NBER WORKING PAPER SERIES

FIRMS IN INTERNATIONAL TRADE

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Working Paper 13054
http://www.nber.org/papers/w13054

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
April 2007

Bernard, Jensen, and Schott thank the National Science Foundation (SES-0241474, SES-0552029 and SES-0550190) and Redding thanks Princeton University and the Centre for Economic Performance (CEP) for research support. We are grateful to Jim Davis of the Census Bureau for timely disclosure of our data analysis and to Jim Tybout, Jim Hines and the JEP editorial board for extremely helpful comments and suggestions. The research in this paper was conducted while Bernard, Jensen and Schott were Special Sworn Status researchers of the U.S. Census Bureau at the Boston Research Data Center, New York Research Data Center, and Center for Economic Studies. We thank the NSF for infrastructure grants that support Census Research Data Centers (SES-0550190 and ITR-0427889). Research results and conclusions expressed are those of the authors and do not necessarily reflect the views of the Census Bureau, the NBER, or any other institution to which the authors are affiliated.

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NBER Working Paper No. 13054
April 2007
JEL No. F1,F2,L1,L2,L6

ABSTRACT

Despite the fact that importing and exporting are extremely rare firm activities, economists generally devote little attention to the role of firms when discussing international trade. This paper summarizes key differences between trading and non-trading firms, demonstrates how these differences present a challenge to standard trade models and shows how recent "heterogeneous-firm" models of international trade address these challenges. We then make use of transaction-level U.S. trade data to introduce a number of new stylized facts about firms and trade. These facts reveal that the extensive margins of trade -- that is, the number of products firms trade as well as the number of countries with which they trade -- are central to understanding the well-known role of distance in dampening aggregate trade flows.

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In discussing the origins and implications of international trade, economists emphasize comparative advantage, increasing returns to scale and consumer love of variety but pay relatively little attention to the firms that actually drive trade flows. Yet engaging in international trade is an exceedingly rare activity: of the 5.5 million firms operating in the United States in 2000, just 4 percent were exporters. Among these exporting firms, the top 10 percent accounted for 96 percent of total U.S. exports.

Since the mid-1990s, a large number of empirical studies have provided a wealth of information about the important role that firms play in mediating countries' imports and exports. This research, based on micro datasets that track countries' production and trade at the firm level, demonstrates that trading firms differ substantially from firms that solely serve the domestic market. Across a wide range of countries and industries, exporters have been shown to be larger, more productive, more skill- and capital-intensive, and to pay higher wages than non-trading firms. Furthermore, these differences exist even before exporting begins. A large literature documenting these findings has emerged, beginning with Bernard and Jensen (1995).

The ex ante productivity advantage of exporters suggests self-selection: exporters are more productive, not as a result of exporting, but because only the most productive firms are able to overcome the costs of entering export markets. This sort of microeconomic heterogeneity can influence macroeconomic outcomes. When trade policy barriers fall or transportation costs decline, high-productivity exporting firms survive and grow, while lower-productivity non-exporting firms are more likely to fail. This reallocation of economic activity across firms raises aggregate productivity and provides a non-traditional source of welfare gains from trade.

We highlight the challenges new empirical research poses for traditional models and discuss how these challenges have shifted the focus of the international trade field from countries and industries towards firms and products. We show how observed differences between trading and non-trading firms have led to the development of a series of heterogeneous-firm models, and that these models offer new insights into the causes and consequences of international trade. Table 1 summarizes key stylized facts about international trade as well as the ability of various models to explain them. These models are discussed throughout the paper.

We also make use of recently available transaction-level U.S. trade data to introduce new stylized facts about firms' participation in international markets. These data show that the extensive margins of trade – that is, the number of products firms trade as well as the number of countries they trade with – are central to understanding the well-known role of distance in dampening aggregate trade flows. We conclude with suggestions for further theoretical and empirical research.

Empirical Challenges to Old and New Trade Theory

Traditional or "old" theories of international trade explain the flow of goods between countries in terms of comparative advantage (differences in opportunity costs of production). Comparative advantage can arise because of productivity differences ("Ricardian" comparative advantage) or because of a combination of cross-industry differences in factor intensity and cross-country differences in factor abundance ("Heckscher-Ohlin" comparative advantage). In either case, as summarized in Table 1, a key implication of old trade theory is "inter-industry trade": that is, countries will export one set of industries and import another. Endowment-driven "old" trade theory models also provide a mechanism through which international trade can influence relative factor rewards (and hence income distribution), as specialization across industries that differ in factor intensity changes the relative demand for the various factors of production.

A large share of international trade, however, takes place between relatively similar trading partners, apparently within industries (Grubel and Lloyd, 1975). Germany and the United States, for example, exchange automobiles. This fact and others led to the creation of "new" trade models by Paul Krugman (1980), Elhanan Helpman (1981) and William Ethier (1982). In these models, a combination of economies of scale and consumer preferences for variety lead otherwise identical firms to "specialize" in distinct horizontal varieties, spurring two-way or "intra-industry" trade between countries. In contrast to old trade theories, where the welfare gains arise from the differences in opportunity costs of production across industries and countries, "new" trade theories have welfare gains accruing from the wider set of varieties that trade makes available to consumers.

In a seminal contribution, Helpman and Krugman (1985) integrated old and new trade theory by embedding horizontal product differentiation and increasing returns to scale in a model featuring endowment-based comparative advantage. This "integrated" framework soon became a standard paradigm for analysis in the field. When modified to allow for technology differences, factor price inequality and trade costs, this integrated framework provides a reasonably successful explanation of aggregate international trade patterns, as Helpman (1999) discussed in this journal.

Both old and new trade theory typically assume a representative firm, at least within each industry. This assumption facilitates the general equilibrium analysis that is core to international trade, but it is inconsistent with the substantial variation in productivity, capital intensity and skill intensity observed across firms within narrowly defined industries.[2]

Of course, the mere existence of heterogeneity is not necessarily a problem for theories of international trade. The assumption of a representative firm could be a convenient, if not perfectly realistic, simplification. However, as we will show, the interaction of firm characteristics and the export orientation of the firm introduces a channel for international trade to influence aggregate productivity.

Firm Exporting is Relatively Rare

Exporting is a relatively rare firm activity. Of the 5.5 million firms operating in the United States in 2000, just 4 percent engaged in exporting. Even within the smaller set of U.S. firms active in industries more predisposed to exporting – like those in the manufacturing, mining or agricultural sectors that produce tradable goods – only 15 percent were exporters.

Table 2 illustrates this point more broadly with data from the 2002 U.S. Census of Manufactures. The second column of the table summarizes the distribution of manufacturing firms across three-digit NAICS industries, while the third column reports the share of firms in each industry that export. These columns reveal that the overall share of U.S. manufacturing firms that export is relatively small, at 18 percent.[3] However, the share of firms that export

[2] Micro datasets vary in terms of the amount of information available on firms and plants within firms. Unless otherwise noted, our discussion and empirical analysis focuses on firms as the relevant unit of analysis. Only recently have researchers begun to examine how production within firms is allocated across plants and how this is influenced by international trade (Bernard and Jensen, 2007).

[3] Similar results are observed at the plant-level. See Appendix Table A1. In the period since the early 1970s, there is a rise in the percentage of firms and plants that export, consistent with the multilateral and regional trade liberalization that has occurred.

within each industry category ranges rather widely. Thirty-eight percent of Computer and Electronic Products firms export, for example, while the share among Apparel firms is just 8 percent.

The fourth column of Table 2 shows that exporting firms ship a relatively small share of their total shipments abroad. Here, too, substantial variation exists across industries, ranging from a high of 21 percent in Computers to a low of 7 percent in Beverages. Across all firms, the share is 14 percent.

