

# Lecture 11:

## Heterogeneous Firms and Horizontal FDI

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We have only seen so far models where the only possibility for a firm to access foreign markets was through exports. We also assumed a rather simple form for the technology of production. Namely, there was only a final goods sector, and no production of intermediate goods (hence no trade in intermediates). The picture in the actual world is far less simple. Firms have many different options for accessing foreign markets, exports being only one of them. And the actual technology of production actually includes many intermediate steps, some of them taking place across borders.

Firms may decide to produce directly part of their output abroad, and sell it directly from abroad. In order to do so, a firm acquires, or builds new plants abroad to produce its output locally. This is known as horizontal foreign direct investment (FDI). Firms may also licence off their production to foreign firms (or domestic firms for that matter).

In the event where the chain of production consists of more than a single stage, firms may decide to split up their production processes across national boundaries, producing intermediate goods in a country, and assembling them in another. This is known as vertical FDI.

In this lecture, we will try to understand the determinants of horizontal FDI, and see what role firm heterogeneity may play. Brainard (1997) presents a simple proximity-concentration theory to understand the trade-off between export and FDI. Markusen and Venables (2000) add factor endowment differences between countries to this simple model. Helpman, Melitz and Yeaple (2004) add firm heterogeneity.

# 1 The Proximity Concentration Trade-Off

## Brainard (1997)

- A key concept for understanding the motive for horizontal FDI is known as the proximity concentration trade-off. It is developed in a simple and elegant model in Brainard (1997). It states that the ratio of exports to FDI will be larger when transportation costs are low, when firm level returns to scale are large relative to plant level returns to scale. The reason is simple and intuitive:
- Other things equal, when (variable) transportation costs increase, it gets more and more costly to ship goods across between countries. It becomes more and more tempting to set up a subsidiary abroad to service the foreign market directly.
- The larger the firm level returns to scale relative to the plant level to scale, the less costly in term of efficiency it is for a given firm to split up its production between different countries. Affiliates in foreign countries benefit from the increasing returns to scale of the multinational firm, and there is little cost lost from building (or buying) these new affiliates. Hence, a firm has an incentive to become a multinational firm, and set up subsidiaries in foreign countries instead of exporting all its output.
- Brainard (1997) finds empirical evidence in support of this model. In addition, she finds that the ratio of exports to FDI is higher when countries are more dissimilar in terms of GDP/capita. This fact cannot be accounted for directly within the context of Brainard's symmetric world model.

## Markusen and Venables (2000)

- Markusen and Venable (2000) incorporate a Heckscher-Ohlin dimension to the model of multinational firms of Brainard, which can explain why FDI tends to be substituted to exports when countries become more similar. The key idea is that when factor endowments (and GDP/capita differences reflect to some extent differences in factor endowments) differ, exports become more profitable relative to FDI. The reason for that prediction is intuitive:
- If factor endowments differ between countries, some country will be relatively more efficient at producing some goods, and vice versa.

The more different are factor endowments, the larger the relative productivity in different sectors between countries.

- If the productivity is very different in different countries, there are incentives to concentrate all the production of a given sector in the country where the productivity in that sector is highest, and export from that country, rather than split up the production of the same sector in different countries.
- So the more different factor endowments between countries, the more export will be substituted for horizontal FDI.

## 2 Helpman, Melitz and Yeaple (2004)

- Helpman, Melitz and Yeaple (2004) come back to the trade-off between concentration and proximity from a different angle. They introduce firm heterogeneity (in productivity, as in Melitz (2003)). The key prediction is that all firms face a trade-off between proximity and concentration of some sort, but the response to that trade off is different between different firms.
- The key predictions of the model is that:
  1. Only the most productive firms engage in foreign activities.
  2. Among those firms, the most productive chose to do FDI rather than export.
  3. At the (sectoral) aggregate level, FDI sales relative to exports are larger in sectors with more firm heterogeneity.
- The intuition for these results is simple. The first two results are basically extensions of the prediction in the Melitz model that only the most productive firms export abroad. If there are fixed costs associated with exporting, then only those firms that are productive enough to recover this cost export. If setting up a foreign affiliate is even more costly than exporting (but allows to save on the variable cost), only the firms that have a large enough scale (large market share because they are highly productive) will find it optimal to perform FDI rather than export.
- In sectors with more firm heterogeneity, the share of high productivity firms relative to lower productivity firms is higher, so that the fraction of firms choosing FDI over export is larger.

