Horizontal FDI: III

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Updated to fix typos in equations 5, 8, and 10. Also updated numerical examples.

In parts one and two of these notes, we developed a model of identical firms competing in a market. This model helped us understand the ways that country-level characteristics (distance and market size) and the industry-level characteristics (returns to scale in production from fixed costs) affect a firm's decision to serve a foreign market by exporting or by creating a foreign affiliate. The model helped us formalize the proximity-concentration tradeoff, which predicts that the number of multinational firms, relative to domestic firms, is larger

1. the larger is the foreign market.
2. the larger are export costs.
3. the smaller are production fixed costs.

Since all the firms in our model were identical, the model could not help us understand why multinational firms are different than domestic firms. Recall from our "six facts" about multinational firms that multinational parents and affiliates, compared to domestic firms, are larger and more productive.[1] In this note we will study a modified version of the previous model in order to understand how firm-level characteristics affect a firm's decision to serve a foreign market by exporting or by creating a foreign affiliate. We will often use the term *firm-level heterogeneity* (or sometimes, just *firm heterogeneity*) to refer to the idea that firms are different from each other.

A model with heterogeneous firms

We need to make three changes to our earlier model.

Market structure. In our previous model, each firm sold the same good and the market was perfectly competitive. This was a model in which every firm sold vanilla ice cream. Each identical firm, selling an identical product, earned an equal share of the market.

In this model, we assume that firms produce differentiated goods — each firm makes ice cream, but in different flavors. Consumers like variety in their ice cream consumption, so they buy some ice cream from each firm. Firms with lower prices sell more ice cream. This assumption implies that each firm will have its own share of the market, and the firm's price determines its market share. We call this kind of market structure *monopolistic competition.*

Formally, we introduce this feature to the model by modeling the demand function. In our earlier analysis, we did not need the demand function. Now we do. The quantity demanded of the firm's good is related to its price,

$$x(p) = E_i \times p^{-\epsilon}, \tag{1}$$

where E_i is total expenditure in country i and $\epsilon > 1$ is the elasticity of demand. Notice that 1) quantity demanded rises as the price falls; 2) for a given price, the quantity demand is larger when E_i is larger; and 3) quantity demanded is more sensitive to price changes when ϵ is large.

[1] This is fact #4. Fact #4 also states that multinationals are more R&D intensive and more likely to export. In this note we will focus just on productivity and size.

Heterogeneous productivity. In our new model, firms are heterogeneous in their productivity: Some firms are more productive than others. This could be for a host of reasons. A firm, for example, might have a better manager, have access to better inputs, or use a better production process. We will not worry about why a firm is more or less productive in this model — we will take firm productivity as given. We represent a firm's productivity as φ,

$$x = \varphi \ell, \tag{2}$$

where ℓ is the amount of labor the firm hires and x is the amount of output the firm produces. The larger is φ, the more output is produced from the same amount of inputs. Notice that (2) implies that the cost of producing one unit of the good is $1/\varphi \times w$, where w is the the wage.

Export fixed costs. Our new model has three fixed costs. The headquarters costs f^h and the production fixed costs f^p are still here from the previous model, but we add to them a fixed cost of exporting, f^e. Exporting requires some fixed costs, for example, maintaining a distribution network and sales force in another country, advertising, and package labeling. We abstracted from export fixed costs in our previous model, but we need them in this model. We assume that the export fixed cost, while potentially large, is smaller than the production fixed cost, $f^e < f^p$.

Firm profits

The world economy consists of two countries: $i = 1, 2$. Each country's total expenditure is E_i. We will consider three kinds of firms: 1) *non-exporters*, which only produce in their home country and sell in their home country; 2) *exporters*, which produce in the home country, sell in the home country and export to the foreign country, and 3) *multinational firms*, which produce in the home country and in the foreign country. As we work through the firm problems, we will consider firms from country 1. The firms in country 2 solve similar problems.

Non-exporting firms. A non-exporting firm with productivity φ earns profit

$$\pi_1(\varphi) = \left(p - \frac{1}{\varphi} w_1\right) E_1 p^{-\epsilon_1} - w_1 f^h - w_1 f^p. \tag{3}$$

