

The Buyer Margins of Firms' Exports

Jerónimo Carballo Gianmarco I.P. Ottaviano
University of Maryland LSE, Bocconi University and CEPR
Christian Volpe Martincus
Inter-American Development Bank

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Abstract

We use highly disaggregated firm-level export data from Costa Rica, Ecuador, and Uruguay over the period 2005-2008 to provide a precise characterization of firms' export margins, across goods, destination countries, and crucially their trading partners. We show that a firm's number of buyers and the distribution of sales across them systematically vary with the characteristics of its destination markets. While most firms serve only very few buyers abroad, the number of buyers and the skewness of sales across them increases with the size and the accessibility of destinations. Based on these findings, we develop a simple model of selection with heterogeneous buyers and sellers in which tougher competition induces a better alignment between consumers' ideal variants and firms' core competencies. This generates a new channel through which tougher competition leads to higher productivity and higher welfare and hints at a new source of gains from trade as long as freer trade fosters competition.

1 Introduction

Starting in the mid-1990s, as data became available, there has been a boom of empirical studies examining the role played by firms in international trade. The first empirical contributions allowed gaining valuable microeconomic insights by analyzing firm-level exports and their determinants (e.g., Roberts and Tybout, 1997; Clerides et al., 1998; Bernard et al., 1999). These contributions inspired theoretical models with heterogeneous firms in open economies (e.g., Melitz, 2003; Bernard et al., 2003; Melitz and Ottaviano, 2008) instead of the representative firm models standard in the international trade literature. This line of research has substantially broadened and deepened in recent years by providing new evidence on the patterns and determinants of firm-level exports across products and destination markets (e.g., Eaton et al., 2004; Eslava et al., 2007; Álvarez et al., 2007; Lawless, 2008; Buono et al., 2008; Iacovone and Javorcik, 2008; Amador and Opromolla, 2008; Volpe Martincus and Carballo, 2008; Arkolakis and Muendler, 2009; Albornoz et al., 2009; Berthou and Fontagné, 2009; Bernard, Redding and Schott, 2012; Mayer, Melitz and Ottaviano, 2012).

Since the mid-2000s, we have witnessed the appearance of studies arguing that importing activities are also a key factor to understand firm heterogeneity. These studies have accordingly focused on firm-level imports (e.g., Halpern et al., 2005) and both firm-level exports and imports (e.g., Kasahara and Lapham, 2008; Vogel and Wagner, 2008; Altomonte and Bekes, 2009; Bernard et al., 2009; Castellani et al., 2009). At the same time, based on samples of manufacturing firms, some researchers have started to look into the patterns and determinants of intra-firm trade by discretely distinguishing firms' imports between those originated from related companies and those originated from independent parties (e.g., Bernard et al., 2008; and Corcos et al., 2009). Virtually all these analyses are based on 'one-sided data', i.e., data that identify either what firms are shipping or receiving the goods, but do not simultaneously identify the sender and the receiver (beyond being or not a related company). Hence, while precious in several dimensions, they do not provide a complete picture of trade relationships as these are actually two-sided. Evidence on how countries' bilateral trade is made up from varying patterns of distributions of firm-firm level transactions across goods and country-pairs is still missing. More precisely, so far existing empirical studies have informed on various extensive and intensive margins of trade: the number of exporting/importing firms (across destination/origin countries), average exports/imports per firm, the number of products firms export and import, average export/import per product, and the number of destination and origin countries. However, there is still little evidence on the number of actual partners for trading companies across products and countries as well as on the distribution of firm-level trade across partners. These are additional extensive and intensive margins of exports.

The aim of this paper is twofold. First, we use highly disaggregated firm-level export from Costa Rica, Ecuador, and Uruguay over the period 2005-2008 to provide a precise characterization of firms' export margins, across goods, destination countries, and crucially their trading partners. The picture that

emerges is very selective. Approximately 35% of the exporters in our sample sell their products to just one trading partner. More than 70% of the exporting firms have five or less trading partners abroad. Roughly 85.0% of the exporting companies spread their total foreign sales across 10 or less trading partners. We also investigate whether and how the buyer margins are shaped by the size and geography of destinations. Here we find that a firm's number of buyers and the distribution of sales across them systematically vary with destination characteristics. In particular, while most firms have only a few trading partners abroad, the number of these partners increases with the size and the accessibility of the destination countries, whereas the concentration in terms of buyers increases with the destination's market size, toughness of competition, and freeness of trade. To the best of our knowledge, this provides, for the first time, evidence on the patterns and determinants of firm exports along the trading partner extensive and intensive margins.