The information in Table 2 is consistent with old and new trade theories in some ways, but not in others. For example, exporting is more likely and export intensity is higher in more skill-intensive sectors like Computers than in more labor-intensive sectors like Apparel. This aspect of the data accords with endowment-driven old trade theory: that is, a relatively skill-abundant country like the United States should be relatively more likely to export in skill-intensive industries in which it possesses comparative advantage. However, while old trade theory can explain why a country is a net importer in one set of industries and a net exporter in another set, it cannot explain why some firms export and others produce solely for the domestic market, or how the firm-level decision to export interacts with comparative advantage.

Although Table 2 shows that exporting is a relatively rare activity, it also shows that exporting occurs in all manufacturing industries. This pervasiveness is consistent with new trade theory's emphasis on variety-motivated trade, although it is not clear in new trade models why a few firms in an industry would export but most would not. Similarly, the presence of exporters in comparative *disadvantage* industries where the United States is a net importer overall is consistent with the spirit of Helpman and Krugman's (1985) “integrated” old and new trade framework, but again this framework does not explain why only some firms export or why the fraction of firms exporting varies with comparative advantage.

Exporters are Different

Firms that export look very different from non-exporters along a number of dimensions. We highlight these differences by reporting U.S. manufacturing exporters’ “export premia” for 2002 in Table 3. Each row of the table summarizes the average percent difference between exporters and non-exporters for a particular firm characteristic.[4]

For example, the first column of the table reports the results of a series of bivariate ordinary least squares regressions. The dependent variables are employment, shipments, value-added per worker, and the other variables noted in the first column, all in logs. The explanatory variable is a dummy variable indicating whether the firm is involved in exporting or not. Since the dependent variable data are in logarithms, the coefficients can be interpreted as percentages. In other words, exporting firms have 119 percent more employment, 148 percent higher shipments, 26 percent higher value-added per worker, and so on.[5]

The second column repeats these regressions, but now includes industry fixed effects in the explanatory variables to control for differences in firm characteristics across industries. Because export participation is correlated with industry characteristics, controlling for industry effects typically reduces these coefficients. However, exporters remain different from non-exporters even in the same detailed industry. Exporters are significantly larger than non-exporters, by approximately 97 percent for employment and 108 per cent for shipments; they are more productive by roughly 11 per cent for value-added per worker and 3 per cent for total factor productivity; they also pay higher wages by around 6 percent. Finally,

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[4] Similar premia are observed at the plant level. See Appendix Table A2.

[5] Since the differences between exporters and non-exporters are often large, the log approximation can understate considerably the size of these differences. Taking exponents of the coefficients in Table 2, exporting firms have 229 percent more employment.

exporters are relatively more capital- and skill- intensive than non-exporters by approximately 12 and 11 percent, respectively. These findings are emblematic of what is typically found in this literature.

The observed differences between exporters and non-exporters are not driven solely by size. When we control for firm size as measured by log employment as well as industry effects in column 3, the differences between exporters and non-exporters within the same industry on all other economic outcomes continue to be statistically significant at the 1 percent level.

The finding that exporters are systematically more productive than non-exporters raises the question of whether higher-productivity firms self-select into export markets, or whether exporting causes productivity growth through some form of "learning by exporting." Results from virtually every study across industries and countries confirm that high productivity precedes entry into export markets. These findings are suggestive of the presence of sunk entry costs into export markets that only the most productive firms find it profitable to incur, as emphasized in Roberts and Tybout (1997).[6] Most studies also find little or no evidence of improved productivity as a result of beginning to export; for example, the work of Bernard and Jensen (1999) on U.S. firms and the work of Clerides, Lach and Tybout (1998) on firms in Mexico, Colombia and Morroco find no differential growth in firm productivity among exporters versus non-exporters. However, some recent research on low-income countries finds productivity improvement after entry. Van Biesebroeck (2005), for example, reports evidence that exporting raises productivity for sub-Saharan African manufacturing firms.

In contrast to the scarcity of studies finding improved firm productivity following entry into export markets, an abundance of evidence indicates that firms entering export markets grow substantially faster in employment and output than non-exporters. The combination of higher initial productivity and faster growth after commencing exporting points to an important role for trade liberalization in enhancing aggregate productivity through reallocation across firms, which will be examined further in the next section.

While much of the existing empirical literature has concentrated on differences in productivity and size between exporters and non-exporters, Table 3 also shows that exporters and non-exporters also display marked differences in factor intensity. The finding that U.S. exporters are more capital- and skill-intensive suggests that "old" trade theory concepts of comparative advantage may be at work within industries. Specifically, if the intensity with which firms use inputs reflects the characteristics of the goods they produce, then firms which are more capital- and skill-intensive are producing goods that are more consistent with U.S. comparative advantage (Bernard, Jensen and Schott, 2006b).

Harder to explain in terms of old trade theory concepts of comparative advantage is the finding that exporters are also more capital- and skill-intensive in developing countries, which are likely to be abundant in unskilled labor (Alvarez and Lopez, 2005). If exporting firms in labor-abundant developing countries were specializing in goods consistent with comparative advantage, they would be labor-intensive rather than capital- and skill-intensive.

How Trade Liberalization Raises Industry Productivity

In old trade theory, the welfare gains from trade are due to specialization according to comparative advantage. In new trade theory, the welfare gains from trade accrue from a combination of economies of scale and the expansion of product varieties available to consumers. Empirical analyses of trade liberalization at the firm level, however, provide

[6] Recent estimates suggest that these sunk costs may be sizable. Das, Roberts and Tybout (2006) estimate values of over $300,000 for Columbian manufacturing plants during 1981-91.

evidence for an additional source of welfare gains: that is, aggregate productivity growth driven by the contraction and exit of low-productivity firms and the expansion and entry into export markets of high-productivity firms. This reallocation of resources from low- to high-productivity establishments raises average industry productivity. These welfare gains may be magnified if the increase in product market competition induced by trade liberalization leads to lower mark-ups of price over marginal cost. In this case, the fall in mark-ups and rise in average productivity both contribute to lower prices and higher real incomes.

In an influential paper, Pavcnik (2002) finds that roughly two-thirds of the 19 percent increase in aggregate productivity following Chile's trade liberalization of the late 1970s and early 1980s is due to the relatively greater survival and growth of high-productivity plants. Similar findings emerge from a large number of studies of trade liberalization reforms in developing countries, as surveyed in Tybout (2003). The within-industry reallocations of resources found by these studies dominate the across-industry reallocations of resources emphasized by old theories of comparative advantage. Therefore, in the labor market, the net changes in employment between industries implied by comparative advantage are small relative to the gross changes in employment caused by simultaneous job creation and destruction within industries.

One concern is that the link from increased trade to the relative expansion of higher-productivity firms in developing-country results might not be driven solely by changes in trade policy, since trade liberalization is often part of a broader package of economic reforms. However, similar patterns of productivity gains from the expansion of high-productivity exporting firms have been found in response to reductions in trade barriers in both Canada (Trefler, 2004) and the United States (Bernard, Jensen and Schott, 2006a).

For example, Trefler (2004) finds effects of Canadian tariff reductions on industry productivity that are roughly twice as large as those on plant productivity, implying market share reallocations favouring high-productivity plants. The resource reallocation effects of reductions in U.S. trade costs are examined by Bernard, Jensen and Schott (2006a). They consider a number of dependent variables including the probability of plant death. Their key explanatory variable is a measure of trade costs, including both tariff rates and shipping costs at the industry level. Controlling for a number of other plant characteristics, they find that plant death is more likely to occur as trade costs fall, and that reductions in trade costs have the greatest impact on plant death for the lowest-productivity plants.

