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Innovation and Export vs. FDI

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Abstract

This paper explores a firm's choice between export and horizontal Foreign Direct Investment (FDI), as well as the impact of these forms of trade on innovation in host country, within a model that incorporates innovation competition. The model reveals that a firm's choice of trade form depends on multiple factors: not just productivity, but also the relative wages in the home and host countries, transport costs and consumers' sensitivity to price changes.

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1 Introduction

Numerous empirical studies have explored the reasons multinational firms choose foreign direct investment (FDI) over exportation, or vice versa. Pioneering paper in the Melitz-type model, notably by Helpman, Melitz and Yeaple (2004), and Yeaple (2008), provide key insights. They suggest that firms with the highest productivity level can serve foreign markets via FDI, those with the next highest level of productivity engage in export, and firms with the lowest productivity operate solely in domestic market. However, many empirical studies have found that the choice between forms of trade depends on a variety of factors. These include fixed investment costs of establishing foreign subsidiaries, production costs, transportation costs, market size and its own productivity level (Aw and Lee 2008).

There are two types of FDI: horizontal FDI and vertical FDI. The former is defined as exports and multinational production serves as two alternative ways for serving a foreign market.[1] The latter involves FDI that is driven by comparative advantage between countries, serving as a motive for locating certain stage of production abroad.[2] This paper treats the horizontal FDI.

First, the objective of this paper is to elucidate the circumstances that lead firms to choose either exporting or FDI. Our analysis shows that firms are more likely to choose FDI over export if: (1) firms with the higher labor productivity engage in FDI, (2) wages in the home country are higher than those in the host country,[3], and (3) transport costs are high.

Wakasugi and Takahashi (2012) pointed out that the results from Melitz-type model represented by Helpman et. al. (2004), and Yeaple (2008) assumed identical market structure across

[1] See Brainard(1997), Markusen and Venables (2000), among others.
[2] See Helpman (1984), Yeaple (2003), and Keller and Yeaple (2009), among others.
[3] Our prediction is identical with many empirical studies. See Braconeir, Norbäck, and Urban (2005)

all countries such as wages, transport costs, and trade costs. Consequently, these studies explain firms' behavior well in developed countries but not developing countries. However, the theoretical predictions in this paper are applicable to any cases.

The reminder of the paper is structured as follows. Section 2 develops a basic model of open economy and demonstrates the choice between export and FDI, and shows the impact of export and FDI on innovation in the host country. Section 3 concludes.

2 The Model

The model is based on Melitz (2003) and Flach and Unger (2022). A representative consumer has the following CES utility function over a continuum of goods,

$$U = \left[\int_{\omega \in \Omega} (q(\omega)x(\omega))^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}},$$

where ω represents the varieties, Ω denotes the whole variety set of differentiated goods, $x_i(\omega)$ is the consumption of differentiated goods i, $q(\omega) > 0$ is its quality and $\sigma > 1$ is the elasticity of substitution between quality-differentiated varieties. The aggregate demand of differentiated goods is given as follows.

$$x(\omega) = q(\omega)^{\sigma-1} p(\omega)^{-\sigma} P^{\sigma-1} Y. \tag{1}$$

where $Y = wL$, Y is aggregate income, and w is wage. Each country is endowed with L units of labor. P is the quality-adjusted aggregate price index of variety, which is defined by

$$P = \left[\int_{\omega \in \Omega} \left(\frac{p(\omega)}{q(\omega)} \right)^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}}. \tag{2}$$

2.1 Production

Consider a world that consists of two countries: domestic country, with associated variables are denoted by d and foreign country, with related variables are labeled as f. Labor is the only factor to produce goods in M sectors. In the following, we will focus on a particular sector. When producing, firms incur a fixed cost, F. If firms choose to export, they must incur an additional fixed export cost c_x units of labor. Therefore, the total fixed cost for an exporter is $F_x = F + c_x$. Additionally, exporters spend an iceberg variable cost of trade, denoted by $\tau > 1$ units of labor to arrive in a foreign f. Variables associated with exporters from domestic country are marked with x. Firms that choose to serve a foreign market via foreign direct investment (FDI) bear an additional fixed costs c_I, making the total fixed cost $F_I = F + c_I$. Variables related to FDI are denoted by I. There is a continuum of firms. A firm offers one differentiated variety ω under monopolistic competition. Each firm draws the productivity φ from a common probability distribution $g(\varphi)$. Labor used in the production is l_m. The firm's production cost is represented by

$$C = F + \frac{q(\varphi)^{\theta}}{\varphi} x(\varphi), \tag{3}$$

where the second term on eq.(3) shows a variable cost. As in Melitz (2003), we take into account that the marginal cost of production is decreasing in firm's productivity φ and increasing in quality $q(\varphi)$, where $0 < \theta < 1$ represents the elasticity of marginal costs with respect to quality. The R&D cost is defined as

$$R(q(\varphi)) = \frac{q^{2\kappa}}{2\kappa\lambda^{\kappa}}, \quad \lambda > 0, \ \ \kappa > 1. \tag{4}$$

κ represents research elasticity. λ shows a quality indicator. As the magnitude of λ is greater, the quality of the firm is higher. The R&D expenditure is a convex function. It means that higher product quality needs more R&D investments. That is, the R&D for quality improvement requires additional endogenous fixed costs. l_R labors are engaged in R&D investments.