Second, we explore whether the buyer margins can be expected to configure a new channel of welfare gains associated with international trade. To this end, we develop a simple model of selection with heterogeneous buyers and sellers merging the 'representative consumer approach' to product differentiation that is standard in international trade theory (Chamberlin, 1933; Spence, 1976; Dixit and Stiglitz, 1977) with the 'address (or characteristics) approach' that is standard in industrial organization (Hotelling, 1929; Lancaster, 1966 and 1977).

Following the address approach as described by Anderson, de Palma and Thisse (1991), we introduce taste heterogeneity by assuming that the variants of a product can be described as points in a characteristics space. Consumer preferences are defined over all potential variants, and each consumer has a most preferred variant known as her 'ideal point' (or 'address') in the characteristics space. Aggregate preferences for within-product diversity arise from the dispersion of ideal points ('segments') over the characteristics space and, for a given price vector, a variant's demand is defined by the mass of consumers preferring that variant over the others. In particular, for each differentiated product there is a measure of ideal variants that, in the wake of Salop (1979), are located around a circle and consumers are assumed to be uniformly distributed along the circle. However, differently from Hotelling (1929) and Salop (1979) but just like Capozza and Van Order (1978), a consumer can buy a variable amount of her ideal variant of each differentiated product as long as this is available in her market segment. Following the representative consumer approach, the consumer loves product variety and therefore demands each differentiated product provided her ideal variant of the product is available.

As in Melitz and Ottaviano (2008) and Mayer, Melitz and Ottaviano (2011), firms choose in which country to locate and in which 'core segment' to position themselves prior to entry. Upon entry they draw their total factor productivity in serving their core customers in their domestic market ('core competency'). They may also decide to serve non-core customers or foreign markets but in both cases they face additional costs of adaptation or export.

In the proposed model the intensity of competition affects: the number and market shares of active firms as in Melitz and Ottaviano (2008); the number of

variants of their products as well as the distribution of sales across these variants as in Mayer, Melitz and Ottaviano (2011); and, crucially, the numbers of their customers and the distribution of sales across them. This last dimension is the key novelty of the model in that tougher competition is shown to induce a better alignment between consumers' ideal variants and firms' core competencies, generating a new channel through which tougher competition leads to higher productivity and higher welfare. This paves the way to a new source of gains from trade as freer trade fosters competition.

The rest of the paper is organized in four sections. Section 2 describes our data and presents our empirical findings. Section 3 presents the closed economy version of the theoretical model. Section 4 extends it to the open economy. Section 5 provides some concluding remarks.

2 The Buyer Margins of Exports

We use three databases consisting of highly disaggregate firm-level export data from Costa Rica, Ecuador, and Uruguay over the period 2005-2008. In particular, data are reported at the exporter-product-importer-country level. Hence, we know exactly the value of the shipment of each exporter of each product (10-digit HS level) to each importing company in each destination country - the level at which trade actually takes place. Noteworthy, these data virtually cover the whole population of exporting firms in the sample countries and not just a sample of manufacturing firms.

The aggregate indicators of the dataset are presented in Table 1, which portrays a rich coverage in terms of markets, products and buyers. This richness disappears in the last column of Table 2, which shows that the numbers of markets, products and buyers covered by the average exporter are all rather limited. Averaging, however, conceals a lot of heterogeneity as revealed by the other columns of Table 2 reporting the percentiles of the distributions of the same firm-level export outcomes. For parsimony, Table 2 focuses on year 2005 but similar patterns emerge for all years in the sample. Such heterogeneity can be further seen by comparing Tables 3 and 4. In particular, Table 3 reports the percentages of firms exporting given numbers of products (rows) to given numbers of markets (columns) and given numbers of buyers (sub-rows and sub-columns). As there are potentially several products and destinations, the number of buyers corresponds to the maximum in each of these products or destinations. Table 4 reports, instead, the percentages of aggregate exports accounted for by firms in the same cells as Table 3. It shows that firms that export several products to several destinations and, on top, to several buyers each (in at least one of the products or destination) account for large shares of Costa Rica's and Uruguay's total exports, and substantially above those that correspond to counterparts that also export several product to several destinations but only to few buyers. In the case of Ecuador, the picture is somehow less clear cut because the main exporting firm is a state oil company that sells abroad only 4-5 products. Nonetheless, even in this case, this company sells to a lot of