- Helpman, Melitz and Yeaple (2004) build measures of firm heterogeneity at the sector level, as well as use measure of bilateral trade barriers at the sector level to test their predictions. They use sectorial data on sales of foreign affiliates of US firms, in different countries, and export from the US in these different countries. They find both evidence of the proximity concentration trade-off, of the sorting of firms by productivity into different activities, and a relationship between firm heterogeneity and the relative importance of FDI.

### Theoretical model:

- Helpman, Melitz and Yeaple (2004) extend the Melitz (2003) model. In addition to deciding whether or not to enter the domestic and the foreign market, firms have an additional option: instead of serving the foreign market through exports, they can instead set up a subsidiary abroad, and serve the market directly.
- The trade-off between FDI and exports is the following: on the one hand, FDI saves on variable trade barriers compared to exports (the proximity argument); on the other hand, setting a subsidiary abroad is more costly than simply entering the foreign market through exports (the concentration argument).

$$f_E, f_D, f_X, \tau, f_I$$

- Formally, there are several costs associated with setting up activities in different countries. To start up a new firm, a sunch entry cost  $f_E$  must be paid. In addition, each period, there is an overhead cost for selling on the domestic market,  $f_D$ . If a firm decides to export abroad, it must pay a fixed cost (each period),  $f_X$ . In addition, there is a variable cost for each unit shipped,  $\tau$  (iceberf transportation cost). If instead a firm decides to set up a foreign affiliate, it must pay a fixed cost  $f_I$ . However, the cost of setting up a foreign affiliate is larger than cost of exporting to a foreign country.
- As in Melitz (2003), each firm draws a random productivity. The marginal labor cost is  $a$ , drawn from a Pareto distribution  $G(\cdot)$ ,

$$G(a) = \Pr[\tilde{a} \leq a] = \left(\frac{a}{a_{\max}}\right)^k, \quad 0 < a \leq a_{\max}$$

- Preferences are CES over a continuum of differentiated goods in  $H$  sectors, and 1 homogenous sector, and Cobb-Douglas between sectors,

$$U = q_1^{\beta_1} \prod_{h \neq 1} \left( \int_{\Omega_h} q_h(\omega)^{\frac{\varepsilon_h - 1}{\varepsilon_h}} d\omega \right)^{\frac{\varepsilon_h - 1}{\varepsilon_h - 1} \beta_h}$$

with  $\sum_{h=1}^{H+1} \beta_h = 1$ . The homogenous good is produced under constant returns to scale, and is freely traded, which will ensure factor price equalization as long as every country produces some of this homogenous good.

- These preferences give the simple demand functions, and pricing strategy of firms,

$$q_h^i(a) = \beta_h E^i \left( \frac{p(a)}{P_h^i} \right)^{-\varepsilon}$$

$$p(a) = \frac{\varepsilon}{\varepsilon - 1} w^i a$$

with  $E^i$  aggregate demand in country  $i$ .

- Upon receiving a cost draw, a firm will decide whether or not to produce domestically, whether or not to enter foreign markets, and if so, through exports or through FDI. Because the marginal product of labor is constant, firms can make those decisions sequentially (there is no interaction between those different decisions). When making those decisions, they look at the net profits from selling in a given market (for entry on the domestic and foreign markets), and they compare the profits from exports and from FDI,

$$\pi_D^i(a) = (a)^{1-\varepsilon} B^i - f_D$$

$$\pi_X^{ij}(a) = (\tau^{ij} a)^{1-\varepsilon} B^j - f_X$$

$$\pi_I^{ij}(a) = (a)^{1-\varepsilon} B^j - f_I$$

with  $B^i = \frac{\beta_h}{\varepsilon} E^i (P_h^i)^{\varepsilon-1}$  the demand level in country  $i$ . Helpman, Melitz and Yeaple make the following assumption,

$$f_D < (\tau^{ij})^{\varepsilon-1} f_X < \left( \frac{w^j}{w^i} \right)^{\varepsilon-1} f_I \quad (1)$$

The first inequality ensures that no firm will be exporting but not selling on the domestic market (which is a prevailing feature of the data). The second inequality ensures that only the most productive firms operating on foreign markets opt out for FDI, and the less productive chose to service foreign markets through exports.

