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Global Firms

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Abstract
Research in international trade has changed dramatically over the last twenty years, as attention has shifted from countries and industries towards the firms actually engaged in international trade. The now-standard heterogeneous firm model posits a continuum of firms that compete under monopolistic competition (and hence are measure zero) and decide whether to export to foreign markets. However, much of international trade is dominated by a few "global firms," which participate in the international economy along multiple margins and are large relative to the markets in which they operate. We outline a framework that allows firms to be of positive measure and to decide simultaneously on the set of production locations, export markets, input sources, products to export, and inputs to import. We use this framework to interpret features of U.S. firm and trade transactions data and highlight interdependencies across these margins of firm international participation. Global firms participate more intensively along each margin, magnifying the impact of underlying differences in firm characteristics, and explaining their dominance of aggregate international trade.

Keywords: firm heterogeneity, international trade, multinationals, multi-product firms
JEL codes: L11; L21; L25; L60

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1 Introduction

Research in international trade has changed dramatically over the last twenty years, as attention has shifted from countries and industries towards firms. An initial wave of empirical research exploring newly available administrative data established a series of stylized facts: only some firms export, exporters are more productive than non-exporters, and trade liberalization is accompanied by an increase in aggregate industry productivity. Subsequent theoretical research emphasized reallocation of resources within and across firms as well as endogenous changes in firm productivity in a setting where measure zero firms compete under monopolistic competition and self-select into export markets (e.g., Melitz (2003)).

In this paper, we review this research and argue that this standard paradigm does not go far enough in recognizing the role of individual firms. In particular, we use U.S firm and trade transactions data to show that aggregate trade is dominated by a few "global firms," which we define as firms that both participate in the international economy along multiple margins and are large relative to the markets in which they operate. We outline a theoretical framework that incorporates these features of the data. The framework explicitly recognizes that such large global firms can internalize the effects of their pricing and product introduction decisions on market aggregates. We include a much richer range of margins along which firms can participate in international markets than the standard paradigm. Each firm can choose the set of production locations in which to operate plants; the set of export markets for each plant; the set of products to export from each plant to each market; the exports of each product from each plant to each market; the set of countries from which to source intermediate inputs for each plant; and imports of each intermediate input from each source country by each plant. Despite this rich range of firm margins, our framework permits a relatively tractable characterization of the firm's problem, which we use to structure our interpretation of the data.

Focusing on global firms yields a number of new insights useful for understanding trade flows and the impact of trade liberalization on welfare. The first insight is *interdependence* in firm decisions for each margin of participation in the international economy. For example, importing decisions are interdependent across source countries, because the decision to incur the fixed costs of sourcing inputs from one country gives the firm access to lower-cost suppliers, which reduces firm production costs and prices. These lower prices in turn imply a larger scale of operation, which makes it more likely that the firm will find it profitable to incur the fixed costs of sourcing inputs from other countries. Exporting and importing decisions are also interdependent, because incurring the fixed exporting cost for an additional market increases firm output, which makes it more likely that the firm will find it profitable to incur the fixed cost of sourcing inputs from any given country. Extensive and intensive margin decisions are related to one another, because choices of the set of markets to serve, the set of products to export, and the set of countries from which to source inputs (the extensive margins) affect production costs and prices, and hence influence exports of each product to each market and imports of each input from each source country (the intensive margins). This interdependence implies that understanding the effects of reductions in trade costs on any one margin (e.g. firm exports) requires taking into account its effects through all other margins (e.g. firm imports).

The second insight is the *magnification* of the effects of differences in exogenous primitives (e.g. exogenous components of firm productivity) on endogenous outcomes (e.g. firm sales and employment). More productive firms participate more intensively in international markets along each margin. Therefore small differences in firm productivity can have magnified consequences for firm sales and employment, as more productive firms lower their production costs by sourcing inputs from more countries and expand their scale of operation by exporting more products to each market and exporting to more markets. Similarly, there is the potential for small changes in exogenous trade costs to have magnified effects on endogenous trade flows, as they induce firms to serve more markets, export more products to each market, export more of each product, source intermediate inputs from more countries, and import more of each intermediate input from each source country.

The third insight relates to *strategic market power*. When firms are large, they internalize the effects of their decisions on market aggregates. This internalization implies that firms charge variable mark-ups of price over marginal cost even in the presence of constant elasticity of substitution (CES) demand, because larger firms have greater impact on aggregate price indices and hence face lower perceived elasticities of demand. The presence of such variable markups provides a natural rationalization for "pricing to market," where firms charge different prices in different markets, because their markups in each market depend on their sales shares in that market. Such variable markups also rationalize "incomplete pass-through," where cost shocks are not passed through fully into consumer prices, because they affect sales shares and hence lead to endogenous changes in markups. Finally, when large firms supply multiple products, they internalize the cannibalization effects of the introduction of new products on the sales of existing products, and hence make systematically different product introduction decisions from single-product firms.

The fourth insight is *granularity*. When a small number of firms dominate the exports and imports of trading nations, individual firm characteristics affect aggregate outcomes. In such a world, the law of large numbers does not hold, and shocks to individual firms can affect country comparative advantage, aggregate welfare, business cycle fluctuations and the international transmission of shocks. In such a world, understanding the micro features of individual firms can be central to understanding the aggregate causes and consequences of trade.

Our paper is related to the influential line of research that has modeled firm heterogeneity in differentiated product markets following Melitz (2003).[1] In this model, a competitive fringe of potential

[1] See also Bernard, Redding, and Schott (2007) and Melitz and Ottaviano (2008). For surveys of the theoretical literature on heterogeneous firms and trade, see Melitz and Redding (2014a) and Redding (2011). For broader surveys of firm organization and trade, see Antràs (2015), Antràs and Rossi-Hansberg (2009) and Helpman (2006).

firms decide whether to enter an industry by paying a fixed entry cost which is thereafter sunk. Potential entrants face *ex ante* uncertainty concerning their productivity. Once the sunk entry cost is paid, a firm draws its productivity from a fixed distribution and productivity remains fixed thereafter. Firms produce horizontally differentiated varieties within the industry under conditions of monopolistic competition.[2] The existence of fixed production costs implies that a firm drawing a productivity level below the "zero-profit productivity cutoff" would make negative profits and hence exits the industry. Fixed and variable costs of exporting ensure that only those active firms that draw a productivity above a higher "export productivity cutoff" find it profitable to export.[3] Following multilateral trade liberalization, high-productivity exporting firms experience increased revenue through greater export market sales; the most productive non-exporters now find it profitable to enter export markets, increasing the fraction of exporting firms; the least productive firms exit; and there is a contraction in the revenue of surviving firms that only serve the domestic market. Each of these responses reallocates resources towards high-productivity firms and raises aggregate productivity through a change in industry composition.[4]

Our contribution relative to this theoretical research is to develop a framework that allows firms to be "granular" or large relative to the markets in which they operate and participate in multiple ways in the global economy. We model these granular firms as choosing prices or quantities taking into account their effects on market price indices, as in Atkeson and Burstein (2008), Eaton, Kortum, and Sotelo (2012), Edmond, Midrigan, and Xu (2012), Gaubert and Itskhoki (2015), and Hottman, Redding, and Weinstein (2015).[5] We consider the following margins of international participation. Each firm chooses the set of export market to serve (as in Eaton, Kortum, and Kramarz (2011))[6] and the set of products to supply to each export market (as in Bernard, Redding, and Schott (2010), Bernard, Redding, and Schott (2011) and Hottman, Redding, and Weinstein (2015)).[7] Each firm also chooses the set of countries from which to source intermediate inputs and which inputs to import from each source country (as in Antràs, Fort, and Tintelnot (2014) and Bernard, Moxnes, and Saito (2014)).[8] We provide the first framework

[2]For alternative approaches to firm heterogeneity, see Bernard, Eaton, Jensen, and Kortum (2003) and Yeaple (2005).

[3]While the original model focuses on exporting, this framework is extended to incorporate foreign direct investment (FDI) as an alternative mode for servicing foreign markets in Helpman, Melitz, and Yeaple (2004).

[4]While firm productivity is fixed in the Melitz (2003) model, subsequent research has incorporated endogenous changes in firm productivity through a variety of mechanisms, including technology adoption (Constantini and Melitz (2008), Bustos (2011) and Lileeva and Trefler (2010)), innovation (Atkeson and Burstein (2010), Perla, Tonetti, and Waugh (2015) and Sampson (2015)), and endogenous changes in product mix (Bernard, Redding, and Schott (2010, 2011)).

[5]Related research on the role of granular firms in aggregate business cycle fluctuations includes Gabaix (2011) and di Giovanni, Levchenko, and Mejean (2014). For broader arguments for incorporating oligopolistic competition into international trade, see Neary (2015) and Thisse and Shimomura (2012).

[6]Mrázová and Neary (2015) examine firm choices between alternative modes of serving export markets (e.g. exports versus foreign direct investment (FDI)).

[7].Other research on multi-product firms and trade includes Arkolakis, Muendler, and Ganapati (2014), Dhingra (2013), Eckel and Neary (2010), Feenstra and Ma (2008), Mayer, Melitz, and Ottaviano (2013) and Nocke and Yeaple (2014).

[8]Firm importing is also examined in Amiti and Konings (2007), Amiti and Davis (2011), Blaum, Lelarge, and Peters (2013, 2014), Goldberg, Khandelwal, Pavcnik, and Topalova (2010), De Loecker, Goldberg, Khandelwal, and Pavcnik (2015) and Halpern, Koren, and Szeidl (2015).

that simultaneously encompasses all of these margins of international participation and we show how this framework can be used to make sense of a number of features of U.S. firm and trade transactions data.

Our research is also related to the large empirical literature that has examined the relationship between firm performance and participation in international markets following Bernard and Jensen (1995).[9] Early empirical studies in this literature used firm and plant-level data to document a number of stylized facts about exporters and non-exporters. In particular, exporters are larger, more productive, more capital-intensive, more skill-intensive and pay higher wages than non-exporters within the same industry (see Bernard and Jensen (1995, 1999)). Subsequent empirical research has used international trade transactions data to establish additional regularities about firm trade participation following Bernard, Jensen, and Schott (2009). Much of the variation in aggregate bilateral trade flows is accounted for by the extensive margins of the number of exporting firms (see Eaton, Kortum, and Kramarz (2004)) and the number of firm-product observations with positive trade (see Bernard, Jensen, Redding, and Schott (2009)). While the extensive margins of export firms and products are sharply decreasing in proxies for bilateral trade costs such as distance, the intensive margin of average exports per firm-product observation with positive trade exhibits little relationship with these proxies because of changes in export composition (see Bernard, Redding, and Schott (2011)). We show how our theoretical framework accounts for these properties of firm export behavior and for a broader range of features of firm participation in the global economy.

Within this empirical literature on export participation, our paper is related to several studies that have focused on the largest firms in the international economy. Bernard, Jensen, and Schott (2009) document the concentration of activity in the largest exporting and importing firms for the U.S. and argue that the "most globally engaged" firms are more likely to trade with difficult markets and perform foreign direct investment. Mayer and Ottaviano (2007) document a set of regularities for European firms and find that the export distribution is highly skewed. Freund and Pierola (2015) examine "export superstars" and find that very large firms shape country export patterns. Among 32 countries, the top firm on average accounts for 14% of a country's total (non-oil) exports, and the top five firms make up 30% and argue that revealed comparative advantage can be created by a single firm.

The remainder of the paper is structured as follows. Section 2 develops our theoretical framework. Section 3 introduces the data. Section 4 reports evidence on the decision margins of global firms. Section 5 concludes.

[9] For existing surveys of this empirical literature, see Bernard, Jensen, Redding, and Schott (2007), Bernard, Jensen, Redding, and Schott (2012) and Melitz and Trefler (2015).

2 Theoretical Framework

We consider a world of many (potentially) asymmetric countries. Firms make three sets of decisions: which markets to serve (typically indexed by n), which countries in produce in (usually denoted by i), and which countries to source inputs from (generally indicated by j). For each destination market, firms choose the range of products to supply to that market (ordinarily referenced by k). For each source country, firms choose the range of intermediate inputs to obtain from that source (most often represented by ℓ). We assume that consumer preferences exhibit a constant elasticity of substitution (CES). However, we allow firms to be large relative to the markets in which they sell their products, which introduces variable markups (because each firm internalizes the effect of its pricing choices on market aggregates).

2.1 Preferences

We consider a nested structure of demand as in Hottman, Redding, and Weinstein (2015). Preferences in each market m are a Cobb-Douglas aggregate of the consumption indices (C^G_{mg}) of a continuum of sectors indexed by g:

$$\ln \mathbb{U}_m = \int_{g \in \Omega^G} \lambda^G_{mg} \ln C^G_{mg} dg, \qquad \int_{g \in \Omega^G} \lambda^G_{mg} dg = 1, \tag{1}$$

where λ^G_{mg} determines the share of market m's expenditure on sector g.[10] The consumption index (C^G_{mg}) for each sector g in each market m is defined over consumption indices (C^F_{mif}) for each final good firm f from each production country i:

$$C^G_{mg} = \left[\sum_{i \in \Omega^N} \sum_{f \in \Omega^F_{mig}} \left(\lambda^F_{mif} C^F_{mif} \right)^{\frac{\sigma^F_g - 1}{\sigma^F_g}} \right]^{\frac{\sigma^F_g}{\sigma^F_g - 1}}, \qquad \sigma^F_g > 1, \lambda^F_{mif} > 0, \tag{2}$$

where σ^F_g is the elasticity of substitution across firms for sector g; Ω^N is the set of countries; λ^F_{mif} is the overall perceived quality of the consumption index supplied by firm f to market m from production country i; and Ω^F_{mig} is the set of firms that supply market m from production country i within sector g. The consumption index (C^F_{mif}) for each firm f from production location i in market m within sector g is defined over the consumption (C^K_{mik}) of each final product k:

$$C^F_{mif} = \left[\sum_{k \in \Omega^K_{mif}} \left(\lambda^K_{mik} C^K_{mik} \right)^{\frac{\sigma^K_g - 1}{\sigma^K_g}} \right]^{\frac{\sigma^K_g}{\sigma^K_g - 1}}, \qquad \sigma^K_g > 1, \lambda^K_{mik} > 0, \tag{3}$$

[10] For expositional clarity, we use the superscripts G, F and K to denote sector, firm and product-level variables. We use the subscripts n, i and j to index the values of variables for individual markets, production countries and source countries respectively. We use the subscripts g, f and k to index the values of variables for individual sectors, firms and products respectively.

where σ_g^K is the elasticity of substitution across products within firms; λ_{mik}^K is the perceived quality of product k supplied to market m from production country i; and Ω_{mifg}^K is the set of products supplied by firm f to market m from production country i within sector g.[11]

There are a few features of this specification worth noting. First, we allow firms to be large relative to sectors (and hence internalize their effects on consumption and the price index for the sector). However, we assume a continuum of sectors so that each firm is of measure zero relative to the economy as a whole (and hence takes aggregate expenditure E_m as given). Second, the assumption that the upper-level of utility is Cobb-Douglas implies that no firm has an incentive to try to manipulate prices in one sector to influence behavior in another sector. The reason is that each firm is assumed to be small relative to the aggregate economy (and hence cannot affect aggregate expenditure) and sector expenditure shares are determined by the parameters λ_{mg}^G alone. Therefore the firm problem becomes separable by sector, which implies that we can treat the divisions of a firm that operates in multiple sectors as if they were separate firms. Henceforth, we adopt this convention, and use the firm index f to refer to firm-divisions within a given sector g for firms that operate in multiple sectors.

Third, the consumption index (C_{mg}^G) for sector g in market m allows for differentiation across both firms f and production locations i, which enables the model to rationalize a firm supplying the same product to the same market from different production locations. Fourth, since preferences are homogeneous of degree one in quality, firm quality (λ_{mif}^F) cannot be defined independently of product quality (λ_{mik}^K). We therefore need a normalization. It proves convenient to make the following normalizations: we set the geometric mean of product quality (λ_{mik}^K) across products within each firm and production country equal to one and the geometric mean of firm quality (λ_{mif}^F) across firms within each sector equal to one:

$$\left(\prod_{k\in\Omega_{mif}^K}\lambda_{mik}^K\right)^{\frac{1}{N_{mif}^K}}=1,\qquad\left(\prod_{i\in\Omega^N}\prod_{f\in\Omega_{mig}^F}\lambda_{mif}^F\right)^{\frac{1}{N_{mg}^F}}=1,\tag{4}$$

where $N_{mif}^K=\left|\Omega_{mif}^K\right|$ is the number of products supplied by firm f from production country i to market m within sector g and $N_{mg}^F=\left|\left\{\Omega_{mig}^F : i\in\Omega^N\right\}\right|$ is the total number of firms supplying market m from all production countries i within sector g.

Under these normalizations, product quality (λ_{mik}^K) determines the relative expenditure shares of products within a given firm from a given production country, while firm quality (λ_{mif}^F) determines the relative expenditure shares of firms within a given sector; the Cobb-Douglas expenditure shares (λ_{mg}^G) determine the relative expenditure shares of sectors; and aggregate expenditure (E_m) determines the overall level of expenditures in a given market. The corresponding sectoral price index dual to (2) is:

[11] A large empirical literature provides evidence of the importance of product quality differences, including Hallak and Schott (2011), Hottman, Redding, and Weinstein (2015), Khandelwal (2010), Manova and Zhang (2012) and Schott (2004).

$$P_{mg}^{G}=\left[\sum_{i\in\Omega^{N}}\sum_{f\in\Omega_{mig}^{F}}\left(\frac{P_{mif}^{F}}{\lambda_{mif}^{F}}\right)^{1-\sigma_{g}^{F}}\right]^{\frac{1}{1-\sigma_{g}^{F}}},\tag{5}$$

and the corresponding firm price index dual to (3) is:

$$P_{mif}^{F}=\left[\sum_{k\in\Omega_{mif}^{K}}\left(\frac{P_{mik}^{K}}{\lambda_{mik}^{K}}\right)^{1-\sigma_{g}^{K}}\right]^{\frac{1}{1-\sigma_{g}^{K}}}.\tag{6}$$

An important property of these CES preferences, which we use below, is that elasticity of the price index with respect to a price of a variety is that variety's expenditure share. Therefore the expenditure share of firm f from production country i in market m within sector g is:

$$S_{mif}^{F}=\frac{\left(P_{mif}^{F}/\lambda_{mif}^{F}\right)^{1-\sigma_{g}^{F}}}{\sum_{i\in\Omega^{N}}\sum_{o\in\Omega_{mig}^{F}}\left(P_{mio}^{F}/\lambda_{mio}^{F}\right)^{1-\sigma_{g}^{F}}}=\frac{\partial P_{mg}^{G}}{\partial P_{mif}^{F}}\frac{P_{mif}^{F}}{P_{mg}^{G}},\tag{7}$$

and the expenditure share of product k from production country i in market m within firm f is:

$$S_{mik}^{K}=\frac{\left(P_{mik}^{K}/\lambda_{mik}^{K}\right)^{1-\sigma_{g}^{K}}}{\sum_{n\in\Omega_{mif}^{K}}\left(P_{min}^{K}/\lambda_{min}^{K}\right)^{1-\sigma_{g}^{K}}}=\frac{\partial P_{mif}^{F}}{\partial P_{mik}^{K}}\frac{P_{mik}^{K}}{P_{mif}^{F}}.\tag{8}$$

The corresponding level of expenditure on product k is:

$$E_{mik}^{K}=\left(\lambda_{mif}^{F}\right)^{\sigma_{g}^{F}-1}\left(\lambda_{mik}^{K}\right)^{\sigma_{g}^{K}-1}\left(\lambda_{mg}^{G}w_{m}L_{m}\right)\left(P_{mg}^{G}\right)^{\sigma_{g}^{F}-1}\left(P_{mif}^{F}\right)^{\sigma_{g}^{K}-\sigma_{g}^{F}}\left(P_{mik}^{K}\right)^{1-\sigma_{g}^{K}},\tag{9}$$

where we have used the Cobb-Douglas upper tier of utility, which implies that sectoral expenditure is a constant share of aggregate expenditure ($E_{mg}^{G}=\lambda_{mg}^{G}E_{m}$). We have also used the fact that aggregate expenditure (E_m) equals aggregate income ($w_m L_m$), where labor is the sole primary factor of production with wage w_m and inelastic supply L_m.

