International Trade and Heterogeneous Firms*

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Abstract

Empirical studies of production units within sectors have reported a massive amount of heterogeneity in various performance measures (most notably, size and productivity). This heterogeneity, within sectors, matters for theoretical and empirical models of trade. Trade, or trade liberalization more generally, induces important reallocations between heterogeneous producers in a sector: the smallest or least productive producers are forced to exit, and market shares are further reallocated between less productive producers (who do not export) towards larger, more productive exporters. These reallocations generate a new channel for productivity and welfare gains from trade.

Census-wide 'micro' level studies of production units for a wide range of countries at all levels of development have documented substantial heterogeneity in virtually all relevant performance measures across these production units. For example, across all U.S. manufacturing plants in 1992, a plant one standard deviation above the mean plant size is 167% bigger, and a plant one standard deviation above the mean plant productivity level (value-added per worker) is 75% more productive (Bernard, Eaton, Jensen and Kortum, 2003).[1] These represent massive differences in performance outcomes, which are also reflected in differences in other key plant characteristics. Furthermore, the extent of this heterogeneity does not diminish much when looking within narrowly defined sectors. In the case of the U.S. plants, the 75% productivity difference mentioned above only drops to a 66% difference when controlling for productivity differences across more than 400 different sectors.

These large differences in firm performance are also strongly correlated with the firm decision to engage in international transactions (such as exporting, importing intermediate goods from foreign suppliers, or investing in foreign subsidiaries): only a small proportion of firms report any such

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[1]More precisely, the standard deviation of log sales is 1.67 and that of labor productivity is .75.

activities, even within narrowly defined sectors; and those firms are substantially larger and more productive than their counterparts with no international contacts in the same sector.[2] For the U.S., Bernard, Jensen, Redding and Schott (2006) report that manufacturing plants are more than twice as large (value of shipments) as and 14% more productive (value-added per worker) than their non-exporting counterparts in the same sector.[3] Bernard et al. (2006) also report how these exporting firms exhibit other different characteristics relative to non-exporters: they are more capital- and skill-intensive, and pay higher wages.

This strong correlation between export status and firm characteristics (notably higher productivity) naturally leads to the follow-up question of causality. A very large number of studies have examined this question, usually focusing on a firm's productivity trajectory over time relative to its export market entry decision. Virtually all these studies find a strong self-selection effect: firms are relatively more productive prior to their entry into export markets.[4] Several of these studies further reject the hypothesis of firm-level productivity growth following export market entry, although some studies, especially for developing countries, do report such a link.[5] However, this distinction – based on the timing of the export market entry – has been blurred given the evidence from some recent studies that firms make innovation/technology use decisions based on current or anticipated export market participation as highlighted by Bustos (2006), Verhoogen (2007), and Trefler and Lileeva (2007). In such a case, productivity and exporting decisions are both endogenous with respect to one-another, and the timing of the export market entry can no longer be used to identify causality.[6] Nonetheless, the results obtained clearly indicate that it is initially more successful firms that make the joint decisions concerning innovation (or 'higher' technology use) and export status. In other words, the least successful firms overwhelmingly tend to undertake neither activity.

Another part of the recent empirical literature using micro-level data has examined the consequences of this link between export status and productivity when the exposure to trade is changing (predominantly because trade costs are decreasing over time). In such a case, trade liberalization induces some reallocations between exporters and non-exporters competing in the same sectors (see

[2] This pattern has been documented at both the firm and the plant level for a very wide range of countries. From here on out, I will mostly focus on differences between exporting and non-exporting firms, although similar differences have also been documented concerning multinational firms and firms that import intermediate goods from foreign suppliers.

[3] Bernard et al. (2006) provide an extensive description of firm-level differences related to international trade based on U.S. manufacturing data and also survey the related empirical and theoretical literatures.

[4] Two early influential papers in this area are Bernard and Jensen (1999) and Clerides, Lach and Tybout (1998)

[5] See, for instance, Loecker (Forthcoming), Topalova (2004), Biesebroeck (2005), and the survey by Girma, Greenaway and Kneller (2004).

[6] Yeaple (2005) theoretically studies this joint technology adoption and export decision by firms, and explores the consequences for the return to skill – highlighting how skill-biased technological change may be induced by trade.

Tybout (2003) for a survey of this literature). One influential such study by Pavcnik (2002) finds that most of the 25% productivity increase in export competing sectors in Chile between 1979 and 1986 is explained by reallocations between producers (generated by entry, exit, export market entry, and market share reallocations). However, since significant changes in trade regimes are also part of a larger set of substantial macroeconomic changes for the involved countries (as was the case for Chile), it nevertheless remains difficult to associate this type of reallocation induced productivity growth to the direct effects of trade liberalization. One notable exception is Bernard, Jensen and Schott (2006), who show that reductions in trade costs for U.S. plants substantially increase both the probability of exit and that of exporting among non-exporters. Given the productivity advantage of exporters, this induces reallocations in favor of the more productive exporting plants and hence increases average industry productivity (which is also confirmed by Bernard et al. (2006) as a result of the decrease in trade costs).