2.2 Export

The export profit function of a domestic exporter is

$$\pi_x(\varphi_x) = p_x(\varphi_x)x_x(\varphi_x) - w_d\left(\frac{\tau q_x(\varphi_x)^{\theta}}{\varphi_x}x_x(\varphi_x) + \frac{q_x^{2\kappa}}{2\kappa\lambda_x^{\kappa}} + F_x\right) \tag{5}$$

where φ_x is the productivity of domestic exporter and w_d is the wage of the export country or home country. From the profit maximization, the optimal price of the firm is given by

$$p_x(\varphi_x) = \frac{\sigma}{\sigma-1}\frac{w_d q_x(\varphi_x)^{\theta}}{\varphi_x}\tau. \tag{6}$$

A larger σ implies that consumers are more sensitive to price change. The price, which the domestic exporters face is $p_x = p_d\tau$, where $p_d = \frac{\sigma}{\sigma-1}\frac{w_d q(\varphi)^\theta}{\varphi}$ is domestic price. The profit function of a foreign firm that competes with the imported goods is

$$\pi_f(\varphi_f) = p_f(\varphi_f)x_f(\varphi_f) - w_f\left(\frac{q_f(\varphi_f)^\theta}{\varphi_f}x_f(\varphi_f) + \frac{q_f^{2\kappa}}{2\kappa\lambda_f^\kappa} + F\right), \tag{7}$$

where the price which the importers face is $p_f = p_d$ by the assumption of symmetry. We consider the interaction between the quality of the exporter q_x and that of the foreign firm q_f.

Thus from the first-order condition of the exporter, we can obtain the optimal quality of exporter as follows.

$$q_x = \left[\lambda_x^\kappa\left(\frac{\varphi_x}{\tau}\right)^{\sigma-1}\left(\frac{w_f}{w_d^\sigma}\right)\mathscr{B}\right]^{\frac{1}{\Phi}} \tag{8}$$

where $\mathscr{B} = (1-\theta)((\sigma-1)/\sigma)^\sigma L_f P_f$, $\Phi = 2\kappa - (\sigma-1)(1-\theta)$ and P_f is an aggregate quality-adjusted price index of variety in the foreign country. An increase in the transport cost τ has an incentive to decrease in innovation.

From the first-order condition of the foreign firm, the optimal quality is

$$q_f = \left[\lambda_f^\kappa\left(\frac{\varphi_f}{w_f}\right)^{\sigma-1}\mathscr{B}\right]^{\frac{1}{\Phi}} \tag{9}$$

The quality-price ratio of exporter is

$$\frac{q_x}{p_x} = \left[\lambda_x^{\kappa(1-\theta)}\left(\frac{\varphi_x}{\tau}\right)^{2\kappa}\left(\frac{w_f^{1-\theta}}{w_d^{2\kappa+1-\theta}}\right)\hat{\mathscr{B}}\right]^{\frac{1}{\Phi}} \tag{10}$$

where $\hat{\mathscr{B}} = \left(\frac{\sigma-1}{\sigma}\right)^{2\kappa+1-\theta}((1-\theta)L_f P_f)^{1-\theta}$. An increase in the transport cost makes exporters' quality-price ratio decrease. Higher productivity gives the exporter an incentive to invest in quality. The quality-price ratio of foreign firm is

$$\frac{q_f}{p_f} = \left[\lambda_f^{\kappa(1-\theta)}\left(\frac{\varphi_f}{w_f}\right)^{2\kappa}\hat{\mathscr{B}}\right]^{\frac{1}{\Phi}} \tag{11}$$

Higher productivity increases in innovation.

2.3 FDI

Let's consider the case where firms in the home country engage in FDI. The profit of FDI is given by

$$\pi_I = p_I(\varphi)x_I(\varphi) - w_I\left(\frac{q_I(\varphi)^\theta}{\varphi_f}x_I(\varphi) + \frac{q_I^{2\kappa}}{2\kappa\lambda_I^\kappa} + F_I\right). \tag{12}$$

A firm serving its product via FDI faces the same wage as that of the foreign firm, denoted by w_f. An FDI firm and a foreign firm (or a firm in host country) compete based on their product quality. By applying the same competitive process between an exporter and a foreign firm, we can obtain the following optimal qualities and quality-price ratio. The optimal product quality is given by

$$q_I(\varphi) = \left[\lambda_I^\kappa\left(\frac{\varphi_I}{w_f}\right)^{\sigma-1}\mathscr{B}\right]^{\frac{1}{\Phi}} \tag{13}$$

The explanation of the quality remains consistent with the previous discussion. The quality-price ratio as follows.