The relationship between trade liberalization and aggregate productivity growth is not limited to the relative growth and expansion of high-productivity firms. In Pavcnik (2002), one-third of the increase in aggregate productivity following the Chilean liberalization was due to within-plant productivity gains, potentially from the reallocation of resources across activities within plants. Qualitatively similar evidence is reported by Trefler (2004), who finds that the Canada-U.S. Free Trade Agreement raised the labor productivity of Canadian manufacturing plants by 7.4 percent or by an annual compound growth rate of 0.93 percent.

Bernard, Jensen and Schott (2006a) also find evidence supporting a link between falling trade costs and within-plant productivity growth in U.S. data. One of their specifications uses plants' total factor productivity as the dependent variable. The key explanatory variable is again the changes in industry trade costs described above. In their preferred specification (column 3 of Table 6 of their paper), changes in industry-level trade costs are negatively and significantly associated with plant-level productivity growth, with a one standard deviation fall in trade costs (a drop of 1 percentage point) implying a productivity increase of 2.3 percent.

Standard trade models emphasizing comparative advantage and the proliferation of product variety have little to say about firm or aggregate productivity growth. However, a growing body of evidence shows that trade liberalization causes relatively faster output and employment growth among high-productivity exporting firms within an industry. A smaller body of results suggests a less pronounced but still important effect of trade liberalization on firm productivity.

Heterogeneous-Firm Trade Theories

Empirical challenges to old and new trade theory have led to the development of richer theoretical models emphasizing the importance of firm heterogeneity in generating international trade and inducing aggregate productivity growth.[7] These models provide natural explanations for some of the empirical challenges noted above, and their analysis currently occupies a large portion of international trade research. One framework, developed by Bernard et al. (2003), introduces stochastic firm productivity into the multi-country Ricardian model of Eaton and Kortum (2002). A second class of models initiated by Melitz (2003) introduces firm heterogeneity into Krugman's (1980) model of intra-industry trade. The Melitz framework has proved to be particularly tractable and has stimulated a great deal of analysis into the implications of firm heterogeneity for a wide range of issues in international trade.

In the Melitz (2003) model, a competitive fringe of potential firms can enter an industry by paying a fixed entry cost, which is thereafter sunk. Potential entrants face uncertainty concerning their productivity in the industry. Once the sunk entry cost is paid, a firm draws its productivity from a fixed distribution. Productivity remains fixed thereafter, but firms face a constant exogenous probability of death. Firms produce horizontally differentiated varieties within the industry under conditions of monopolistic competition. The existence of fixed production costs implies that firms drawing a productivity level below some lower threshold (the "zero-profit productivity cutoff") would make negative profits if they produced, and therefore these firms choose to exit the industry. Fixed and variable costs of exporting ensure that, of the active firms in an industry, only those who draw a productivity above a higher threshold (the "export productivity cutoff") find it profitable to export in equilibrium. There is a steady-state mass of firms active in the industry, which implies that the mass of new firms who enter and draw a productivity level above the zero-profit productivity cutoff equals the mass of existing firms that die.

In this model, reductions in world-wide barriers to trade increase profits that existing exporters can earn in foreign markets and reduce the export productivity cutoff above which firms export. Labor demand within the industry rises, due both to expansion by existing exporters and to new firms beginning to export. This increase in labor demand bids up factor prices and reduces the profits of non-exporters. This reduction in profits in the domestic market induces some low-productivity firms who were previously marginal to exit the industry. As low-productivity firms exit, and as output and employment are reallocated towards higher-productivity firms, average industry productivity rises.

Heterogeneous-firm models address a number of the empirical challenges facing old and new trade theory. They capture the interaction between firm heterogeneity and international trade, with the productivity advantage of exporters explained by the self-selection of the most productive firms into exporting. The shift in resources from low- to high-productivity firms generates improvements in aggregate productivity. During this shift, exporters grow more rapidly than non-exporters in terms of size and employment. The models feature simultaneous job creation and job destruction within industries as low-productivity firms exit and high-productivity firms expand. In the models of Bernard et al. (2003) and Melitz and Ottaviano (2005), the mark-up of price over marginal cost is

[7] A related literature has concentrated on contracting issues and the international boundaries of the firm. See Helpman (2006) for a recent survey.

endogenous and decreases as import competition intensifies following reductions in trade costs.

Heterogeneous firms are integrated into the standard trade paradigm of Helpman and Krugman (1985) in Bernard, Redding and Schott (2007). The resulting framework explains why some countries export more in certain industries than in others (endowment-driven comparative advantage); why nonetheless two-way trade is observed within industries (firm-level horizontal product differentiation combined with increasing returns to scale); and why, within industries engaged in these two forms of trade, some firms export and others do not (self-selection driven by trade costs). Consistent with the empirical findings reported in Table 2, the fraction of exporting firms and the share of exports in firm shipments varies systematically across industries and countries with comparative advantage.

Although trade liberalization in this framework induces within-industry reallocation and raises aggregate productivity in all industries, productivity growth is stronger in the comparative advantage industry. The greater export opportunities in that industry lead to a larger increase in factor demand than in the comparative disadvantage industry, which bids up the relative price of the factor used intensively in the comparative advantage industry, and so leads to greater exit by low-productivity firms than in the comparative disadvantage industry. This differential productivity growth across industries gives rises to differences in average industry productivity that magnify factor-abundance-based comparative advantage, and so provide an additional source of welfare gains from trade.

Trade liberalization in this framework not only generates aggregate welfare gains but also has implications for the distribution of income across factors. Increases in average industry productivity arising from trade liberalization drive down goods prices and therefore raise the real income of all factors. If productivity increases are strong enough, the real income of a country's scarce factor may even rise during trade liberalization (a contradiction of the well-known Stolper-Samuelson theorem). More generally, the productivity gains induced by the behavior of heterogeneous firms dampen the decline of the real income of the scarce factor that occurs in more neoclassical settings.

New Transaction-Level Data on Firms and Trade

Recently available transaction-level trade data permit examination of a number of new dimensions of international trade, including the concentration and scarcity of firms' exports, the range of products that firms export, and the variety of destinations to which firms' exports are shipped. In this section we analyze the Linked-Longitudinal Firm Trade Transaction Database (LFTTD) that is based on data collected by the U.S. Census Bureau and the U.S. Customs Bureau. This dataset captures all U.S. international trade transactions between 1992 and 2000. For each flow of goods across a U.S. border, this dataset records the product classification(s) of the shipment, the value and quantity shipped, the date of the shipment, the destination or source country, the transport mode used to ship the goods, and the identity of the U.S. firm engaging in the trade. Bernard, Jensen, and Schott (forthcoming) provide a more detailed description of the LFTTD and its construction.

We use these data to distinguish between the firms' extensive margins – that is, the number of products that firms trade and their number of export destinations – and their intensive margin – that is, the value they trade per product per country. We show that adjustment along the extensive margins is central to understanding the well-known "gravity model" of international trade, which emphasizes the role of distance in dampening trade flows between countries. More generally, we find that while some aspects of the LFTTD illuminate directions in which recent theories of heterogeneous firms and trade can be extended, others pose additional challenges that have yet to be explored.

Trade is Concentrated

International trade is extremely concentrated across firms. In 2000, the top 1 percent of trading firms by value (that is, by the sum of imports plus exports) accounted for over 80 percent of the value of total trade, while the top 10 percent of trading firms accounted for over 95 percent of the value of total trade (Bernard, Jensen and Schott, forthcoming, Table 3). As a point of comparison, the employment shares of the top 1 and 10 percent of trading firms were 14 and 24 percent respectively.

Existing theories of heterogeneous firms and trade can explain this high concentration in two ways. The first possibility is that an extremely unequal distribution of productivity across firms leads to an accordingly unequal distribution of trade. The second possibility is based on a very high elasticity of substitution between firm varieties, so that small differences in productivity and prices lead to large differences in sales, as low-priced varieties are easily substitutable for high-priced varieties.