2.2 Final Goods Production Technology

A final good firm f is defined by its productivity (φ_{if}) in each potential country of production i, consumers' perceptions of the overall quality of the firm from that production country in market m (λ_{mif}^{F}), and consumers' perceptions of the quality of each product k supplied by the firm from that production country to that market (λ_{mik}^{K}). Each product k is produced using a continuum of intermediate inputs indexed by $\ell\in[0,1]$, which are modeled following Eaton and Kortum (2002) and Antràs, Fort, and Tintelnot (2014).[12] A firm f with productivity φ_{if} that locates a plant in production country i and uses

[12]See also Bernard, Moxnes, and Saito (2014), Rodríguez-Clare (2010) and Tintelnot (2014).

an amount $Y_{ik}^{K}(\ell)$ of each intermediate input ℓ can produce the following output (Q_{ik}^{K}) of product k:

$$Q_{ik}^{K} = \varphi_{if}\left[\int_0^1 Y_{ik}^{K}(\ell)^{\frac{\eta_g-1}{\eta_g}} d\ell\right]^{\frac{\eta_g}{\eta_g-1}}, \qquad \eta_g > 1, \tag{10}$$

where η_g is the elasticity of substitution across intermediate inputs for sector g; more productive firms (with higher φ_{if}) generate more output for given use of intermediate inputs $Y_{ik}^{K}(\ell)$.

To open a plant in production country i, firm f must incur a fixed production cost of $F_i^P > 0$ units of labor. We also assume that the firm must incur a fixed exporting cost of $F_{mi}^X > 0$ units of labor to export to market m from production country i, after which it can supply that market subject to iceberg variable trade costs of $d_{mi}^X \geqslant 1$, where $d_{mi}^X > 1$ for $m \neq i$ and $d_{mm}^X = 1$. Additionally, we assume that the firm must incur fixed sourcing costs of $F_{ij}^I > 0$ units of labor to obtain intermediate inputs in production country i from source country j, after which it can obtain these inputs subject to iceberg variable trade costs of $d_{ij}^I \geqslant 1$, where $d_{ij}^I > 1$ for $i \neq j$ and $d_{ii}^I = 1$. These fixed costs of production, exporting and sourcing (F_i^P, F_{mi}^X and F_{ij}^I) are incurred in terms of labor in country i and must be paid irrespective of the number of products exported or the number of inputs used. To rationalize firms only exporting a subset of their products to some markets, we also assume a fixed product exporting cost (F_{mik}^K) for each product k exported from production country i to market m. We allow the variable trade costs to differ between final and intermediate goods ($d_{mi}^X \neq d_{mi}^I$). For simplicity, we assume that the final goods variable trade costs (d_{mi}^X) are the same across products k, and the intermediate inputs variable trade costs (d_{ij}^I) are the same across inputs ℓ, although it is possible to relax both these assumptions. Consistent with a large empirical literature, we assume that fixed and variable trade costs are sufficiently high that only a subset of firms from each production country i export to foreign markets $m \neq i$ and that only a subset of these firms from production country i import intermediate inputs from foreign source countries $j \neq i$.

2.3 Intermediate Input Production Technology

Intermediate inputs are produced with labor according to a linear technology under conditions of perfect competition. If a firm f in production country i has chosen to incur the fixed importing costs for source country j, the cost of sourcing an intermediate input ℓ from country j for product k is:

$$a_{ijfk}(\ell) = \frac{w_j d_{ij}^I}{z}, \tag{11}$$

where recall that w_j is the wage in country j and z is a stochastic draw for intermediate input productivity. We assume that intermediate input productivity is drawn independently for each final good firm f, product k, intermediate input ℓ, production country i and source country j from a Fréchet distribution:

$$G_{ijfk}(z) \quad = e^{-T_{jk}^{K} z^{-\theta_k^K}}, \tag{12}$$

where T_{jk}^K is the Fréchet scale parameter that determines the average productivity of intermediate inputs from source j for product k; θ_k^K is the Fréchet shape parameter that determines the dispersion of intermediate input productivity for product k.

Although intermediate input productivity (z) is specific to a final goods firm, we assume that all intermediate input firms within source country j have access to this productivity, which ensures that intermediate inputs are produced under conditions of perfect competition.[13] Although intermediate input productivity draws are assumed to be independent, we allow the scale parameter T_{jk}^K to vary across both products and countries. Therefore, if source country j with a high value of T_{jk}^K for product k also has a high value of T_{jn}^K for another product $n \neq k$, this variation in the Fréchet scale parameter will induce a correlation between intermediate input productivity draws for products k and n.

2.4 Exporting and Importing Decisions

Firm decisions involve the organization of global production chains.[14] Each firm chooses the set of production countries in which to operate plants, taking into account the location of these facilities relative to final goods markets and their location relative to sources of intermediate inputs. Each firm also chooses the set of markets to supply from each plant, the range of products to export from each plant to each market, the set of countries from which to source intermediate inputs for each product in each plant, and imports of each input for each product in each plant.

We analyze the firm's optimal exporting and importing decisions in two stages. First, for given sets of countries for which the fixed production costs (F_i^P), fixed exporting costs (F_{mi}^X) and fixed sourcing costs (F_{ij}^I) have been incurred, and for a given set of products for which the fixed product exporting costs (F_{mik}^K) have been incurred, we characterize the firm's optimal decisions of which intermediate inputs to source from each country, how much of each intermediate input to import from each source country, and how much of each product to export to each market. Second, we characterize the firm's optimal choices of the set of countries for which to incur the fixed production costs (F_i^P), fixed exporting costs (F_{mi}^X) and fixed sourcing costs (F_{ij}^I) and the set of products for which to incur the product fixed exporting costs (F_{mik}^K).

2.4.1 Sourcing Decisions for a Given Set of Production, Market and Source Countries

We begin with the firm's sourcing decisions for intermediate inputs. Suppose that firm f has chosen the set of production countries i in which to locate plants ($\Omega_f^{NP} \subseteq \Omega^N$), the set of markets m to which to export from each plant ($\Omega_{if}^{NX} \subseteq \Omega^N$), the set of source countries j from which to obtain intermediate

[13] We thus abstract from issues of incomplete contracts and hold-up with relationship-specific investments, as considered in Antràs (2003), Antràs and Helpman (2004) and Helpman (2006). Within our framework, final goods firms are indifferent whether to source intermediate inputs within or beyond the boundaries of the firm.

[14] The determinants and implications of global production chains are explored in Antràs and Chor (2013), Alfaro, Antrás, Chor, and Conconi (2015), Baldwin and Venables (2013), Costinot, Vogel, and Wang (2013), Dixit and Grossman (1982), Grossman and Rossi-Hansberg (2008), Johnson and Noguera (2012), Melitz and Redding (2014b) and Yi (2003).

inputs for each plant ($\Omega_{if}^{NI} \subseteq \Omega^{N}$), and the set of products k to export from each plant to each market (Ω_{mif}^{K}). Given these sets of countries and products, we now characterize the firm's optimal sourcing decisions for each intermediate input for each product. Using the monotonic relationship between the price of intermediate inputs ($a_{ijfk}(\ell)$) and intermediate input productivity (z) in (11) and the Fréchet productivity distribution (12), the firm f in production country i faces the following distribution of prices for intermediate inputs for each product k from each source country $j \in \Omega_{if}^{NI}$:

$$G_{ijfk}(a, \Omega_{if}^{NI}) = \quad 1 - e^{-T_{jk}^{K}(w_j d_{ij}^{I})^{-\theta_k^K} a^{\theta_k^K}}, \qquad j \in \Omega_{if}^{NI}. \tag{13}$$

The firm f in production country i sources each intermediate input for each product k from the lowest-cost supplier of that input from among the set of source countries $j \in \Omega_{if}^{NI}$. Since the minimum of Fréchet distributed random variables is itself Fréchet distributed, the corresponding distribution of minimum prices across all source countries $j \in \Omega_{if}^{NI}$ is:

$$G_{ifk}(a, \Omega_{if}^{NI}) = 1 - e^{-\Phi_{ifk} a^{\theta_k^K}}, \qquad \Phi_{ifk} = \sum_{j \in \Omega_{if}^{NI}} T_{jk}^{K}(w_j d_{ij}^{I})^{-\theta_k^K}. \tag{14}$$

Given this distribution for minimum prices, the probability that the firm f in production country i sources an intermediate input for product k from source country $j \in \Omega_{if}^{NI}$ is:

$$\mu_{ijfk}(\Omega_{if}^{NI}) = \frac{T_{jk}^{K}(w_j d_{ij}^{I})^{-\theta_k^K}}{\sum_{h \in \Omega_{if}^{NI}} T_{hk}^{K}(w_h d_{ih}^{I})^{-\theta_k^K}}. \tag{15}$$

The variable unit cost function dual to the final goods production technology (10) is:

$$\delta_{ifk}^{K}(\varphi_{if}, \Omega_{if}^{NI}) = \frac{1}{\varphi_{if}} \left[\int_0^1 a_{ifk}(\ell)^{1-\eta_g} d\ell \right]^{\frac{1}{1-\eta_g}}. \tag{16}$$

Using the distribution for intermediate input prices (14), variable unit costs can be expressed as:

$$\delta_{ifk}^{K}(\varphi_{if}, \Omega_{if}^{NI}) = \frac{1}{\varphi_{if}} \gamma_k^K \left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right) \right]^{-\frac{1}{\theta_k^K}}, \tag{17}$$

$$\text{where} \qquad \gamma_k^K = \left[\Gamma\left(\frac{\theta_k^K + 1 - \eta_g}{\theta_k^K} \right) \right]^{\frac{1}{1-\eta_g}}, \qquad \Phi_{ifk}\left(\Omega_{if}^{NI}\right) = \sum_{j \in \Omega_{if}^{NI}} T_{jk}^{K}(w_j d_{ij}^{I})^{-\theta_k^K},$$

$\Gamma(\cdot)$ is the Gamma function and we require $\theta_k^K > \eta_g - 1$.

We refer to $\Phi_{ifk}\left(\Omega_{if}^{NI}\right)$ as *firm supplier access*, because it summarizes a firm's access to intermediate inputs around the globe as a function of its choice of the set of source countries (Ω_{if}^{NI}). Firm supplier access is decreasing in the number of source countries: $N_{if}^{I} = \left|\Omega_{if}^{NI}\right|$. Firm supplier access also depends on wages (w_j) and intermediate input productivity (T_{jk}^{K}) in each source country $j \in \Omega_{if}^{NI}$ and the variable trade costs of importing intermediate inputs from those source countries (d_{ij}^I). The firm's total cost function (including fixed sourcing costs and taking into account the firm's output choice) for product k is:

$$\Lambda\left(\varphi_{if}, \Omega_{if}^{NI}, Q_{ik}^K\right) = \frac{\gamma_k^K \left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}}{\varphi_{if}} Q_{ik}^K + \sum_{j \in \Omega_{if}^{NI}} F_{ij}^I, \tag{18}$$

where Q_{ik}^K is total firm output of product k in country i, which is the sum of output produced for each market m (Q_{mik}^K) across all markets: $Q_{ik}^K = \sum_{m \in \Omega_{if}^{NX}} Q_{mik}^K$. Firms that incur the fixed sourcing costs (F_{ij}^I) for more source countries j have higher total fixed costs, but lower variable costs, because of improved firm supplier access $\Phi_{ifk}\left(\Omega_{if}^{NI}\right)$.

Finally, an implication of the Fréchet assumption for intermediate input productivity is that the average prices of intermediate inputs conditional on sourcing those inputs from a given source country are the same across all source countries. Therefore the probability ($\mu_{ijfk}(\Omega_{if}^{NI})$) that a firm f in production country i obtains an input for product k from source country j (15) also corresponds to its share of expenditure on inputs from source country j in its total expenditure on intermediate inputs for product k.

2.4.2 Exporting Decisions for a Given Set of Production, Market and Source Countries

Given firm f's choice of sets of production countries i (Ω_f^{NP}), markets m (Ω_{if}^{NX}) and sources j (Ω_{if}^{NI}) and sets of products exported to each market (Ω_{mif}^K), we now characterize the firm's optimal pricing decisions for each exported product. Firm f from production country i chooses the price (P_{mik}^K) for each product k for each market m within sector g to maximize its profits subject to the downward-sloping demand curve (9) and taking into account the effects of its choices on market price indices:

$$\max_{\left\{P_{mik}^K : m \in \Omega_{if}^{NX}, k \in \Omega_{mif}^K\right\}} \Pi_{igf}^F = \left\{ \begin{array}{c} \sum_{m \in \Omega_{if}^{NX}} \sum_{k \in \Omega_{mif}^K} \left[P_{mik}^K Q_{mik}^K\left(P_{mik}^K\right) - \frac{d_{mi}^X \gamma_k^K \left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}}{\varphi_{if}} Q_{mik}^K\left(P_{mik}^K\right) \right] \\ - \sum_{m \in \Omega_{if}^{NX}} \sum_{k \in \Omega_{mif}^K} w_i F_{mik}^K - \sum_{m \in \Omega_{if}^{NX}} w_i F_{mi}^X - \sum_{j \in \Omega_{if}^{NI}} w_i F_{ij}^I - w_i F_i^P \end{array} \right\} \tag{19}$$

where recall that $d_{mi}^X > 1$ for $m \neq i$ are iceberg variable trade costs for final goods.

Under our assumption of nested CES demand, each firm f from production country i internalizes that it is the monopoly supplier of the firm consumption index (C_{mif}^F) to market m, and hence chooses a common markup (μ_{mif}^F) of price over marginal cost across all products within a given sector and market, as in Hottman, Redding, and Weinstein (2015):

$$P_{mik}^K = \mu_{mif}^F \frac{d_{mi}^X \gamma_k^K \left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}}{\varphi_{if}}. \tag{20}$$

The size of the mark-up (μ_{mif}^F) depends on the perceived elasticity of demand (ε_{mif}^F) for the firm consumption index in market m:

$$\mu_{mif}^{F}=\frac{\varepsilon_{mif}^{F}}{\varepsilon_{mif}^{F}-1},\tag{21}$$

where this perceived elasticity of demand depends on the firm's market share within that sector and market:

$$\varepsilon_{mif}^{F}=\sigma_{g}^{F}-\left(\sigma_{g}^{F}-1\right)S_{mif}^{F}=\sigma_{g}^{F}\left(1-S_{mif}^{F}\right)+S_{mif}^{F},\tag{22}$$

where S_{mif}^{F} is the share of firm f from production country i in sectoral expenditure in market m.[15]

Although consumers have constant elasticity of substitution preferences (σ_g^F), each firm perceives a variable elasticity of demand (ε_{mif}^F) that is decreasing in its expenditure share (S_{mif}^F), because it internalizes the effect of its pricing choices on market price indices, as in Atkeson and Burstein (2008), Eaton, Kortum, and Sotelo (2012), Edmond, Midrigan, and Xu (2012) and Hottman, Redding, and Weinstein (2015). As a result, the firm's equilibrium pricing rule (20) involves a variable markup (μ_{mif}^F) that is increasing in its expenditure share (S_{mif}^F). Our framework is thus consistent with empirical evidence of "*pricing to market*," because firms charge higher markups over marginal costs in markets where they account for a larger shares of sectoral expenditure.[16]

The property that the firm charges a common markup across all products within a given sector and market is a generic implication of nested demand systems. In such specifications, the firm's profit maximization problem can be thought of in two stages. First, the firm chooses the price index (P_{mif}^F) to maximize the profits from supplying the firm consumption index (C_{mif}^F), which implies a markup at the firm level within a given sector and market over the cost of supplying that real consumption index. Second, the firm chooses the price for each product to minimize the cost of supplying that real consumption index (C_{mif}^F), which requires setting the relative prices of products equal to their relative marginal costs. Together these two results ensure the same markup across all products supplied by the firm within a given sector and market. Nonetheless, firm markups vary across markets within a given sector (with the firm market share in those markets), and they vary across sectors within a given market (with the firm market share and elasticity of substitution across products within those sectors).[17]

Using the equilibrium pricing rule (20) in the firm problem (19), equilibrium profits for firm f from production location i within sector g can be written in terms of sales from each product k in each market, the common markup across products within each market, and the fixed costs:

[15] Although we assume that firms choose prices under Bertrand competition, it is straightforward to consider the alternative case under which firms choose quantities under Cournot competition. In this alternative specification, firms again charge variable markups that are common across products within a given sector and market, but the expression for the perceived elasticity of demand differs, as shown in Atkeson and Burstein (2008) and Hottman, Redding, and Weinstein (2015).

[16] See Atkeson and Burstein (2008), Bergin and Feenstra (2001), Fitzgerald and Haller (2015), Goldberg and Hellerstein (2013), Krugman (1987) and the review in De Loecker and Goldberg (2014). De Loecker and Warzynski (2012) provide evidence of substantial differences in markups between exporters and non-exporters.