$$\frac{q_I}{p_I} = \left[\lambda_I^{\kappa(1-\theta)} \left(\frac{\varphi_I}{w_f} \right)^{2\kappa} \hat{\mathscr{B}} \right]^{\frac{1}{\Phi}}. \tag{14}$$

2.4 Export vs. FDI

By substituting eqs.(10) and (12) into eq.(5), we derive the optimal profit function of an exporting firm. Concequently, the cutoff for the firms is determined by

$$\pi_x = 0 \quad \Leftrightarrow \quad (\varphi_x^{2\kappa} \lambda_x^{\kappa(1-\theta)}) \mathfrak{B}_x^{\Phi} = F_x^{\Phi} \tau^{2\kappa(\sigma-1)} \tag{15}$$

where $\mathfrak{B}_x = \frac{\psi}{\sigma\kappa} \{(1-\theta)^{1-\theta} \left(\frac{\sigma-1}{\sigma}\right)^{2\kappa+1-\theta}\}^{\frac{\sigma-1}{\Phi}} (L_f P_f^{\sigma-1} \frac{w_f}{w_d^{\sigma}})^{\frac{2\kappa}{\Phi}}$. The higher transport cost raises the magnitude of the cutoff. If the transport cost is directly proportional to the distance to import countries, the cutoff is getting higher. Thus exporting requires higher productivity. Applying the same manner as above, the cutoff of the firm which chooses FDI is determined by

$$\pi_I = 0 \quad \Leftrightarrow \quad (\varphi_I^{2\kappa} \lambda_I^{\kappa(1-\theta)}) \mathfrak{B}_I^{\Phi} = F_I^{\Phi} \tag{16}$$

where $\mathfrak{B}_I = \frac{\psi}{\sigma\kappa} \{(1-\theta)^{1-\theta} (\frac{\sigma-1}{\sigma})^{2\kappa+1-\theta}\}^{\frac{\sigma-1}{\Phi}} (L_f P_f^{\sigma-1})^{\frac{2\kappa}{\Phi}} \left(\frac{1}{w_I^{2\kappa(\sigma-1)}} \right)^{\frac{1}{\Phi}}$. Firms with higher productivity can choose FDI. Following Helpman et al. (2004), let's compare the sales in the case of

export to that of FDI. The sale is determined by eq.(16). Therefore, we can get

$$\frac{r_x}{r_I} = \frac{A_x(q_x/p_x)^{\sigma-1}}{A_I(q_I/p_I)^{\sigma-1}}. \tag{17}$$

Assuming the firm exports or serves its product via FDI to the same direction, that is, country f. Eq.(17) is reduced as follows.

$$\frac{r_x}{r_I} = \left[\left(\frac{\varphi_x}{\varphi_I}\right)^{2\kappa}\left(\frac{\lambda_x}{\lambda_I}\right)^{\kappa(1-\theta)}\left(\frac{w_f}{w_d}\right)^{2\kappa+1-\theta}\left(\frac{1}{\tau}\right)^{2\kappa}\right]^{\frac{\sigma-1}{\Phi}} \tag{18}$$

Rewriting eq.(18), we can obtain

$$r_x > r_I \quad \Leftrightarrow \quad \left(\frac{\varphi_x}{\varphi_I}\right)^{2\kappa}\left(\frac{\lambda_x}{\lambda_I}\right)^{\kappa(1-\theta)}\left(\frac{w_f}{w_d}\right)^{2\kappa+1-\theta} > \tau^{2\kappa} > 1 \tag{19}$$

If the wages of both countries are normalized to 1, export is superior to FDI when the exporter has higher productivity, greater quality, and a smaller transport cost. If the wages of both countries are not equal to 1, when the wage in the foreign country is higher than that of the exporting country, firms are more likely to choose export.

Proposition 1. *Firms choose FDI over export if (1) the productivity of firms engaging in export is lower than that of those engaging in FDI, (2) the wage in the home country is higher than that in the host country, and (3) the transport cost is high.*

These results are quite intuitive. If quality in the case of export is larger than that of FDI, firms choose export.

3 Conclusion

In this paper, we analyzed the circumstances when firms choose either Foreign Direct Investment (FDI) or export. It shows that firms are more likely to choose FDI over export if: (1) firms with the higher productivity and greater quality engage in FDI, (2) wages in the home country are higher than those in the host country, and (3) transport costs are high.

Second, we also investigate the impact of these trade forms on innovation in the host country. The present paper suggests that whether the innovation in the host country enhances depends on the magnitude of marginal trade costs between export and FDI. Specifically, the innovation in the host country is improved when the domestic country engage in FDI if the marginal trade cost of export is larger than that of FDI, the firms in the host country increase innovation. On the other hand, the innovation is reduced when the firms in domestic country choose export if the marginal cost of export is smaller than that of FDI.

However, some important issues remain unaddressed, such the impact of inward FDI and the spillover effects it may have on firms in both domestic and host countries. Additionally, we did not examine government policies like FDI subsidies. Investigating these theme within a model incorporates innovation competition could provide new insights into the literature.

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