entreprises qui investissent directement à l’étranger; toutefois, les niveaux d’emploi et de production des premières sont aussi élevés que ceux des secondes. Les auteures montrent par ailleurs que l’investissement direct à l’étranger s’accompagne de niveaux de formation, de salaire et de productivité supérieurs à ceux qu’implique la production de biens destinés au marché intérieur, mais que le nombre des emplois est moindre. Autre résultat intéressant et inattendu du modèle, l’activité d’exportation se caractérise par les mêmes niveaux de formation et de productivité que la production tournée vers le marché national. Toutefois, sous des conditions de demande équivalentes, la société exportatrice affecte moins de main-d’œuvre à la production de biens d’exportation qu’à celle de biens destinés au marché intérieur, de sorte qu’elle produit davantage pour celui-ci que pour le marché extérieur. Les auteures étudient également les facteurs sous-tendant la décision d’une entreprise d’exporter ou d’investir directement à l’étranger et déterminent les valeurs des paramètres qui président au choix de l’un ou de l’autre régime.

Classification JEL : F22, F23
Classification de la Banque : Questions internationales; Marchés du travail; Productivité

1 Introduction

Empirical studies have shown that exporting firms and firms that engage in foreign direct investment (FDI) are more productive than their purely domestic counterparts (Yeaple, 2005; Melitz, 2003; Bernard, Eaton, Jensen, and Kortum, 2003; Baldwin and Gu, 2003, 2005; Blomström and Kokko, 1998). The theoretical literature has sought to examine the effect of productivity on firms' decisions to participate in international markets. Helpman, Melitz, and Yeaple (2004) forms part of this literature. In their study, firms are heterogeneous with respect to their (exogeneous) productivity and, conditional on productivity, they sort themselves into purely domestic, exporting, and FDI firms. Abstracting away from differences in preferences across countries, their analysis shows that low-productivity firms serve only the domestic market, while more productive firms serve both the domestic market and foreign markets. Of the firms serving foreign markets, the more productive ones engage in FDI, while the less productive ones become exporters. This hierarchy reflects the fact that exporting entails higher variable costs (i.e. it includes transport costs) than does production for the home market and FDI entails higher fixed costs than does exporting or production for the home market. In a similar vein, Yeaple (2005) shows that even when firms are assumed to be identical ex ante, exporting firms are more productive than purely domestic firms. In this study, ex post firm heterogeneity arises because firms endogeneously choose to adopt different technologies and hire different types of workers.

Our paper complements the literature and provides an analysis of how a firm's decision to serve a foreign market by exporting or by engaging in FDI affects firm productivity. The distinguishing features of our model are workers' occupational choice and endogeneous productivity. We incorporate the former by allowing workers to select where they work. Worker mobility in our framework is, in fact, intra-company mobility of skilled labour. Our set-up is meant to incorporate the growing importance of international mobility of skilled labour both among OECD countries and between OECD countries and the rest of the world. Recent studies show that skilled-labour mobility is becoming an important factor in firms' decisions to expand their operations abroad, and so FDI gives rise to increased labour mobility through intra-company mobility of skilled labour (Gera, Laryea, and Songsakul, 2004; Harris and Schmitt, 2003; PricewaterhouseCooper, 2003; Globerman, 2001). Also in this more recent literature, labour mobility reduces transactions costs and, therefore, attracts

FDI. Furthermore, MNEs increasingly resort to intra-company transfers of skilled workers to increase efficiency by training workers in the foreign affiliate faster and cheaper than they can learn on their own (Markusen, 2005; Gera, Laryea, and Songsakul, 2004; Mercer Human Resource Consulting, 2006).[1] Our paper models intra-company labour mobility in an occupational choice setting by assuming that workers bear an attachment-to-home cost if they work for an FDI firm abroad. The attachment-to-home cost reflects workers' cultural and nationalistic preferences for working in their home country. Thus, a lower degree of attachment-to-home reflects higher international labour mobility.[2]

Endogneous productivity is incorporated in our model in the firm's decision to train workers, which represents an important component of human capital investment that increases worker productivity. In our context, we think of training as just one component that affects labour productivity, along with other factors that are exogeneous to our model. Our setting thus allows us to examine how exporting, FDI, or production for the home market affects worker training. In the case of FDI, the firm employs home-country trained workers and employee training is undertaken by the parent firm in the home country.

Elements of our model are similar to that in Helpman, Melitz, and Yeaple (2004) in that production for the domestic market entails lower fixed costs than does production for export, and production for export entails lower fixed costs than does FDI. Furthermore, exporting entails "melting-iceberg" transportation costs that raise variable costs relative to domestic production and FDI. In our model, a monopolist firm always serves the home market, and it serves the foreign market either by exporting or by engaging in FDI. The main result of our paper is that, with endogeneous productivity, exporting results in lower productivity than does FDI, but exporting may result in higher or lower employment than does FDI. Thus, exporting may result in higher or lower output than would FDI. Our result thus shows that FDI firms are more productive than exporters, and it is an important complement to the result in Yeaple (2005) who finds that exporters are more productive than domestic firms.

We also show that FDI has lower employment, higher training, higher wages and higher productivity than does production for the home market. A further interesting and unexpected result of our model is that exporting results in the same level of training and

[1] This mechanism also gives rise to important spillover effects when a trained worker leaves the MNE and is hired by a local competitor (Fosfuri, Motta, and Rønde, 2001; Markusen, 2005). In this paper, we ignore productivity spillover issues.