- Given the very simple form for the demand function, we can compare graphically the profits generated by each type of activity, for firms with different productivity. This is shown on Fig. (1) for the

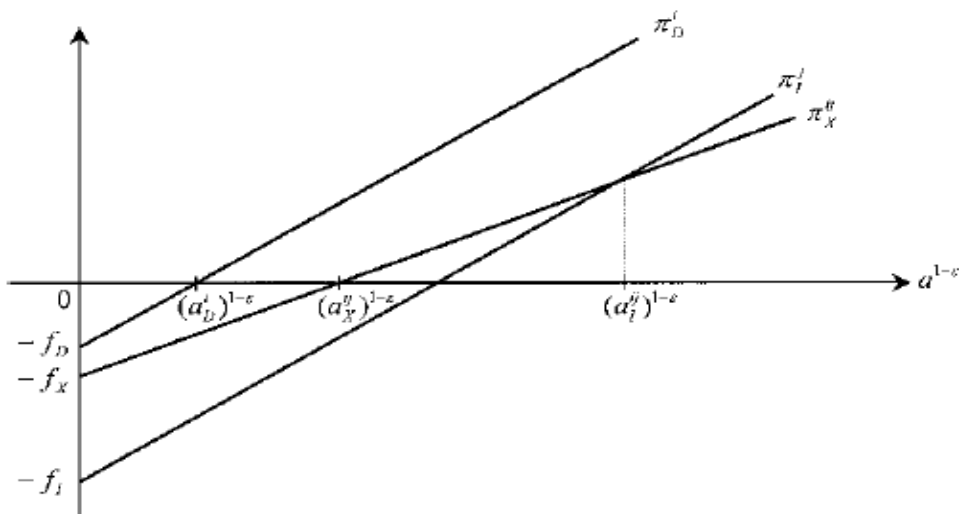


Figure 1: Profits from domestic sales, exports, and FDI.

case of two symmetrical countries ( $B^i = B^j$ ).

**Important note:** in this setting with CES preferences and monopolistic competition, there is a one for one mapping between the productivity of a firm and the scale of its production. More productive firms charge a lower price, and capture a larger market share. The proximity-concentration trade-off arises naturally with this formalization. More productive firms have a larger scale of production, and therefore, they are able to cover their fixed cost more easily.

- **Proximity concentration trade-off:** Because there is a per unit variable cost of export, but none for FDI sales, the slope of the profit function for exports is flatter than the slope of the profit function for FDI. So despite the fact that setting up a foreign affiliate is more costly than simply exporting ( $f_I > f_X$ ), there is a range of low productivities for which exporting is more profitable than FDI. However, this is not enough. A firm still requires that profits are positive. This is where the assumption in Eq. (1) comes into play. It ensures that there are at least some firms that are productive enough to export, but for which export is more profitable than FDI.

- We can now define the productivity cutoffs that determines which range of productivity exits, sells domestically, exports, or does FDI. By imposing free entry, we can further determine the number of entrants in each country. The productivity cutoffs are given by,

$$\begin{aligned} (a_D^i)^{1-\varepsilon} B^i &= f_D, \quad \forall i \\ (\tau^{ij} a_X^{ij})^{1-\varepsilon} B^j &= f_X, \quad \forall j \neq i \\ (1 - \tau^{ij}) (a_I^{ij})^{1-\varepsilon} B^j &= f_I - f_X, \quad \forall j \neq i \end{aligned}$$

The free entry condition imposes that the expected value of entering equals the cost of entry,

$$\begin{aligned} V(a_D^i) + \sum_{j \neq i} \left(1 - (\tau^{ij})^{1-\varepsilon}\right) V(a_I^{ij}) B^j + \sum_{j \neq i} (\tau^{ij})^{1-\varepsilon} V(a_X^{ij}) B^j \\ - \left[ G(a_D^i) f_D + \sum_{j \neq i} G(a_I^{ij}) (f_I - f_X) + \sum_{j \neq i} G(a_X^{ij}) f_X \right] = f_E, \quad \forall i \end{aligned}$$

with  $V(a) = \int_0^a y^{1-\varepsilon} dG(y)$ .