buyers. On the contrary, in Table 3 exporters are concentrated in the cell one-product/one-destination/one-buyer. This concentration of aggregate exports in the hands of few large firms that sell several product to several markets concurs with the findings of Bernard, Jensen, Redding and Schott (2007) for the US and Mayer and Ottaviano (2007) for the EU. In addition, Tables 3 and 4 reveal that an analogous pattern applies to the number of buyers: firms with a large pool of customers are a very selective sample of the population.

Bernard, Jensen, Redding and Schott (2007), Mayer and Ottaviano (2007) as well as Mayer, Melitz and Ottaviano (2011) use gravity regressions to explore the way the number of exporters ('firm extensive margin'), the number of exported products ('product extensive margin') and export volumes per exporter/product ('firm/product intensive margin') vary with export market characteristics. All these margins are negatively affected by the distance and size (GDP) of destination markets. Mayer, Melitz and Ottaviano (2011) also show that each exporter's sales are not uniformly distributed across its product mix but rather skewed towards some 'core' products. This skewness is more pronounced in bigger and more accessible markets.

The gravity regressions in Bernard, Jensen, Redding and Schott (2007), Mayer and Ottaviano (2007) and Mayer, Melitz and Ottaviano (2011) are used to decompose the behavior of aggregate bilateral trade flows along their various margins. We obtain similar results when we run analogous regressions in our sample. Tables 5 to 8 report, instead, our findings at the firm-destination(-year) level. In particular, Table 5 reports the estimates of gravity specifications testing the impact of distance and market size on firms' exports (X), number of buyers (N) and sales concentration across buyers as measured by the share of main buyer (SMB) and the Herfindhal Index (HH). The novel pieces of information that emerge stress the negative impact of distance and the positive impact of market size on the number of buyers per exporter ('buyer extensive margin') and average export per buyer ('buyer intensive margin'). These buyer margins behave very much like the product margins. More strikingly, also the skewness of sales across buyers - conditional on the number of buyers - reacts to distance and market size in the same way as the skewness of the product mix in Mayer, Melitz and Ottaviano (2011) - conditional on the number of products - being more pronounced in closer and larger markets.

Further focusing on skewness, Table 6 reports the results of a gravity-like estimation in which alternative measures of price dispersion are regressed on the same set of variables used in Table 5. It shows that the impacts of distance and market size on the skewness of prices and sales are opposite: distance impacts negatively and market size impacts positively on the extent of price heterogeneity across buyers, though the latter effect is more robust than the former. Hence, a more skewed buyer mix comes with higher price dispersion. These estimations are carried out for the main product of the exporter in a given destination and require that the exporter has at least two buyers of the product in that destination. This implies a restriction on the estimating sample and that is why, for comparability, we also include the estimates for the other dependent variables such as the number of buyers from this restricted sample.

In the wake of Mayer, Melitz and Ottaviano (2011), Table 7 investigates whether the observed behavior of the distribution of export sales and prices across buyers can be interpreted as a reaction of firms to different toughness of competition faced in different markets as determined by a destination’s size and geography (proximity of big countries). The table controls for country size using GDP expressed in a common currency and constant prices and comes from the Word Bank WDI. To control for geography, it uses the ‘supply potential’ introduced by Redding and Venables (2004) and defined as the aggregate predicted exports to a destination based on a bilateral trade gravity equation (in logs) with both exporter and importer fixed effects and the standard bilateral measures of trade barriers/enhancers. The results show that the concentration of buyers increases with the size and the supply potential of destination countries. These findings are robust to: including country-random year effects to control for within-country correlation; using Poisson and Tobit estimators to account for zeroes; adopting alternative measures of within-sales concentration by exporter. In Table 8 analogous regressions are run for different measures of price dispersion across buyers. They reveal that, differently from sales skewness, within-firm within-destination price dispersion increases with country size and market potential.