Clearly, these empirical patterns can not be addressed by trade models based on representative firms. Such models, by construction, predict that trade affects all firms in a sector in similar ways.[7] In response to this empirical evidence, theoretical models of trade have been developed to incorporate firm-level productivity differences, and analyze the consequences for the effects of trade liberalization. One class of models, developed by Bernard et al. (2003) and Eaton and Kortum (Forthcoming) introduce stochastic firm productivity into the multi-country Ricardian model analyzed in Eaton and Kortum (2002). In this class of models, there is a fixed number of products that can be produced by competing firms in all countries. All these firms (both in the same country but also across countries) use different technologies to produce the same good (based on a stochastic productivity draw) – hence the Ricardian framework. Consumers in any given country buy each good from the lowest-cost producer across all countries. Due to trade costs, several firms producing the same good can survive if they are located in different countries (although each firms is the sole supplier to any given destination). This model thus emphasizes the resulting competition between firms to be this exclusive supplier. Bernard et al. (2003) show how such a model can be calibrated to fit both micro-level data on U.S. producers and macro-level data on cross-country trade and aggregate production across countries. The calibrated model can then be used to analyze many counterfactual predictions involving the consequences of trade liberalization.

Another class of models developed in Melitz (2003) and Melitz and Ottaviano (2005) eschews the

[7] Note that extensive firm-level heterogeneity per se is not necessarily problematic for a representative firm model of trade so long as firms, on average, respond in similar ways to trade. However, the evidence reviewed clearly shows that this is not the case.

analysis of the direct competition between firms to produce the same good by using a monopolistic competition framework: each firm produces its own distinctive differentiated good. These models incorporate firm heterogeneity into the one-sector models of intra-industry trade (the 'new' trade theory) developed in Krugman (1979) and Krugman (1980). In this type of model, the product variety available to consumers in any given country varies endogenously with the characteristics of the country and the trade costs linking it to its trading partners (these affect the endogenous number of varieties produced domestically, as well as the endogenous fraction of firms from all trading partners that export to that country). Firms face sunk costs of entry, along with uncertainty concerning their future productivity (or also possibly the quality of the differentiated good that is under development). Upon entry, each firm instantaneously learns about its productivity level, modeled as a draw from a known distribution. Due to the sunk nature of the entry costs, firms with heterogeneous productivity levels remain active and produce. The least productive firms face negative profits and therefore exit. As exporting is costly, only the relatively more productive firms (among those surviving) choose to export, while the remaining firms only serve their domestic market. Exporting is not profitable for these firms, either because it involves fixed or sunk costs, or because import demand is driven to zero at prices below the firms' delivered cost.

Both classes of models predict that trade liberalization induces the type of reallocations between firms that was previously described: the least productive firms are constrained to exit, new firms enter the export market, and market shares are reallocated towards more productive firms. These reallocations generate both aggregate productivity and welfare gains. Both classes of models also predict an important empirical regularity regarding bilateral trade flows: that differences in these trade flows reflect both differences in the amount of each good traded (the intensive margin of trade) as well as differences in the number of goods traded (the extensive margin of trade).[8] Helpman, Melitz and Rubinstein (2007) and Chaney (2006) show how the framework of Melitz (2003) can be extended to derive a gravity specification for bilateral trade flows where trade costs affect both the extensive and intensive margin of trade. Both papers highlight the empirical importance of incorporating changes in trade at both margins.

Due to the absence of strategic interactions between firms, the monopolistic competition model of Melitz (2003) provides a convenient framework for the modeling of additional firm-level decisions in an open economy environment – where heterogeneous firms self-select into different types of

[8] See Bernard, Jensen and Schott (2005), Broda and Weinstein (2006), Broda, Greenfield and Weinstein (2006), Eaton, Kortum and Kramarz (2004), and Kehoe and Ruhl (2003) for some empirical applications.

activities. This framework can thus also explain why only a fraction of firms choose to become multinationals and operate foreign affiliates (horizontal FDI) as in Helpman, Melitz and Yeaple (2004) or integrate with their foreign suppliers (vertical FDI) as in Antras and Helpman (2004).[9] Additionally, other firm-level decisions that are also affected by the exposure to international trade can be incorporated: the choice of technology as in Acemoglu, Antras and Helpman (Forthcoming), the level of investment in innovation as in Atkeson and Burstein (2006), or the range of products produced and exported within multi-product firms as in Bernard, Redding and Schott (2006). Lastly the structure from Melitz (2003) has also been fruitfully integrated into various other types of models that rely on the basic monopolistic competition of trade. This includes extension to two-sector models of trade with comparative advantage and factor proportion differences (Bernard, Redding and Schott, 2007), open economy models of growth (Baldwin and Robert-Nicoud, 2006), and international macro-dynamics (Ghironi and Melitz, 2005). In each case, the addition of firm-level heterogeneity allows the models to explore additional important features upon which a model with representative firms remains silent.

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[9] Helpman (2006) provides a much more extensive review of the related models.

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