[17] As long as the elasticity of substitution across products within firms (σ_g^K) is greater than the elasticity of substitution across firms (σ_g^F), firms face cannibalization effects, whereby the introduction of new products cannibalizes the sales of existing products, as examined in Hottman, Redding, and Weinstein (2015).

$$\Pi^F_{igf} = \left\{ \sum_{m\in\Omega^{NX}_{if}} \sum_{k\in\Omega^K_{mif}} \left(\frac{\mu^F_{mif}-1}{\mu^F_{mif}}\right) E^K_{mik} - \sum_{m\in\Omega^{NX}_{if}} \sum_{k\in\Omega^K_{mif}} w_i F^K_{mik} - \sum_{m\in\Omega^{NX}_{if}} w_i F^X_{mi} - \sum_{j\in\Omega^{NI}_{if}} w_i F^I_{ij} - w_i F^P_i \right\}. \tag{23}$$

Using the markup (21) and our assumption of constant marginal costs to recover variable costs from sales (as E^K_{mik}/μ^F_{mif}), and using the share of each source country in variable costs (15), imports of intermediate inputs for product k by firm f from production location i within sector g from source country j are:

$$M^K_{ifkj} = \frac{T^K_{jk}(w_j d^I_{ij})^{-\theta^K_k}}{\sum_{h\in\Omega^{NI}_{if}} T^K_{hk}(w_h d^I_{ih})^{-\theta^K_k}} \left[\sum_{m\in\Omega^{NX}_{if}} \frac{E^K_{mik}}{\mu^F_{mif}}\right]. \tag{24}$$

Finally, using the equilibrium pricing rule (20) in the revenue function (9), sales of each product (E^K_{mik}) depend on firm supplier access (Ω^{NI}_{if}) through variable production costs:

$$E^K_{mik} = \left(\lambda^F_{mif}\right)^{\sigma^F_g-1} \left(\lambda^K_{mik}\right)^{\sigma^K_g-1} \left(\lambda^G_{mg} w_m L_m\right) \left(P^G_{mg}\right)^{\sigma^F_g-1} \left(P^F_{mif}\right)^{\sigma^K_g-\sigma^F_g} \left(\mu^F_{mif} \frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifk}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}}\right)^{1-\sigma^K_g}. \tag{25}$$

As in Antràs, Fort, and Tintelnot (2014), incurring the fixed sourcing cost for a new source country (expanding Ω^{NI}_{if}) has two effects on imports from existing source countries for each product. On the one hand, the addition of the new source country reduces imports from existing source countries through a substitution effect (from the expenditure shares (15)). On the other hand, the addition of the new source country improves supplier access (Φ_{ifk}), which reduces production costs and expands firms sales (from the revenue function (25)), which raises imports from existing source countries through a production scale effect. Which of these two effects dominates, and whether source countries are substitutes or complements, depends on whether $\left(\sigma^K_g - 1\right)/\theta^K_k$ is less than or greater than one respectively.

We now examine the properties of firm variables with respect to productivity using the firm expenditure share (7), price index (6) and pricing rule (20). These results should be interpreted carefully for the following reasons. First, they are partial equilibrium relationships, because we hold constant wages in all countries m (w_m). Second, we hold constant the set of production countries in which plants are located for each firm f (Ω^{NP}_f), the set of markets for each plant in each production country i (Ω^{NX}_{if}), the set of products exported from each plant in each production country i to each market m in each sector g (Ω^K_{mif}), and the set of input sources for each plant (Ω^{NI}_{if}). Each of these choice sets are themselves endogenous. Therefore these results should be interpreted as partial derivatives of firm variables with respect to productivity, holding constant these choice sets and wages. Finally, we also hold fixed all other model parameters, including firm appeal (λ^F_{mif}), product appeal (λ^K_{mik}) and intermediate input productivities (T^K_{jk}).

Proposition 1. *Given wages in all countries m (w_m), the set of production countries in which plants are located for each firm f (Ω^{NP}_f), the set of markets for each plant in each production country i (Ω^{NX}_{if}), the set of products*

exported from each plant in each production country i to each market m in each sector g (Ω^K_{mif}), and the set of source countries for intermediate inputs for each plant (Ω^{NI}_{if}), an increase in firm productivity (φ_{if}) implies:
(i) *higher expenditure shares within each market (S^F_{mif}),*
(ii) *lower prices (P^K_{mik}) for each product k and higher markups (μ^K_{mik}) within each market,*
(iii) *higher sales (E^K_{mik}) and output (Q^K_{mik}) of each product within each market.*

Proof. See the appendix. □

Higher firm productivity reduces firm prices in each market, which leads to higher sales and output of each product in each market, and hence higher total sales and output of each product across all markets. This higher total output for each product in turn implies higher imports of intermediate inputs for each productive. Therefore a key empirical prediction of the model is that higher firm productivity leads to an expansion of the intensive margins of exports of each product and imports of each input. The expansion of firm sales in turn implies a reduction in the firm's perceived elasticity and demand and hence higher firm markups. Therefore our framework features "*incomplete pass-through*" of production costs to consumer prices, consistent with a large empirical literature.[18]

2.4.3 Optimal Set of Production, Market and Source Countries

We now turn to the firm's optimal choice of the sets of production countries in which to locate plants (Ω^{NP}_f), markets for each plant (Ω^{NX}_{if}), source countries for each plant (Ω^{NI}_{if}), and products exported from each plant to each market served (Ω^K_{mif}). Firm f chooses these sets of countries and products to maximize its equilibrium profits (23):

$$\left\{\hat{\Omega}^{NP}_f, \hat{\Omega}^{NX}_{if}, \hat{\Omega}^{NI}_{if}, \hat{\Omega}^{K}_{mif}\right\} = \arg\max \left\{ \sum_{i\in\Omega^{NP}_f} \left[\begin{array}{c} \sum_{m\in\Omega^{NX}_{if}} \sum_{k\in\Omega^K_{mif}} \left(\frac{\mu^F_{mif}-1}{\mu^F_{mif}}\right) E^K_{mik} - \sum_{m\in\Omega^{NX}_{if}} \sum_{k\in\Omega^K_{mif}} w_i F^K_{mik} \\ - \sum_{m\in\Omega^{NX}_{if}} w_i F^X_{mi} - \sum_{j\in\Omega^{NI}_{if}} w_i F^I_{ij} - w_i F^P_i \end{array} \right] \right\}, \tag{26}$$

where sales (E^K_{mik}) and the markup (μ^F_{mif}) in each market are determined from the CES revenue function for each product (9), the firm expenditure share (7) and the firm equilibrium pricing rule (20).

This expression for the firm's problem has an intuitive interpretation. For each set of production, market and source countries and each set of products exported, the firm first solves for its equilibrium variable profits as determined in the previous subsection (in terms of the markup (μ^F_{mif}) and sales (E^K_{mik})). Having computed this solution for each set of production, market and source countries and each set of products exported, the firm then searches over all possible combinations of production, market and source countries and products exported for the combination that maximizes total profits.

Although conceptually straightforward, this firm problem is highly computationally demanding. First, the choice set is high dimensional (for each production location i, the firm chooses sets of export

[18] See for example Amiti, Itskhoki, and Konings (2015), Berman, Martin, and Mayer (2012), and the review in Goldberg and Knetter (1997).

markets and intermediate input sources from N countries and chooses sets of products for each market). Second, exporting and importing decisions are interdependent with one another and across countries. Importing decisions are interdependent across source countries, because incurring the fixed sourcing cost (F^I_{ij}) for an additional source country j increases firm supplier access ($\Phi_{ifk}\left(\Omega^{NI}_{if}\right)$) and hence reduces variable unit costs (17) and prices (20). These lower prices in turn imply higher output from the revenue function (9), which makes it more likely that the firm will find it profitable to incur the fixed sourcing costs for another country $h \neq j$. Exporting and importing decisions are interdependent with one another, because incurring the fixed exporting cost (F^X_{mi}) for an additional export market m increases firm output. This increased output makes it more likely that the firm will find it profitable to incur the fixed sourcing cost (F^I_{ij}) for any given source country j. The resulting reduction in variable unit costs and prices from adding an additional source country in turn makes it more likely that the firm will find it profitable to incur the fixed exporting cost (F^X_{hi}) for another export market $h \neq m$.

Providing a general characterization of the solution to (26) becomes all the more demanding once this firm problem is embedded in general equilibrium, which requires solving for the endogenous set of firms and wages. However, without explicitly solving this firm problem or the full general equilibrium, we can again establish some properties of the firm's decisions. We begin with the firm's decisions of the set of products to export to each market (Ω^K_{mif}). We again examine partial derivatives, holding constant wages in all countries m (w_m), the sets of production countries (Ω^{NP}_f), markets (Ω^{NX}_{if}) and sources of supply (Ω^{NI}_{if}), and all other model parameters besides productivity (including other firm characteristics such as firm appeal (λ^F_{mif}) and product appeal (λ^K_{mik})).

A firm f from production country i will expand the set of products k exported to a given market m within a given sector g from Ω^K_{mif} to $\tilde{\Omega}^K_{mif}$ (where $\Omega^K_{mif} \subset \tilde{\Omega}^K_{mif}$) if the resulting increase in variable profits exceeds the additional product fixed costs:

$$\sum_{k \in \left\{\tilde{\Omega}^K_{mif} \backslash \Omega^K_{mif}\right\}} \left(\frac{\mu^F_{mif} - 1}{\mu^F_{mif}}\right) E^K_{mik} - \sum_{k \in \left\{\tilde{\Omega}^K_{mif} \backslash \Omega^K_{mif}\right\}} w_i F^K_{mik} \geq 0. \tag{27}$$

From Proposition 1, an increase in firm productivity implies higher sales (E^K_{mik}) of each product and higher markups (μ^F_{mif}) within each market for given $\{w_m,\, \Omega^{NP}_f,\, \Omega^{NX}_{if},\, \Omega^{NI}_{if},\, \Omega^K_{mif}\}$. Therefore an increase in firm productivity implies greater variable profits from expanding the set of products from Ω^K_{mif} to $\tilde{\Omega}^K_{mif}$ in (27).

Proposition 2. *Given wages in all countries m (w_m), the set of production countries in which plants are located for each firm f (Ω^{NP}_f), the set of markets for each plant in each production country i (Ω^{NX}_{if}), and the set of source countries for intermediate inputs for each plant (Ω^{NI}_{if}), an increase in firm productivity (φ_{if}) increases the variable profits from an expansion in the set of products supplied to each market from Ω^K_{mif} to $\tilde{\Omega}^K_{mif}$ (where $\Omega^K_{mif} \subset \tilde{\Omega}^K_{mif}$).*

Proof. See the appendix. □

We next consider the firm's decision of the set of export markets (Ω_{if}^{NX}), holding constant wages in all countries m (w_m), the sets of production locations (Ω_f^{NP}), source countries (Ω_{if}^{NI}) and products exported to each market (Ω_{mif}^K), and all model parameters besides firm productivity. A firm f from production country i will expand the set of markets served from Ω_{if}^{NX} to $\tilde{\Omega}_{if}^{NX}$ (where $\Omega_{if}^{NX} \subset \tilde{\Omega}_{if}^{NX}$) if the resulting increase in variable profits exceeds the additional fixed exporting costs:

$$\sum_{m \in \left\{\tilde{\Omega}_{if}^{NX} \backslash \Omega_{if}^{NX}\right\}} \sum_{k \in \Omega_{mif}^K} \left(\frac{\mu_{mif}^F - 1}{\mu_{mif}^F}\right) E_{mik}^K - \sum_{m \in \left\{\tilde{\Omega}_{if}^{NX} \backslash \Omega_{if}^{NX}\right\}} \sum_{k \in \Omega_{mif}^K} w_i F_{mik}^K - \sum_{m \in \left\{\tilde{\Omega}_{if}^{NX} \backslash \Omega_{if}^{NX}\right\}} w_i F_{mi}^X \geq 0. \quad (28)$$

From Proposition 1, an increase in firm productivity implies higher sales (E_{mik}^K) of each product and higher markups (μ_{mif}^F) within each market for given $\{w_m, \Omega_f^{NP}, \Omega_{if}^{NX}, \Omega_{if}^{NI}, \Omega_{mif}^K\}$. Therefore an increase in firm productivity implies greater variable profits from expanding the set of export markets from Ω_{if}^{NX} to $\tilde{\Omega}_{if}^{NX}$ in (28).

Proposition 3. *Given wages in all countries m (w_m), the set of production countries in which plants are located for each firm f (Ω_f^{NP}), the set of source countries for intermediate inputs for each plant (Ω_{if}^{NI}), and the set of products exported from each plant to each export market (Ω_{mif}^K), an increase in firm productivity (φ_{if}) increases the variable profits from an expansion in the set of export markets from Ω_{if}^{NX} to $\tilde{\Omega}_{if}^{NX}$ (where $\Omega_{if}^{NX} \subset \tilde{\Omega}_{if}^{NX}$).*

Proof. See the appendix. □

Finally, we consider the firm's decision of the set of source countries from which to obtain intermediate inputs (Ω_{if}^{NI}). As shown in Antràs, Fort, and Tintelnot (2014), even if firm supplier access (Φ_{ifk}) is increasing in firm productivity, the number of countries from which a firm sources need not be increasing in firm productivity. In the case in which source countries are substitutes ($\left(\sigma_g^K - 1\right)/\theta_k^K < 1$), a highly productive firm might pay a large fixed cost to source from one country with particularly low variable costs of producing intermediate inputs, after which the marginal incentive to add further source countries might be diminished. In contrast, in the case in which source countries are complements ($\left(\sigma_g^K - 1\right)/\theta_k^K > 1$), adding source one country increases the profitability of adding another source country, so that both firm supplier access (Φ_{ifk}) and the number of source countries are increasing in firm productivity.

Throughout the following, we focus on the complements case ($\left(\sigma_g^K - 1\right)/\theta_k^K > 1$) and examine the variable profits from adding an additional source country, holding constant wages in all countries m (w_m), the sets of production locations (Ω_f^{NP}), markets (Ω_{if}^{NX}) and products supplied to each market (Ω_{mif}^K), and all model parameters besides productivity. A firm f from production location i will expand the set of source countries from Ω_{if}^{NI} to $\tilde{\Omega}_{if}^{NI}$ (where $\Omega_{if}^{NI} \subset \tilde{\Omega}_{if}^{NI}$) if the resulting increase in variable profits exceeds the additional fixed sourcing costs:

$$\left\{ \left[\sum_{m \in \Omega_{if}^{NX}} \sum_{k \in \Omega_{mif}^{K}} \left(\frac{\mu_{mif}^{F}\left(\tilde{\Omega}_{if}^{NI}\right) - 1}{\mu_{mif}^{F}\left(\tilde{\Omega}_{if}^{NI}\right)} \right) E_{mik}^{K}\left(\tilde{\Omega}_{if}^{NI}\right) \right] - \left[\sum_{m \in \Omega_{if}^{NX}} \sum_{k \in \Omega_{mif}^{K}} \left(\frac{\mu_{mif}^{F}\left(\Omega_{if}^{NI}\right) - 1}{\mu_{mif}^{F}\left(\Omega_{if}^{NI}\right)} \right) E_{mik}^{K}\left(\Omega_{if}^{NI}\right) \right] \right\} - \sum_{j \in \left\{\tilde{\Omega}_{if}^{NI} \backslash \Omega_{if}^{NI}\right\}} w_i F_{ij}^{I} \geq 0, \tag{29}$$

where we make explicit that both the markup (μ_{mif}^{F}) and sales of each product (E_{mik}^{K}) are functions of the set of source countries (Ω_{if}^{NI}).

An expansion in the set of source countries from Ω_{if}^{NI} to $\tilde{\Omega}_{if}^{NI}$ increases firm variable profits through two channels. First, the expansion in the set of source countries increases firm supplier access ($\Phi_{ifk}\left(\Omega_{if}^{NI}\right)$), which reduces variable unit costs (17) and prices (20), and in turn increases sales for each product (E_{mik}^{K}). Second, the expansion in sales for each product increases firm market share and mark-ups (μ_{mif}^{F}). Together these two effects ensure that the first term in curly braces for the increase in variable profits is positive.

From Proposition 1, an increase in firm productivity implies higher sales (E_{nik}^{K}) of each product and higher markups (μ_{nif}^{F}) within each market for given $\{w_m, \Omega_{f}^{NP}, \Omega_{if}^{NX}, \Omega_{if}^{NI}, \Omega_{mif}^{K}\}$. Therefore an increase in firm productivity implies greater variable profits from expanding the set of source countries from Ω_{if}^{NI} to $\tilde{\Omega}_{if}^{NI}$ in (29).

Proposition 4. *Given wages in all countries m (w_m), the set of production countries in which plants are located for each firm f (Ω_{f}^{NP}), the set of export markets for each plant (Ω_{if}^{NI}), and the set of products exported from each plant to each export market (Ω_{mif}^{K}), an increase in firm productivity (φ_{if}) increases the variable profits from an expansion in the set of source countries for intermediate inputs from Ω_{if}^{NX} to $\tilde{\Omega}_{if}^{NX}$ (where $\Omega_{if}^{NX} \subset \tilde{\Omega}_{if}^{NX}$).*

Proof. See the appendix. □

Taking Propositions 2-4 together, a second key empirical prediction of the model is that higher firm productivity leads to an expansion of the extensive margins of the number of products exported to each market, the number of export markets and the number of source countries for intermediate inputs. Combining these results with those of the previous subsection, the model implies that more productive firms participate more in the international economy along all margins simultaneously: higher exports of each product, higher imports of each intermediate input, more products exported to each market, more export markets and more import sources. Therefore we should expect to see that all these margins of international participation co-move together across firms: more exports and imports on the intensive margins should be systematically correlated with more export and import participation on the extensive margins.

This correlation implies that a given exogenous difference in productivity between firms has a magnified impact on endogenous differences in performance such as sales and employment, because it induces firms to simultaneously expand along each of the margins of international specialization. Furthermore, as more productive firms import intermediate inputs from a wider range of source countries, this improves their supplier access and reduces their production costs, magnifying the endogenous difference in costs between firms relative to the exogenous difference in productivity. This expansion by more successful firms along multiple margins of international specialization, and the magnification of primitive productivity differences by endogenous sourcing decisions, helps to explain the extent to which aggregate international trade is dominated by a relatively small number of firms.

3 Data

To provide empirical evidence on these margins of firm participation in the international economy, we use the Linked-Longitudinal Firm Trade Transaction Database (LFTTD), which combines information from three separate databases collected by the U.S. Census Bureau and the U.S. Customs Bureau. The first dataset is the U.S. Census of Manufactures (CM), which reports data on the operation of establishments in the U.S. manufacturing sector, including information on output (shipments and value-added), inputs (capital, employment and wagebills for production and non-production workers, and materials) and export participation (whether a firm exports and total export shipments).[19]

The second dataset is the Longitudinal Business Database (LBD), which records employment and survival information for all U.S. establishments outside of agriculture, forestry and fishing, railroads, the U.S. Postal Service, education, public administration and several other smaller sectors.[20] The third dataset includes all U.S. export and import transactions between 1992 and 2007. 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, the identity of the U.S. firm engaging in the trade, and whether the trade is with a related party or occurs at arms length.[21]

We aggregate the establishment-level data from the CM and LBD and the trade transactions data up to the level of the firm. We thus obtain a dataset for each firm that contains information on firm characteristics (e.g. industry, employment, productivity and total shipments) as well as on each of the margins of firm international participation considered above (exports of each product, the number of products exported to each market, the number of export markets, imports of each input, the number of imported inputs from each source country, and the number of source countries).

[19] For further discussion of the CM see, for example, Bernard, Redding, and Schott (2010).

[20] See Jarmin and Miranda (2002) for further details on the LBD.

[21] See Bernard, Jensen, and Schott (2009) for a detailed description of the LFTTD and its construction. Related-party trade refers to trade between U.S. companies and their foreign subsidiaries as well as trade between U.S. subsidiaries of foreign companies and their foreign affiliates. For imports, firms are related if either owns, controls or holds voting power equivalent to 6 percent of the outstanding voting stock or shares of the other organization (see Section 402(e) of the Tariff Act of 1930). For exports, firms are related if either party owns, directly or indirectly, 10 percent or more of the other party (see Section 30.7(v) of The Foreign Trade Statistics Regulations).