To make Tables 5 to 8 more readable, we only have reported the OLS estimation results. Similarly, we have presented results for only one measure of sales concentration and only one price dispersion measure (coefficient of variation, in logs). In the same vein, results for the share of the main buyer are based on a specification that controls for the number of buyers (but not by its cubic polynomial). All previous findings are, nonetheless, robust to: including country-year random effects to control for within-country correlation; using Poisson and Tobit estimators to account for zeroes; adopting alternative measures of within sales concentration by exporter or price dispersion. These results are available from the authors upon request.

To summarize, the existing literature has established the presence of several margins along which aggregate export flows react to market conditions: number of exporting firms, average firm exports, number of products per exporter, average firm export per product. Similar decompositions have been applied to aggregate imports. More recently, the literature on multiproduct firms has also emphasized firms’ adjustment to market conditions in terms of the skewness of firms’ export sales across products. Our findings reveal the presence of additional margins of adjustment whereby market conditions affect also the number of buyers as well as the distribution of export sales across buyers in a way that resembles the adjustment across products. The next sections presents a model that is consistent with these new findings and uses the model to suggest that adjustment along the buyer margins of firms’ exports may be an additional source of gains from trade.

3 The Model in Closed Economy

As discussed by Anderson, de Palma and Thisse (1991), there are three main approaches to modeling product differentiation: the representative consumer approach (Chamberlin, 1933; Spence, 1976; Dixit and Stiglitz, 1977), the address (or characteristics) approach (Hotelling, 1929; Lancaster, 1966 and 1977) and the discrete choice approach (McFadden, 1974; Manski, 1977). This section combines the first two approaches to develop a simple model of selection with heterogeneous consumers and firms. In the proposed model the intensity of competition affects the number and market shares of active firms as in Melitz and Ottaviano (2008), the number of variants of their products and the distribution of sales across these variants as in Mayer, Melitz and Ottaviano (2011) as well as the numbers of their customers and the distribution of sales across them. This is the key novelty of the proposed model in that tougher competition induces a better match between consumers' ideal variants and firms' core competencies, generating a new channel through which tougher competition leads to higher productivity and higher welfare. This paves the way to a new source of gains from trade that will be investigated in the next section.

3.1 Heterogeneous Consumers

There are L consumers with preferences defined over a homogenous good 0 and a set Ω of horizontally differentiated products indexed $i \in \Omega$. Each consumer is endowed with \bar{q}_0 units of the homogeneous good and one unit of labor that she inelastically supplies to the market. Each differentiated product comes itself in different variants and consumers differ in terms of their tastes for these variants.

Following the address approach, taste heterogeneity is introduced by assuming that the variants of a product can be described as points in a characteristics space. Consumer preferences are defined over all potential variants, and each consumer has a most preferred variant known as her ideal point (or 'address') in the characteristics space. Aggregate preferences for within-product diversity arise from the dispersion of ideal points over the characteristics space and, for a given price vector, a variant's demand is defined by the mass of consumers preferring that variant over the others.¹ In particular, for each differentiated product i there is a measure 2 of ideal variants that, in the wake of Salop (1979), are located around a circle C of circumference 2 and are indexed in a clockwise manner starting from noon. Each ideal variant $s \in [0, 2]$ defines a market segment consisting of the set of consumers whose ideal variant is s and consumers are assumed to be uniformly distributed across the segments. Each segment, therefore, consists of $L/2$ consumers.

Differently from Hotelling (1929) and Salop (1979) but just like Capozza and Van Order (1978), a consumer can buy a variable amount of her ideal variant of each differentiated product as long as available in her market segment. In

¹As pointed out by Anderson, de Palma and Thisse (1991), this address model is equivalent to a discrete choice model with each consumer choosing the variant yielding the highest utility, while the taste distribution can be obtained from the distribution of ideal points.

particular, let $\Omega^s \subseteq \Omega$ be the set of products whose variants are available in segment s . The utility function of a representative consumer in segment s is then given by

$$U_c^s = q_c^s(0) + \alpha \int_{i \in \Omega^s} q_c^s(i) di - \frac{1}{2} \gamma \int_{i \in \Omega^s} [q_c^s(i)]^2 di - \frac{1}{2} \eta \left[\int_{i \in \Omega} q_c^s(i) di \right]^2 \quad (1)$$

where $\gamma > 0$ measures the ‘love for variety’ of the different products while α and η measure the preference for the differentiated products with respect to the homogeneous good. The initial endowment \bar{q}_0 of the homogeneous good is assumed to be large enough for its consumption to be strictly positive at the market equilibrium. According to this preference structure, each market segment is characterized in terms of a representative consumer who likes a variety of differentiated products but demands a specific ideal variant of each of them. When her ideal variant of a product is not available, the consumer does not demand that product at all.

