Horizontal Foreign Direct Investment

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In these notes we will build a model to help us understand foreign direct investment that is undertaken to provide market access, what economists call *horizontal FDI*. This model will help us understand the ways that country-level characteristics (such as distance and market size) and industry-level characteristics (such as returns to scale in production) affect a firm's decision to serve a foreign market by exporting or by creating a foreign affiliate.

Our first goal is to formalize the proximity-concentration tradeoff, which predicts that a foreign market is more likely to be served by multinational firms, relative to exporting firms, when

1. the foreign market is larger.
2. export costs are larger (markets are remote; the good is difficult to ship,...).
3. production fixed costs are smaller.

Our second goal is to understand how the firm's productivity influences the firm's decision on how to serve a foreign market. Recall from our "six facts" about multinational firms that multinational parents and affiliates, compared to domestic firms, are larger and more productive.[1] 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.

1 A model with heterogeneous firms

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) *domestic firms*, which only produce in their home country and sell in their home country, 2) *exporting firms*, which only produce in the home country and sell to both the home and foreign countries, and 3) *multinational firms*, which produce in the home country to sell in the home country and produce in the foreign country to sell in the foreign country.

Market structure. This is a model of an industry, for example, the footwear industry. Within the industry, each firm produces a unique variety of the good. In the footwear market, each firm makes shoes, but in different styles. Consumers like variety in their shoe consumption, so they buy some shoes from each firm. Firms with lower prices sell more shoes. 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. The quantity demanded of the firm's variety is related to its price,

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

where E_i is total expenditure in country i and $\epsilon > 1$ is the elasticity of demand. Notice that 1) the quantity demanded rises as the price falls; 2) for a given price, the quantity demanded 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.

Elasticity refresher. The price elasticity of demand is — holding everything else constant — the proportional change in quantity sold relative to the proportional change in price. Mathematically, this is

$$\epsilon = \frac{\Delta x/x}{\Delta p/p} \text{ or } \frac{\partial x}{\partial p} \times \frac{p}{x}. \tag{2}$$

This value is usually negative, since demand curves usually slope down. The larger is the elasticity, the more responsive are quantities to a change in price. The price elasticity of gasoline, for example, is small: When gas prices rise, people still have to drive places. The price elasticity of a Big Mac is large: When the price of a Big Mac rises, people can eat tacos, or Whoppers.

Heterogeneous productivity. 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. The production function is

$$x = \varphi \ell, \tag{3}$$

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 (3) implies that the cost of producing one unit of the good is $1/\varphi \times w$, where w is the the wage.

Fixed costs. Each firm faces two fixed costs. [How does a fixed cost differ from a variable cost?] The production cost, f^p, must be paid in each location that the firm produces. The production fixed cost includes, for example, the construction of the factory and the wages of managers. If the firm chooses to export to the foreign country, it pays a fixed cost f^e. Exporting fixed costs include, for example, maintaining a distribution network and sales force in another country, advertising, and package labeling. The export fixed cost may be substantial, but we assume that it is smaller than the cost of operating a production facility: $f^p > f^e$. We will assume that the fixed costs are paid in units of labor, but this is not necessary.

2 Firm structure

How should a firm structure itself? As a domestic firm? An exporter? A multinational? To answer this question, we will compute the profit associated with each firm structure. The structure that delivers the largest profit is the best choice. As we work through the firm's problems, we will consider firms from country 1. The firms in country 2 solve similar problems.

2.1 Domestic firms.

A firm with productivity φ that only produces and sells in its home market earns profit

$$\begin{aligned}\pi_1(\varphi) &= px(p) - \frac{w_1}{\varphi}x(p) - w_1 f^p \\ &= \left(p - \frac{w_1}{\varphi}\right) x(p) - w_1 f^p. \end{aligned} \tag{4}$$

The term $px(p)$ is the firm's sales. The firm sells $x(p)$ units when it sets price p. The term $\frac{w_1}{\varphi}x(p)$ are the variable costs of production. The firm pays w_1/φ for each unit it produces. The term $w_1 f^p$ is the fixed cost the firm pays for operating the firm. If we substitute (1) into (4) we have

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

Notice that the only control the firm has over its profit level is its choice of price. Everything else ($w_1, \varphi, E_1, \epsilon_1$, and f^p) the firm takes as given.