4 Evidence on Global Firms

We now provide empirical evidence on the margins of firm international participation. Section 4.1 examines the frequency of firm exporting. Section 4.2 compares exporter and non-exporter characteristics. Section 4.3 considers the prevalence of firm importing. Section 4.4 contrasts the characteristics of importers, exporters, and other firms. Section 4.5 investigates the extensive margins of the number of exported products, the number of export markets, the number of imported products, and the number of import countries. Section 4.6 explores the relationship between each of the intensive and extensive margins of firm participation in the international economy.

4.1 Firm Exporting

NAICS	Industry	Percent of Firms	Fraction of Firms that Export	Mean Exports as a Share of Total Shipments
311	Food Manufacturing	6.8	0.23	0.21
312	Beverage and Tobacco Product	0.9	0.30	0.30
313	Textile Mills	0.8	0.57	0.39
314	Textile Product Mills	2.7	0.19	0.12
315	Apparel Manufacturing	3.6	0.22	0.16
316	Leather and Allied Product	0.3	0.56	0.19
321	Wood Product Manufacturing	4.8	0.21	0.09
322	Paper Manufacturing	1.5	0.48	0.06
323	Printing and Related Support	11.1	0.15	0.10
324	Petroleum and Coal Products	0.5	0.34	0.13
325	Chemical Manufacturing	3.3	0.65	0.23
326	Plastics and Rubber Products	3.9	0.59	0.11
327	Nonmetallic Mineral Product	4.3	0.19	0.09
331	Primary Metal Manufacturing	1.5	0.58	0.31
332	Fabricated Metal Product	20.6	0.30	0.09
333	Machinery Manufacturing	8.7	0.61	0.15
334	Computer and Electronic Product	3.9	0.75	0.28
335	Electrical Equipment, Appliance,	1.7	0.70	0.47
336	Transportation Equipment	3.4	0.57	0.16
337	Furniture and Related Product	6.5	0.16	0.14
339	Miscellaneous Manufacturing	9.3	0.32	0.16
Aggregate Manufacturing		100	0.35	0.17

Notes: Data are from the 2007 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. Firm exports measured using customs information from LFTTD. The final column reports mean exports as a percent of total shipments across all firms that export in the noted industry.

Table 1: Firm Exporting

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 1 provides further evidence on firm export participation using data from the 2007 LFTTD and building on the earlier results from Bernard and Jensen (1995, 1999). Column (1) reports the share of each three-digit North American Industrial Classification (NAIC) industry in the number of manufacturing firms, which ranges from 0.3 percent for Leather and Allied Products (316) to 20.6 percent for Fabricated Metal Products (332).

Column (2) summarizes the share of firms within each industry that export. Consistent with the selection of only some firms into export markets in heterogeneous firm theories, around 35 percent of firms in the U.S. manufacturing sector export. However, this share of exporters ranges rather widely, from 75 percent of firms in Computer and Electronic Products (311) to 15 percent of firms in Printing and Related Support (323). Comparing across the rows of the column, the variation in the share of exporters accords with priors about industries in which the U.S. is likely to have comparative advantage. High-skill and capital-intensive sectors such as Electrical Equipment, Appliance (335) have exporter shares more than twice as large as those of labor-intensive sectors such as Apparel Manufacturing (315). This variation in the share of exporters with industry factor intensity is in line with the predictions of the model of heterogeneous firms and comparative advantage of Bernard, Redding, and Schott (2007).

Column (3) presents the average share of exports in firm shipments for each sector. Here again we find evidence of the scarcity of trade. The average export share for manufacturing as a whole of 17 percent is substantially lower than would be predicted in a world of zero trade costs and identical and homothetic preferences.[22] Although trade costs directly reduce the share of exports in firm shipments relative to such a frictionless world, other contributory factors are the selection of only a subset of firms into export markets (as in Eaton, Kortum, and Kramarz (2011)) and the selection of only a subset of products within firms into export markets (as in Bernard, Redding, and Schott (2011)).

We also find substantial variation in the average share of exports in firm shipments across industries, ranging from a high of 47 percent in Electrical Equipment (335) to a low of 6 percent in Paper Manufacturing (322). Furthermore, this variation again appears related to priors about comparative advantage, with substantially higher export shares in Electrical Equipment, Appliance (335) than in Apparel Manufacturing (315). This relationship is consistent with a model in which the selection of heterogeneous firms into export markets and the selection of products within firms into export markets is influenced by comparative advantage, as in Bernard, Redding, and Schott (2007, 2011).

Comparing the results for 2007 in Table 1 with those for 2002 in Bernard, Jensen, Redding, and Schott (2007), we find a larger fraction of exporters and a higher share of firm exports in total shipments in Table 1. The main reason for this difference is that Table 1 measures firm exporting using the

[22] In such a frictionless world, the share of a firm's exports in its total shipments would equal the share of the rest of the world in world GDP, which is substantially larger than the reported export shares in Table 1 (see also Brooks (2006)).

customs records from LFTTD, whereas Bernard, Jensen, Redding, and Schott (2007) measures firm exporting using the export question in the Census of Manufactures.[23] Following the 2001 recession and the granting of Permanent Normal Trading Relations (PNTR) to China, there was also a sharp decline in overall employment and high rates of exit in U.S. manufacturing (as examined in Pierce and Schott (2012)), both of which are likely to differ between exporters and non-exporters.

4.2 Exporter Characteristics

Exporters are not only rare but look systematically different from non-exporters. In Table 2, we highlight these differences by estimating export premia using the 2007 LFTTD and following the approach of Bernard and Jensen (1995, 1999). Each cell in the table corresponds to a separate regression, in which we regress the log of a firm characteristic on a dummy variable for whether a firm exports. Column (1) estimates these regressions for the firm characteristics shown in the rows of the table. Since the dependent variables are in logarithms, the estimated coefficients can be interpreted as percentages (up to a log approximation). We find that exporting firms have 128 percent more employment, 172 percent higher shipments, 33 percent higher value-added per worker, and 3 percent higher total factor productivity (TFP).[24] All of these differences are statistically significant at conventional critical values.[25]

Column (2) estimates the same regression including industry fixed effects to control for the fact that export participation is correlated with industry characteristics, as discussed in the previous section. We find smaller but still substantial within-industry differences in performance between exporters and non-exporters. Exporters are larger than nonexporters, by approximately 111 percent for employment and 135 percent for shipments; they are more productive by roughly 19 percent for value-added per worker and 4 percent for TFP; they also pay higher wages by around 9 percent. Finally, exporters are relatively more capital- and skill-intensive than nonexporters by approximately 16 and 1 percent, respectively. All of these differences are again statistically significant at conventional critical values. Column (3) shows that the estimated differences are not driven solely by firm size. Including log firm employment as an additional control, we continue to find statistically significant differences between exporters and non-exporters within the same industry for all the other firm characteristics.

[23]Using this alternative definition of firm exporting from the Census of Manufactures, we find a relatively similar pattern of results for 2007 as for 2002 in Bernard, Jensen, Redding, and Schott (2007). Therefore the customs records from LFTTD imply that exporting is more prevalent than would be concluded based on the export question in the Census of Manufactures.

[24]Total Factor Productivity (TFP) is measured using the Törnqvist superlative index number of Caves, Christensen, and Diewert (1982). Since the differences between exporters and nonexporters are often large, the log approximation can understate considerably the size of these differences. Taking exponents of the employment coefficient in Column 1 of Table 2, exporting firms have 260 percent more employment (since 100*(exp(1.28)-1)=260).

[25]Similar performance differences are observed between plants that ship short versus long distances within the U.S., as shown in Holmes and Stevens (2012).

	Exporter Premia		
	(1)	(2)	(3)
Log Employment	1.28	1.11	-
Log Shipments	1.72	1.35	0.24
Log Value Added per Worker	0.33	0.19	0.21
Log TFP	0.03	0.04	0.04
Log Wage	0.21	0.09	0.10
Log Capital per Worker	0.28	0.16	0.20
Log Skill per Worker	0.06	0.01	0.11
Additional Covariates	None	Industry Fixed Effects	Industry Fixed Effects, Log Employment

Notes: Notes: Data are for 2007 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. Firm exports measured using customs information from LFTTD. 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 except the Log Skill per Worker results in column 2 which are not significant at the 10 percent level.

Table 2: Exporter Premia

As emphasized in the theoretical framework developed above, the decision to export is endogenous. Therefore these estimated "export premia" do not have a causal interpretation and instead capture differences in conditional means between exporters and non-exporters. Two potential explanations for the estimated productivity differences are "selection into exporting" (causality runs from productivity to exporting) and "learning by exporting" (causality runs from exporting to productivity). As productivity differences between future exporters and other non-exporters are typically found to predate entry into exporting, most existing research interprets these productivity differences as largely the result of selection in exporting (see Bernard and Jensen (1999) for U.S. evidence and Clerides and Tybout (1998) for evidence from Mexico, Colombia, and Morocco). Therefore these findings provide empirical support for the mechanism of firm selection into export markets in the original heterogeneous firm model and the theoretical framework developed above. More recently, a number of empirical studies have provided evidence that firm entry into exporting can stimulate the adoption of new productivity-enhancing technologies, including in particular Bustos (2011) and Lileeva and Trefler (2010).

While most existing research has focused on productivity differences between exporters and non-exporters, the results in Table 2 emphasize that exporters differ from non-exporters along a number of other dimensions. The estimated differences in size, wages, capital and skill-intensity are also much larger than those in TFP, consistent with the idea that primitive differences in technology affect a number of firm decision margins, leading to endogenous differences in firm outcomes that are larger than these primitive differences in technology. Burstein and Vogel (2015) and Harrigan and Reshef (2015) explore complementarities between heterogeneous firm technology and the skill-intensity of production. Helpman, Itskhoki, and Redding (2010) and Helpman, Itskhoki, Muendler, and Redding (2015) examine endogenous differences in workforce composition. In such a setting, the increase in the dispersion of revenues across firms as a result of firm selection into export markets increases the dispersion of wages across firms, thereby providing a new mechanism for trade to affect wage inequality.[26]

A subsequent empirical literature has used linked employer-employee datasets to decompose the exporter wage premium into the contributions of unobserved differences in workforce composition and wage premia for workers with identical characteristics. Following Abowd, Kramarz, and Margolis (1999), Abowd, Creecy, and Kramarz (2002), this literature typically assumes that the production function is log additively separable in worker ability and that the switching of workers between firms is random conditional on firm fixed effects, worker fixed effects and time-varying worker observables. In general, this literature finds a role for both unobserved differences in workforce composition and wage premia, with their relative contributions varying across studies, as in Baumgarten (2013), Davidson, Heyman, Matusz, Sjöholm, and Zhu (2014), Frías, Kaplan, and Verhoogen (2015), Krishna, Poole, and Senses (2014), Munch and Skaksen (2008) and Schank, Schnabel, and Wagner (2007).

4.3 Firm Importing

With the emergence of trade transactions datasets based on customs records that can be merged to firms, researchers have gained access to information about firm importing as well as exporting. These new trade transactions data have revealed that firm importing displays many of the same features as firm exporting.

Table 3 compares firm exporting and importing using the 2007 LFTTD, updating results for an earlier year in Bernard, Jensen, Redding, and Schott (2007). Column (1) reproduces the share of each three-digit North American Industrial Classification (NAIC) industry in the number of manufacturing firms from Table 1; Column (2) reproduces the share of firms within each industry that export from Table 1; Column (3) reports the share of firms within each industry that import; and Column (4) summarizes the share of firms within each industry that both export and import.

[26] For a review of the literature on heterogeneous workers and trade, see Grossman (2013).

NAICS Industry		Percent of All Firms	Fraction of Firms that Export	Fraction of Firms that Import	Fraction of Firms that Import & Export
311	Food Manufacturing	6.8	0.23	0.15	0.10
312	Beverage and Tobacco Product	0.9	0.30	0.18	0.11
313	Textile Mills	0.8	0.57	0.44	0.37
314	Textile Product Mills	2.7	0.19	0.14	0.09
315	Apparel Manufacturing	3.6	0.22	0.23	0.15
316	Leather and Allied Product	0.3	0.56	0.53	0.40
321	Wood Product Manufacturing	4.8	0.21	0.09	0.06
322	Paper Manufacturing	1.5	0.48	0.25	0.21
323	Printing and Related Support	11.1	0.15	0.05	0.03
324	Petroleum and Coal Products	0.5	0.34	0.18	0.14
325	Chemical Manufacturing	3.3	0.65	0.40	0.36
326	Plastics and Rubber Products	3.9	0.59	0.34	0.29
327	Nonmetallic Mineral Product	4.3	0.19	0.15	0.09
331	Primary Metal Manufacturing	1.5	0.58	0.32	0.29
332	Fabricated Metal Product	20.6	0.30	0.12	0.10
333	Machinery Manufacturing	8.7	0.61	0.30	0.28
334	Computer and Electronic Product	3.9	0.75	0.50	0.47
335	Electrical Equipment, Appliance,	1.7	0.70	0.46	0.41
336	Transportation Equipment	3.4	0.57	0.35	0.31
337	Furniture and Related Product	6.5	0.16	0.12	0.07
339	Miscellaneous Manufacturing	9.3	0.32	0.20	0.17
Aggregate Manufacturing		100	0.35	0.20	0.16

Notes: Data are for 2007 and are for firms that appear in both the U.S. Census of Manufacturers and the LFTTD. Firm exports and imports measured using customs information from 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 3: Firm Importing and Exporting

Comparing Columns (2) and (3), importers like exporters are relatively rare, accounting for around 20 percent of firms in the U.S. manufacturing sector as a whole. Again there is substantial variation across industries, with the share of importers ranging from a low of 5 percent in Printing and Related Support (323) to a high of 50 percent in Computer and Electronic Product (334). Although traditional models of international trade assume a representative firm (and hence do not explain why only some firms trade within industries), one could try to rationalize the variation across industries in the share of firms that export and import in terms of comparative advantage. Such an explanation would predict a negative relationship between the share of firms that export (highest in comparative advantage industries) and the share of firms that import (highest in comparative disadvantage industries). In contrast to this prediction, we find a strong positive correlation across industries between the share of firms that export and import. In the theoretical framework developed above, this positive correlation can be generated by variation across industries in the fixed costs of participating in international markets (with the shares of both exporting and importing firms higher in industries with lower values of both the fixed exporting and sourcing costs). The theoretical model also identifies another economic mechanism that contributes towards this positive correlation across industries: the higher the share of firms that import, the greater firm supplier access and the lower production costs, thereby increasing export profitability and the share of firms that export.

Comparing Columns (2)-(3) to the fraction of firms that both export and import in Column (4), it is clear that a substantial fraction of firms that engage one margin of international participation also engage in the other. Again this pattern is consistent with the theoretical model developed above, in which there is a complementarity between exporting and importing. On the one hand, incurring the fixed cost to export increases firm sales and output, which makes it more likely that the firm will find it profitable to incur the fixed cost to import. On the other hand, incurring the fixed cost to import reduces firm production costs and prices, which in turn increases firm sales and output, which makes it more likely that the firm will find it profitable to incur the fixed cost to export.

While Table 3 reports results for firms in the U.S. manufacturing sector, many firms in other sectors export or import manufacturing products or other goods. A small body of research has sought to analyze the trade behavior of such intermediaries, wholesalers and retailers, including Ahn, Khandelwal, and Wei (2011), Akerman (2010), Antràs and Costinot (2011), Bernard, Grazzi, and Tomasi (2014), Bernard, Jensen, Redding, and Schott (2010b) and Blum, Claro, and Horstmann (2000).

4.4 Importer Characteristics

Importers exhibit many of the same characteristics as exporters. In Table 4, we highlight this by estimating trading premia using the 2007 LFTTD, updating results for an earlier year in Bernard, Jensen, Redding, and Schott (2007). Each cell in the table again corresponds to a separate regression, in which we regress the log of a firm characteristic on a dummy variable for whether a firm exports (Column (1)), imports (Column (2)) or both exports and imports (Column (3)). We estimate these regressions for the log firm characteristic shown in the rows of the tables. All three columns include industry fixed effects and hence capture within-industry differences in performance between trading and domestic firms. All three specifications also control for firm size (log employment) for all characteristics except log employment.

	Exporter Premia	Importer Premia	Exporter & Importer Premia
Log Employment	1.11	1.20	1.39
Log Shipments	0.24	0.32	0.36
Log Value Added per Worker	0.21	0.25	0.28
Log TFP	0.04	0.03	0.03
Log Wage	0.10	0.09	0.11
Log Capital per Worker	0.20	0.28	0.34
Log Skill per Worker	0.11	0.16	0.18

Notes: Data are for 2007 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. Firm exports and imports measured using customs information from LFTTD. 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 4: Exporter and Importer Premia

Comparing Columns (1) and (2), we find that the performance differences between importers and other firms are of around the same magnitude as those between exporters and other firms. Controlling for size, importers are larger than other firms within the same industry, by approximately 120 percent for employment and 32 percent for shipments; they are more productive by roughly 25 percent for value-added per worker and 3 percent for TFP; they also pay higher wages by around 9 percent. Finally, importers are relatively more capital- and skill-intensive than other firms within the same industry by approximately 28 and 16 percent, respectively, after controlling for size.[27] Comparing Column (3) to Columns (1)-(2), we find that these estimated performance differences between exporters/importers and other firms are partly driven by firms that both export and import. Indeed, we find that the most globally engaged firms that engage in both of these forms of participation in the global economy exhibit the largest performance differences relative to other firms.[28] Therefore, in line with the theoretical framework above, more productive firms participate in the international economy in more ways than less productive firms.

Motivated by the early empirical findings from micro datasets on plants and firms that contained only export information, the paradigmatic heterogeneous firm model following Melitz (2003) concentrates on firm exporting. However, a growing body of theoretical and empirical research examines firm decisions to participate in international markets through both exporting and importing, including Amiti and Davis (2011), Amiti, Itskhoki, and Konings (2015) Antràs, Fort, and Tintelnot (2014), Blaum, Lelarge, and Peters (2013, 2014), Eaton, Kortum, Kramarz, and Sampognaro (2014), Fort (2014) and

[27] Since the differences between importers and other firms are sometimes large, the log approximation again can understate considerably the size of these differences. Taking exponents of the employment coefficient in Column (2) of Table 4, importing firms have 232 percent more employment (since 100*(exp(1.20)-1)=232).

[28] While we focus on firm exporting and importing, similar performance differences are observed between multinationals and other firms. See for example Doms and Jensen (1998), Helpman, Melitz, and Yeaple (2004) and Yeaple (2009).

Oberfield (2015). An extreme internationalization of production occurs when a firm offshores all stages of production abroad and becomes a "factory-less goods producing firm." Such firms are like domestic manufacturers, in the sense that they design the goods they sell and coordination production activities, and yet their domestic employment is concentrated outside manufacturing. Bernard and Fort (2015), show that these factory-less goods producing firms account for an increasing share of U.S. employment over time.

In the theoretical framework developed above, sourcing inputs from foreign countries reduces firm variable production costs by expanding the set of locations from which the lowest-cost supplier of each intermediate input can be chosen. Consistent with this prediction, Blaum, Lelarge, and Peters (2014) finds a modest increase in firm productivity from importing, of around 5 percent for the median firm relative to autarky. As larger firms have higher import intensities, the aggregate gains from importing are larger and range from 16 to 47 percent, depending on the strength of interlinkages between firms.