[2] See, for example, Mansoorian and Myers (1993) for more on the idea of attachment-to-home.

productivity as does production for the home market. In particular, transportation costs turn out to have no effect on the optimal amount of training because the monopolist adjusts its optimal employment level in response to changes in transportation costs so that the total effect on training is zero. The exporting firm, however, employs less labour for foreign production than for home production and, consequentely, output for the foreign market is lower than output for the home market.

The remainder of the paper is organized as follows. Section 2 sets up the model and the analysis to follow. Section 3 provides a comparison of employment and training in production for the home market, for the foreign market through exporting, and for the foreign market through FDI. Section 4 examines the factors that influence the firm's decision to serve the foreign market by exporting or by engaging in FDI. Concluding comments are provided in section 5.

2 The Model

2.1 Technology

There are two countries, home, H, and foreign, F. Both countries produce a homogeneous good, X, using a constant returns to scale technology with labour, L_X, as the only variable input. Industry X is perfectly competitive and good X is used as the numeraire. Good Y is produced also using skilled labour, L_Y, as the only variable input. Producing good Y, however, requires a specialized technology, and workers in industry Y need to be trained to some degree to use this technology. The production function is given by $Y = A(t)L_Y$, where $A(t)$ is productivity as a function of firm-specific training, t, and $A(0) = 0$. Training increases worker productivity, $A' > 0$, but at decreasing returns, $A'' < 0$, and it is costly for the firm, with cost function given by $K(t)$, and $K' > 0$, $K'' > 0$.

One monopolist firm has gained access to a specialized proprietary technology in the production of good Y. This firm is located in the home country. Production of good Y for the domestic market alone entails fixed costs of f_D. In addition to producing for the domestic market, the firm serves the foreign market either by exporting or engaging in FDI. The latter entails employment of home-country trained workers. Employee training is undertaken by the parent company in country H only. This allows us to incorporate endogenous labour mobility across countries into the model. Exporting involves fixed costs f_E and a "melting-iceberg" transport cost per unit sold in the foreign market, $\tau > 1$. The fixed costs f_E include distribution costs in the foreign market. FDI entails fixed costs f_I, which include distribution costs of servicing the foreign market and the additional costs of setting up an affiliate in F. Thus, $f_I > f_E > f_D$. Note that in the analysis that follows, we use a subscript to refer to the industry, $i \in \{X, Y\}$, and a superscript to refer to the market in industry Y, $j \in \{H, E, I\}$.

We denote by P_X and P_Y the prices of good X and Y, respectively. Workers earn a wage w_X in industry X and w_Y^j in industry Y, where $j \in \{H, E, I\}$. With a constant returns to scale production technology, perfect competition in industry X implies that $P_X = w_X = 1$ in both countries, since good X is the numeraire.

2.2 Preferences and Occupational Choice

Consumers-cum-workers supply one unit of labour inelastically, but can choose to work in industry X and earn wage w_X or in industry Y and earn wage w_Y^j, $j \in \{H, E, I\}$. Working in industry Y requires training, which entails a disutility cost, $c(t)$, for the worker, with $c' > 0$ and $c'' > 0$. We can think of training in our setting as training outside work hours.[3] In addition to this disutility cost, the worker bears an attachment-to-home cost, γ, if working abroad. Workers thus bear a non-pecuniary cost of living abroad that reflects their preference for working in their home country for cultural or nationalistic reasons. The attachment-to-home parameter also captures the degree of international (intra-company) labour mobility; a higher γ indicates lower mobility.

The preferences of a representative consumer are quasi-linear over goods X and Y, and we assume constant elasticity of demand for good Y. More specifically, consumer preferences are given by:

$$U = X + \frac{\varepsilon}{\varepsilon - 1} Y^{\frac{\varepsilon-1}{\varepsilon}} - c(t), \tag{1}$$

where $\varepsilon > 1$ is the absolute value of the price elasticity of demand for good Y.[4] The problem for a consumer is to maximize utility (1) subject to the budget constraint:

$$X + P_Y Y = M. \tag{2}$$

[3] An example of training outside work hours is a night course or a weekend intensive training course.

[4] Recall that workers supply one unit of labour inelastically, which implies that the labour/leisure decision does not enter the consumer's optimizatio problem. However, the decision of where to supply that one unit of labour is endogenous, and constitutes the consumer's occupational choice decision discussed below.

In country H, income, M, is dependent upon which type of firm the consumer is employed. Thus, for the home country, we have

$$M_i^j = \begin{cases} w_X, & \text{if} \quad i = X, \\ w_Y^H, & \text{if} \quad i = Y, \quad j = H, \\ w_Y^E, & \text{if} \quad i = Y, \quad j = E, \\ w_Y^I, & \text{if} \quad i = Y, \quad j = I. \end{cases} \tag{3}$$

From the first-order conditions we derive a consumer's demands for goods X and Y:

$$X_i(P_Y, M_i) = M_i - P_Y^{1-\varepsilon}, \tag{4}$$

$$Y_i(P_Y) = P_Y^{-\varepsilon}. \tag{5}$$

Note that, with quasi-linear preferences, consumer j's demand for good Y is independent of income, M_i^j. Thus, with identical preferences and populations, demand for good Y is identical in H and F.