Alternative explanations for the concentration of trade involve relatively simple extensions of existing heterogeneous firm models. First, there may be economies of scale in overseas distribution and marketing that favor the concentration of trade among a small number of producers. Second, if there are sunk costs specific to individual destinations, and if destinations vary in terms of their profitability, relatively more productive exporters will export to more destinations. This expansion along the extensive margin of the number of destinations served leads to more inequality in export values than if the number of destinations per firm were constant. Third, if there are sunk costs specific to individual products, and if products vary in terms of their profitability for a firm, relatively more productive exporters will also export a wider range of products. This expansion along another extensive margin of the number of products will also magnify the inequality in export values. We present empirical evidence below on the importance of these two extensive margin expansions for individual firms and aggregate trade.

Trade is Even Scarcer Than Thought

Observed international trade flows are small relative to the levels predicted by both old and new trade theory. In old trade theory, the amount of trade predicted by cross-country differences in factor endowments is a good deal greater than observed values of trade, as Trefler (1995) points out in his analysis of the "mystery of the missing trade." In standard new trade theory models, all varieties are traded in equilibrium, a prediction that is at odds with the large number of zero bilateral trade flows observed in both aggregated and disaggregated trade data.[8] The absence of trade flows can be explained by old trade theory in terms of prohibitive trade costs and complete specialization. But these explanations are not fully persuasive and do not explain why, when positive trade occurs, some firms export while others do not.

The examination of firm-level data deepens the mystery of the missing trade. The average share of exports in firm output is well below the level predicted by standard new trade theory models. With no trade costs and identical and homothetic preferences, these models predict that the share of exports in firm output equals the share of the rest of the world in world GDP, a value substantially higher than those reported in Table 2. Similarly, the number of destination countries served by the average exporting firm is small. Table 4 shows that 64 percent of U.S. manufacturing firms that export do so to a single destination country

[8] As long as the demand for varieties is sufficiently strong (as with constant elasticity of substitution preferences), all varieties are traded in new trade theory models for any finite value of trade costs. For empirical evidence on the large number of zeros in bilateral trade flows, see Schott (2004) and Helpman, Melitz and Rubinstein (2007).

in 2000 (first column, top panel), though these exports represent just 3.3 percent of aggregate export value (first column, middle panel). By contrast, firms exporting to five or more destinations account for just 13.7 percent of exporters (fifth column, top panel), but 92.9 percent of export value (fifth column, middle panel). In recent work, Eaton, Kortum and Kramarz (2006) exploit variation in the number of destination countries served by French firms to estimate destination-specific fixed costs of exporting within a structural model of heterogeneous firms and trade.

Another message from Table 4 is the importance of multi-product exporters in overall U.S. exports. In 2000, 42.2 percent of firms exported a single product abroad (first row, top panel). Here, too, however, these exporters represented a small share of aggregate exports, just 0.4 percent (first row, middle panel). Firms exporting five or more products accounted for 25.9 percent of firms but 98 percent of export value (fifth row of top and middle panels, respectively).

These results provide support for some of the explanations for the concentration of trade advanced above. They reveal that the very small share of firms that dominate U.S. exports are large in part because they ship many products to many destinations. Indeed, across exporting firms in 2000, we find a positive and statistically significant correlation between the number of products that firms export and the number of countries they export to (correlation coefficient of 0.81, significant at the 1 percent level).

Neither old nor new trade theory includes consideration of these extensive margins of firm participation in export markets. Yet adjustment along these margins explains much of the variation in aggregate trade patterns. Furthermore, a firm's decision of the number of export destinations to serve and the number of products to export is systematically correlated with the characteristics of the firm, so that firm heterogeneity is again important for understanding aggregate trade outcomes. From Table 4, we see that firms that export to five or more destinations have employment levels five times larger than firms that export to a single destination (69.2 divided by 14.2 in the third panel), have export values that are 30 times greater (92.9 divided by 3.3 in the second panel), and hence have exports per worker that are around six times greater.

Multi-Product Firms and Exporting

One implication of Table 4 is that, when firms export, they typically export multiple products. Thus, in the year 2000, firms that export more than one ten-digit Harmonized System (HS) product comprise 58 percent of exporting firms and account for more than 99 percent of export value. Since firm output equals the number of products (the extensive margin) times average output per product (the intensive margin), the differences in size between exporters and non-exporters noted earlier can be broken down into these two margins.

The first column of Table 5 reports the results of two regressions using the 1997 Census of Manufactures. As in Table 3 earlier, the dependent variables are listed in the left-hand column. These variables are the number of five-digit SIC products that firms produced and total firm shipments divided by the number of products produced. The explanatory variable is a dummy variable indicating whether the firm is an exporter. Since the dependent variables are measured in logs, the coefficient on the explanatory variable can be interpreted as a percentage difference between exporter and non-exporters. Thus, manufacturing firms that export in 1997 produce 23 percent more five-digit SIC products and ship 125 percent more per product.

The second column of Table 5 adds industry fixed effects to the explanatory variables. Manufacturing firms that export now produce an average of 27 percent more products than non-exporters in the same industry, while their average shipments per product are more than 73 percent larger.

Existing trade theories yield few clear predictions for the determinants of how many products a firm will produce and export. In standard old trade theory models, which are based on the assumptions of constant returns to scale and perfect competition, firm boundaries and number of products are indeterminate. New trade theories typically assume that firms produce only a single, horizontally differentiated variety. Similarly, most models of heterogeneous firms and trade assume that each firm produces a single variety.

More recently, theoretical research has begun to explore models in which heterogeneous firms produce multi-products. These models find that trade liberalization induces endogenous changes in firm scope; for example, leading firms to drop marginal products to focus on their "core competencies."[9]

As noted earlier, empirical studies of trade liberalization demonstrate the importance of firm entry and exit in spurring a reallocation of economic resources across firms as trade barriers fall. However, because surviving firms can enter and exit individual product markets, this focus on the creation and destruction of firms may understate the true extent of reallocation following trade liberalization.

Evidence supporting the significance of within-firm reallocation in driving aggregate output growth is provided by Bernard, Redding and Schott (2006a), who find that net product adding and dropping by surviving firms accounts for roughly one-third of aggregate U.S. manufacturing growth between 1972 and 1997, a contribution that dwarfs that of firm entry and exit. Together with the positive correlations observed between the number of products firms export, exports per product and total exports of the firm, these findings suggest that more attention should be paid to the interaction of international trade and firm scope.

Gravity Reconsidered

The "gravity equation" for bilateral trade flows is one of the most successful empirical relationships in international economics. Early research on the gravity equation supposed that the aggregate value of trade between a pair of countries was proportional to the product of their incomes and inversely related to the distance between them. Subsequent research has considered a wide range of other variables that may influence bilateral trade and developed micro-foundations. The micro-founded formulations of the gravity equation control not only for bilateral frictions between trade partners but also multilateral frictions with all trade partners.

Despite this extensive body of research, empirical and theoretical work with a gravity equation typically concentrates on the aggregate value of trade and ignores the roles of firms and products. In this section, we use a basic gravity equation to examine whether the effect of distance on bilateral trade operates through the extensive margin (the number of firms and the number of products) or the intensive firm (value per product per firm).

We decompose the aggregate value of U.S. exports to a particular destination into three factors: the contribution of the number of firms exporting to the destination; the number of products exported to the destination; and the average value of exports per product per firm. This last term, the average value of exports per product per firm, will depend on both the prices charged for the products and the quantities shipped.