4.5 Extensive Margins of Firm Exporting and Importing

One of the central features of the theoretical framework developed above is that firms decide to participate in the international economy along multiple extensive margins: the number of products to export to each market, the number of export markets, the number of intermediate inputs to import from each source country, and the number of countries from which to source intermediate inputs. We now use U.S. export and import transactions data to provide evidence on these firm extensive margin decisions.[29]

In Table 5, we report the joint distributions for exporting firms across the number of products exported (rows) and the number of markets served (columns). The top panel reports the percentage of exporting firms; the middle panel reports the percentage of export value; and the bottom panel reports the percentage of exporter employment. The cells in each panel sum to 100. Comparing results across the three panels, we find that around 35 percent exporters ship one product to one market (top panel, top left cell), but they account for only 11 percent of employment (bottom panel, top left cell) and a mere 1 percent of export value (middle panel, top left cell). In contrast, the 5 percent of exporters that ship eleven or more products to eleven or more markets (top panel, bottom right cell) account for around 46 percent of employment (bottom panel, bottom right cell) and nearly 80 percent of export value (middle panel, bottom right cell). Across all three panels, the diagonal terms in each panel tend to be large relative to the off-diagonal terms, so that firms that export to many markets also on average export many products. This pattern of results is consistent with the positive correlation between the different margins of firm international participation in the theoretical framework above. More successful firms export more of each product to each market, as well as exporting more products to each market and exporting to more markets, thereby ensuring that relatively few firms account for most of aggregate

[29] As discussed in the data section, we aggregate the data on individual trade transactions by firm, product, destination and year. Relatively little research has explored the properties of these data at a more disaggregated level, with some exceptions such as Hornok and Koren (2014) and Hornok and Koren (2015).

export value.[30]

Percentage of Exporting Firms								
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	34.9	8.6	3.5	1.8	1.1	1.8	1.0	**52.8**
2	2.1	5.7	2.8	1.5	0.9	1.4	0.6	**14.9**
3	0.6	1.3	1.9	1.2	0.8	1.4	0.6	**7.7**
4	0.3	0.5	0.7	0.8	0.7	1.3	0.6	**4.8**
5	0.2	0.3	0.4	0.4	0.4	1.1	0.5	**3.3**
6-10	0.3	0.5	0.6	0.7	0.7	2.9	2.4	**8.1**
11+	0.1	0.2	0.2	0.3	0.3	1.8	5.5	**8.4**
All	**38.4**	**17.0**	**10.1**	**6.7**	**4.9**	**11.7**	**11.2**	**100.0**

Percentage of Export Value								
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	0.8	0.5	0.3	0.2	0.2	0.5	1.0	**3.6**
2	0.2	0.3	0.3	0.2	0.1	0.5	0.7	**2.4**
3	0.1	0.1	0.2	0.1	0.2	0.5	0.6	**1.9**
4	0.1	0.1	0.1	0.2	0.1	0.4	0.4	**1.4**
5	0.0	0.1	0.1	0.1	0.1	0.3	0.6	**1.2**
6-10	0.3	0.2	0.3	0.3	0.3	1.2	2.9	**5.6**
11+	0.2	0.4	0.3	0.4	0.3	2.6	79.7	**83.9**
All	**1.7**	**1.9**	**1.6**	**1.4**	**1.3**	**6.1**	**86.0**	**100.0**

Percentage of Employment								
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	11.3	3.0	1.4	0.7	0.4	1.3	0.6	**18.7**
2	0.5	3.0	1.3	0.8	0.4	1.0	1.1	**8.1**
3	0.2	0.7	1.5	0.6	0.7	1.3	0.7	**5.7**
4	0.0	0.3	0.3	0.8	0.4	1.6	2.5	**6.0**
5	0.0	0.2	0.1	0.1	0.4	1.3	2.1	**4.2**
6-10	0.1	0.2	0.2	0.3	0.2	2.5	5.5	**9.0**
11+	0.0	0.0	0.1	0.1	0.3	1.5	46.4	**48.3**
All	**12.1**	**7.4**	**4.9**	**3.4**	**2.7**	**10.5**	**59.0**	**100.0**

Notes: Data are from the 2007 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: Export Distribution by Product and Country

In Table 6, we report analogous joint distributions of importing firms across the number of products imported (rows) and the number of foreign countries from which products are imported (columns). The cells in each panel again sum to 100. Looking across the three panels, we find a similar a similar pattern of results for imports as for exports. Around 30 percent of importers source one product from one foreign country (top panel, top left cell), but they account for around 11 percent of employment (bottom panel, top left cell) and less than 1 percent of import value (middle panel, top left cell). By

[30]Another feature of international trade besides its concentration across firms is its "sparsity": the prevalence of zeros with many firms exporting few products to few destinations, as examined in Armenter and Koren (2014).

comparison, the 3 percent of importers that ship eleven or more products to eleven or more markets (top panel, bottom right cell) account for around 46 percent of employment (bottom panel, bottom right cell) and approximately 76 percent of export value (middle panel, bottom right cell). We again find that the diagonal terms in each panel tend to be large relative to the off-diagonal terms, implying that firms that import from many countries also on average import many products. These results again confirm the positive correlation between the different margins of international participation in the model. More successful firms import more of each product from each country, as well as importing more products from each country and importing from more countries, thereby again enabling a relatively small number of firms to be responsible for most of aggregate import value.

More broadly, these findings provide additional support for a growing body of research that emphasizes the importance of the extensive margins of firm selection into export markets for aggregate trade. Comparing the Krugman (1980) model to the Melitz (2003) model with an untruncated Pareto productivity distribution, Chaney (2008) shows that the presence of the extensive margin in the heterogeneous firm model reverses the relationship between the elasticity of substitution and the sensitivity of trade flows to trade costs. Using firm export data from France, Eaton, Kortum, and Kramarz (2004) decompose the variation in aggregate exports across destination markets, and show that the extensive margin of the number of exporting firms accounts for over 60 percent of the variation.[31] Using the same French data, Eaton, Kortum, and Kramarz (2011) structurally estimate an extension of the paradigmatic model of heterogeneous firms and trade and show that the extensive margin of firm export participation plays a central role in shaping the effects of a counterfactual 10 percent in bilateral trade barriers for all French firms.[32] Most of the overall increase in French exports of around $16 million is accounted for by a rise in the sales of the top decile of firms of around $23 million.[33] In contrast, every other decile of firms experiences a decline in sales, with around half the firms in the bottom decile exiting. Using a gravity equation specification, Helpman, Melitz, and Rubinstein (2008) show that incorporating the extensive margin of firm selection into export markets is consequential for estimates of the impact of standard trade frictions (such as distance and whether countries share a common border) on trade flows.

[31] Following trade liberalization reforms, Kehoe and Ruhl (2013) find that much of the growth in overall trade occurs in goods that were not previously exported or were only previously exported in small amounts.

[32] Other quantitative analyses of models of heterogeneous firms and trade include the study of trade integration in Corcos, Del Gatto, Mion, and Ottaviano (2012), the analysis of the impact of China's productivity growth on world welfare in Hsieh and Ossa (2011), the investigation of patterns of trade in Bangladesh's apparel sector in Cherkashin, Demidova, Kee, and Krishna (2010), and the exploration of foreign direct investment (FDI) activity in Irarrazabal, Opromolla, and Moxnes (2013).

[33] The importance of the extensive margins in understanding variation in aggregate trade flows does not necessarily imply that they are relevant for measuring the aggregate welfare gains from trade. For the circumstances under which the aggregate gains from trade can be summarized by a constant trade elasticity and an aggregate domestic trade share in the paradigmatic model of heterogeneous firms, see Arkolakis, Costinot, and Rodriguez-Clare (2012) and Melitz and Redding (2015).

	Share of Importing Firms							
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	29.7	8.5	4.1	2.5	1.6	3.6	2.1	**52.1**
2	2.4	5.3	3.1	1.8	1.3	3.2	2.3	**19.3**
3	0.6	1.2	1.5	1.2	0.8	2.3	2.1	**9.6**
4	0.2	0.4	0.5	0.6	0.5	1.6	1.6	**5.5**
5	0.1	0.2	0.2	0.3	0.3	1.1	1.4	**3.5**
6-10	0.1	0.2	0.2	0.3	0.3	1.6	3.9	**6.6**
11+	0.0	0.0	0.0	0.0	0.0	0.2	3.0	**3.4**
All	**33.0**	**15.7**	**9.7**	**6.6**	**4.9**	**13.5**	**16.5**	**100.0**
	Share of Import Value							
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	0.6	0.5	0.3	0.2	0.2	0.6	0.5	**3.0**
2	0.2	0.3	0.2	0.3	0.2	0.8	1.0	**3.0**
3	0.1	0.2	0.2	0.2	0.2	0.8	1.2	**2.8**
4	0.1	0.1	0.1	0.2	0.1	0.4	1.2	**2.3**
5	0.0	0.0	0.1	0.1	0.1	0.4	1.3	**2.0**
6-10	0.0	0.0	0.1	0.2	0.2	1.3	7.1	**8.9**
11+	0.0	0.2	0.0	0.1	0.1	1.1	76.4	**78.0**
All	**1.0**	**1.4**	**1.1**	**1.2**	**1.1**	**5.5**	**88.7**	**100.0**
	Share of Employment							
Number of Products	Number of Countries							
	1	2	3	4	5	6 - 10	11+	**All**
1	11.3	3.0	1.4	0.7	0.4	1.3	0.6	**18.7**
2	0.5	3.0	1.3	0.8	0.4	1.0	1.1	**8.1**
3	0.2	0.7	1.5	0.6	0.7	1.3	0.7	**5.7**
4	0.0	0.3	0.3	0.8	0.4	1.6	2.5	**6.0**
5	0.0	0.2	0.1	0.1	0.4	1.3	2.1	**4.2**
6-10	0.1	0.2	0.2	0.3	0.2	2.5	5.5	**9.0**
11+	0.0	0.0	0.1	0.1	0.3	1.5	46.4	**48.3**
All	**12.1**	**7.4**	**4.9**	**3.4**	**2.7**	**10.5**	**59.0**	**100.0**

Notes: Data are from the 2007 LFTTD. Table displays the joint distribution of U.S. manufacturing firms that import (top panel), their import value (middle panel) and their employment (bottom panel), according to the number of products firms import (rows) and their number of import sources (columns). Products are defined as ten-digit Harmonized System categories.

Table 6: Import Distribution by Product and Country

Other research has established the importance of the extensive margin of the number of products exported to each market within firms. Bernard, Redding, and Schott (2011) develops a general equilibrium model of multiple-product, multiple-destination firms, which features heterogeneity and selection across products within firms as well as across firms.[34] Firms choose whether to export to each market and the range of products to export to each market. Under the assumption of untruncated Pareto distributions for firm productivity and product attributes, the model implies log linear relationships for aggregate trade, the intensive margin of average exports per firm-product conditional on positive trade,

[34] Other recent research on multi-product firms in international trade includes Arkolakis, Muendler, and Ganapati (2014), Eckel and Neary (2010), Feenstra and Ma (2008), Mayer, Melitz, and Ottaviano (2013) and Nocke and Yeaple (2014).

and the extensive margin of the number of firm-product observations with positive trade. Estimating these gravity equation relationships using U.S. trade transactions data, the negative effect of distance on aggregate bilateral trade is largely explained by the extensive margin of the number of firm-product observations with positive trade. Although distance reduces the intensive margin of exports of a given product by a given firm, average firm-product exports conditional on positive trade are largely uncorrelated with distance, because of endogenous changes in export composition.[35]

More recent research has begun to provide evidence on the extensive margins of firm importing. As discussed above, Antràs, Fort, and Tintelnot (2014) develops a quantitative multi-country sourcing model in which heterogeneous firms self-select into importing based on their productivity and country-specific variables (wages, trade costs, and technology).[36] For parameter values for which firm importing decisions are complementary across source countries, firm import participation exhibits a strict hierarchy, according to which the number of countries from which a firm sources is (weakly) increasing in its productivity. The presence of endogenous import sourcing decisions plays a central important role in shaping the effects of a counterfactual shock of increased import competition from China. While this common import competition shock decreases overall domestic sourcing and employment, some firms can be induced to select into sourcing from China as a result of the shock. For parameter values for which importing decisions are complementary across source countries, these firms on average increase their input purchases not only from China, but also from the U.S. and other countries.

4.6 Co-movement in the Margins of International Participation

We now provide further evidence on one of the model's key predictions of co-movement across the margins of firm participation in international markets. In Table 7, we calculate the correlations of log value (total trade, imports, exports and total related-party trade) and log counts (import and export counts of country-products, products, and countries) for firms with positive values in the category. In every case we find positive and significant correlations across the different dimensions of international activity of the firm. Perhaps unsurprisingly, total firm trade is strongly positively correlated with firm exports and imports as well as total related-party trade. In addition, however, we see that export value and counts of export products and countries are positively related to similar measures on the import side. As predicted by the model, firms that source from more countries, or import more products, also export more products to more countries and the total value of their exports is higher.

[35] As shown in Bernard, Jensen, Redding, and Schott (2009), the extensive margins of the number of number of exported products and export markets account for much of the cross-section variation in aggregate U.S. exports and imports. Over short time horizons, the intensive margin of average trade conditional on trade being positive is relatively more important, and the extensive and intensive margins behave differently for arms-length versus related-party trade in response to macroeconomic shocks such as the 1997 Asian financial crisis.

[36] Using French firm import data, Blaum, Lelarge, and Peters (2013) provide evidence that larger firms spend relatively more on their most important import variety, and examine three mechanisms that can account for this finding: a complementarity between input quality and firm productivity, a search process by which larger firms search for foreign suppliers more intensively, and the presence of intra-firm trade.

Table 7: Correlations

			Value				Counts					
							Import			Export		
			Total	Exports	Imports	RP Total	Country-Products	Products	Countries	Product-Countries	Products	Countries
Value		Total	1.00									
			270.0									
		Exports	0.85	1.00								
			210.0	*210.0*								
		Imports	0.88	0.34	1.00							
			140.0	*77.1*	*140.0*							
		RP Total	0.70	0.52	0.65	1.00						
			44.7	*38.7*	*35.4*	*44.7*						
Counts	Import	Country-Products	0.66	0.30	0.74	0.47	1.00					
			140.0	*77.1*	*140.0*	*35.4*	*140.0*					
		Products	0.62	0.27	0.70	0.45	0.98	1.00				
			140.0	*77.1*	*140.0*	*35.4*	*140.0*	*140.0*				
		Countries	0.62	0.42	0.64	0.40	0.79	0.69	1.00			
			140.0	*77.1*	*140.0*	*35.4*	*140.0*	*140.0*	*140.0*			
	Export	Product-Countries	0.71	0.79	0.31	0.39	0.37	0.34	0.47	1.00		
			210.0	*210.0*	*77.1*	*38.7*	*77.1*	*77.1*	*77.1*	*210.0*		
		Products	0.68	0.75	0.33	0.41	0.39	0.38	0.46	0.95	1.00	
			210.0	*210.0*	*77.1*	*38.7*	*77.1*	*77.1*	*77.1*	*210.0*	*210.0*	
		Countries	0.62	0.68	0.25	0.28	0.31	0.28	0.44	0.87	0.74	1.00
			210.0	*210.0*	*77.1*	*38.7*	*77.1*	*77.1*	*77.1*	*210.0*	*210.0*	*210.0*

Note: This table reports correlations of log of the variables (value or counts) for firms that have positive values of both variables. The smaller numbers in italics are the counts of firms in thousands for each cell. All correlations are significant at the 1% level.

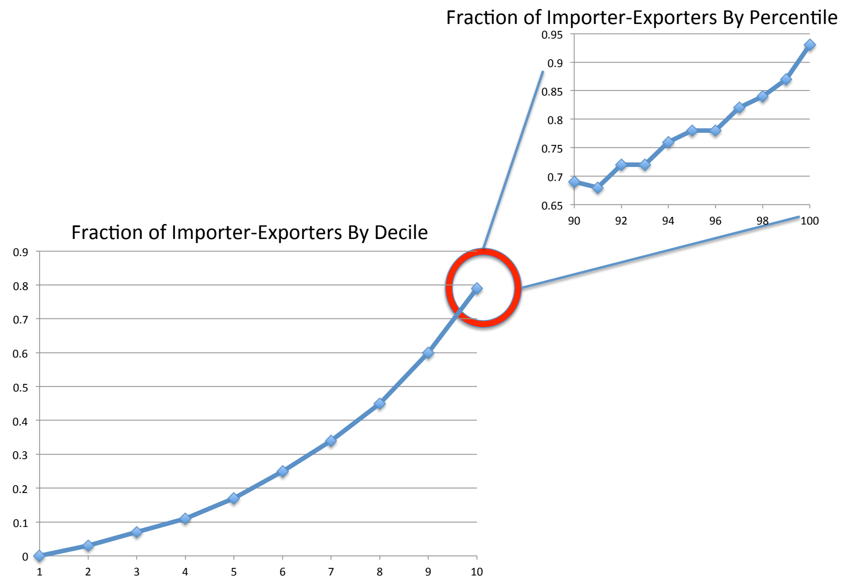

Figure 1: Fraction of Importer-Exporters by Decile/Percentile of Firm Total Trade

In Figure 1, we provide evidence on the correlation between firm exporting and importing decisions suggested by the model. For each decile or percentile bin of the distribution of total firm trade, we compute the fraction of all trading firms within the bin that both export and import. As shown in the main panel of the figure, the extent of two-way trade increases non-linearly across the distribution of total firm trade, whether we look across decile bins of the distribution as a whole or across percentile bins of the top decile of the distribution. Therefore the most successful trading firms are disproportionately likely to both export and import, consistent with the presence of fixed costs of both exporting and importing in the theoretical framework above.

The framework also predicts that the various margins of international participation will interact with each other. Increases in firm productivity have more than proportional increases in international trade because of the reinforcing connections between exporting and importing. In Figures 2-6, we examine how the different margins of firm international participation vary across deciles and percentiles of the value of total firm trade (exports plus imports). The horizontal axis of the graph in the lower left of each figure represents the ten deciles of firms sorted by their total trade and is held constant across each of the figures. The horizontal axis of the graph in the upper right hand corner of each figure covers firms in the 90th to 100th percentiles of the firm total trade distribution and is held constant across the figures. The vertical axis in the five figures uses a log scale. In the main panel of each figure, we report means across decile bins of total firm trade. In the call-out panel of each figure, we show means across percentile bins of the top decile of total firm trade.