Aggregating over consumers we derive the aggregate demands for goods X and Y:

$$X(P_Y, M) = \sum_i L_i X_i(P_Y, M_i), \tag{6}$$

$$Y(P_Y) = P_Y^{-\varepsilon}, \tag{7}$$

where $M_i = (w_X, w_Y^H, w_Y^E, w_Y^I)$ denotes the vector of incomes.

In country H, an occupational choice equilibrium requires that workers be indifferent between working in industry X and industry Y. There are three possibilities for a worker in industry Y. Either they can produce for the home market, or they can produce good Y at home but for export to country F, or they can be sent abroad to produce good Y directly in the foreign market. With quasi-linear preferences, an equilibrium entails that the worker be indifferent between these alternatives when he/she derives the same income from either alternative. Thus, we have

$$\begin{aligned} w_X = 1 = w_Y^H - c(t^H) = w_Y^E - c(t^E) \quad \text{or} \\ w_X = 1 = w_Y^H - c(t^H) = w_Y^I - c(t^I) - \gamma, \end{aligned} \tag{8}$$

depending on whether the industry-Y firm serves the foreign market through exports or FDI.

Proposition 1 *With quasi-linear preferences, the wage rate is increasing in training.*

Proof: The occupational choice equilibrium condition gives

$$w_Y^H(t^H) = 1 + c(t^H), \quad w_Y^E = 1 + c(t^E), \quad w_Y^I = 1 + c(t^I) + \gamma, \tag{9}$$

which imply that ${w_Y^j}'(t^j) = c'(t^j) > 0$. *Q.E.D.*

This result shows that workers do not pay for training by receiving lower wages. Workers are free to choose their occupation, i.e., industry X or industry Y, and this ensures that the marginal benefit of training, ${w_Y^j}'$, equals the marginal cost of training, c'.[5] This result is consistent with a number of empirical studies that find that workers in training programs do not receive lower wages (Bishop, 1991; Barron, Black, and Loewenstein, 1989; Barron, Berger, and Black, 1993).

2.3 Employment and Training in Industry-Y

The monopolist in industry-Y selects labour and training to maximize profits in the home and foreign markets. An interior equilibrium allows us to analyze the two markets separately. However, in order to lessen the burden of repetition on the reader, we will examine the profit-maximization problem for the "generic" case; that is, one that potentially includes all possibilities. Table 1 summarizes these possibilities.

Table 1: Transportation cost and attachment-to-home

j	H	E	I
τ	$=1$	>1	$=1$
γ	$=0$	$=0$	>0

We can examine the firm's problem using two approaches, both of which yield the same solution. One approach is to look at the firm's problem in two stages. In the first stage, the firm hires workers and, in the second stage, it trains them. The two-stage approach allows us to examine the interdependence of employment and training and derive partial comparative statics properties of the optimal employment and optimal training functions. The second approach is a one stage approach where employment and training are determined

[5]This assumes that there are no labour market imperfections and that workers can costlessly choose their occupation.

simultaneously by directly examining the first order conditions. The one-stage approach allows us to gain more intuition about the properties of the optimal employment and optimal training functions. We begin with the two-stage approach and we will turn to the one-stage approach in section 3.

We start with the two-stage approach. In the first stage, the firm hires workers and, in the second stage, it trains them. We begin the analysis in stage 2. The problem is therefore to choose the level of training, t^j, to maximize profits, taking as given L_Y^j determined at stage 1:

$$\max_{t^j} \frac{1}{\tau} P_Y^j \cdot Y - (w_Y^j(t^j) + K(t^j))L_Y^j - f_j, \tag{10}$$

where the "melting-iceberg" transport cost is defined in Table 1. The solution to the firm's problem at this stage is $t^{j*}(L_Y^j, \tau, \varepsilon)$ and solves the first-order condition

$$\left[\frac{1}{\tau} MR \cdot A' - ({w_Y^j}' + K')\right] L_Y^j = 0, \tag{11}$$

where $MR = (\varepsilon - 1)/\varepsilon) Y^{-1/\varepsilon}$ is the firm's marginal revenue. We assume that the second-order condition for an interior solution holds; that is, $\Delta_t = (MR' \cdot A' \cdot L_Y + MR \cdot A'')/\tau - (w_Y'' + K'') < 0$. Substituting $t^{j*}(L_Y^j, \tau, \varepsilon)$ into the firm's objective function defines the profit function $\Pi(L_Y^j, \tau, \varepsilon)$.

Using (8), the first-order condition (11) can be re-written as:

$$\left[\frac{1}{\tau} MR \cdot A' - (c' + K')\right] L_Y^j = 0. \tag{12}$$

Since both the firm and the worker capture a share of the returns on training in the form of productivity increases and wage increases, respectively, each is willing to share the costs of training.[6]

The properties of the training function are easily derived to be:

$$\frac{\partial t^{j*}}{\partial L_Y^j} < 0, \quad \frac{\partial t^{j*}}{\partial \tau} < 0, \quad \frac{\partial t^{j*}}{\partial \varepsilon} > 0. \tag{13}$$

[6]The primary aim of our paper is to shed light on how firm participation in international markets by exporting or FDI affects firm productivity. Understanding all the incentives or disincentives facing firms in training workers is beyond the scope of this paper. We thus assume away externalities that may result in firms being unwilling to pay for worker training in the event that they do not capture all of the returns to training.