- In their working paper version, Helpman, Melitz and Yeaple show that under the assumption that costs are symmetrical (meaning the fixed costs are the same in every country, and  $\tau^{ij} = \tau$ ,  $\forall i \neq j$ ), then the cutoffs are the same in every country, and the demand level are the same in every country ( $B^i = B$ ,  $\forall i$ ). The cutoff levels and the free entry condition then become,

$$\begin{aligned} (a_D)^{1-\varepsilon} B &= f_D \\ (\tau a_X)^{1-\varepsilon} B &= f_X \\ (1 - \tau) (a_I)^{1-\varepsilon} B &= f_I - f_X \end{aligned}$$

$$\begin{aligned} V(a_D) + (N - 1) (1 - \tau^{1-\varepsilon}) V(a_I) B + (N - 1) \tau^{1-\varepsilon} V(a_X) B \\ - [G(a_D) f_D + (N - 1) G(a_I) (f_I - f_X) + (N - 1) G(a_X) f_X] = f_E \end{aligned}$$

This gives a system of 4 equations with 4 unknowns, which can easily be solved for the different cutoffs, and the residual demand. From the demand level, it is easy to recover the number of entrants in each country, by plugging back in the formula for the price index, and using the fact that there are no pure profits, so that  $E^i = L^i$  in every country.

- **Home market effect:** Helpman, Melitz and Yeaple, once again in their working paper version, uncover an interesting home market effect. Larger countries attract more firms. Even more, the number of firms rises more than proportionately with the country size, so that large countries have disproportionately more firms. Because the number of firms that sell domestically, export, and do FDI are all proportional to the number of firms in the country, larger countries export disproportionately more, and the sales of their foreign affiliates are disproportionately larger.

A corollary is that in larger countries, the share of sales by domestic firms relative to either exporters, or foreign owned firms, is larger than in smaller countries. Not only are bigger countries less open to trade, but also less open to foreign investment (in proportional terms).

- **Exports versus FDI:** to be continued...

$$\frac{s_X^{ij}}{s_I^{ij}} = \tau^{1-\varepsilon} \left[ \frac{V(a_X)}{V(a_I)} - 1 \right]$$

$$\text{with } V(a) = \int_0^a y^{1-\varepsilon} dG(y)$$

$$\begin{aligned} \frac{s_X^{ij}}{s_I^{ij}} &= \tau^{1-\varepsilon} \left[ \left( \frac{a_X}{a_I} \right)^{k-(\varepsilon-1)} - 1 \right] \\ &= \tau^{1-\varepsilon} \left[ \left( \frac{f_I - f_X}{f_X} \frac{1}{\tau^{\varepsilon-1} - 1} \right)^{\frac{k-(\varepsilon-1)}{\varepsilon-1}} - 1 \right] \end{aligned}$$

$$\frac{s_{hX}^{USj}}{s_{hI}^{USj}} = \left( \frac{w^{US}}{w^j} \tau_h^{USj} \right)^{1-\varepsilon_h} \left[ \left( \frac{f_{hP}}{f_X^j} \frac{1}{\left( \frac{w^{US}}{w^j} \tau_h^{USj} \right)^{\varepsilon-1} - 1} \right)^{\frac{k_h-(\varepsilon_h-1)}{\varepsilon_h-1}} - 1 \right]$$

with  $f_{hP} = f_{hI} - f_{hX}$  plant-level returns to scale

$$\ln \frac{s_{hX}^{USj}}{s_{hI}^{USj}} = \alpha + \alpha_j + \beta_\tau \ln \left( \tau_h^{USj} \right) + \beta_f \ln (f_{hP}) + \beta_k (k_h + (\varepsilon_h - 1)) + \beta_X X_h + u_{hj}$$

## References

- [1] Brainard, S. Lael (1997), “An Empirical Assessment of the Proximity-Concentration Trade-off Between Multinational Sales and Trade,” *American Economic Review*, 87:4, pp. 520-544.
- [2] Markusen, James R. and Anthony J. Venables (2000), “The Theory of Endowment, Intra-industry and Multi-national Trade,” *Journal of International Economics*, 52, pp. 209-234.
- [3] Helpman, Elhanan; Marc J. Melitz, and Stephen R. Yeaple (2004), “Exports versus FDI with Heterogeneous Firms,” *American Economic Review*, 94:1, pp. 300-316.