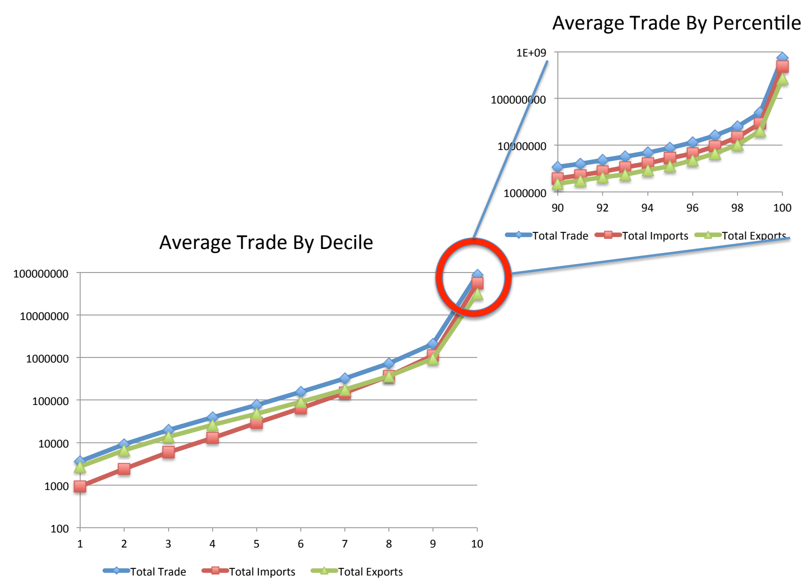

Figure 2: Value of Firm Exports, Imports and Total Trade by Decile/Percentile of Firm Total Trade

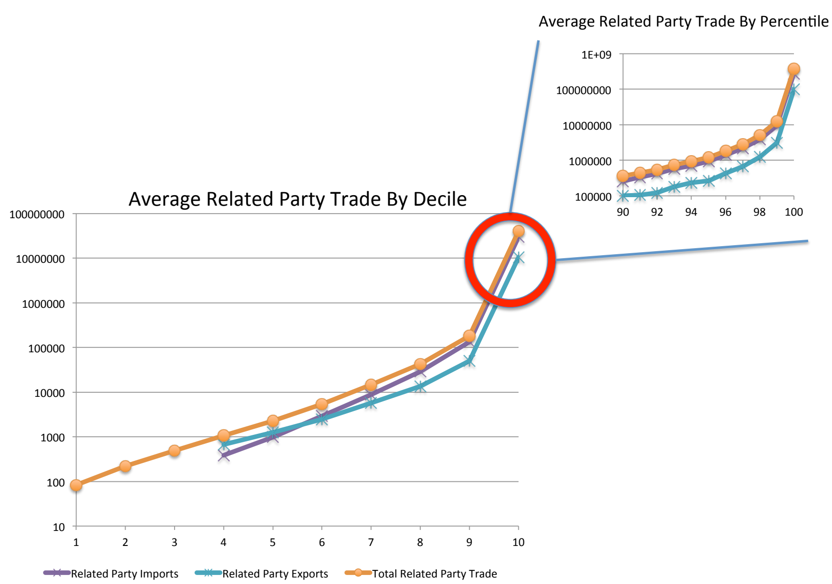

Figure 3: Value Firm Related-Party Trade by Decile/Percentile of Firm Total Trade

As shown in the main panel of Figure 2, the logs of the average values of firm exports and imports increase monotonically across the first nine deciles of the firm total trade distribution. Total trade for the average firm increases roughly 225 percent from one decile to the next.[37] The picture changes drastically for the top decile. Average total trade for the largest ten percent of firms is 42 times greater than that of the previous decile. The biggest traders are far larger than the rest of the trading firms and this pattern holds for both their imports as well as their exports. Comparing the main and call-out panels of Figure 2, we find that the distribution of trade across firms has a fractal property, where we find the same pattern across percentiles of the top decile as across the deciles of the distribution as a whole. Average total trade, exports and imports increased relatively steadily until the very top percentile when it jumps again. The top one percent of trades are 15 times larger than the second largest percentile of firms.

In Figure 3, we calculate the average value of related-party trade: total, exports and imports.[38] As is apparent from the main panel, average related-party trade is sharply increasing across the deciles.[39] Again we find a positive correlation between the margins of international participation: firms that trade more not only import and export more overall, but also import and export more with related parties. Related-party exports and imports increase more rapidly across deciles of the total trade distribution than overall exports and imports, so that related-party trade accounts for a bigger share of overall trade for the larger trading firms. Comparing the main and call-out panels of the figure, we again observe that the results exhibit a fractal property, with the same pattern across percentiles of the top decile as across the deciles of the distribution as a whole. The average firm in the top percentile of trading firms conducts 29 times as much related-party trade as the average firm in the next percentile.[40]

While the first two figures focus on trade values, the next several figures examine the extensive margins of firm participation in international markets. In Figure 4, we show the number of product-country observations with positive exports or imports across percentiles of the value of total firm trade. As evident from the main panel, the product-country extensive margin increases monotonically across deciles of the total firm trade distribution, with the level of activity in terms of country-products jumping in the highest decile. Therefore more successful firms trade more than less successful firms, not only because they export or import more of a given number of products with a given number of countries, but also because they export and import with more product-country pairs. Again, we find the same properties

[37] The growth of exports is slightly lower, 210 percent, while the growth of imports is slightly higher, 244 percent. See Table 8.

[38] To conform with census disclosure requirements we only report results for related-party exports and imports from the fourth decile upwards.

[39] For evidence on firm productivity as a determinant of related-party trade, see Nunn and Trefler (2008, 2013) and Bernard, Jensen, Redding, and Schott (2010a).

[40] The sharp increase in the share of related-party trade with the size of firm total trade explains why related-party trade accounts for around half of aggregate U.S. imports (see Antràs (2003) and Bernard, Jensen, and Schott (2009)), even though intra-firm shipments are relatively unimportant for the average plant or firm (see Atalay, Hortaçsu, and Syverson (2014) and Ramondo, Rappaport, and Ruhl (2015)). The key to reconciling these features of the data is that related-party trade is disproportionately important for the very largest firms that account for a disproportionate share of aggregate trade value.

across the percentiles of the top decile (in the call-out panel) as across the deciles of the distribution as a whole (in the main panel).

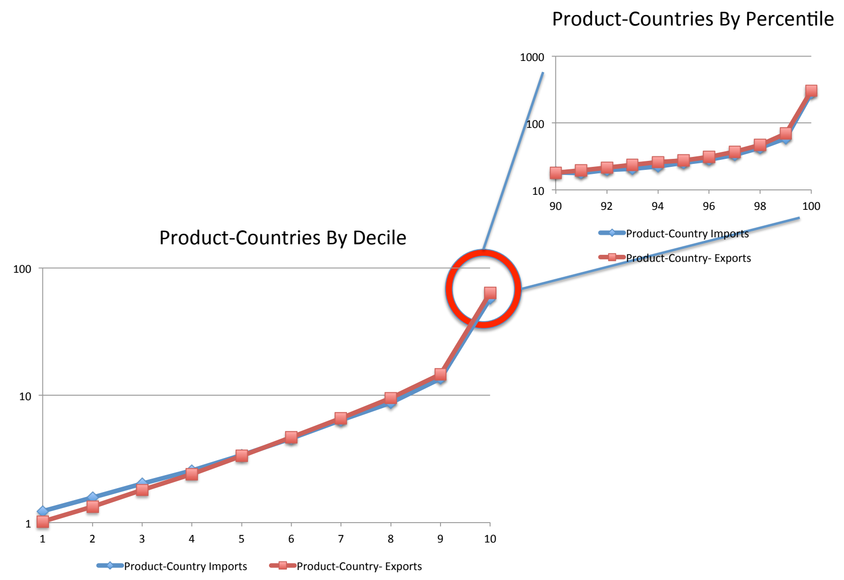

Figure 4: Product–Country Extensive Margin by Decile/Percentile of Firm Total Trade

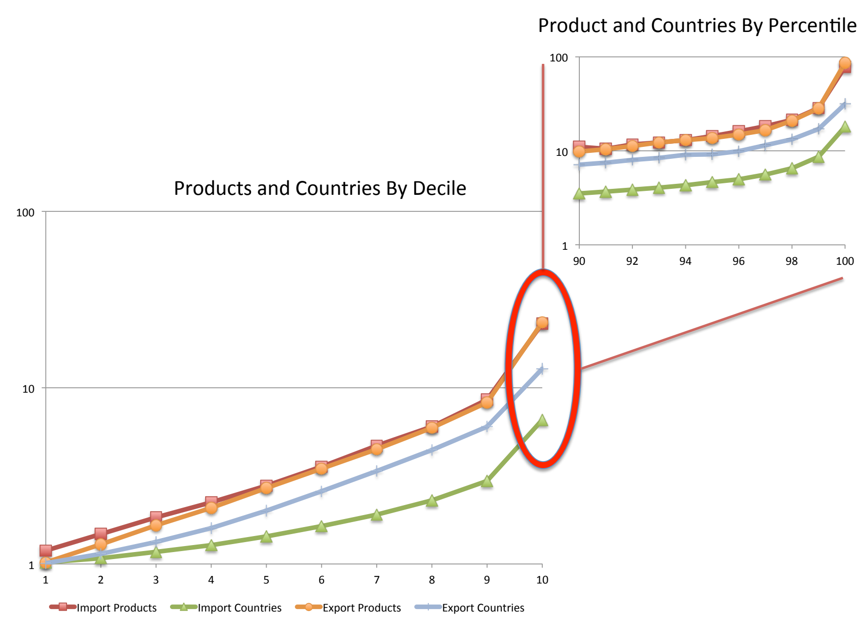

Figure 5: Product and Country Extensive Margins by Decile/Percentile of Firm Total Trade

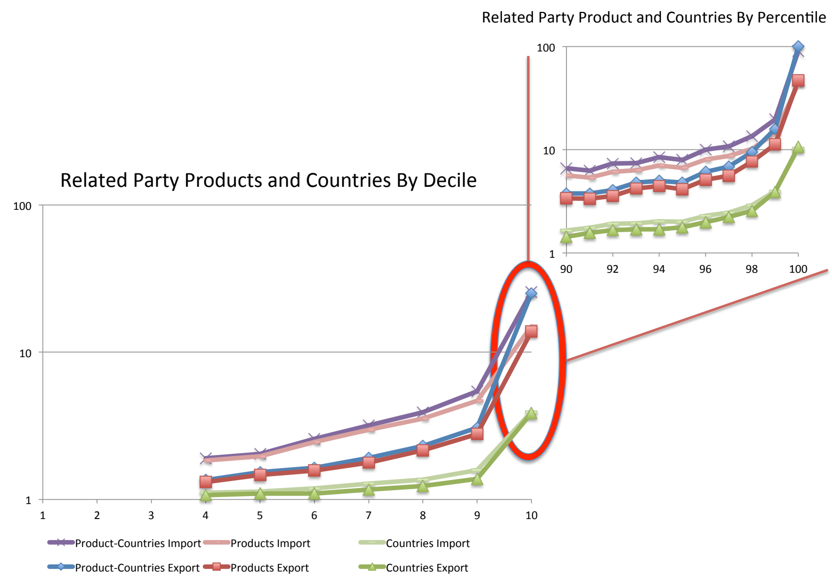

Figure 6: Related Party Product and Country Extensive Margins by Decile/Percentile of Firm Total Trade

In Figures 4 and 5, we break out the product-country extensive margin in the contributions of the product and country extensive margins separately. As shown in the main panel, the increase in the number of product-country observations with positive trade across the deciles of the total firm trade distribution is achieved partly through an increase in the number of products with positive trade and partly through an increase in the number of countries with positive trade. While the extensive margins for export and import products rise at approximately the same rate across the deciles of total firm trade, the extensive margin for export destinations rises more rapidly than that for import source countries, suggesting that fixed sourcing costs are large relative to fixed exporting costs. For all these extensive margins, the level of activity jumps the top decile, and the distributions are fractal, in the sense that we observe a similar pattern across percentiles of the top decile as across the deciles of the distribution as a whole.

Figure 6 shows the distribution of extensive margins activity for related-party trade. the pattern is a familiar one with a roughly log-linear increase across the deciles until the largest decile where there is a substantial jump in activity. Again, we see the pattern repeated within the top decile as the largest trading firms have many more related-party connections for both imports and exports. This extensive margin of related party activity suggests a useful extension of the framework to incorporate the decision whether to organize overseas production within the boundaries of the firm (foreign direct investment (FDI)) or through arms-length transactions (outsourcing). Work on firm-level FDI has consistently found that more productive firms are more likely to be multinationals, i.e. have at least one foreign affiliate, and that the numbers of host countries and affiliates are increasing in measures of firm performance.[41]

Taken together, these results paint a picture in which all the margins of firm international participation co-move together, with greater participation along one margin correlated with more active engagement along another. This pattern of results is consistent with two core mechanisms in the model. On the one hand, higher firm productivity propels greater international participation along all margins simultaneously through the non-random selection of firms into these different activities. On other hand, the decisions to participate in international markets along each margin are complementary with one another. As more productive firms incur the fixed exporting costs of serving additional markets, this increases their production scale, and raises the profitability of incurring the fixed sourcing costs for additional countries. Incurring these additional fixed sourcing costs in turn reduces production costs, which raises the profitability of incurring the fixed exporting costs for additional markets. Through these both these forces of selection and complementarity, exogenous differences across firms are magnified, such that a relatively small number of firms account for a disproportionately large share of aggregate trade.

5 Conclusions

Over the last two decades, a growing body of theoretical and empirical research has demonstrated the role of heterogeneous firm decisions in mediating the economy's response to international trade. The now-standard model of heterogeneous firms and trade envisions a continuum of measure zero firms that compete under conditions of monopolistic competition and self-select into export markets. In this paper, we review this research and argue that this standard paradigm does not go far enough in recognizing the role of individual firms. In particular, much of international trade is dominated by a few large firms that are far from measure zero and participate in international markets in multiple ways.

We outline a theoretical framework that recognizes the role played by such global firms. We allow large firms to internalize the effects of their choices on market aggregates, which results in variable markups, pricing to market and incomplete pass-through. We include a much richer range of margins along which firms can participate in international markets than the standard paradigm. Each firm can choose the set of production locations in which to operate plants; the set of export markets for each plant; the set of products to export from each plant to each market; the exports of each product from each plant to each market; the set of countries from which to source intermediate inputs for each plant; and imports of each intermediate input from each source country by each plant.

[41] The large literature on foreign direct investment (FDI) includes Antràs (2003), Antràs and Helpman (2004), Arkolakis, Ramondo, Rodriguez-Clare, and Yeaple (2015), Brainard (1997), Doms and Jensen (1998), Helpman (1984), Helpman, Melitz, and Yeaple (2004), Markusen and Venables (1998, 2000), Ramondo and Rodriguez-Clare (2013), and Yeaple (2009), as reviewed in Antràs and Yeaple (2009).

Table 8: Values and counts by Decile/Percentile of Total Trade

	Total		Exports					Imports				
Decile	Trade	Related Party	Total	Related Party	Product-Countries	Products	Countries	Total	Related Party	Product-Countries	Products	Countries
1	3,636	83	2,710		1.0	1.0	1.0	926		1.2	1.2	1.0
2	9,089	221	6,667		1.3	1.3	1.1	2,422		1.5	1.5	1.1
3	19,602	488	13,731		1.8	1.7	1.3	5,871		1.9	1.8	1.2
4	39,083	1,057	26,162	671	2.4	2.1	1.6	12,921	386	2.4	2.2	1.3
5	76,677	2,254	47,753	1,263	3.2	2.7	2.0	28,924	991	3.0	2.8	1.4
6	154,424	5,331	90,274	2,453	4.5	3.5	2.6	64,149	2,879	4.0	3.6	1.6
7	324,256	14,500	175,594	5,695	6.3	4.5	3.4	148,661	8,805	5.5	4.7	1.9
8	733,326	42,046	367,218	13,358	9.0	5.9	4.4	366,109	28,688	7.3	6.0	2.3
9	2,065,189	182,897	936,988	49,775	13.7	8.3	6.0	1,128,201	133,122	11.1	8.6	3.0
10	88,061,648	39,984,764	32,075,318	10,515,436	56.2	23.4	12.8	55,986,328	29,469,326	42.0	23.0	6.6

	Total		Exports					Imports				
Percentile	Trade	Related Party	Total	Related Party	Product-Countries	Products	Countries	Total	Related Party	Product-Countries	Products	Countries
90	3,435,321	357,656	1,490,421	100,988	16.8	9.8	7.1	1,944,900	256,668	14.7	11.0	3.5
91	4,023,476	443,004	1,745,703	105,011	18.3	10.4	7.5	2,277,773	337,993	14.3	10.5	3.7
92	4,745,500	540,808	2,051,352	122,827	20.2	11.2	8.0	2,694,148	417,981	15.9	11.7	3.9
93	5,699,326	749,423	2,360,996	178,258	22.0	12.2	8.4	3,338,330	571,165	16.6	12.3	4.0
94	6,976,046	942,954	2,916,673	231,552	24.1	13.0	9.1	4,059,373	711,402	17.9	13.0	4.3
95	8,759,872	1,198,860	3,537,986	267,746	25.4	13.6	9.2	5,221,886	931,115	20.2	14.4	4.7
96	11,483,836	1,845,385	4,772,462	438,196	28.7	14.8	9.9	6,711,374	1,407,188	22.3	16.0	5.0
97	15,995,423	2,856,674	6,607,454	675,232	34.1	16.6	11.4	9,387,969	2,181,443	26.1	18.3	5.6
98	24,941,730	5,088,683	10,179,695	1,244,585	42.8	20.9	13.3	14,762,034	3,844,098	32.7	21.3	6.5
99	49,822,084	12,626,625	20,263,520	3,136,505	63.2	28.4	17.1	29,558,564	9,490,120	44.8	28.4	8.6
100	748,328,256	373,635,840	266,373,648	98,775,784	261.7	86.0	31.4	481,954,592	274,860,064	193.4	78.2	18.0

We use this framework to structure our interpretation of U.S. firm and trade transactions data. We show that only a subset of firms participate in international markets (through either exporting or importing) and that these trading firms have superior performance characteristics: they are larger, more productive, more capital-intensive, more skill-intensive and pay higher wages than purely domestic firms. We find strong support for the model's prediction of a correlation between the different margins of firm participation in the global economy. A substantial fraction of firms that export or import do both. More successful firms export more of each product to each market, export more products to each market, export to more markets, import more of each product from each source country, importing more products from each source country, and import from more source countries. Therefore small differences in exogenous firm characteristics have magnified effects on endogenous firm performance (such as sales), because they are magnified by these endogenous market participation decisions, thereby helping to explain how a relatively small number of firms dominate aggregate international trade.

While much already has been achieved within the literature on heterogeneous firms and trade, there remains much to be done. One area for further research includes the implications of global firms for the transmission of international shocks, the elasticity of trade with respect to trade costs, and the aggregate welfare gains from trade. Although we consider many margins of firm participation in the international economy, we abstract from the decision whether to organize global production chains within or beyond the boundaries of the firm, which itself has been the subject of much recent research. Therefore another interesting area for further inquiry is exploring the implications of this internalization decision for firm performance and country comparative advantage in a world of such global firms.