What price should the firm charge? What quantity is associated with this price? The standard approach would be to take the derivative (with respect to the price) of the profit function in (5) and set it to zero. If we did this, we would find that the marginal revenue of the firm should equal its marginal cost. [This should sound very familiar.] This condition implies that

$$p = \frac{w_1}{\varphi}\frac{\epsilon_1}{\epsilon_1 - 1}, \tag{6}$$

which is a markup over marginal cost. The markup is $\epsilon_1/(\epsilon_1 - 1)$ and the marginal cost is w_1/φ. A more productive firm (a firm with a larger φ) charges a lower price. [Is the firm's price increasing or decreasing in ϵ_i? What is the intuition for this?]

If we substitute the optimal price back into (5), we have

$$\pi_1(\varphi) = \frac{1}{\epsilon_1}\left(\frac{\epsilon_1}{\epsilon_1 - 1}\frac{w_1}{\varphi}\right)^{1-\epsilon_1} E_1 - w_1 f^p. \tag{7}$$

Notice that, if we hold everything else constant, increasing φ increases profits. More productive firms charge lower prices, sell more, and earn larger profits.

Numerical example. Let $\epsilon_1 = 3$, $w_1 = 2$, $E_1 = 50$, and $f^p = 1.7$.

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

The firm sets $p = 3000$, has sales of 0.0000056, has employment of 0.0000019, and earns profits of -3.40. This firm should be out of business!

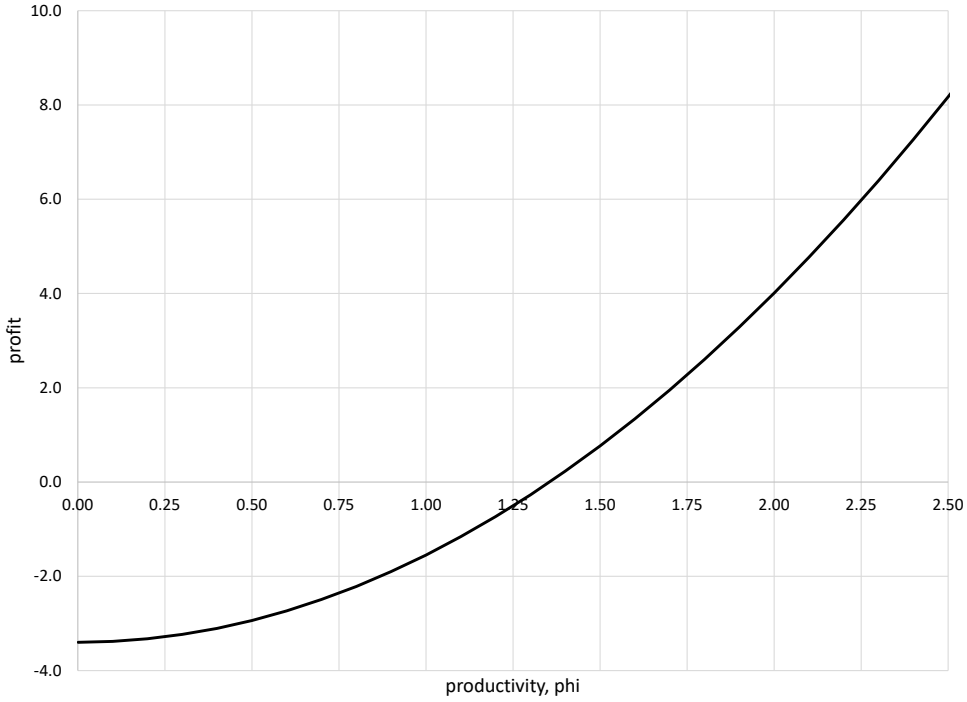
What price does a non-exporter with $\varphi = 1.5$ charge in the home market? What are the firm's profits, sales, and employment? Should this firm be producing?

The firm sets $p = 2.0$, has sales of 12.5, has employment of 4.167, and earns profits of 0.767. The more productive firm charges a lower price and sells more. This firm is making profits and should be selling in this market.

In figure 1, we plot the profits of a domestic firm 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, $-w_1 f^p = -3.4$.

The example also illustrates an important feature of the model: more productive firms charge lower prices and sell more. As measured by either sales or employment, more productive firms are larger.

Figure 1: Profit for non-exporters



2.2 Exporting firms.

Exporters differ from domestic firms because they 1) pay export fixed costs; 2) earn revenues from selling in country 2 as well as country 1; and 3) pay an extra "tax" τ on the value of goods sold abroad. The cost τ includes things such as tariffs and transport costs. Note that the *ad valorem* export cost τ is different than the export fixed cost.

