



# Firm heterogeneity and the structure of U.S. multinational activity<sup>☆</sup>

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## ABSTRACT

We use firm-level data for U.S. multinational enterprises (MNEs) and the model of firm heterogeneity presented in Helpman, Melitz, and Yeaple [Helpman, E., Melitz, M., Yeaple, S., 2004. Exports versus FDI with heterogeneous firms. *The American Economic Review* 94 (1), 300–316.] to make four empirical contributions. First, we show that the most productive U.S. firms invest in a larger number of foreign countries and sell more in each country in which they operate. Second, we assess the importance of firm heterogeneity in the structure of MNE activity. Third, we use the model to identify the mechanisms through which country characteristics affect the structure of MNE activity. Finally, we assess the model's shortcomings in order to inform the development of new theory.

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## 1. Introduction

A tiny minority of firms engage in international trade, and a still smaller fraction of firms own production facilities in more than one country. These internationally engaged firms are systematically different from their domestically oriented peers. Firms that export are larger and more productive than firms that do not (Bernard and Jensen, 1999), while firms that open foreign affiliates are still larger and more productive than firms that only export (Tomiura, 2007). A well-developed body of theory explains these phenomena as the sorting of heterogeneous firms into modes of foreign market access.<sup>1</sup>

In this paper, we investigate how well a model of firm heterogeneity adapted from Helpman et al. (2004) can explain the cross-country structure of U.S. multinational activity. The model is built on two key assumptions. First, firms face a trade-off in serving foreign markets: by opening a local affiliate, firms avoid per unit transport costs associated with trade but must instead incur fixed costs

associated with managing a foreign affiliate. Second, firms differ in their productivity. These assumptions imply that for each country there is a productivity cutoff, which is determined by the country's characteristics, such that only those firms whose productivity exceeds this cutoff will open an affiliate in that country. Hence, the model predicts a "pecking order" such that the most productive firms should open an affiliate in even the least attractive countries, while progressively less productive firms enter progressively more attractive countries.

In the model, country characteristics affect the aggregate volume of multinational activity, measured as the sales of affiliates to host customers, through two channels. First, country characteristics determine the productivity cutoff, and so affect the productivity composition of the firms that invest there. The key feature of the model is that a change in a country characteristic that encourages a greater number of foreign firms to open a local affiliate must be inducing progressively less productive firms to enter. Second, country characteristics determine the optimal level of sales, holding fixed the set of firms that own an affiliate there.

We use the model and firm-level data collected by the Bureau of Economic Analysis for all U.S. multinational enterprises for the year 1994 to make four empirical contributions. First, we show that more productive U.S. firms own affiliates in a larger number of countries and these affiliates generate greater revenue on sales in their host countries. Previous studies, such as Girma et al. (2005), Head and Ries (2003), and Tomiura (2007) show only that firms that become multinational are systematically different from firms that export. Our

<sup>☆</sup> The statistical analysis of firm-level data on U.S. multinational corporations reported in this study was conducted at the U.S. Bureau of Economic Analysis, under arrangements that maintained legal confidentiality requirements. Views expressed are those of the authors and do not necessarily reflect those of the Bureau of Economic Analysis. I thank Peter Egger, Richard Kneller, Bill Zeile, and Jonathan Eaton for their comments.

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<sup>1</sup> See, for instance, Melitz (2003), Bernard et al. (2003), and Helpman et al. (2004).

analyses demonstrate that this sorting extends to the scale and scope of multinational enterprises: more productive firms own affiliates in a larger set of countries and their affiliates are larger than those of less productive firms. This sorting has quantitatively important implications for the aggregate structure of U.S. multinational activity.

The second contribution of our analysis is to assess how important firm heterogeneity is in determining the structure of U.S. multinational activity. We show that as a country becomes more attractive to U.S. multinationals, it attracts progressively smaller and less productive firms. For instance, our estimates suggest that a 10% increase in a country's GDP per capita leads to a 7.6% increase in the number of U.S. firms that enter that country, but because new entrants are less productive than old entrants, the average productivity of all entrants falls by 2.0%. Thus, the contribution of the extensive margin, adjusted for the productivity composition of entrants, is 5.6%. Although there are several papers exploring the importance of firm heterogeneity models in the structure of international trade (e.g. Eaton et al., 2008), little has been done to investigate whether this body of theory improves our understanding of the aggregate structure of multinational activity.

Our third contribution is to use the structure of the model to disentangle the mechanisms through which individual country characteristics affect the structure of U.S. multinational activity. For example, while it has long been known that horizontal FDI is primarily attracted to developed countries, previous analyses do not shed light as to exactly why this is the case. We show that multinational activity is increasing in a host country's GDP per capita because individual entrants face greater effective demand in richer countries, not because these countries have relatively lower entry costs. The analysis generates similarly surprising conclusions concerning the mechanisms through which physical distance and a shared language affect the structure of U.S. multinational activity.<sup>2</sup>

The fourth contribution of this paper is to assess the manner in which the model fails. We document systematic deviations from the pecking order. Although multinational activity is highly concentrated in the most productive firms, the model predicts that an even greater concentration of affiliate sales in the largest firms than is actually observed. In particular, larger firms underinvest in the least attractive countries. These observations should prove useful for the future development of models of firm heterogeneity.<sup>3</sup>