The first property shows that the training function is decreasing in firm employment, which reflects the fact that labour and training are substitutes in production. The second property shows that, for given levels (L_Y^j, ε), the existence of transport costs provides a disincentive for training in the exporting regime. The third property shows that a reduction in market power, as measured by an increase in the price elasticity of demand, results in an increase in training.

The first stage of the firm's problem is the hiring of workers, while anticipating the impact of hiring on training in stage 2. The firm chooses the amount of labour to hire to maximize $\Pi(L_Y^j, \tau, \varepsilon)$. Using the Envelope Theorem, the first-order condition is:

$$\frac{\partial \Pi}{\partial L_Y^j} = \frac{1}{\tau} MR \cdot A - (w_Y^j(t^{j*}) + K(t^{j*})) = 0, \tag{14}$$

which gives the solution ${L_Y^j}^*(\tau, \varepsilon, \gamma)$. We assume that the second-order condition for an interior solution is satisfied; i.e., $\Delta_L = MR' \cdot A^2/\tau - (MR' \cdot A \cdot A'/\tau)^2/\Delta_t \cdot L_Y < 0$. The properties of ${L_Y^j}^*(\cdot)$ are straightforward to derive. The first one is

$$\frac{d{L_Y^j}^*}{d\tau} = \frac{1}{\Delta_L}\left\{\frac{(MR)A}{\tau^2} + \frac{A(MR')L_Y A'}{\tau}\frac{\partial t^*}{\partial \tau}\right\} \gtreqless 0. \tag{15}$$

This property shows that the total effect of an increase in the transport cost on employment can be decomposed into two effects. The first one reflects the direct negative impact an increase in τ has on the marginal revenue product of labour. The second effect reflects the second-order impact an increase in τ has on marginal revenue. That is, an increase in τ, ceteris paribus, lowers optimal training, and thus lowers output. A decrease in output raises marginal revenue, and thus an increase in τ has a positive effect on optimal labour. Although these two effects work in opposite directions, we would expect that the direct effect of a change in τ dominates the second-order effect. That is, we expect the exporting firm to hire less labour for foreign production than for home production.

Further properties of ${L_Y^j}^*(\cdot)$ are

$$\frac{d{L_Y^j}^*}{d\gamma} = \frac{1}{\Delta_L} < 0 \tag{16}$$

and

$$\frac{d{L_Y^j}^*}{d\varepsilon} = \frac{-A}{\tau\Delta_L}\left\{\frac{1}{\varepsilon^2} + A(MR')L_Y^j A'\frac{\partial t^*}{\partial \varepsilon}\right\} > 0. \tag{17}$$

As would be expected, an increase in workers' attachment-to-home increases their wage from employment abroad, and thus decreases ${L_Y^j}^*$. Furthermore, an increase in the price elasticity of demand lowers the firm's market power, which raises employment.

We can now derive the total comparative statics properties of the optimal training function.

Proposition 2 *The total comparative statics properties of the optimal training function are given by:*

$$\frac{dt^{j*}}{d\tau} = \frac{\partial t^{j*}}{\partial \tau} + \frac{\partial t^{j*}}{\partial {L_Y^j}^*}\frac{d{L_Y^j}^*}{d\tau} = 0, \tag{18}$$

$$\frac{dt^{j*}}{d\gamma} = \frac{\partial t^{j*}}{d{L_Y^j}^*}\frac{d{L_Y^j}^*}{d\gamma} > 0, \tag{19}$$

$$\frac{dt^{j*}}{d\varepsilon} = \frac{\partial t^{j*}}{\partial \varepsilon} + \frac{\partial t^{j*}}{\partial {L_Y^j}^*}\frac{d{L_Y^j}^*}{d\varepsilon} = 0. \tag{20}$$

Proof: The proof is relegated to Appendix A. *Q.E.D.*

2.4 Labour market clearing

Completion of the equilibrium in the model requires that the labour market clears. Thus, the following condition must be satisfied

$$\begin{aligned} L_X + L_Y^H + L_Y^E &= 1 \quad \text{or} \\ L_X + L_Y^H + L_Y^I &= 1, \end{aligned} \tag{21}$$

depending on whether the foreign market is served through exports or FDI.

Substituting L_Y^{H*}, L_Y^{E*}, and ${L_Y^I}^*$ into (21) gives ${L_X}^*$.

3 Comparison of Employment and Training Across Production Regimes

We now turn to the one-stage approach to solving the monopolists profit-maximization problem. After some manipulation, the first-order conditions for the firm's maximization problem with respect to t^j and L_Y^j can be written as:

$$\frac{1}{\tau}MR \cdot A' = {w_Y^j}' + K', \tag{22}$$

$$\frac{1}{\tau}MR \cdot A = w_Y^j + K. \tag{23}$$

Dividing these equations through gives

$$\frac{A'}{A} = \frac{{w_Y^j}' + K'}{w_Y^j + K}. \tag{24}$$

Equation (24) shows that, at the optimum, the technical rate of substitution equals the economic rate of substitution. Equation (24) is particularly useful in understanding some of the results in this section.