The exporting firm produces everything in the home country and sells it to both the home and the foreign country. What price does the firm charge in the foreign country? In the home country? How much does the firm sell abroad?

A firm with productivity φ charges p_e abroad and p domestically to earn a profit of

$$\pi_1^e(\varphi) = \left(p - \frac{w_1}{\varphi}\right) E_1 p^{-\epsilon_1} + \left(p_e - \frac{w_1}{\varphi}(1+\tau)\right) E_2 p_e^{-\epsilon_2} - w_1 f^e - w_1 f^p. \tag{8}$$

The first term on the right-hand side is the operating profit from domestic sales. It is identical to the operating profit in (5). The second term on the right-hand side is the operating profit from exporting. The last two terms are the fixed costs. The firm pays f^p for the factory it operates in the home market and f^e to export. Notice that the marginal cost of selling a unit abroad is different than the marginal cost of selling a unit in the home market. The marginal cost of selling abroad is $w_1/\varphi(1+\tau)$. This is the marginal cost of producing the good (w_1/φ) times the extra costs associated with selling in the foreign market, $(1+\tau)$.

We solve this problem in the same way that we did in (5), by setting marginal revenue equal to marginal cost. The solution to this problem is to keep the domestic price as in (6) and to set the

price in the foreign market to

$$p_e = \frac{w_1}{\varphi}\frac{\epsilon_2}{\epsilon_2 - 1}(1+\tau). \tag{9}$$

Compare this price to the domestic price in (6). If $\epsilon_1 = \epsilon_2$, 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 (8), we have

$$\pi_1^e(\varphi) = \frac{1}{\epsilon_1}\left(\frac{\epsilon_1}{\epsilon_1 - 1}\frac{w_1}{\varphi}\right)^{1-\epsilon_1} E_1 + \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2 - 1}\frac{w_1}{\varphi}(1+\tau)\right)^{1-\epsilon_2} E_2 - w_1 f^p - w_1 f^e. \tag{10}$$

2.3 Multinational firms.

A multinational firm serves the foreign market by producing in and selling to the foreign country. By not paying the extra transportation and tariff costs, τ, the multinational firm is more competitive (can charge a lower price) than an exporter.

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 profit does a multinational firm earn? A multinational firm with productivity φ charges p_m abroad and p in the domestic market to earn

$$\pi_1^m(\varphi) = \left(p - \frac{w_1}{\varphi}\right) E_1 p_m^{-\epsilon_1} + \left(p_m - \frac{w_2}{\varphi}\right) E_2 p_m^{-\epsilon_2} - w_1 f^p - w_2 f^p. \tag{11}$$

The first term on the right-hand side is the variable profit from selling domestically. The second term is the variable profit from selling in the foreign market through the MNE affiliate, and the last terms are the fixed production costs. The marginal cost in the foreign country is $\frac{w_2}{\varphi}$. The firm hires workers in the foreign country and pays the foreign wage, w_2, but transfers its technology φ. The firm now pays two production fixed costs in order to set up production facilities in both markets.

The solution to this problem is to set the price $p_m = \frac{w_2}{\varphi}\frac{\epsilon_2}{\epsilon_2 - 1}$ in the foreign market. The domestic price, again, is the same as in (6). The foreign price still a mark up ($\frac{\epsilon_2}{\epsilon_2 - 1}$) over marginal cost, but the marginal cost depends on the wage in the foreign country. If we substitute the price back into (11), we have

$$\pi_1^m(\varphi) = \frac{1}{\epsilon_1}\left(\frac{\epsilon_1}{\epsilon_1 - 1}\frac{w_1}{\varphi}\right)^{1-\epsilon_1} E_1 + \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2 - 1}\frac{w_2}{\varphi}\right)^{1-\epsilon_2} E_2 - w_1 f^p - w_2 f^p. \tag{12}$$

2.4 The extra profit from the foreign market.

If we compare (10) to (12), we see that the variable profit earned domestically is the same, and each firm pays the production fixed cost for its domestic operations. This means that when we want to

know if a firm should be an exporter or a multinational, we only need to compute the profit from abroad. The extra profits from exporting and from becoming a multinational are

$$\Delta\pi_1^e(\varphi) = \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_1}{\varphi}(1+\tau)\right)^{1-\epsilon_2} E_2 - w_1 f^e \tag{13}$$

$$\Delta\pi_1^m(\varphi) = \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_2}{\varphi}\right)^{1-\epsilon_2} E_2 - w_2 f^p. \tag{14}$$

[Notice the Greek letter Δ in front of the π symbols. This notation means that we are looking at the change in total profit that comes from being an exporter or a multinational.]