To examine whether the effect of distance on bilateral trade flows operates through firm participation, the number of products exported or the average value of a product exported by

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[9] In a series of recent working papers, Bernard, Redding and Schott (2006b), Eckel and Neary (2006) and Nocke and Yeaple (2006) provide theoretical analyses of multiple-product trading firms.

a firm, we estimate gravity equations for the aggregate value of exports and each of these three components.

In gravity equations, it is typical to have data on many different pairs of trading partners and include both exporter and importer income in the regression. But since our data are for a single exporting country (the United States), exporter income is captured in the regression constant and only importer income is included in the regression. Thus, our explanatory variables in these regressions are a constant term, the log of the distance from the U.S. to the destination and the log of the importer's GDP, along with an error term. Our dependent variables are the log of the aggregate value of exports and the log of each of its three components: the number of firms exporting to a destination, the number of products exported to that destination, and average exports per product per firm. Estimation is by ordinary least squares.

Table 6 reports the results. Since the dependent and explanatory variables are in logarithms, the estimated coefficients correspond to elasticities. Aggregate exports are the dependent variable in the first column, and the coefficients confirm that that trade is increasing in destination GDP and sharply decreasing in distance. The next three columns provide estimates for the extensive and intensive margins of adjustment. Since the three remaining columns combine to make up aggregate exports, by the properties of ordinary least squares, the sums of the coefficients across the three components equal those for the aggregate value of exports.

Both the number of exporting firms and the number of exported products are sharply decreasing in the distance to the destination country and increasing in importer income. In contrast, the average export value is increasing in distance and decreasing in importer income. The elasticities on the two extensive margins – number of firms and number of products – are larger in absolute value than for the intensive margin of average export value, particularly for the coefficient on importer income.[10]

This pattern of estimated coefficients contrasts starkly with the predictions of new trade theories. In these models, consumer love of variety implies that all varieties are traded in equilibrium, and so as trade costs increase with distance, all of the adjustment in the aggregate value of trade occurs through the intensive margin. Recent theories of heterogeneous firms and trade, on the other hand, do provide a theoretical rationale for the relationship between firm export participation and distance: as trade costs increase with distance, lower-productivity firms no longer find it profitable to serve export markets. These theories also explain the relationship between firm export participation and income: as the size of the foreign market increases, firms of lower productivity find it profitable to incur the fixed costs of exporting. However, as noted above, these theories yield few predictions for the number of products exported per firm due to the embedded assumption that firms produce only a single differentiated variety.

Our findings suggest that aggregate trade relationships are heavily influenced by extensive-margin adjustments both in terms of the number of destinations and the number of exported products. The finding that the intensive margin – the average value of exports per product per firm – is increasing in distance and decreasing in importer income is at first sight puzzling. One potential explanation involves the idea that costs of exporting depend on quantity or weight rather than value (for example, the costs of exporting depend on the number of bottles of wine rather than the quality of their contents). In this case, increases in distance or reductions in importer income may lead to a change in the composition of exports towards higher-value commodities, for which it is profitable to incur the fixed and variable

[10] Hummels and Hillberry (2005), using data on commodity shipments across localities within the United States, also find that the extensive margin accounts for much of the impact of distance on trade.

trade costs of servicing the remote and small foreign market. The differences in value-to-weight ratio across commodities may in turn be explained by differences in their quality, an idea to which we will return below. If the change in composition towards higher-value commodities is sufficiently large, the average value of exports per product per firm may be increasing in distance and decreasing in importer income.[11]

Importing and Exporting

The empirical literature on firms in international trade has been concerned almost exclusively with exporting, largely due to limitations in datasets based on censuses of domestic production or manufacturing. As a result, the new theories of heterogeneous firms and trade were developed to explain facts about firm export behavior and yield few predictions (if any) for firm import behavior. In most models, consumers purchase imports directly from foreign firms and no intermediate inputs exist – that is, firms themselves do not import.

With the development of transactions-level trade data, information on direct firm imports is now available.[12] The data on firm imports display many of the same features as those on firm exports. As summarized in Table 7, firm importing is relatively rarer than firm exporting, though it also varies systematically across industries. Looking across industries, there is a strong correlation (0.87) between industries with high shares of importing firms and those with high shares of exporters. Forty-one percent of exporting firms also import while 79 percent of importers also export. We also find that the share of export-only firms is positively and significantly correlated with industry skill intensity, while the share of import-only firms is negatively but not significantly correlated with industry skill intensity.

In Table 8 we compare the characteristics of exporting and importing firms. The firm characteristics data are from the Census of Manufactures, the identification of exporting and importing comes from the customs-documents-based LFTTD. Again, we use illustrative regressions. The variables listed on the left are the dependent variables in these regressions. In the first column, the regression includes a dummy variable for whether the firm is an exporter or not, along with variables controlling for industry fixed effects and for size of employment. (Of course, the first row omits the size of employment control variable.) The second column carries out a parallel set of regressions, except that in this case a dummy variable for whether the firm is an importer replaces the exporter variable. The final column instead includes a dummy variable for firms that are both exporters and importers.

Firms that are exporters share a variety of positive attributes with firms that are importers. They are both bigger, more productive, pay higher wages and are more skill- and capital-intensive than non-exporters and non-importers. Again, these results suggest that firm characteristics are systematically related to participation in international trade, whether importing and exporting. Reductions in trade costs are likely to benefit the largest, most productive, most skill- and capital-intensive firms in any given sector, both because they export and because they import.

One possible explanation for the presence of importing in all manufacturing industries, for the correlation between importing and exporting, and hence for the similarity of importer and exporter premia, is the "international fragmentation of production," where stages of production are spread across national boundaries. This practice is also referred as "offshoring" or "slicing the value-added chain." If some stages of production are undertaken abroad, while others occur at home, firms will both import and export, since components and

[11] These ideas relate to the so-called "Alchian-Allen hypothesis" that goods exported are on average of higher quality than those sold domestically (Hummels and Skiba, 2004).
[12] Firms may also import *indirectly* by purchasing inputs that have been imported by domestic wholesalers. Indirect importing is not observed in the LFTTD.

final products are shipped between countries. Moreover, as a firm's volume of production increases, the level of activity at each stage of production rises, giving rise to a positive correlation between firm imports and exports.[13]

In the same way that the aggregate value of exports to a destination can be decomposed into the number of firms, the number of products and average exports per product per firm, the aggregate value of imports from a source can be similarly decomposed. We assess the importance of the extensive margins of the number firms and number of products for understanding variation in aggregate imports by estimating gravity equation regressions for aggregate imports and each of its components, as reported in Table 9. Following the pattern established earlier in Table 6, the first column uses aggregate imports as the dependent variable, while the explanatory variables include a constant term, the log GDP of the source country and the log distance to the source country. The remaining three columns break down aggregate imports into its three components, and run separate regressions for each.

As with exports, the aggregate value of imports is decreasing in distance and increasing in source country income. Similarly, the extensive margins of the number of firms and number of products again dominate the intensive margin of average value per product per firm, with the difference particularly apparent for source country income. While the number of firms and the number of products are decreasing in distance and increasing in source country income, the average value per product per firm is again increasing in distance (though the coefficient is not statistically significant for imports) and decreasing in source country income, again suggesting the potential importance of product quality considerations. One notable feature of the results is that the magnitude of the coefficients on distance is quite different for imports and exports.

Vertical Differentiation

Much of the research on new and heterogeneous-firm theories of international trade has emphasized the horizontal differentiation of varieties. But analysis of U.S. imports reveals that a substantial number of import products originate in countries with very dissimilar relative endowments. This fact holds for narrowly-defined products, such as those of the ten-digit Harmonized System (HS) classification, of which there are roughly 10,000 categories (for example, men's cotton shirts).