A Appendix

A.1 Derivation of Equilibrium Pricing Rule

The first-order condition for the price of product k for firm f from production country i in market m within sector g is:

$$Q^K_{mik} + \sum_{h\in\Omega^K_{mif}} \left(P^K_{mih} \frac{dQ^K_{mih}}{dP^K_{mik}} - \frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}} \frac{dQ^K_{mih}}{dP^K_{mik}} \right) = 0. \tag{30}$$

From equation (9), we have:

$$\frac{\partial Q^K_{mih}}{\partial P^K_{mik}} = \left(\sigma^F_g - 1\right) \frac{Q^K_{mih}}{P^G_{mg}} \frac{\partial P^G_{mg}}{\partial P^K_{mik}} + \left(\sigma^K_g - \sigma^F_g\right) \frac{Q^K_{mih}}{P^F_{mif}} \frac{\partial P^F_{mif}}{\partial P^K_{mik}} - \sigma^K_g \frac{Q^K_{mih}}{P^K_{mik}} \frac{\partial P^K_{mih}}{\partial P^K_{mik}}.$$

We now can use the expenditure shares (7) and (8) to solve for the elasticities and rewrite $\partial Q^K_{mih} / \partial P^K_{mik}$ as

$$\begin{aligned}
\frac{\partial Q^K_{mih}}{\partial P^K_{mik}} &= \left(\sigma^F_g - 1\right) \left(\frac{\partial P^G_{mg}}{\partial P^F_{mif}} \frac{P^F_{mif}}{P^G_{mg}} \right) \left(\frac{\partial P^F_{mif}}{\partial P^K_{mik}} \frac{P^K_{mik}}{P^F_{mif}} \right) \frac{Q^K_{mih}}{P^K_{mik}} + \left(\sigma^K_g - \sigma^F_g\right) \left(\frac{\partial P^F_{mif}}{\partial P^K_{mik}} \frac{P^K_{mik}}{P^F_{mif}} \right) \frac{Q^K_{mih}}{P^K_{mik}} - \sigma^K_g \frac{Q^K_{mih}}{P^K_{mik}} 1_{\{k=h\}} \\
&= \left(\sigma^F_g - 1\right) S^F_{mif} S^K_{mik} \frac{Q^K_{mih}}{P^K_{mik}} + \left(\sigma^K_g - \sigma^F_g\right) S^K_{mik} \frac{Q^K_{mih}}{P^K_{mik}} - \sigma^K_g \frac{Q^K_{mih}}{P^K_{mik}} 1_{\{k=h\}}.
\end{aligned} \tag{31}$$

If we now substitute equation (31) into equation (30) and divide both sides by Q^K_{mik}, we get:

$$\begin{aligned}
& 1 + \sum_{h\in\Omega^K_{mif}} \left(\sigma^F_g - 1\right) S^F_{mif} S^K_{mik} \frac{P^K_{mih} Q^K_{mih}}{P^K_{mik} Q^K_{mik}} + \sum_{h\in\Omega^K_{mif}} \left(\sigma^K_g - \sigma^F_g\right) S^K_{mik} \frac{P^K_{mih} Q^K_{mih}}{P^K_{mik} Q^K_{mik}} - \sigma^K_g \\
& - \sum_{h\in\Omega^K_{mif}} \left(\sigma^F_g - 1\right) S^F_{mif} S^K_{mik} \frac{\frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}} Q^K_{mih}}{P^K_{mik} Q^K_{mik}} - \sum_{h\in\Omega^K_{mif}} \left(\sigma^K_g - \sigma^F_g\right) S^K_{mik} \frac{\frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}} Q^K_{mih}}{P^K_{mik} Q^K_{mik}} \\
& + \sigma^K_g \frac{\frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifk}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}}}{P^K_{mik}} = 0.
\end{aligned} \tag{32}$$

We define the markup as $\mu^K_{mih} \equiv P^K_{mih} \Big/ \left(d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}} / \varphi_{if} \right)$. Since $S^K_{mik} \frac{1}{P^K_{mik} Y^K_{mik}} = \frac{1}{\sum_{h\in\Omega^K_{mif}} P^K_{mih} Y^K_{mih}}$ and therefore $\sum_{h\in\Omega^K_{mif}} S^K_{mik} \frac{P^K_{mih} Y^K_{mih}}{P^K_{mik} Y^K_{mik}} = 1$, we can rewrite equation (32) as:

$$\begin{aligned}
& \left[1 + \left(\sigma^F_g - 1\right) S^F_{mif} + \left(\sigma^K_g - \sigma^F_g\right) - \sigma^K_g\right] - \left(\sigma^F_g - 1\right) S^F_{mif} \frac{\sum_{h\in\Omega^K_{mif}} \frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}} Q^K_{mih}}{\sum_{h\in\Omega^K_{mif}} P^K_{mih} Q^K_{mih}} \\
& - \left(\sigma^K_g - \sigma^F_g\right) \frac{\sum_{h\in\Omega^K_{mif}} \frac{d^X_{mi}\gamma^K_k \left[\Phi_{ifh}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\varphi_{if}} Q^K_{mih}}{\sum_{h\in\Omega^K_{mif}} P^K_{mih} Q^K_{mih}} + \sigma^K_g \frac{1}{\mu^K_{mik}} = 0.
\end{aligned}$$

Note that μ^K_{mik} is the only k-specific term in this expression. Hence, μ^K_{mik} must take the same value for all products k supplied by firm f from production country i to market m within sector g: $\mu^K_{mik} = \mu^F_{mif}$ for all $k \in \Omega^K_{mif}$. In other words, *markups are the same across products within a given firm, market and sector*. We can now solve for μ^F_{mif} using:

$$\left[1 + \left(\sigma^F_g - 1\right) S^F_{mif} + \left(\sigma^K_g - \sigma^F_g\right) - \sigma^K_g\right] - \left(\sigma^F_g - 1\right) S^F_{mif} \frac{1}{\mu^F_{mif}} - \left(\sigma^K_g - \sigma^F_g\right) \frac{1}{\mu^F_{mif}} + \sigma^K_g \frac{1}{\mu^F_{mif}} = 0$$

$$\Rightarrow \mu^F_{mif} = \frac{\sigma^F_g - \left(\sigma^F_g - 1\right) S^F_{mif}}{\sigma^F_g - \left(\sigma^F_g - 1\right) S^F_{mif} - 1}.$$

A.2 Proof of Proposition 1

Proof. **(i)** From the firm price index (6) and firm pricing rule (20), we have:

$$P^F_{mif} = \left(\frac{\mu^F_{mif}}{\varphi_{if}}\right) \Gamma^F_{mif}, \tag{33}$$

where

$$\Gamma^F_{mif} = d^X_{mi} \gamma^K_k \left[\sum_{k \in \Omega^K_{mif}} \left(\frac{\left[\Phi_{ifk}\left(\Omega^{NI}_{if}\right)\right]^{-\frac{1}{\theta^K_k}}}{\lambda^K_{mik}}\right)^{1-\sigma^K_g}\right]^{\frac{1}{1-\sigma^K_g}},$$

$$\Phi_{ifk}\left(\Omega^{NI}_{if}\right) = \sum_{j \in \Omega^{NI}_{if}} T^K_{jk} (w_j d^I_{ij})^{-\theta^K_k}.$$

Using the firm expenditure share (7) and (33), we obtain:

$$S^F_{mif} = \frac{\left(\mu^F_{mif}/\varphi_{if}\right)^{1-\sigma^F_g} \left(\Gamma^F_{mif}/\lambda^F_{mif}\right)^{1-\sigma^F_g}}{\sum_{i \in \Omega^N} \sum_{o \in \Omega^F_{mig}} \left(\mu^F_{mio}/\varphi_{io}\right)^{1-\sigma^F_g} \left(\Gamma^F_{mio}/\lambda^F_{mio}\right)^{1-\sigma^F_g}}. \tag{34}$$

Using the mark-up (21) and perceived elasticity (22), we define the following implicit function:

$$\Xi = S^F_{mif} - \frac{\left(\frac{\sigma^F_g - \left(\sigma^F_g - 1\right) S^F_{mif}}{\left(\sigma^F_g - 1\right) - \left(\sigma^F_g - 1\right) S^F_{mif}}\right)^{1-\sigma^F_g} \varphi_{if}^{\sigma^F_g - 1} \left(\Gamma^F_{mif}/\lambda^F_{mif}\right)^{1-\sigma^F_g}}{\sum_{i \in \Omega^N} \sum_{o \in \Omega^F_{mig}} \left(\frac{\sigma^F_g - \left(\sigma^F_g - 1\right) S^F_{mio}}{\left(\sigma^F_g - 1\right) - \left(\sigma^F_g - 1\right) S^F_{mio}}\right)^{1-\sigma^F_g} \varphi_{io}^{\sigma^F_g - 1} \left(\Gamma^F_{mio}/\lambda^F_{mio}\right)^{1-\sigma^F_g}} = 0. \tag{35}$$

From the implicit function theorem:

$$\frac{\partial S^F_{mif}}{\partial \varphi_{if}} = -\frac{\partial \Xi / \partial \varphi_{if}}{\partial \Xi / \partial S^F_{mif}}, \tag{36}$$

where we hold constant $\{w_m, \Omega^{NP}_f, \Omega^{NX}_{if}, \Omega^{NI}_{if}, \Omega^K_{mif}\}$ and all other model parameters except productivity. From (35), we have:

$$\frac{\partial \Xi}{\partial \varphi_{if}} = -\frac{\sigma^F_g - 1}{\varphi_{if}} S^F_{mif} \left(1 - S^F_{mif}\right) < 0, \tag{37}$$

$$\frac{\partial \Xi}{\partial S_{mif}^{F}} = 1 + \left(\sigma_g^F - 1\right)\left(\frac{\partial \mu_{mif}^{F}}{\partial S_{mif}^{F}}\frac{S_{mif}^{F}}{\mu_{mif}^{F}}\right)\left(1 - S_{mif}^{F}\right) > 0, \tag{38}$$

since

$$\frac{\partial \mu_{mif}^{F}}{\partial S_{mif}^{F}}\frac{S_{mif}^{F}}{\mu_{mif}^{F}} = \frac{\sigma_g^F - 1}{\varepsilon_{nif}^{F} - 1} S_{mif}^{F}\left(1 - \frac{1}{\mu_{mif}^{F}}\right) > 0. \tag{39}$$

From (36)-(39), an increase in firm productivity raises expenditure shares within each market:

$$\frac{\partial S_{mif}^{F}}{\partial \varphi_{if}} > 0, \tag{40}$$

(ii) Together (39) and (40) imply that an increase in firm productivity raises markups:

$$\frac{\partial \mu_{mif}^{F}}{\partial \varphi_{if}} > 0. \tag{41}$$

From (34), the firm expenditure share is decreasing in the ratio of the markup to firm productivity $(\mu_{mif}^{F}/\varphi_{if})$:

$$\frac{\partial S_{mif}^{F}}{\partial \left(\mu_{mif}^{F}/\varphi_{if}\right)} = -\frac{\sigma_g^F - 1}{\left(\mu_{mif}^{F}/\varphi_{if}\right)} S_{mif}^{F}\left(1 - S_{mif}^{F}\right) < 0. \tag{42}$$

Now we combine (40)-(42). The firm expenditure share increases in productivity in (40), even though the firm markup increases in productivity in (41). Therefore, from (42), the firm markup must rise less than proportionately with productivity (to ensure that the firm expenditure share increases in productivity), which implies that the price of each product must decrease in productivity:

$$\frac{\partial P_{mik}^{K}}{\partial \varphi_{if}} = \frac{\partial \left(\frac{\mu_{mif}^{F}}{\varphi_{if}} d_{mi}^{X}\gamma_k^K\left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}\right)}{\partial \varphi_{if}} < 0. \tag{43}$$

(iii) Sales of each product in each sector in each market can be written as:

$$E_{mik}^{K} = S_{mik}^{K} S_{mif}^{K}\left(\lambda_{mg}^{G} w_m L_m\right), \tag{44}$$

where the share of each product k in firm expenditure (S_{mik}^{K}) is independent of firm productivity and the markup because both are common across products within a given firm in a given market:

$$S_{mik}^{K} = \frac{\left(\left[\Phi_{ifk}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}/\lambda_{mik}^{K}\right)^{1-\sigma_g^K}}{\sum_{n\in\Omega_{mif}^{K}}\left(\left[\Phi_{ifn}\left(\Omega_{if}^{NI}\right)\right]^{-\frac{1}{\theta_k^K}}/\lambda_{min}^{K}\right)^{1-\sigma_g^K}}. \tag{45}$$

From (40), (44) and (45), the firm expenditure share (S_{mif}^{K}) increases in firm productivity, while the product expenditure share (S_{mik}^{K}) is unaffected by firm productivity. Therefore an increase in firm productivity raises sales of each product in a given market:

$$\frac{\partial E_{mik}^{K}}{\partial \varphi_{if}} > 0. \tag{46}$$

Output of each product in a given sector and market can be written as:

$$Q^K_{mik} = \frac{E^K_{mik}}{P^K_{mik}}. \tag{47}$$

From (43) and (46), an increase in firm productivity raises sales (E^K_{mik}) and reduces (P^K_{mik}) of each product in each market, which implies that it raises output (Q^K_{mik}) of each product in each market:

$$\frac{\partial Q^K_{mik}}{\partial \varphi_{if}} > 0. \tag{48}$$

Since an increase in firm productivity raises sales and output of each product in each market, it also raises overall sales (E^K_{ik}) and output (Q^K_{ik}) of each product across all markets:

$$\frac{\partial E^K_{ik}}{d\varphi_{if}} > 0, \qquad \frac{\partial Q^K_{ik}}{\partial \varphi_{if}} > 0, \tag{49}$$

where $E^K_{ik} = \sum_{m \in \Omega^{NX}_{if}} E^K_{mik}$ and $Q^K_{ik} = \sum_{m \in \Omega^{NX}_{if}} Q^K_{mik}$. □

A.3 Proof of Proposition 2

Proof. From Proposition 1, we have:

$$\frac{\partial E^K_{mik}}{\partial \varphi_{if}} > 0, \qquad \frac{\partial \mu^F_{mif}}{\partial \varphi_{if}} > 0,$$

where we hold constant $\{w_m, \Omega^{NP}_f, \Omega^{NX}_{if}, \Omega^{NI}_{if}, \Omega^K_{mif}, \tilde{\Omega}^K_{mif}\}$ and all model parameters except productivity. Therefore we have:

$$\frac{\partial \left(\left(\frac{\mu^F_{mif} - 1}{\mu^F_{mif}} \right) E^K_{mik} \right)}{\partial \varphi_{if}} > 0, \qquad \text{for all } k \in \left\{ \tilde{\Omega}^K_{mif} \backslash \Omega^K_{mif} \right\},$$

which together with (27) establishes the proposition. □

A.4 Proof of Proposition 3

Proof. From Proposition 1, we have:

$$\frac{\partial E^K_{mik}}{\partial \varphi_{if}} > 0, \qquad \frac{\partial \mu^F_{mif}}{\partial \varphi_{if}} > 0,$$

where we hold constant $\{w_m, \Omega^{NP}_f, \Omega^{NX}_{if}, \Omega^{NI}_{if}, \Omega^K_{mif}, \tilde{\Omega}^K_{mif}\}$ and all model parameters except productivity. Therefore we have:

$$\frac{\partial \left(\left(\frac{\mu^F_{mif} - 1}{\mu^F_{mif}} \right) E^K_{mik} \right)}{\partial \varphi_{if}} > 0, \qquad \text{for all } k \in \Omega^K_{mif},$$

which together with (28) establishes the proposition. □

A.5 Proof of Proposition 4

Proof. From Proposition 1, we have:

$$\frac{\partial E^K_{mik}\left(\Omega^{NI}_{if}\right)}{\partial \varphi_{if}} > 0, \qquad \frac{\partial \mu^F_{mif}\left(\Omega^{NI}_{if}\right)}{\partial \varphi_{if}} > 0,$$

where we make explicit that both the markup (μ^F_{mif}) and sales of each product (E^K_{mik}) are functions of the set of source countries (Ω^{NI}_{if}); we also hold constant $\{w_m, \Omega^{NP}_{f}, \Omega^{NX}_{if}, \Omega^{NI}_{if}, \Omega^{K}_{mif}, \tilde{\Omega}^{K}_{mif}\}$ and all model parameters except productivity. Therefore we have:

$$\frac{\partial\left(\left(\frac{\mu^F_{mif}\left(\Omega^{NI}_{if}\right)-1}{\mu^F_{mif}\left(\Omega^{NI}_{if}\right)}\right)E^K_{mik}\left(\Omega^{NI}_{if}\right)\right)}{\partial \varphi_{if}} > 0, \qquad \text{for all } k \in \Omega^K_{mif},$$

which together with (29) establishes the proposition. □

References

ABOWD, J. M., R. H. CREECY, AND F. KRAMARZ (2002): "Computing Person and Firm Effects Using Linked Longitudinal Employer-Employee Data," *LEHD Technical Paper*, 2002-06.

ABOWD, J. M., F. KRAMARZ, AND D. N. MARGOLIS (1999): "High Wage Workers and High Wage Firms," *Econometrica*, 67(2), 251–333.

AHN, J., A. KHANDELWAL, AND S. WEI (2011): "The Role of Intermediaries in Facilitating Trade," *Journal of International Economics*, 84(1), 73–85.

AKERMAN, A. (2010): "Wholesalers and Economies of Scope in International Trade," Research Papers in Economics, Department of Economics, Stockholm University 2010:1.

ALFARO, L., P. ANTRÁS, D. CHOR, AND P. CONCONI (2015): "Internalizing Global Value Chains: A Firm-Level Analysis," *NBER Working Paper*, 21582.

AMITI, M., AND D. R. DAVIS (2011): "Trade, Firms and Wages: Theory and Evidence," *Review of Economic Studies*, 79(1), 1–36.

AMITI, M., O. ITSKHOKI, AND J. KONINGS (2015): "Importers, Exporters and Exchange Rate Disconnect," *American Economic Review*.

AMITI, M., AND J. KONINGS (2007): "Trade Liberalization, Intermediate Inputs, and Productivity: Evidence from Indonesia," *American Economic Review*, 97(5), 1611–1638.

ANTRÀS, P. (2003): "Firms, Contracts, and Trade Structure," *Quarterly Journal of Economics*, 118(4), 1375–1418.

——— (2015): *Global Production: Firms, Contracts, and Trade Structure*. Princeton University Press, Princeton.

ANTRÀS, P., AND D. CHOR (2013): "Organizing the Global Value Chain," *Econometrica*, 81(6), 2127–2204.

ANTRÀS, P., AND A. COSTINOT (2011): "Intermediated Trade," *Quarterly Journal of Economics*, 126(3), 1319–1374.

ANTRÀS, P., T. FORT, AND F. TINTELNOT (2014): "The Margins of Global Sourcing: Theory and Evidence from U.S. Firms," Harvard University, mimeograph.

ANTRÀS, P., AND E. HELPMAN (2004): "Global Sourcing," *Journal of Political Economy*, 112(3), 552–80.

Antràs, P., and E. Rossi-Hansberg (2009): "Organizations and Trade," *Annual Review of Economics*, 1, 43–64.

Antràs, P., and S. Yeaple (2009): "Multinational Firms and the Structure of International Trade," in *Handbook of International Trade*, ed. by G. Gopinath, E. Helpman, and K. Rogoff, vol. 4, chap. 2, pp. 55–130. Elsevier North Holland, Amsterdam.

Arkolakis, C., A. Costinot, and A. Rodriguez-Clare (2012): "New Trade Models, Same Old Gains," *American Economic Review*, 102(1), 94–130.

Arkolakis, C., M. A. Muendler, and S. Ganapati (2014): "The Extensive Margin of Exporting Products: A Firm-Level Analysis," *NBER Working Paper*, 16641.