3.2 Heterogeneous Firms

Labor is the only factor of production. It can be employed in the production of the homogeneous good under perfect competition and constant returns to scale with unit labor requirement equal to one. It can also be employed in the production of the differentiated products under monopolistic competition. In each segment s there is an infinite number of potential entrants with entry requiring an R&D effort of $f > 0$ units of labor to design a new product and its production process, which is also characterized by constant returns to scale. Effort f leads to the design of a new product in segment s with certainty whereas the unit labor requirement c of the corresponding production process is uncertain, being randomly drawn from a continuous distribution with cumulative density

$$G(c) = \left(\frac{c}{c_M} \right)^k, \quad c \in [0, c_M] \quad (2)$$

This corresponds to the empirically relevant case in which marginal productivity $1/c$ is Pareto distributed with shape parameter $k \geq 1$ over the support $[1/c_M, \infty)$.² Hence, as k rises, density is skewed towards the upper bound of the support of $G(c)$.

The R&D effort cannot be recovered and this gives rise to a sunk entry cost. By sinking f in a given segment, an entrant selects it as its ‘core segment’, inventing the corresponding ‘core variant’ with its ‘core unit input requirement’ (or ‘core competency’) c . However, after entry, the entrant can also decide to supply variants of its product to other non-core segments. This involves additional adaptation imposing incrementally higher unit labor requirement for the variants the further away their segments are from the entrant’s core segment.

²As argued by Mayer, Melitz and Ottaviano (2011), the distributional assumption (2) yields, up to an additive shift, a Pareto distribution for firm size and product sales that fits empirical patterns well.

Specifically, if the core variant introduced in segment s entails a unit labor requirement c , its non-core variant adapted to segment s' entails a unit labor requirement $e^{\delta|s-s'|}c$, where $|s-s'|$ is the length of shortest arc linking s and s' on the circle C . In this setup, the parameter $\delta > 0$ can be interpreted as an index of ‘taste heterogeneity’. When $\delta = 0$, all consumers share the same ideal variants of the differentiated products and no adaptation is thus required. As δ grows, consumers’ ideal variants diverge and adaptation becomes increasingly costly.³

3.3 Firms’ Selection

On the demand side, utility maximization gives the following individual inverse demand for product i ’s variant in segment s

$$p^s(i) = \alpha - \gamma q_c^s(i) - \eta Q_c^s \quad (3)$$

with $Q_c^s = \int_{i \in \Omega_s} q_c^s(i) di$ as long as $q_c^s(i) > 0$. Total demand in segment s therefore equals

$$q^s(i) \equiv L^s q_c^s(i) = \frac{\alpha L^s}{\eta N^s + \gamma} - \frac{L^s}{\gamma} p^s(i) + \frac{\eta N^s}{\eta N^s + \gamma} \frac{L^s}{\gamma} \bar{p}^s, \quad \forall i \in \Omega_*^s \quad (4)$$

where the set Ω_*^s is the largest subset of Ω^s such that demand is positive, N^s is the measure (‘number’) of varieties in Ω_*^s and $\bar{p}^s = (1/N^s) \int_{i \in \Omega_*^s} p^s(i) di$ is their average price. Product i belongs to this set when

$$p^s(i) \leq \frac{1}{\eta N^s + \gamma} (\gamma \alpha + \eta N^s \bar{p}^s) \equiv p_{\max}^s \quad (5)$$

where $p_{\max}^s \leq \alpha$ represents the price at which demand for a product is driven to zero. Given (3), the lower p_{\max}^s the higher the price elasticity of demand.