We are now in a position to examine how the levels of employment and training in industry-Y compare in production for the home market, for export to country F, and for FDI. Proposition 3 compares the performance of the FDI firm in the home market versus the foreign market in terms of employment, training and productivity:

Proposition 3 *FDI results in lower employment and higher training than does production in the home country, i.e.,* ${t^I}^* > {t^H}^*$ *and* ${L_Y^I}^* < {L_Y^H}^*$*.*

Proof: The result that ${L_Y^I}^* < {L_Y^H}^*$ follows from (16) along with the fact that $\gamma = 0$ for home production and $\gamma > 0$ for employment abroad. Then, from (19) we know that optimal training is increasing in the attachment-to-home. Because $\gamma = 0$ for a purely domestic firm and $\gamma > 0$ for an FDI firm, it follows that ${t^I}^* > {t^H}^*$. *Q.E.D.*

The intuition behind Proposition 3 is straightforward. Higher attachment-to-home makes labour more expensive abroad. As a result, firms choose to substitute training for labour, thus increasing productivity. This implies that higher international labour mobility (lower γ) makes hiring labour abroad cheaper and firms substitute labour for training. Hence, higher international labour mobility results in lower productivity.

Corollary 1 *The FDI firm pays higher wages in the foreign country than in the home country, i.e.,* $w_Y^I > w_Y^H$*.*

Proof: This follows from Propositions 1 and 3. *Q.E.D.*

Higher training is reflected in higher wages. Since the FDI firm has higher training than the purely domestic firm and workers' attachment to home imparts a premium on working abroad, it follows that the FDI firm also has higher wages.

Proposition 4 next compares the level of training and productivity of the exporting firm in the home market compared with the foreign market:

Proposition 4 *The exporting firm has the same level of training for home and foreign production.*

Proof: This follows directly from Proposition 2. *Q.E.D.*

Proposition 4 is an interesting and unexpected result. We can understand this result by referring back to equation (24). Equation (24) can be solved for ${t^j}^*$, and since this equation does not depend on τ, it follows that the optimal training is independent of transportation costs, τ. Additional intuition for this result can be gained by breaking down the total effect of an increase in the transportation cost, τ, on training into two effects as in (18). The first effect is the negative direct effect $(\partial {t^j}^*/\partial\tau) < 0$ and reflects the fact that, with transportation costs, the exporting firm has a disincentive to train workers. The second effect is the second-order effect of a change in the transportation cost working through changes in employment. Since a change in transportation cost has, in general, an ambiguous effect on employment, the second-order effect is of ambiguous sign. Proposition 4 shows, however, that the total effect is zero. That is, as transportation cost changes the exporting firm adjusts optimal labour such that the total effect on training is zero. This implies that the exporting firm has the same level of training for both home and foreign production. Consequently, the exporting firm has the same productivity for home production as for foreign production.

Note that this result is very general; it does not depend on the assumed preferences. In fact, condition (24) is the same for any demand function and does not depend on the elasticity of demand, ε. Furthermore, the same equation obtains when assuming different demand functions in the home and foreign countries and, a fortiori, different demand elasticities in the two countries. Hence, even when the exporter faces a more elastic demand function in the foreign market it would still choose to adjust production by adjusting employment and leaving training for home and foreign production equal. That is, for the exporting firm home and foreign production are equally productive.

Next, Propositions 5 compares the level of employment of the exporting firm for home production compared with home production:

Proposition 5 *The exporting firm hires more labour for home production than for foreign production, i.e.,* $L_Y^{H^*} > L_Y^{E^*}$.

Proof: From the first-order condition for L_Y^j we obtain

$$L_Y^{j\,*} = \left[\frac{1}{\tau}\frac{\varepsilon - 1}{\varepsilon}\frac{A(t^{j*})^{\frac{\varepsilon-1}{\varepsilon}}}{1 + c(t^{j*}) + K(t^{j*})}\right]^{\varepsilon}, \tag{25}$$

for $j \in \{H, E\}$. Since $t^{H^*} = t^{E^*}$ and $\tau = 1$ for home production and $\tau > 1$ for foreign production, it follows that $L_Y^{H^*} > L_Y^{E^*}$. *Q.E.D.*

The following result is a direct implication of Propositions 4 and 5.

Corollary 2 *The output of the exporting firm is higher for the home market than it is for the foreign market.*

The intution for this result is straightforward. The exporting firm hires more labour for the home production than for the foreign production and has the same level of training for workers producing for the home and foreign market. The overall result is thus higher output for home production than for foreign production. This result is consistent with the existing empirical evidence that exporters usually export only a small fraction of their output.[7]

Proposition 6 next compares the foreign production performance of the FDI and the exporting regimes in terms of level of training, productivity, and wages:

Proposition 6 *FDI results in higher training, higher productivity and pays higher wages than does production for export.*

Proof: Referring to (24), the necessary condition for an optimum under exporting is:

$$\frac{A'(t^{E*})}{A(t^{E*})} = \frac{w_Y^{E\prime}(t^{E*}) + K'(t^{E*})}{w_Y^{E}(t^{E*}) + K(t^{E*})} = \frac{c'(t^{E*}) + K'(t^{E*})}{1 + c(t^{E*}) + K(t^{E*})}, \tag{26}$$

[7]See, for example, (Bernard, Eaton, Jensen, and Kortum, 2003; Bernard and Jensen, 1995, 1999; Clerides, Lach, and Tybout, 1998; Aw, Chung, and Roberts, 1998). Bernard, Eaton, Jensen, and Kortum (2003) find that around two-thirds of the U.S. exporters in their sample sell less than 10 percent of their output abroad.