Arkolakis, C., N. Ramondo, A. Rodriguez-Clare, and S. Yeaple (2015): "Innovation and Production in the Global Economy," Yale University, mimeograph.

Armenter, R., and M. Koren (2014): "A Balls-and-Bins Model of Trade," *American Economic Review*, 104(7), 2127–2151.

Atalay, E., A. Hortaçsu, and C. Syverson (2014): "Vertical Integration and Input Flows," *American Economic Review*, 104(4), 1120–48.

Atkeson, A., and A. Burstein (2008): "Pricing to Market, Trade Costs and International Relative Prices," *American Economic Review*, 98(5), 1998–2031.

Atkeson, A., and A. T. Burstein (2010): "Innovation, Firm Dynamics, and International Trade," *Journal of Political Economy*, 118(3), 433–484.

Baldwin, R., and A. Venables (2013): "Spiders and Snakes: Off-shoring and Agglomeration in the Global Economy," *Journal of International Economics*, 90, 245–254.

Baumgarten, D. (2013): "Exporters and the Rise in Wage Inequality: Evidence from German Linked Employer-Employee Data," *Journal of International Economics*, 90(1), 201–217.

Bergin, P., and R. Feenstra (2001): "Pricing-to-Market, Staggered Contracts and Real Exchange Rate Persistence," *Journal of International Economics*, 44, 333–359.

Berman, N., P. Martin, and T. Mayer (2012): "How do Different Exporters React to Exchange Rate Changes? Theory, Empirics and Aggregate Implications," *Quarterly Journal of Economics*, 127(1), 437–492.

Bernard, A. B., J. Eaton, J. B. Jensen, and S. S. Kortum (2003): "Plants and Productivity in International Trade," *American Economic Review*, 93(4), 1268–1290.

BERNARD, A. B., AND T. FORT (2015): "Factoryless Goods Producing Firms," *American Economic Review*, forthcoming.

BERNARD, A. B., M. GRAZZI, AND C. TOMASI (2014): "Intermediaries in International Trade: Margins of Trade and Export Flows," *NBER Working Paper*, 17711.

BERNARD, A. B., AND J. B. JENSEN (1995): "Exporters, Jobs, and Wages in US Manufacturing: 1976-87," *Brookings Papers on Economic Activity: Microeconomics*, pp. 67–112.

——— (1999): "Exceptional Export Performance: Cause, Effect or Both?," *Journal of International Economics*, 47(1), 1–25.

BERNARD, A. B., J. B. JENSEN, S. J. REDDING, AND P. K. SCHOTT (2007): "Firms in International Trade," *Journal of Economic Perspectives*, 21(3), 105–130.

——— (2009): "The Margins of U.S. Trade," *American Economic Review*, 99(2), 487–493, Papers and Proceedings.

——— (2010a): "Intra-firm Trade and Product Contractibility," *American Economic Review*, 100(2), 444–448, Papers and Proceedings.

——— (2010b): "Wholesalers and Retailers in U.S. Trade," *American Economic Review*, 100(2), 408–413, Papers and Proceedings.

——— (2012): "The Empirics of Firm Heterogeneity and International Trade," *Annual Review of Economics*, 4, 283–313.

BERNARD, A. B., J. B. JENSEN, AND P. K. SCHOTT (2009): "Importers, Exporters and Multinationals: A Portrait of Firms in the U.S. that Trade Goods," in *Producer Dynamics: New Evidence from Micro Data*, ed. by T. Dunne, J. B. Jensen, and M. J. Roberts. Chicago University Press, Chicago.

BERNARD, A. B., A. MOXNES, AND Y. SAITO (2014): "Production Networks, Geography and Firm Performance," Tuck School of Business at Dartmouth, mimeograph.

BERNARD, A. B., S. J. REDDING, AND P. K. SCHOTT (2007): "Comparative Advantage and Heterogeneous Firms," *Review of Economic Studies*, 74(1), 31–66.

——— (2010): "Multi-product Firms and Product Switching," *American Economic Review*, 100(1), 70–97.

——— (2011): "Multiproduct Firms and Trade Liberalization," *Quarterly Journal of Economics*, 126(3), 1271–1318.

Blaum, J., C. Lelarge, and M. Peters (2013): "Non-Nomothetic Import Demand: Firm Productivity and Quality Bias," Brown University, mimeograph.

——— (2014): "Estimating the Productivity Gains from Importing," Brown University, mimeograph.

Blum, B., S. Claro, and I. Horstmann (2000): "Facts and Figures on Intermediated Trade," *American Economic Review*, 100(2), 419–423, Papers and Proceedings.

Brainard, S. L. (1997): "An Empirical Assessment of the Proximity-Concentration Trade-off between Multinational Sales and Trade," *American Economic Review*, 87(4), 520–544.

Brooks, E. (2006): "Why Don't Firms Export More? Product Quality and Colombian Plants," *Journal of Development Economics*, 80, 160–178.

Burstein, A., and J. Vogel (2015): "International Trade, Technology, and the Skill Premium," Columbia University, mimeograph.

Bustos, P. (2011): "Trade Liberalization, Exports and Technology Upgrading: Evidence on the impact of MERCOSUR on Argentinian Firms," *American Economic Review*, 101(1), 304–340.

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

Chaney, T. (2008): "Distorted Gravity: The Intensive and Extensive Margins of International Trade," *American Economic Review*, 98(4), 1707–1721.

Cherkashin, I., S. Demidova, H. L. Kee, and K. Krishna (2010): "Firm Heterogeneity and Costly Trade: A New Estimation Strategy and Policy Experiments," Penn State, mimeograph.

Clerides, Sofronis, S. L., and J. Tybout (1998): "Is Learning by Exporting Important? Micro-dynamic Evidence from Columbia, Mexico and Morocco," *Quarterly Journal of Economics*, 113(3), 903–947.

Constantini, J. A., and M. J. Melitz (2008): "The Dynamics of Firm-Level Adjustment to Trade Liberalization," in *The Organization of Firms in a Global Economy*, ed. by E. Helpman, D. Marin, and T. Verdier, pp. 107–141. Harvard University Press, Princeton.

Corcos, G., M. Del Gatto, G. Mion, and G. Ottaviano (2012): "Productivity and Firm Selection: Quantifying the New Gains from Trade," *Economic Journal*, 122(561), 754–798.

Costinot, A., J. Vogel, and S. Wang (2013): "An Elementary Theory of Global Supply Chains," *Review of Economic Studies*, 80, 109–144.

Davidson, C., F. Heyman, S. Matusz, F. Sjöholm, and S. C. Zhu (2014): "Globalization and Imperfect Labor Market Sorting," *Journal of International Economics*, 94(2), 177–94.

De Loecker, J., and P. Goldberg (2014): "Firm Performance in a Global Market," *Annual Review of Economics*, 6, 201–227.

De Loecker, J., P. Goldberg, A. Khandelwal, and N. Pavcnik (2015): "Prices, Markups and Trade Reform," *Econometrica*, forthcoming.

De Loecker, J., and F. Warzynski (2012): "Markups and Firm-level Export Status," *American Economic Review*, 102(6), 2437–2471.

Dhingra, S. (2013): "Trading Away Wide Brands for Cheap Brands," *American Economic Review*, 103(6), 2554–84.

di Giovanni, J., A. Levchenko, and I. Mejean (2014): "Firms, Destinations, and Aggregate Fluctuations," *Econometrica*, 82(4), 1303–1340.

Dixit, A., and G. M. Grossman (1982): "Trade and Protection with Multi-Stage Production," *Review of Economic Studies*, 49(4), 583–94.

Doms, M. E., and J. . B. Jensen (1998): "Comparing Wages, Skills, and Productivity between Domestically and Foreign-Owned Manufacturing Establishments in the United States," in *Geography and Ownership as Bases for Economic Accounting*, pp. 235–258. Chicago University Press, Chicago.

Eaton, J., and S. Kortum (2002): "Technology, Geography, and Trade," *Econometrica*, 70(5), 1741–1779.

Eaton, J., S. Kortum, F. Kramarz, and R. Sampognaro (2014): "Firm-to-Firm Trade: Imports, Exports, and the Labor Market," Yale University, mimeograph.

Eaton, J., S. Kortum, and S. Sotelo (2012): "International Trade: Linking the Micro and the Macro," *NBER Working Paper*, 17864.

Eaton, J., S. S. Kortum, and F. Kramarz (2004): "Dissecting Trade: Firms, Industries, and Export Destinations," *American Economic Review*, 94(2), 150–154, Papers and Proceedings.

——— (2011): "An Anatomy of International Trade: Evidence from French Firms," *Econometrica*, pp. 1453–1498.

Eckel, C., and P. J. Neary (2010): "Multi-product Firms and Flexible Manufacturing in the Global Economy," *Review of Economic Studies*, 77, 188–217.

Edmond, C., V. Midrigan, and D. Y. Xu (2012): "Competition, Markups, and the Gains from International Trade," *NBER Working Paper*, 18041.

Feenstra, R., and H. Ma (2008): "Optimal Choice of Product Scope for Multiproduct Firms," in *The Organization of Firms in a Global Economy*, ed. by D. M. Elhanan Helpman, and T. Verdier, chap. 6, pp. 173–199. Harvard University Press, Cambridge MA.

Fitzgerald, D., and S. Haller (2015): "Pricing-to-Market: Evidence from Plant-Level Prices," *Review of Economic Studies*, forthcoming.

Fort, T. (2014): "Technology and Production Fragmentation: Domestic versus Foreign Sourcing," Tuck School of Business, mimeograph.

Freund, C., and M. D. Pierola (2015): "Export Superstars," *Review of Economics and Statistics*, 97(5), 1023–1032.

Frías, J. A., D. S. Kaplan, and E. A. Verhoogen (2015): "Exports and Wage Premia: Evidence from Mexican Employer-Employee Data," Columbia University, unpublished manuscript.

Gabaix, X. (2011): "The Granular Origins of Aggregate Fluctuations," *Econometrica*, 79, 733–772.

Gaubert, C., and O. Itskhoki (2015): "Granular Comparative Advantage," Princeton University, mimeograph.

Goldberg, P., and R. Hellerstein (2013): "A Structural Approach to Identifying the Sources of Local-Currency Price Stability," *Review of Economic Studies*, 80, 175–210.

Goldberg, P., A. Khandelwal, N. Pavcnik, and P. Topalova (2010): "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," *Quarterly Journal of Economics*, 125(4), 1727–67.

Goldberg, P., and M. Knetter (1997): "Goods Prices and Exchange Rates: What Have We Learned?," *Journal of Economic Literature*, 35(3), 1243–1272.

Grossman, G. M. (2013): "Heterogeneous Workers and International Trade," *Review of World Economics*, 149(2), 211–245.

Grossman, G. M., and E. Rossi-Hansberg (2008): "Trading Tasks: A Simple Theory of Offshoring," *American Economic Review*, 98(5), 1978–97.

Hallak, J. C., and P. K. Schott (2011): "Estimating Cross-Country Differences in Product Quality," *Quarterly Journal of Economics*, 126(1), 417–474.

Halpern, L., M. Koren, and A. Szeidl (2015): "mported Inputs and Productivity," *American Economic Review*.

Harrigan, J., and A. Reshef (2015): "Skill-biased Heterogeneous Firms, Trade Liberalization and the Skill Premium," *Canadian Journal of Economics*.

Helpman, E. (1984): "A Simple Theory of International Trade with Multinational Corporations," *Journal of Political Economy*, 92(3), 451–471.

——— (2006): "Trade, FDI and the Organization of Firms," *Journal of Economic Literature*, 44(3), 589–630.

Helpman, E., O. Itskhoki, M. A. Muendler, and S. J. Redding (2015): "Trade and Inequality: From Theory to Estimation," *NBER Working Paper*, 17991.

Helpman, E., O. Itskhoki, and S. J. Redding (2010): "Inequality and Unemployment in a Global Economy," *Econometrica*, 78(4), 1239–1283.

Helpman, E., M. J. Melitz, and Y. Rubinstein (2008): "Estimating Trade Flows: Trading Partners and Trading Volumes," *Quarterly Journal of Economics*, 123(2), 441–87.

Helpman, E., M. J. Melitz, and S. R. Yeaple (2004): "Export Versus FDI with Heterogeneous Firms," *American Economic Review*, 94(1), 300–316.

Holmes, J., and J. J. Stevens (2012): "Exports, Borders, Distance and Plant Size," *Journal of International Economics*, 88(1), 91–103.

Hornok, C., and M. Koren (2014): "Per-Shipment Costs and the Lumpiness of International Trade," *Review of Economics and Statistics*, forthcoming.

——— (2015): "Administrative Barriers to Trade," *Journal of International Economics*, forthcoming.

Hottman, C., S. Redding, and D. Weinstein (2015): "Quantifying the Sources of Firm Heterogeneity," *Quarterly Journal of Economics*, forthcoming.

Hsieh, C.-T., and R. Ossa (2011): "A Global View of Productivity Growth in China," *NBER Working Paper*, 16778.

Irarrazabal, A., L. Opromolla, and A. Moxnes (2013): "The Margins of Multinational Production and the Role of Intrafirm Trade," *Journal of Political Economy*, 121(1), 74–126.

Jarmin, R. S., and J. Miranda (2002): "The Longitudinal Business Database," *Center for Economic Studies Working Paper*, 02(17).

Johnson, R. C., and G. Noguera (2012): "Fragmentation and Trade in Value Added over Four Decades," *NBER Working Paper*, 18186.

Kehoe, T. J., and K. J. Ruhl (2013): "How Important Is the New Goods Margin in International Trade?," *Journal of Political Economy*, 121(2), 358–392.

Khandelwal, A. (2010): "The Long and Short (of) Quality Ladders," *Review of Economic Studies*, 77(4), 1450–1476.

Krishna, P., J. P. Poole, and M. Z. Senses (2014): "Wage Effects of Trade Reform with Endogenous Worker Mobility," *Journal of International Economics*, 93(2), 239–252.

Krugman, P. (1980): "Scale Economies, Product Differentiation, and the Pattern of Trade," *American Economic Review*, 70(5), 950–59.

——— (1987): "Pricing to Market When the Exchange Rate Changes," in *Real Financial Linkages Among Open Economies*, ed. by S. W. Arndt, and J. Richardson. MIT Press, London.

Lileeva, A., and D. Trefler (2010): "Improved Access to Foreign Markets Raises Plant-Level Productivity... for Some Plants," *Quarterly Journal of Economics*, 125(3), 1051–1099.

Manova, K., and Z. Zhang (2012): "Export Prices across Firms and Destinations," *Quarterly Journal of Economics*, 127, 379–436.

Markusen, J. R., and A. J. Venables (1998): "Multinational Firms and the New Trade Theory," *Journal of International Economics*, 46(2), 183–203.

——— (2000): "The Theory of Endowment, Intra-industry Trade and Multinational Trade," *Journal of International Economics*, 52, 209–234.

Mayer, T., M. Melitz, and G. I. Ottaviano (2013): "Market Size, Competition, and the Product Mix of Exporters," *American Economic Review*, 104(2), 495–536.

Mayer, T., and G. Ottaviano (2007): *The Happy Few: New Facts on the Internationalization of European Firms*. Bruegel-CEPR EFIM2007 Report, Bruegel Blueprint Series.

Melitz, M., and G. Ottaviano (2008): "Market Size, Trade, and Productivity," *Review of Economic Studies*, 75, 295–316.

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

MELITZ, M. J., AND S. J. REDDING (2014a): "Heterogeneous Firms and Trade," in *Handbook of International Economics*, ed. by E. Helpman, G. Gopinath, and K. Rogoff, vol. 4, chap. 1, pp. 1–54. Elsevier: North Holland, Amsterdam.

——— (2014b): "Missing Gains from Trade?," *American Economic Review*, 104(5), 317–321, Papers and Proceedings.

——— (2015): "New Trade Models, New Welfare Implications," *American Economic Review*, 105(3), 1105–1146.

MELITZ, M. J., AND D. TREFLER (2015): "Gains from Trade when Firms Matter," *Journal of Economic Perspectives*, 26(2), 91–118.

MRÁZOVÁ, M., AND J. P. NEARY (2015): "Selection Effects with Heterogeneous Firms," University of Oxford, mimeograph.

MUNCH, J. R., AND J. R. SKAKSEN (2008): "Human Capital and Wages in Exporting Firms," *Journal of International Economics*, 75(2), 363–372.

NEARY, J. P. (2015): "International Trade in General Oligopolistic Equilibrium," University of Oxford, mimeograph.

NOCKE, V., AND S. YEAPLE (2014): "Globalization and Endogenous Firm Scope," *International Economic Review*, 55(4), 993–1018.

NUNN, N., AND D. TREFLER (2008): "The Boundaries of the Multinational Firm: An Empirical Analysis," in *The Organization of Firms in a Global Economy*, ed. by E. Helpman, D. Marin, and T. Verdier, pp. 55–83. Harvard University Press, Cambridge MA.

——— (2013): "Incomplete Contracts and the Boundaries of the Multinational Firm," *Journal of Economic Behavior and Organization*, 94(1), 330–344.

OBERFIELD, E. (2015): "Business Networks, Production Chains, and Productivity: A Theory of Input-Output Architecture," Princeton University, mimeograph.

PERLA, J., C. TONETTI, AND M. E. WAUGH (2015): "Equilibrium Technology Diffusion, Trade, and Growth," forthcoming.

PIERCE, J., AND P. K. SCHOTT (2012): "The Surprisingly Swift Decline of U.S. Manufacturing Employment," *NBER Working Paper*, 18655.

RAMONDO, N., V. RAPPAPORT, AND K. RUHL (2015): "Intrafirm Trade and Vertical Fragmentation in U.S. Multinational Corporations," *Journal of International Economics*, forthcoming.

Ramondo, N., and A. Rodriguez-Clare (2013): "Trade, Multinational Production and the Gains from Openness," *Journal of Political Economy*, 121(2), 273–322.

Redding, S. J. (2011): "Theories of Heterogeneous Firms and Trade," *Annual Review of Economics*, 3, 77–105.

Rodríguez-Clare, A. (2010): "Offshoring in a Ricardian World," *American Economic Journal: Macroeconomics*, 2(2), 227–258.

Sampson, T. (2015): "Dynamic Selection: An Idea Flows Theory of Entry, Trade and Growth," *Quarterly Journal of Economics*, forthcoming.

Schank, T., C. Schnabel, and J. Wagner (2007): "Do Exporters Really Pay Higher Wages? First Evidence from German Linked Employer-Employee Data," *Journal of International Economics*, 72(1), 52–74.

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

Thisse, J.-F., and K.-I. Shimomura (2012): "Competition Among the Big and the Small," *Rand Journal of Economics*, 43(2), 329–347.

Tintelnot, F. (2014): "Global Production with Export Platforms," University of Chicago, mimeograph.

Yeaple, S. R. (2005): "A Simple Model of Firm Heterogeneity, International Trade, and Wages," *Journal of International Economics*, 65, 1–20.

——— (2009): "Firm Heterogeneity and the Structure of U.S. Multinational Activity: An Empirical Analysis," *Journal of International Economics*, 78(2), 206–215.

Yi, K.-M. (2003): "Can Vertical Specialization Explain the Growth of World Trade?," *Journal of Political Economy*, 111(1), 52–102.

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