On the supply side, due to perfect competition and the assumed unit labor requirement for the production of the homogeneous good, choosing this good as numeraire implies that also the wage equals one. Henceforth, this will allow us to refer to unit labor requirement and marginal cost interchangeably. Turning to the monopolistically competitive sector, consider a firm with marginal cost c in its core segment s that maximizes the profit from selling to segment s' . We assume market segmentation, so the problem of profit maximization is solved for each segment s' independently with the first order condition for profit maximization satisfied by an output level equal to

$$q^{ss'}(c) = \frac{L}{4\gamma} \left(c^{s'} - e^{\delta|s-s'|} c \right) \quad (6)$$

³Whereas in our data both sellers and buyers are firms (B2B), in our model buyers are consumers (B2C). This apparent inconsistency can be circumvented by assuming that each market segment is populated by perfectly competitive final producers that buy segment-specific intermediates from the monopolistically competitive firms and transform them one-to-one into segment-specific final products. Such a B2B model would be homomorphic to the B2C model we propose and we prefer to stick to the latter for ease of exposition.

with corresponding price, markup, revenue and profit

$$p^{ss'}(c) = \frac{1}{2} \left(c^{s'} + e^{\delta|s-s'|} c \right) \quad (7)$$

$$\mu^{ss'}(c) = \frac{1}{2} \left(c^{s'} - e^{\delta|s-s'|} c \right) \quad (8)$$

$$r^{ss'}(c) = \frac{L}{8\gamma} \left[\left(c^{s'} \right)^2 - \left(e^{\delta|s-s'|} c \right)^2 \right] \quad (9)$$

$$\pi^{ss'}(c) = \frac{L}{8\gamma} \left(c^{s'} - e^{\delta|s-s'|} c \right)^2 \quad (10)$$

This determines a cutoff rule for selling to segment s' . In particular, a firm with marginal cost c will sell to segment s' if and only if $c \leq c^{s'} e^{-\delta|s-s'|}$, where $c^{s'} = p_{\max}^{s'}$ is the threshold below which the marginal costs of any firm with core segment s' has to fall for the firm to be able to profitably serve its core segment ('core cutoff cost'). The cutoff rule explains the theoretical appeal of the distributional assumption (2) in that any truncation of $G(c)$ from above maintains its distributional properties. For instance, the distribution of firms with core segment s selling to segment s' is given by $G^{ss'}(c) = \left(c/c^{ss'} \right)^k$, with $c \in \left[0, c^{ss'} \right]$, where $c^{ss'} \equiv \left(c^{s'} \right) e^{-\delta|s-s'|}$ is the marginal cost of producers with core segment s that are just indifferent between serving segment s' or not.

Due to free entry expected profit has to be zero in equilibrium

$$\int_0^2 \left[\int_0^{c^{ss'}} \pi^{ss'}(c) dG(c) \right] ds' = f \quad (11)$$

which generates a set of free entry conditions, one for each segment. The symmetry of the address model, however, simplifies the analysis a lot. First of all, it implies that the core cutoff cost has to be the same in all segments: $c^{s'} = c^s = c_D$. Then, as all firms face symmetric conditions whatever their core segment, we can index $m \in [0, 1]$ the variants of the product sold by a firm in increasing order of shortest arc distance from its core segment ($m = 0$). We thus have $e^{-\delta|s-s'|} = e^{-\delta m}$ so that (11) can be rewritten as

$$\int_0^1 \left[\int_0^{c_D e^{-\delta m}} \frac{L}{4\gamma} \left(c_D - e^{\delta m} c \right)^2 dG(c) \right] dm = f \quad (12)$$

and solved for the common core cutoff cost

$$c_D = \left(\frac{k\delta}{1 - e^{-k\delta}} \frac{\gamma\phi}{L} \right)^{\frac{1}{k+2}} \quad (13)$$

where $\phi \equiv 2(k+2)(k+1)(c_M)^k f$ is a bundle of technological parameters and $k\delta/(1 - e^{-k\delta}) \in (0, 1)$ measures the impact of the interaction between consumer

and firm heterogeneity on competition (as measured by the price elasticity of demand) and selection. When $\delta = 0$, taste heterogeneity disappears and (13) boils down to the analogous expression in Melitz and Ottaviano (2008) who assume homogeneous consumers and, therefore, a single market segment. As δ increases, also c_D increases.⁴ Accordingly, more taste heterogeneity weakens competition and selection. The more so, the larger k , that is, the less heterogeneous firms are.