where the last equality comes from the occupational choice equilibrium condition. Similarly, the necessary condition for an optimum under FDI is:

$$\frac{A'(t^{I*})}{A(t^{I*})} = \frac{{w_Y^I}'(t^{I*}) + K'(t^{I*})}{w_Y^I(t^{I*}) + K(t^{I*})} = \frac{c'(t^{I*}) + K'(t^{I*})}{1 + c(t^{I*}) + K(t^{I*}) + \gamma}. \tag{27}$$

Evaluating the necessary condition (27) at t^{E*} gives:

$$\frac{A'(t^{E*})}{A(t^{E*})} = \frac{c'(t^{E*}) + K'(t^{E*})}{1 + c(t^{E*}) + K(t^{E*})} > \frac{c'(t^{E*}) + K'(t^{E*})}{1 + c(t^{E*}) + K(t^{E*}) + \gamma}, \tag{28}$$

since $\gamma > 0$. *Q.E.D.*

The intuition for Proposition 6 is straightforward. The presence of the attachment-to-home premium for wages received when working abroad implies that, at t^{E*}, the technical rate of substitution of the FDI firm is higher than the economic rate of substitution. Thus, the FDI firm can increase its profits by increasing training above t^{E*}. This implies that the FDI firm chooses a higher level of training for foreign production than would an exporting firm. Productivity and wages are consequently higher for the FDI firm than for the exporting firm.

Finally, Proposition 7 compares the level of employment of the FDI and the exporting firms:

Proposition 7 *FDI may result in higher or lower employment than does exporting.*

Proof: Manipulating the first-order conditions for optimal employment under exporting and FDI we obtain:

$$\frac{1}{\tau} \cdot \left(\frac{A(t^{E*})}{A(t^{I*})}\right)^{\frac{\varepsilon-1}{\varepsilon}} \cdot \left(\frac{L_Y^{E*}}{L_Y^{I*}}\right)^{-\frac{1}{\varepsilon}} = \frac{1 + c(t^{E*}) + K(t^{E*})}{1 + c(t^{I*}) + K(t^{I*}) + \gamma}. \tag{29}$$

As $\tau > 1$ and $t^{E*} < t^{I*}$ the first two factors on the left-hand side and the term on the right-hand side of (29) are less than one. The third factor on the left-hand side of (29) may, however, be less or greater than one. That is, the exporting firm may hire less or more labour for foreign production than the FDI firm. *Q.E.D.*

To illustrate how either case can arise in Proposition 7, consider the following example. First assume the following functional forms for the training function, workers' disutility cost function, and firms' training cost function: $A(t) = t^q$, $c(t) = ct$, and $K(t) = kt$, where $q < 1$

is the workers' constant training efficiency and $c > 0$, $k > 0$. The assumption that $q < 1$ captures decreasing returns to training. With these functional forms we can easily derive the following:

$$t^{j*} = \frac{q(1+\gamma)}{1-q}\frac{1}{c+k}, \tag{30}$$

$$L_Y^{j*} = \left(\frac{1}{\tau}\frac{\varepsilon-1}{\varepsilon}\right)^{\varepsilon}\left(\frac{1-q}{1+\gamma}\right)^{\varepsilon-q(\varepsilon-1)}\left(\frac{q}{c+k}\right)^{q(\varepsilon-1)}, \tag{31}$$

for $j \in \{E, I\}$ and $\gamma = 0$ and $\tau > 1$ for the exporting firm and $\gamma > 0$ and $\tau = 1$ for the FDI firm. These expressions imply that $t^{I*} > t^{E*}$ and $L_Y^{I*} \gtreqless L_Y^{E*}$ as $\tau \gtreqless (1+\gamma)^{\varepsilon-q(\varepsilon-1)}$. The latter shows that as attachment-to-home becomes large/small relative to transportation costs, the FDI firm will reduce/increase employment below/above that of the exporting firm. Thus, employment can be higher or lower with exporting compared to FDI depending on the relative magnitudes of transportation costs and attachment-to-home.

In section 4 we turn to the firm's choice of serving the foreign market by exporting versus FDI.

4 The Decision to Export or Engage in FDI

Our analysis in section 3 allows us to examine the factors that influence the monopoly firm's decision to serve the foreign market through exports or by engaging in FDI. Recall that the exporting and FDI regimes embody differences in both variable and fixed costs. Exporting results in transport costs, but we have learned in section 3 that it also results in lower wages and training than does FDI. Employment of labour is also different under the two regimes, and depends on the relative strengths of transport costs, training, and attachment-to-home. FDI, on the other hand, entails higher fixed costs than does exporting, which has obvious implications for the decision to export versus FDI.