This fact is at first sight consistent with the idea that countries export unique horizontal varieties. However, the data also show that prices within product categories vary substantially and systematically across countries, with imports from capital- and skill-abundant countries generally commanding much higher prices than imports from labor-abundant countries (for example, Schott, 2004; Hummels and Klenow, 2005; Hallak, 2006; Hallak and Schott, 2006). For example, Schott (2004) finds that across all U.S. manufacturing imports in 1994, the median ratio of high to low unit values was 24. This price variation suggests the importance of vertical differentiation, with higher prices reflecting in part higher product quality.

The relationship between export prices and exporter relative endowments echoes a key implication of old trade theory, albeit one working at a much more disaggregate level within narrow products rather than across broad industries. These findings are consistent with the idea that developed countries use their endowment advantage to produce high unit-value, high-quality varieties even within narrow product categories.

[13] For further discussion of the decision whether to offshore stages of production, see the literature on contracting and the boundaries of the firm reviewed in Helpman (2006).

Product quality was first emphasized in international trade by Linder (1961), who argued that wealthy countries have both a higher taste for quality and, given their firms' proximity to relatively wealthy customers, a comparative advantage in producing it. Product quality is also central to theories of product cycles following Vernon (1966), where the most advanced products are produced by developed economies until they are successfully copied and taken over by developing economies, where production costs are lower. Recent empirical research using firm-level data suggests that countries' movement through product cycles may take place within continuing firms. Bernard, Jensen and Schott (2006b), for example, find that U.S. manufacturing plants in industries with relatively high exposure to low-wage country imports systematically switch into industries facing less exposure. They also show that plants' survival within industries is associated positively with plants' capital intensity. These results suggest that U.S. manufacturing firms escape competition with low-wage countries by upgrading their mix of products to one that is more consistent with U.S. comparative advantage.

Conclusions and Future Prospects

Research in both theoretical and empirical international trade increasingly focuses on firms and products in addition to their traditional focus on countries and industries. This shift in emphasis is driven by a wealth of evidence indicating that firms that trade differ substantially from those that do not, and that these differences have important consequences for evaluating the gains from trade and their distribution across factors of production. Some of these consequences complement traditional insights; others are new. Though the most recent theories of international trade have made substantial progress in explaining patterns of trade and productivity growth by incorporating the behavior of heterogeneous firms, much remains unexplained.

Relatively little theoretical research examines how firms determine the range of products they will export and import or the breadth of countries they will export to or import from – or how any of these margins are influenced by globalization. Yet these margins of trade appear to be central to understanding the role of distance in dampening aggregate trade flows and the empirical success of the gravity equation. Further progress in this area is will likely require explicit consideration of the boundaries of the firm, including the decisions about whether to insource or outsource stages of production, and whether such insourcing or outsourcing takes place within or across national boundaries. Specialization and reallocation within the firm may turn out to play an important role in enhancing productivity and realizing welfare gains from trade. As the conversation between empirical and theoretical research progresses, our understanding of the micro-foundations of international trade will no doubt deepen.

References

Alvarez, Roberto, and Ricardo A. López, (2005) "Exporting and Performance: Evidence from Chilean Plants", Canadian Journal of Economics, 38(4), 1384-1400.

Bernard, Andrew B. and J. Bradford Jensen (1995) "Exporters, Jobs, and Wages in US Manufacturing: 1976-87", Brookings Papers on Economic Activity: Microeconomics, 67-112.

Bernard, Andrew B. and J. Bradford Jensen (1999) "Exceptional Exporter Performance: Cause, Effect, or Both?", Journal of International Economics, 47(1), 1-25.

Bernard, Andrew B., and J. Bradford Jensen, (2007) "Firm Structure, Multinationals, and Manufacturing Plant Deaths", Review of Economics and Statistics, 89(1): 1-11.

Bernard, Andrew B., Jonathan Eaton, J. Bradford Jensen, and Samuel S. Kortum, (2003) "Plants and Productivity in International Trade", American Economic Review, 93(4), 1268-1290.

Bernard, Andrew B., J. Bradford Jensen and Peter K. Schott, (forthcoming) "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods", in T. Dunne, J.B. Jensen and M.J. Roberts (eds.), Producer Dynamics: New Evidence from Micro Data (University of Chicago Press, forthcoming)

Bernard, Andrew B., J. Bradford Jensen and Peter K. Schott, (2006a) "Trade Costs, Firms and Productivity", Journal of Monetary Economics 53(5).

Bernard, Andrew B., J. Bradford Jensen and Peter K. Schott, (2006b) "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of US Manufacturing Plants", Journal of International Economics 68, 219-237.

Bernard, Andrew B., Redding, Stephen J and Peter K. Schott (2006a) "Multi-product Firms and Product Switching", NBER Working Paper, #12293.

Bernard, Andrew B., Redding, Stephen J and Peter K. Schott (2006b) "Multi-product Firms and Trade Liberalization", NBER Working Paper, 12782.

Bernard, Andrew B., Redding, Stephen J. and Peter K. Schott (2007) "Comparative Advantage and Heterogeneous Firms", Review of Economic Studies, 74, 31-66.

Caves, D., Christensen, L. and Diewert, E. (1982) "The Economic Theory of Index Numbers and the Measurement of Input, Output and Productivity", Econometrica, 50, 6, 1393-1414.

Clerides, Sofronis, Saul Lach, and James Tybout, (1998) "Is Learning by Exporting Important? Micro-dynamic Evidence from Columbia, Mexico and Morocco", Quarterly Journal of Economics, 113, 903-47.

Das, Sanghamitra, Mark Roberts and James Tybout (2006) "Market Entry Costs, Producer Heterogeneity and Export Dynamics", *Econometrica*, forthcoming.

Eaton, Jonathan and Kortum, Samuel (2002) "Technology, Geography, and Trade," Econometrica, 70(5), 1741-1779.

Eaton, Jonathan, Samuel Kortum and Francis Kramarz (2006) "An Anatomy of International Trade: Evidence from French Firms", University of Minnesota, mimeograph.

Eckel, Carsten and Neary, Peter (2006) "Multi-Product Firms and Flexible Manufacturing in the Global Economy", CEPR Discussion Paper, 5941.

Ethier, William J., (1982), 'National and International Returns to Scale in the Modem Theory of International Trade,' American Economic Review, 72,389-405.

Grubel, Herbert G. and Peter J. Lloyd (1975) Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products, London.

Hallak, Juan Carlos (2006) "Product Quality and the Direction of Trade", Journal of International Economics, 68 (1), 238-265.

Hallak, Juan Carlos and Peter K. Schott (2006) "Estimating Cross-Country Differences in Product Quality", Yale University, mimeograph.

Helpman, Elhanan, (1981) "International Trade in the Presence of Product Differentiation, Economies of Scale, and Monopolistic Competition: A Chamberlin-Heckscher-Ohlin model," Journal of International Economics, 11, 305-340.

Helpman, Elhanan and Paul Krugman, (1985) Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition and the International Economy, MIT Press, Cambridge, MA.

Helpman, Elhanan (1999) "The Structure of Foreign Trade", Journal of Economic Perspectives, 13(2), 121-44.

Helpman, Elhanan (2006) "Trade, FDI and the Organization of Firms", Journal of Economic Literature, XLIV, 589-630.

Helpman, Elhanan, Marc Melitz and Yona Rubinstein (2007) "Estimating Trade Flows: Trading Partners and Trading Volumes", Harvard University, mimeograph.

Hummels, David and Hillberry, Russell (2005) "Trade Responses to Geographic Frictions: A Decomposition Using Micro-Data", NBER Working Paper, #11339.

Hummels, David and Peter Klenow (2005) "The Variety and Quality of a Nation's Exports", American Economic Review, 95, 704-723.