The remainder of this paper is divided into five sections. In section 2, we use a version of Helpman et al. (2004) to derive predictions over the investment behavior of individual firms and to specify a structural econometric model of aggregate multinational activity. In section 3, we describe the firm-level data and the set of firm and country characteristics used to estimate this model. In section 4, we present the main results of our empirical analyses. The results confirm that it is important to account for firm heterogeneity in order to understand the structure of aggregate multinational affiliate sales, and they illuminate the channels through which country characteristics influence multinational activity. In section 5, we calculate the structure of multinational affiliate sales that would be observed if the pecking order were strictly observed and compare this counterfactual measure to the actual structure in order to demonstrate precisely how the model falls short. The final section concludes and presents suggestions for future research.

<sup>2</sup> In this respect, our analysis is similar in flavor to Helpman et al. (2008) who use a model of firm heterogeneity and trade to disentangle the effect of distance on trade patterns. There is also some similarity to the work of Head and Ries (2008). They propose a mechanism that probabilistically assigns firms to countries. They too use their structural model to interpret the data.

<sup>3</sup> In this sense, our paper is similar to Baldwin and Harrigan (2007) who show that the Melitz (2003) model of firm heterogeneity fits certain facts well while systematically failing along other dimensions. Unlike Baldwin and Harrigan (2007) we do not pursue specific adjustments to the model to address these short-comings.

## 2. The analytical framework

We use a framework based on Helpman et al. (2004) to organize an econometric analysis of the structure of U.S. multinational activity across a range of host countries.<sup>4</sup> We first specify the model and generate firm-level predictions. We then aggregate over individual firms to form country-wide predictions. Finally, we develop a series of equilibrium conditions that can be taken to the data.

### 2.1. The model

The preferences of the representative consumer are the same everywhere and are given by

$$U = \left( \int_{\omega \in \Omega} x(\omega)^\alpha d\omega \right)^{\frac{1}{\alpha}}$$

where  $x(\omega)$  is the quantity of good  $\omega$  consumed,  $\alpha = (\sigma - 1)/\sigma$ ,  $\sigma > 1$  is the elasticity of substitution across goods, and  $\Omega$  is the set of goods available. These preferences imply the following demand curve in country  $j$ ,

$$x_j(\omega) = \frac{E_j}{P_j} \left( \frac{p_j(\omega)}{P_j} \right)^{-\sigma}, \quad (1)$$

where  $E_j$  is gross national expenditure in country  $j$ ,  $P_j$  is the price index in country  $j$ , and  $p_j(\omega)$  is the price of good  $\omega$  in country  $j$ .

There are  $J$  countries indexed by  $j$ . In country  $j$  the mass of firms is  $N_j$ . Each firm is capable of producing a single good using a single input called labor. The price of labor in country  $j$  is  $w_j$ . Firms are heterogeneous in terms of their productivity  $\varphi$ .<sup>5</sup> The empirical distribution of  $\varphi$  in each country  $G$  is assumed to be Pareto, i.e.

$$G(\varphi) = 1 - \varphi^{-k},$$

where  $k > \sigma - 1$ .<sup>6</sup>

Each firm sells its good in each country. In serving foreign markets, a firm faces a trade-off in the way that it organizes its production. If a firm from country  $h$  chooses to export its good from country  $h$  to a foreign country  $j$ , it faces wage  $w_h$  and incurs iceberg transport cost  $\tau_{hj} > 1$ . Alternatively, the firm may avoid this transport cost by opening an affiliate in country  $j$ . Setting up an affiliate in country  $j$  requires the firm to incur the fixed cost  $F_j$ . The firm must also pay the local labor cost  $w_j$ . We assume that technology transfer is perfect so that the firm's productivity is the same in every country. To focus on the pure proximity-concentration trade-off, we abstract away from the possibility that a firm engages in export platform FDI and vertical FDI by assuming that transport costs are relatively high compared to wage differences between countries so that  $w_h \tau_{hj} > w_j$  for all  $h$  and  $j$ .<sup>7</sup>

In the remainder of this section, we derive equilibrium conditions to organize the empirical analyses, but we do not solve for the full general equilibrium of the model. In particular, the set of equilibrium price indexes and the set of nominal wages will not be derived. As such, we will need to take a reduced-form approach in relating these variables to country characteristics when implementing our empirical work.

<sup>4</sup> The model presented in this section differs from that presented in Helpman et al. (2004) in two respects. First, the model is not closed via a free entry condition. Second, because we do not observe firm-level exports in our dataset, we do not include a fixed cost of exporting.

<sup>5</sup> Variation in productivity across firms can be thought of more generally as variation in firm characteristics that lead to a higher value of output per unit input. As pointed out by Melitz (2003), variation in productivity across firms is isomorphic to variation in quality across firms when preferences are CES.

<sup>6</sup> We have assumed here that the lowest possible productivity draw is unity.

<sup>7</sup> For an analysis of a very different geography where affiliate exports are prominently featured in a model of firm heterogeneity, see Yeaple (2008).

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