3 The proximity-concentration tradeoff

How does the firm's structure depend on country and industry characteristics? We begin by deriving an expression that tells us when a firm would become a multinational rather than an exporter, that is, when $\Delta\pi_1^m(\varphi) > \Delta\pi_1^e(\varphi)$. Using (13) and (14), we know that a firm will choose to become a multinational when

$$\frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_2}{\varphi}\right)^{1-\epsilon_2} E_2 - w_2 f^p > \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_1}{\varphi}(1+\tau)\right)^{1-\epsilon_2} E_2 - w_1 f^e. \tag{15}$$

After rearranging the terms, we have

$$\frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_2}{\varphi}\right)^{1-\epsilon_2} E_2 - \frac{1}{\epsilon_2}\left(\frac{\epsilon_2}{\epsilon_2-1}\frac{w_1}{\varphi}(1+\tau)\right)^{1-\epsilon_2} E_2 > w_2 f^p - w_1 f^e. \tag{16}$$

Suppose that $w_1 = w_2$. The left-hand side of (16) is the extra revenue the firm would earn if it was a multinational. The right-hand side of (16) is the extra cost the extra cost the firm pays to be a multinational. (Recall that $f^p > f^e$.) When the extra revenue is larger than the extra cost, the firm chooses to be a multinational rather than an exporter.

Equation 16 encapsulates the tensions inherit in horizontal multinational activity. On the one hand, becoming a multinational provides better access to the foreign market, but, on the other hand, the firm pays more fixed costs to set up production.

This tension is known as the proximity-concentration tradeoff. The *proximity-concentration tradeoff* says that, compared to exporters, we are more likely to see multinationals serve a foreign market when

1. the foreign market is larger (larger E_2).
2. the export costs are larger (larger τ).
3. the production fixed cost is smaller (smaller $w_2 f^p$).

Proximity. Firms would like to be close to the markets they serve. Producing in the foreign market saves on transportation, tariff, and other costs of exporting. The gain to market proximity is larger when export costs are large or when the foreign market is large.

Concentration. Firms would like to concentrate their production in one facility so that they minimize fixed production costs. When fixed production costs ($w_j f^p$) are small, the penalty to replicating production in other countries is small, so firms are more likely to be multinationals. [How does this relate to economies of scale?]

The proximity-concentration tradeoff in the model helps us understand multinational fact #1: FDI is concentrated in developed countries with big markets.

4 Selection

When we derived the proximity-concentration tradeoff, we held fixed the productivity of the firm; We were comparing the extra profit earned by building an affiliate to that earned by exporting for the same firm. In this section, we ask: How does the firm structure depend on the firm type, φ?

We can answer this question by inspecting (16). Again, assume that $w_1 = w_2$. The right-hand side does not change as φ changes. Since $\epsilon > 1$, the left-hand side is increasing in φ. So a larger φ makes the firm more likely to be a multinational. This is because a higher productivity firm can charge a lower price, sell more, and earn more profit. Building an affiliate requires paying the larger fixed cost, so operating at a large scale spreads this cost across more units produced and sold. Firms with higher productivities operates at larger scales.

Numerical example. Let $\epsilon_1 = \epsilon_2 = 3$, $w_1 = w_2 = 2$, $E_1 = E_2 = 50$, $f^p = 1.7$, $f^e = 0.6$ and $\tau = 0.3$.

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

In the export market, the firm sets price 2.6 and earns extra profits of $\Delta\pi_1^e(1.5) = 1.265$. As a MNE, it charges price 2.0, and earns profits of $\Delta\pi_1^m(1.5) = 0.767$. The firm should serve the foreign market as an exporter.

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

In the export market, the firm sets price 1.95 and earns profits of $\Delta\pi_1^e(2.0) = 3.183$. As a MNE, it charges price 1.50, and earns profits of $\Delta\pi_1^m(2.0) = 4.007$. The firm should serve the foreign market with a foreign affiliate.

In figure 2, we plot (13) and (14) for different values of firm productivity. For low values 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 1.05, exporting becomes profitable. Once productivity reaches about 1.72, multinational production is now more profitable than exporting. This implies that firms with productivity below 1.05 should not sell abroad, firms with productivity between 1.05 and 1.72 should export, and firms with productivity greater than 1.72 should become multinationals.

We say that this model features *selection* on firm productivity: the more productive firms self-select into multinational production. This selection 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