Hummels, David and Skiba, Alexander (2004) "Shipping the Good Apples Out: An Empirical Confirmation of the Alchian-Allen Conjecture," Journal of Political Economy, 112, 1384-1402.

Krugman, Paul (1980) "Scale Economies, Product Differentiation, and the Pattern of Trade", American Economic Review, 70, 950-59.

Linder, Staffan Burenstam (1961) An Essay on Trade and Transformation, New York: Wiley & Sons.

Melitz, M. (2003) "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity", Econometrica, 71, 1695-1725.

Melitz, M and Ottaviano, G (2005) "Market Size, Trade, and Productivity," NBER Working Paper, #11393.

Nocke, Volker and Yeaple, Stephen (2006) "Globalization and Endogenous Firm Scope", NBER Working Paper, 12322.

Pavcnik, Nina (2002) "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants", Review of Economic Studies, 69(1), 245-76.

Roberts, Mark J. and James Tybout, (1997) "The Decision to Export in Colombia: An Empirical Model of Entry with Sunk Costs", American Economic Review, 87(4), 545-64.

Schott, Peter K. (2004) "Across-Product versus Within-Product Specialization in International Trade", Quarterly Journal of Economics, 119(2), 647-678.

Trefler, D. (1995) "The Case of the Missing Trade and Other Mysteries," American Economic Review , 85(5), 1029-46.

Trefler, Daniel (2004) "The Long and Short of the Canada-U.S. Free Trade Agreement", American Economic Review, 94, 870-895.

Tybout, J (2003) "Plant- and Firm-Level Evidence on the `New' Trade Theories", Chapter 13, in (eds) E. Kwan Choi and James Harrigan, Handbook of International Trade, Basil Blackwell: Oxford.

Van Biesebroeck, Johannes (2005) "Exporting Raises Productivity in Sub-Saharan African Manufacturing Firms", Journal of International Economics, 67 (2), 373-391.

Vernon, Raymond (1966) "International Investment and International Trade in the Product Cycle", Quarterly Journal of Economics, 80, 190-207.

Table 1: Trade Theories and Their Ability to Explain Stylized Facts about Trade

	Theory				
	"Old" Trade Theory	"New" Trade Theory	Integrated Model	Heterogeneous Firms	"Integrated" Heterogeneous Firms
Stylized Facts	Ricardo (1817), Heckscher (1919), Ohlin (1933)	Krugman (1980)	Helpman and Krugman (1985)	Melitz (2003), Bernard et al. (2003)	Bernard, Redding and Schott (2007)
Trade					
Inter-industry Trade	Yes	No	Yes	No	Yes
Intra-industry Trade	No	Yes	Yes	Yes	Yes
Exporters and non-exporters within industries	No	No	No	Yes	Yes
Trade and Productivity					
Exporters are more productive than non-exporters within industries	No	No	No	Yes	Yes
Trade liberalization raises industry productivity through reallocation	No	No	No	Yes	Yes
Trade and Labor Markets					
Net changes in employment across industries following trade liberalization	Yes	No	Yes	No	Yes
Simultaneous gross job creation and destruction within industries following trade liberalization	No	No	No	Yes	Yes
Trade liberalization affects relative factor rewards (income distribution)	Yes	No	Yes	No	Yes

Notes: inter-industry trade occurs when a country exports in one set of industries and imports in another set of industries; intra-industry trade occurs when there is two-way exporting and importing within the same industry.

Table 2: Exporting By U.S. Manufacturing Firms, 2002

NAICS Industry		Percent of Firms	Percent of Firms that Export	Mean Exports as a Percent of Total Shipments
311	Food Manufacturing	6.8	12	15
312	Beverage and Tobacco Product	0.7	23	7
313	Textile Mills	1.0	25	13
314	Textile Product Mills	1.9	12	12
315	Apparel Manufacturing	3.2	8	14
316	Leather and Allied Product	0.4	24	13
321	Wood Product Manufacturing	5.5	8	19
322	Paper Manufacturing	1.4	24	9
323	Printing and Related Support	11.9	5	14
324	Petroleum and Coal Products	0.4	18	12
325	Chemical Manufacturing	3.1	36	14
326	Plastics and Rubber Products	4.4	28	10
327	Nonmetallic Mineral Product	4.0	9	12
331	Primary Metal Manufacturing	1.5	30	10
332	Fabricated Metal Product	19.9	14	12
333	Machinery Manufacturing	9.0	33	16
334	Computer and Electronic Product	4.5	38	21
335	Electrical Equipment, Appliance,	1.7	38	13
336	Transportation Equipment	3.4	28	13
337	Furniture and Related Product	6.4	7	10
339	Miscellaneous Manufacturing	9.1	2	15
Aggregate Manufacturing		100	18	14

Notes: Data are from the 2002 U.S. Census of Manufactures. Column 2 summarizes the distribution of manufacturing firms across three-digit NAICS manufacturing industries. Column 3 reports the share of firms in each industry that export. The final column reports mean exports as a percent of total shipments across all firms that export in the noted industry.

Table 3: Exporter Premia in U.S. Manufacturing, 2002

	Exporter Premia		
	(1)	(2)	(3)
Log Employment	1.19	0.97	.
Log Shipments	1.48	1.08	0.08
Log Value Added per Worker	0.26	0.11	0.10
Log TFP	0.02	0.03	0.05
Log Wage	0.17	0.06	0.06
Log Capital per Worker	0.32	0.12	0.04
Log Skill per Worker	0.19	0.11	0.19
Additional Covariates	None	Industry Fixed Effects	Industry Fixed Effects, Log Employment

Notes: Notes: Data are for 2002 and are from the U.S. Census of Manufactures. All results are from bivariate OLS regressions of firm characteristic in first column on a dummy variable indicating firm's export status. Columns two and three include industry fixed effects and industry fixed effects plus log firm employment, respectively, as additional controls. Total factor productivity (TFP) is computed as in Caves et al (1982). Capital and skill per worker are capital stock and non-production workers per total employment, respectively. All results are significant at the 1 percent level.

Table 4
Distribution of Exporters and Export Value by Number of Products and Export Destinations, 2000

Share of Exporting Firms

Number of Products	Number of Countries: 1	2	3	4	5+	All
1	40.4	1.2	0.3	0.1	0.2	42.2
2	10.4	4.7	0.8	0.3	0.4	16.4
3	4.7	2.3	1.3	0.4	0.5	9.3
4	2.5	1.3	1.0	0.6	0.7	6.2
5+	6.0	3.0	2.7	2.3	11.9	25.9
All	64.0	12.6	6.1	3.6	13.7	100

Share of Export Value

Number of Products	Number of Countries: 1	2	3	4	5+	All
1	0.20	0.06	0.02	0.02	0.07	0.4
2	0.19	0.12	0.04	0.03	0.15	0.5
3	0.19	0.07	0.05	0.03	0.19	0.5
4	0.12	0.08	0.08	0.04	0.27	0.6
5+	2.63	1.23	1.02	0.89	92.2	98.0
All	3.3	1.5	1.2	1.0	92.9	100

Share of Employment

Number of Products	Number of Countries: 1	2	3	4	5+	All
1	7.0	0.0	0.0	0.0	0.0	7.1
2	1.9	2.6	0.1	0.0	0.0	4.6
3	1.3	1.0	0.8	0.0	0.2	3.3
4	0.5	0.4	0.3	0.2	0.2	1.6
5+	3.5	2.6	4.3	4.1	68.8	83.3
All	14.2	6.7	5.5	4.3	69.2	100

Notes: Data are from the 2000 LFTTD. Table displays the joint distribution of U.S. manufacturing firms that export (top panel), their export value (middle panel) and their employment (bottom panel), according to the number of products firms export (rows) and their number of export destinations (columns). Products are defined as ten-digit Harmonized System categories.