Notice that this expression looks just like the expression for profits in our earlier notes, except we have used (1) for x and the marginal cost of production includes the $1/\varphi$ term. The solution to this problem is to set the price

$$p = \frac{1}{\varphi} w_1 \frac{\epsilon_1}{\epsilon_1 - 1}, \tag{4}$$

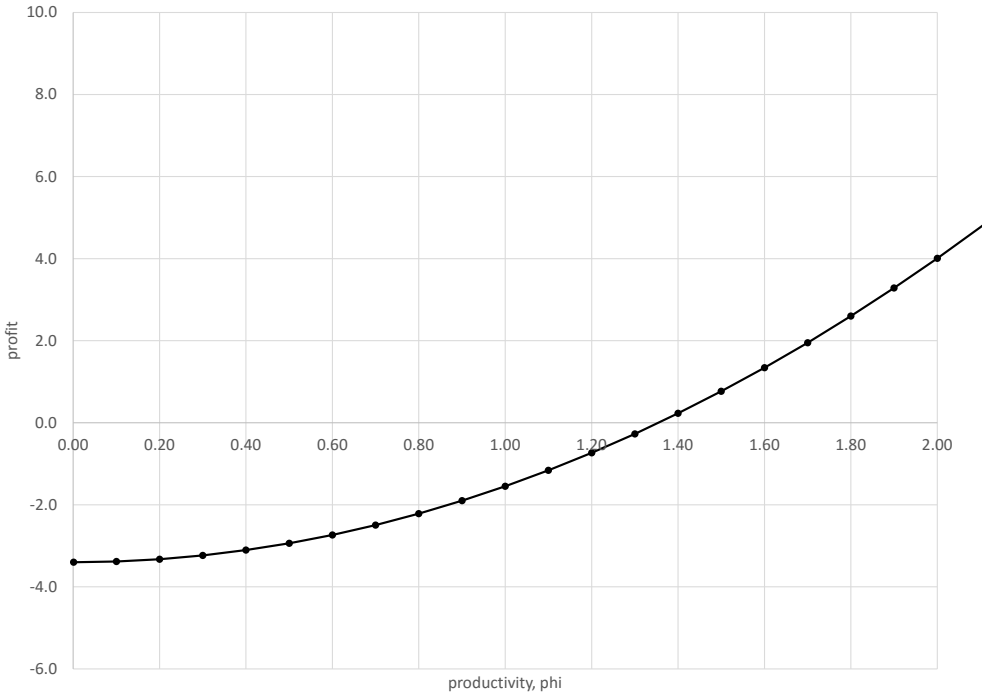
which is our familiar markup over marginal cost.[2] If we substitute the price back into (3), we have

$$\pi_1(\varphi) = \cancel{\frac{1}{\epsilon_1 - 1}} \frac{1}{\epsilon_1} \left(\frac{\epsilon_1}{\epsilon_1 - 1} \frac{1}{\varphi} w_1\right)^{1-\epsilon_1} E_1 - w_1 f^h - w_1 f^p. \tag{5}$$

Notice that, if we hold everything else constant, increasing φ increases profits. More productive firms charge lower prices, capture a larger share of the market, and earn larger profits.

[2] For those on top of their calculus: To derive the price, take the derivative of (3), set it equal to zero, and solve for p.

Figure 1: Profit for non-exporters



Numerical example. Let $\epsilon_1 = 3$, $w_1 = 2$, $E_1 = 50$, $f^h = 0.2$, and $f^p = 1.5$.

What price does a non-exporter with $\varphi = 0.001$ charge in the home market? What are the firm's profits? Should this firm be producing?

The firm sets $p = 3000$ *and earns profits of -3.40. This firm should be out of business!*

What price does a non-exporter with $\varphi = \cancel{1.2}$ 1.5 charge in the home market? What are the firm's profits? Should this firm be producing?

The firm sets $p = \cancel{2.5}$ 2.0 *and earns profits of* ~~*0.60*~~ *0.767. The more productive firm charges a lower price and captures more of the market. This firm is making profits and should be selling in this market.*

In figure 1 we plot the profits of a non-exporter for different values of φ. Notice that profits are negative until φ is about 1.35. Very inefficient firms cannot earn enough operating profit to cover their fixed costs. When productivity is very close to zero, operating profits are almost zero, and the firms profits are equal to the losses from the fixed costs, $-w_1 f^h - w_2 f^p$.

Exporting firms. Exporters differ from non-exporters because they 1) pay export fixed costs; 2) earn revenues from selling in country 2; and 3) pay an extra "tax" τ on each unit sold abroad. How much extra profit does a firm earn by exporting? A firm with productivity φ charges p_e abroad to

earn an export profit of

$$\pi_1^e(\varphi) = \left(p_e - \frac{1}{\varphi} w_1 (1+\tau)\right) E_2 p_e^{-\epsilon_2} - w_1 f^e. \tag{6}$$

The first term on the right-hand side are the operating profits from exporting and the last term is the export fixed cost.