The comparison of profits under the two regimes allows us to explore the competing influences on the firm's decision to export or engage in FDI. First note that, from (14), the firm's labour demand under the two regimes can be written as:

$$L_Y^E = \left[\frac{1}{\tau}\frac{\varepsilon-1}{\varepsilon}\frac{A(t^{E*})^{\frac{\varepsilon-1}{\varepsilon}}}{w(t^{E*})+K(t^{E*})}\right]^{\varepsilon} \tag{32}$$

and

$$L_Y^I = \left[\frac{\varepsilon - 1}{\varepsilon} \frac{A(t^{I*})^{\frac{\varepsilon-1}{\varepsilon}}}{w(t^{I*}) + K(t^{I*})}\right]^{\varepsilon}. \tag{33}$$

Substituting these into the firm's profit function gives the following simplified expressions for profits under the two regimes:

$$\pi^{E*} = \frac{1}{\tau}\big(w(t^{E*}) + K(t^{E*})\big)L_Y^E - f_E = \frac{1}{\tau^{\varepsilon}}\frac{(\varepsilon-1)^{\varepsilon-1}}{\varepsilon^{\varepsilon}}\left[\frac{A(t^{E*})}{1 + c(t^{E*}) + K(t^{E*})}\right]^{\varepsilon-1} - f_E, \tag{34}$$

and

$$\pi^{I*} = \big(w(t^{I*}) + K(t^{I*})\big)L_Y^I - f_I = \frac{(\varepsilon-1)^{\varepsilon-1}}{\varepsilon^{\varepsilon}}\left[\frac{A(t^{I*})}{1 + c(t^{I*}) + \gamma + K(t^{I*})}\right]^{\varepsilon-1} - f_I. \tag{35}$$

As noted above, there are competing influences of transport costs, training, employment of labour, and attachment-to-home on the firm's decision of how to serve the foreign market. Recall that transport costs have no effect on training, but they do reduce the employment of labour. In (34) and (35), we see that they thus tend to make profits higher under FDI than under exporting, as would be expected. Attachment-to-home does affect training, and we have learned that it makes training higher under FDI than under exporting. Attachment-to-home also has a direct positive effect on wages. Both the training effect and the direct effect on wages tend to make employment of labour lower under FDI than under exporting. Offsetting this, however, is the fact that higher training makes labour more productive, and this tends to make employment of labour higher under FDI than under exporting.

A graphical analysis of the above discussion can shed more light on the competiting influences on the decision to export or engage in FDI. For any value of $\varepsilon > 1$ and any given difference in fixed costs, $f_I - f_E$, we can derive a profit indifference curve in (γ, τ)-space such that $\pi^E = \pi^I$. Denote by

$$S \equiv \{(\hat{\tau}, \hat{\gamma}) \quad \text{s.t.} \quad \pi^{E*} = \pi^{I*}\}, \tag{36}$$

the locus of combinations of (τ, γ) that make exporting and FDI equally profitable. Thus, $(\hat{\tau}, \hat{\gamma})$ satisfy

$$\hat{\tau} = \left[\frac{\frac{(\varepsilon-1)^{\varepsilon-1}}{\varepsilon^{\varepsilon}}\left[\frac{A(t^E)}{1+c(t^E)+K(t^E)}\right]^{\varepsilon-1}}{\frac{(\varepsilon-1)^{\varepsilon-1}}{\varepsilon^{\varepsilon}}\left[\frac{A(t^I)}{1+c(t^I(\hat{\gamma}))+\hat{\gamma}+K(t^I(\hat{\gamma}))}\right]^{\varepsilon-1} - (f_I - f_E)}\right]^{1/\varepsilon}. \tag{37}$$

Note that the firm is indifferent between exporting and FDI for $(\forall)$ $(\hat{\tau}, \hat{\gamma}) \in S$.

Lemma 1 *$\hat{\tau}$ is increasing in $\hat{\gamma}$.*

Proof: The proof is relegated to Appendix 1. *Q.E.D.*

Proposition 8 *The monopolist chooses to serve the foreign market by FDI for $(\forall)\ \tau \geq \hat{\tau}$, $(\forall)\ \gamma \geq \hat{\gamma}$ and by exporting for $(\forall)\ \tau < \hat{\tau}$, $(\forall)\ \gamma < \hat{\gamma}$, $(\forall)\ (\hat{\tau}, \hat{\gamma}) \in S$.*

Proof: This follows directly by inspection of (34), (35) and Lemma 1. *Q.E.D.*

Figure 1 is a graphical representation of Proposition 8. The upward sloping curve in Figure 1 represents combinations of (τ, γ) that make the firm indifferent between exporting and engaging in FDI. The area above the profit-indifference curve is the region where the monopolist chooses to serve the foreign market by engaging in FDI. Finally, exporting is most profitable in the area below the profit-indifference curve.

Note that the profit-indifference curve is drawn for given values of the demand elasticity, ε, and given values of the fixed costs, f_E and f_I. Changes in these values would result in shifts of the profit-indifference curve. Equation 37 shows that an increase in ε has an ambiguous effect on the profit indifference curve. As would be expected, an increase in $f_I - f_R$ shifts the profit indifference curve upwards, and thus increases the combinations of τ and γ for which exporting is more profitable than FDI.