Table 5
The Intensive and Extensive Margins of Exporters, 2002

	Exporter Premia	
	(1)	(2)
Log Number of Products	0.23	0.27
Log Mean Shipments/Product	1.25	0.73
Additional Covariates	None	Industry Fixed Effects

Notes: Notes: Data are for 1997 and are from the U.S. Census of Manufactures. All results are from bivariate OLS regressions of firm characteristic in first column on a dummy variable indicating firm's export status. Column two includes four-digit SIC industry fixed effects. First dependent variable is the number of five-digit SIC products produced by the firm in 1997. Second dependent variable is total firm shipments divided by the number of products. All results are significant at the 1 percent level.

Table 6: Gravity and Aggregate U.S. Exports, 2000

	Total Export Value	Number of Exporting Firms	Number of Exported Products	Export Value per Product per Firm
GDP_{ct}	0.98 ***	0.71 ***	0.52 ***	-0.25 ***
	0.04	0.04	0.03	0.04
$Distance_{ct}$	-1.36 ***	-1.14 ***	-1.06 ***	0.84 ***
	0.17	0.16	0.15	0.19
Observations	175	175	175	175
R^2	0.82	0.74	0.64	0.25

Notes: Data are from the 2000 LFFTD. Each column reports the results of a country-level OLS regression of dependent variable noted at the top of each column on the covariates noted in the first column. Results for constant are suppressed. Standard errors are noted below each coefficient. *, ** and *** represent statistical significance at the 10, 5 and 1 percent level, respectively. Products are defined as ten-digit Harmonized System categories.

Table 7
Exporting and Importing by U.S. Manufacturing Firms, 1997

NAICS Industry	Percent of All Firms	Percent of Firms that Export	Percent of Firms that Import	Percent of Firms that Import & Export
311 Food Manufacturing	7	17	10	7
312 Beverage and Tobacco Product	1	28	19	13
313 Textile Mills	1	47	31	24
314 Textile Product Mills	2	19	13	9
315 Apparel Manufacturing	6	16	15	9
316 Leather and Allied Product	0	43	43	30
321 Wood Product Manufacturing	5	15	5	3
322 Paper Manufacturing	1	42	18	15
323 Printing and Related Support	13	10	3	2
324 Petroleum and Coal Products	0	32	17	14
325 Chemical Manufacturing	3	56	30	26
326 Plastics and Rubber Products	5	42	20	16
327 Nonmetallic Mineral Product	4	16	11	7
331 Primary Metal Manufacturing	1	51	23	21
332 Fabricated Metal Product	20	21	8	6
333 Machinery Manufacturing	9	47	22	19
334 Computer and Electronic Product	4	65	40	37
335 Electrical Equipment, Appliance,	2	58	35	30
336 Transportation Equipment	3	40	22	18
337 Furniture and Related Product	6	13	8	5
339 Miscellaneous Manufacturing	7	31	19	15
Aggregate Manufacturing	100	27	14	11

Notes: Data are for 1997 and are for firms that appear in both the U.S. Census of Manufacturers and the LFTTD. Column 2 summarizes the distribution of manufacturing firms across three-digit NAICS industries. Remaining columns report the percent of firms in each industry that export, import and do both.

Table 8
Trading Premia in U.S. Manufacturing, 1997

	Exporter Premia	Importer Premia	Exporter & Importer Premia
Log Employment	1.50	1.40	1.75
Log Shipments	0.29	0.26	0.31
Log Value Added per Worker	0.23	0.23	0.25
Log TFP	0.07	0.12	0.07
Log Wage	0.29	0.23	0.33
Log Capital per Worker	0.17	0.13	0.20
Log Skill per Worker	0.04	0.06	0.03

Notes: Data are for 1997 and are for firms that appear in both the U.S. Census of Manufacturers and the LFTTD. All results are from bivariate OLS regressions of firm characteristic in first column on dummy variable noted at the top of each column as well as industry fixed effects and firm employment as additional controls. Employment regressions omit firm employment as a covariate. Total factor productivity (TFP) is computed as in Caves et al (1982). Capital and skill per worker are capital stock and non-production workers per total employment, respectively. All results are significant at the 1 percent level.

Table 9: Gravity and Aggregate U.S. Imports, 2000

	Total Import Value	Number of Importing Firms	Number of Imported Products	Import Value per Product per Firm
GDP_{ct}	1.14 ***	0.82 ***	0.71 ***	-0.39 ***
	0.06	0.03	0.03	0.05
$Distance_{ct}$	-0.73 ***	-0.43 ***	-0.61 ***	0.31
	0.27	0.15	0.15	0.24
Observations	175	175	175	175
R^2	0.69	0.78	0.74	0.25

Notes: Data are from the 2000 LFFTD. Each column reports the results of a country-level OLS regression of dependent variable noted at the top of each column on the covariates noted in the first column. Results for constant are suppressed. Standard errors are noted below each coefficient. *, ** and *** represent statistical significance at the 10, 5 and 1 percent level, respectively. Products are defined as ten-digit Harmonized System categories.

Appendix Table A1: Exporting By U.S. Manufacturing Plants, 2002

NAICS Industry	Percent of Plants	Percent of Plants that Export	Mean Exports as a Percent of Total Shipments
311 Food Manufacturing	7.5	15	15
312 Beverage and Tobacco Product	0.8	21	9
313 Textile Mills	1.1	27	14
314 Textile Product Mills	1.7	14	11
315 Apparel Manufacturing	2.7	8	14
316 Leather and Allied Product	0.3	24	15
321 Wood Product Manufacturing	5.2	10	17
322 Paper Manufacturing	2.1	28	9
323 Printing and Related Support	10.1	6	13
324 Petroleum and Coal Products	1.0	12	13
325 Chemical Manufacturing	4.5	35	16
326 Plastics and Rubber Products	5.3	30	11
327 Nonmetallic Mineral Product	5.8	9	13
331 Primary Metal Manufacturing	1.8	33	11
332 Fabricated Metal Product	17.8	16	12
333 Machinery Manufacturing	8.7	36	16
334 Computer and Electronic Product	4.6	40	23
335 Electrical Equipment, Appliance,	1.9	41	13
336 Transportation Equipment	3.8	34	14
337 Furniture and Related Product	5.4	8	9
339 Miscellaneous Manufacturing	7.8	19	15
Aggregate Manufacturing	100	20	15

Notes: Data are from the 2002 U.S. Census of Manufactures. Column 2 summarizes the distribution of manufacturing plants across three-digit NAICS manufacturing industries. Column 3 reports the share of plants in each industry that export. The final column reports mean exports as a percent of total shipments across all plants that export in the noted industry.

Appendix Table A2: Plant-Level Exporter Premia in US Manufacturing, 2002

	Exporter Premia		
	(1)	(2)	(3)
Log Employment	1.20	0.91	.
Log Shipments	1.53	1.05	0.11
Log Value Added per Worker	0.28	0.14	0.13
Log TFP	0.02	0.03	0.04
Log Wage	0.18	0.07	0.06
Log Capital per Worker	0.41	0.20	0.13
Log Skill per Worker	0.13	0.08	0.17
Additional Covariates	None	Industry Fixed Effects	Industry Fixed Effects, Log Employment

Notes: Notes: Data are for 2002 and are from the U.S. Census of Manufactures. All results are from bivariate OLS regressions of plant characteristic in first column on a dummy variable indicating plant's export status. Columns two and three include industry fixed effects and industry fixed effects plus log plant employment, respectively, as additional controls. Total factor productivity (TFP) is computed as in Caves et al (1982). Capital and skill per worker are capital stock and non-production workers per total employment, respectively. All results are significant at the 1 percent level.