To find the common number of sellers N in any given segment, we call $G_D^m(c) = G(c)/G(c_D e^{-\delta m}) = [c/(c_D e^{-\delta m})]^k$ the conditional distribution of firms with core segment at distance m for the segment under consideration and use (7) to write the price of one of those firms as

$$p^m(c) = \frac{1}{2} (c_D + e^{\delta m} c)$$

The average price in the segment can then be rewritten as

$$\bar{p} = \int_0^1 \left[\int_0^{c_D e^{-\delta m}} p^m(c) dG_D^m(c) \right] dm = \frac{2k+1}{2(k+1)} c_D$$

With this result at hand, imposing $p_{\max}^s = c_D$ in (5) allows us to solve the resulting equation for the number of sellers

$$N = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c_D}{c_D} \quad (14)$$

while the number of producers whose core segment is the segment under consideration is $N^P = N/2$ and the associated number of entrants is $N^E = G(c_D)N^P = (c_D/c_M)^k N^P$. Hence, expressions (13) and (14) fully characterize the equilibrium.

3.4 Consumers' Selection

How many consumers does a firm with core marginal cost c serve? As adaptation costs rise with distance from the core segment and core cutoff costs are the same in all segments, demand in a segment for the product of a firm whose core segment is at distance m from the segment under consideration falls when the shortest arc distance m from the core increases. Along the circle there are two segments at such distance and their combined demand evaluates to

$$q^m(c) = \frac{L}{4\gamma} (c_D - e^{\delta m} c) \quad (15)$$

which implies that there exists some threshold distance $m_D(c)$ at which consumers are just indifferent between buying or not, that is: $q^m(c) = 0$ for

⁴The sign $\frac{\partial c_D}{\partial \delta} > 0$ follows from $\frac{\partial [\delta/(1 - e^{-k\delta})]}{\partial \delta} = \frac{[1 - (1 + k\delta) e^{-k\delta}]}{(1 - e^{-k\delta})^2} > 0$ as $[1 - (1 + k\delta) e^{-k\delta}]$ equals 0 for $\delta = 0$ and increases with δ for $\delta > 0$.

$m = m_D(c)$. This threshold defines the firm's 'cutoff segment' with

$$m_D(c) = \begin{cases} 1 & \text{if } c \leq c_D e^{-\delta} \\ \frac{1}{\delta} \ln\left(\frac{c_D}{c}\right) & \text{if } c_D e^{-\delta} < c \leq c_D \\ 0 & \text{if } c > c_D \end{cases} \quad (16)$$

As there are two such segments, one on each side of the circle starting from the firm's core segment, the total number of segments served by the firm is $2m_D(c)$. The corresponding combined number of consumers served from the core segment up to the two cutoff segments is $m_D(c)L$ with combined demand given by (15). Accordingly, the lower c the larger the numbers of segments $2m_D(c)$ and consumers $m_D(c)L$ the firm serves, and the larger the output $q^m(c)$ it sells at any given distance from its core segment $m \leq m_D(c)$. This shows that firms with lower core marginal cost have a wider and thicker market, and only firms whose core marginal costs is low enough are able to serve all consumers.

3.5 Firm Performance

Expressions (7)-(10) can be rewritten so as to show that at any distance $m \leq m_D(c)$ firms with lower core marginal cost c quote lower prices but enjoy higher markups, revenues and profits:

$$\begin{aligned} p^m(c) &= \frac{1}{2} (c_D + e^{\delta m} c) \\ \mu^m(c) &= \frac{1}{2} (c_D - e^{\delta m} c) \\ r^m(c) &= \frac{L}{8\gamma} [(c_D)^2 - (e^{\delta m} c)^2] \\ \pi^m(c) &= \frac{L}{8\gamma} (c_D - e^{\delta m} c)^2 \end{aligned}$$

This implies that firms with lower c are also larger in terms of both total output $Q(c)$ and total revenue $R(c)$ as

$$\begin{aligned} Q(c) &= 2 \int_0^{m_D(c)} q^m(c) dm = \frac{L}{2\gamma} \int_0^{m_D(c)} (c_D - e^{\delta m} c) dm \\ R(c) &= 2 \int_0^{m_D(c)} r^m(c) dm = \frac{L}{4\gamma} \int_0^{m_D(c)} [(c_D)^2 - (e^{\delta m} c)^2] dm \end{aligned} \quad (17)$$

They also achieve higher total profit

$$\Pi(c) = 2 \int_0^{m_D(c)} \pi^m(c) dm = \frac{L}{4\gamma} \int_0^{m_D(c)} (c_D - e^{\delta m} c)^2 dm$$