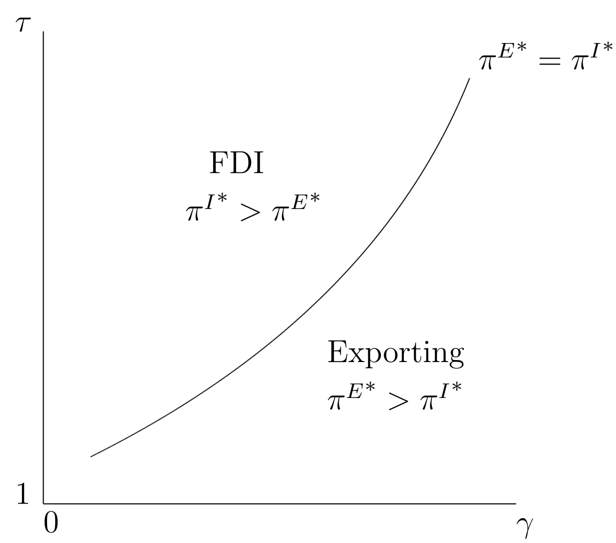

Figure 1: Profits from Exports and FDI

5 Conclusions

The primary aim of our paper has been to examine how a firm's decision to serve a foreign market through exporting or FDI affects productivity. In our analysis, productivity is affected by worker training, which is endogenous in our model. Workers are also free to select their occupation. In this setting, we have shown that FDI results in higher training - and hence higher productivity - than does exporting. We have also found that exporting results in the same amount of training as does production for the home market. Our results for the levels of training are driven by differences in variable costs between exporting and FDI. These differences in variable costs also affect the firm's labour demand under home production, exporting, and FDI. In particular, we have found that exporting may result in higher or lower employment than does FDI. Thus, exporting may result in higher or lower output than would FDI. The exporting firm, however, employs less labour for foreign production than for home production and, consequentely, output for the foreign market is lower than output for the home market. We have also investigated the firm's decision to serve the foreign market by exporting or by engaging in FDI and explored various parameter values for which either case arises.

One main result of our paper—FDI is more productive than exporting—is an important contribution to the literature which, to date, has only shown that exporting is more productive than purely domestic production (Yeaple, 2005). A natural extension of our paper would be to incorporate endogenous training into a framework whereby many firms endogenously sort themselves into purely domestic, exporting, and FDI firms. A further extension would be to examine other imperfectly competitive market structures. An interesting and relevant example of this would be strategic competition from a rival foreign firm, with the possibility of luring trained workers away from the home firm. We leave these extensions for future research.

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A Proof of Proposition 2

The first part of the proposition follows from manipulating the expression for the total derivative $(dt^{j*}/d\tau)$:

$$
\begin{aligned}
\frac{dt^{j*}}{d\tau} &= \frac{\partial t^{j*}}{\partial \tau} + \frac{\partial t^{j*}}{\partial L_Y^{j\,*}} \frac{dL_Y^{j\,*}}{d\tau} \\
&= \frac{MR \cdot A'}{\tau^2 \cdot \Delta_t} + \frac{MR' \cdot A \cdot A'}{\tau \cdot \Delta_t} \frac{1}{\Delta_L} \left[- \frac{MR \cdot A}{\tau^2} + \frac{MR' \cdot MR \cdot A \cdot (A')^2}{\tau^3 \cdot \Delta_t} L_Y^{j\,*} \right] \\
&= \frac{MR \cdot A'}{\tau^2 \cdot \Delta_t} \left\{ 1 - \frac{MR' \cdot (A')^2}{\tau} \frac{1}{\Delta_L} \left[1 - \frac{MR' \cdot (A')^2}{\tau \Delta_t} L_Y^{j\,*} \right] \right\} \\
&= 0,
\end{aligned}
\tag{1}
$$

where the last equality follows from substituting in for Δ_L and cancelling out like terms.

The second part follows directly from equations (13) and (16).

The last part can be derived by direct calculation of the total derivative $dt^{j*}/d\varepsilon$ by substituting in

$$
\frac{\partial t^{j*}}{\partial \varepsilon} = -\frac{A'}{\tau \varepsilon^2 \Delta_t} [MR \cdot \ln Y + Y^{-1/\varepsilon}], \tag{2}
$$

$$
\frac{dL_Y^{j\,*}}{d\varepsilon} = -\frac{A}{\tau \Delta_L} \left[\frac{1}{\varepsilon^2} MR \cdot \ln Y + \frac{1}{\varepsilon^2} Y^{-1/\varepsilon} + MR' \cdot L_Y \cdot A' \frac{\partial t^{j*}}{\partial \varepsilon} \right] \tag{3}
$$

to obtain:

$$
\begin{aligned}
\frac{dt^{j*}}{d\varepsilon} &= \frac{\partial t^{j*}}{\partial \varepsilon} + \frac{\partial t^{j*}}{\partial L_Y^{j\,*}} \frac{dL_Y^{j\,*}}{d\varepsilon} \\
&= \frac{A'}{\tau^3 \varepsilon^2 \Delta_t^2 \Delta_L} (MR \cdot \ln Y + Y^{-1/\varepsilon})(\tau \cdot MR' \cdot A^2 \cdot \Delta_t - \tau^2 \Delta_t \Delta_L - (MR' \cdot A' \cdot A)^2 L_Y) \\
&= 0,
\end{aligned}
\tag{4}
$$

where the last equality comes from substituting in for Δ_L and cancelling out like terms.

B Proof of Lemma 1

We can easily show that the denominator of the expression in (37) is decreasing in $\hat{\gamma}$:

$$
\frac{d}{d\hat{\gamma}} \left[\frac{A'(t^{I*})}{c'(t^{I*}(\hat{\gamma})) + K'(t^{I*}(\hat{\gamma}))} \right] = \frac{1}{(c' + K')^2} [A''(c' + K') - A'(c'' + K'')] \frac{dt^{I*}}{d\hat{\gamma}} < 0. \tag{5}
$$

This implies that $\hat{\tau}$ is increasing in $\hat{\gamma}$.