The solution to this problem is to set the price in the foreign market to

$$p_e = \frac{1}{\varphi} w_1 \frac{\epsilon_2}{\epsilon_2 - 1}(1+\tau). \tag{7}$$

Compare this price to the domestic price in (4). The export price is $(1+\tau)$ times larger than the domestic price, $p_e = p(1+\tau)$. The firm charges a higher price in the export market, but only enough to cover the extra costs, τ. If we substitute the price back into (6), we have

$$\pi_1^e(\varphi) = \cancel{\frac{1}{\epsilon_2 - 1}} \frac{1}{\epsilon_2} \left(\frac{\epsilon_2}{\epsilon_2 - 1} \frac{1}{\varphi} w_1 (1+\tau)\right)^{1-\epsilon_2} E_2 - w_1 f^e. \tag{8}$$

Since the firm charges a higher price in the export market, its market share is smaller than in its home market.

Multinational firms. Multinationals avoid the extra costs τ and f^e that exporters pay, but must pay the extra production cost in the foreign country, $w_2 f^p$. We assume that the firm gets to transfer its technology, φ, to use in production in the other country. This is a way to model an ownership advantage: The firm owns a production technology that it uses to produce abroad. How much extra profit does a firm earn through multinational production? A multinational firm with productivity φ charges p_m abroad to earn foreign profit of

$$\pi_1^m(\varphi) = \left(p_m - \frac{1}{\varphi} w_2\right) \times E_2 p_m^{-\epsilon_2} - w_2 f^p. \tag{9}$$

The first term on the right-hand side are the profits from selling in the foreign market through the MNE affiliate, and the last term is the fixed production cost. The marginal cost in the foreign country is $\frac{1}{\varphi} w_2$. The firm hires workers in the foreign country and pays the foreign wage, w_2, but transfers its technology φ.

The solution to this problem is to set the price $p_m = \frac{1}{\varphi} w_2 \frac{\epsilon_2}{\epsilon_2 - 1}$ in the foreign market. Prices are still a mark up $(\frac{\epsilon_2}{\epsilon_2 - 1})$ over marginal cost, but the marginal costs differ. If we substitute the price back into (9), we have

$$\pi_1^m(\varphi) = \cancel{\frac{1}{\epsilon_2 - 1}} \frac{1}{\epsilon_2} \left(\frac{\epsilon_2}{\epsilon_2 - 1} \frac{1}{\varphi} w_2\right)^{1-\epsilon_2} E_2 - w_2 f^m. \tag{10}$$

If we compare (8) to (10), we see the proximity-concentration tradeoff that we studied earlier — that does not change as we add heterogeneity to the model.

Numerical example. Let $\epsilon_1 = \epsilon_2 = 3$, $w_1 = w_2 = 2$, $E_1 = E_2 = 50$, $f^h = 0.2$, $f^p = 1.5$, $f^e = 0.6$ and $\tau = 0.3$.

Should a firm with $\varphi = \cancel{1.20}$ 1.5 export to serve the foreign market or use a foreign affiliate?

In the export market, the firm sets price $\cancel{3.25}$ *2.6 and earns profits of* $\cancel{1.167}$ *1.265. As a MNE, it charges price* $\cancel{2.5}$ *2.0, and earns profits of* $\cancel{1.0}$ *1.167. The firm should serve the foreign market as an exporter.*

Should a firm with $\varphi = \cancel{1.50}$ 2.0 export to serve the foreign market or use a foreign affiliate?

In the export market, the firm sets price $\cancel{2.60}$ *1.95 and earns profits of* $\cancel{2.498}$ *3.183. As a MNE, it charges price* $\cancel{2.0}$ *1.50, and earns profits of* $\cancel{3.250}$ *4.407. The firm should serve the foreign market with a foreign affiliate.*

Being a multinational firm is more valuable when the firm has higher productivity. This is because a higher productivity firm can charge a lower price, sell more, and earn more profit. In figure 2, we plot (8) and (10) for different values of firm productivity. For low value of φ, exporting is more profitable than multinational production, but both are negative: A firm with productivity this low should not serve the foreign market at all. Once productivity reaches about 1.1, exporting becomes profitable. Once productivity reaches about 1.55, multinational production is now more profitable than exporting. This implies that firms with productivity below 1.1 should not sell abroad, firms with productivity between 1.1 and 1.55 should export, and firms with productivity greater than 1.55 should become multinationals.

Summary

We have added firm heterogeneity in productivity to a model that is otherwise very similar to our simpler model with identical firms. What did we find? Being more productive makes multinational production more valuable. More productive firms charge lower prices and sell more. The more the firm sells, the more valuable it is to avoid the export costs, τ.

This model helps us understand multinational fact #4: multinational firms, compared to domestic firms or exporters, are larger and more productive.

Figure 2: Additional profit from exporting and MNE sales