Note, incidentally, that

$$\int_0^{c_D} \Pi(c) dG(c) = \int_0^{c_D} \left[\int_0^{m_D(c)} \frac{L}{4\gamma} (c_D - e^{\delta m} c)^2 dm \right] dG(c)$$

can be rewritten as

$$\begin{aligned} \int_0^{c_D} \Pi(c) dG(c) &= \int_0^{c_D} \left[\int_{m|e^{\delta m} c < c_D} \frac{L}{4\gamma} (c_D - e^{\delta m} c)^2 dm \right] dG(c) \\ &= \int_0^1 \left[\int_0^{c_D e^{-\delta m}} \frac{L}{4\gamma} (c_D - e^{\delta m} c)^2 dG(c) \right] dm \end{aligned}$$

so that the free entry condition (12) can be equivalently stated as

$$\int_0^{c_D} \Pi(c) dG(c) = f \quad (18)$$

This will come handy when we open up the economy to international trade.

Finally, firms with lower core marginal cost are more productive in terms of both physical productivity and revenue based productivity, respectively defined as

$$\Phi(c) = \frac{Q(c)}{C(c)} = \frac{\int_0^{m_D(c)} (c_D - e^{\delta m} c) dm}{\int_0^{m_D(c)} c (c_D - e^{\delta m} c) dm}$$

and

$$\Phi_R(c) = \frac{R(c)/\bar{P}}{C(c)} = \frac{\int_0^{m_D(c)} [(c_D)^2 - (e^{\delta m} c)^2] dm / \bar{P}}{\int_0^{m_D(c)} c (c_D - e^{\delta m} c) dm}$$

where $C(c) = [L/(2\gamma)] \int_0^{m_D(c)} c (c_D - e^{\delta m} c) dm$ is total cost (as well as total employment) and \bar{P} is the price deflator

$$\bar{P} \equiv \frac{\int_0^{c_D} R(c) dG(c)}{\int_0^{c_D} Q(c) dG(c)} = \frac{k+1}{k+2} c_D$$

This deflator is the average of the prices of all the variants of all the products weighted by their output share. We could also have used the unweighted price average \bar{p} that we previously defined, or an average weighted by a variety's revenue share (i.e. its market share) instead of output share. In our model, as in Mayer, Melitz and Ottaviano (2011), all of these price averages only differ by a multiplicative constant, so the effects of competition (i.e., the changes in the cutoff c_D) on productivity do not depend on this choice of price averages.

3.6 Aggregate Performance

At the aggregate level, computing average physical productivity

$$\bar{\Phi} = \frac{\int_0^{c_D} \left[\int_0^{m_D(c)} (c_D - e^{\delta m} c) dm \right] dG(c)}{\int_0^{c_D} \left[\int_0^{m_D(c)} c (c_D - e^{\delta m} c) dm \right] dG(c)}$$

and average revenue based productivity

$$\bar{\Phi}_R = \frac{\int_0^{m_D(c)} [(c_D)^2 - (e^{\delta m} c)^2] dm / \bar{P}}{\int_0^{c_D} \left[\int_0^{m_D(c)} c (c_D - e^{\delta m} c) dm \right] dG(c)}$$

give the same result

$$\bar{\Phi} = \bar{\Phi}_R = \frac{k+2}{k} \frac{1}{c_D} \quad (19)$$

This reveals that, as δ increases from zero, rising c_D leads to lower aggregate productivity. Thus, the fact that consumer heterogeneity relaxes competition and firm selection implies that it also hampers productivity.

Lastly, due to the symmetry of the address model, in equilibrium all consumer achieve the same level of utility whatever their ideal variants. Welfare can then be measured in terms of the indirect utility of any individual consumer and this evaluates to

$$U = 1 + \frac{1}{2\eta} (\alpha - c_D) \left(\alpha - \frac{k+1}{k+2} c_D \right) \quad (20)$$

as in Melitz and Ottaviano (2008) and Mayer, Melitz and Ottaviano (2011).

3.7 Market Size, Productivity and Welfare

A hallmark result in Melitz and Ottaviano (2008) and Mayer, Melitz and Ottaviano (2011) concerns the impact of market size on aggregate productivity through firm selection. In the single-product firm model by Melitz and Ottaviano (2008), a larger number of consumers makes competition tougher by compressing the cutoff marginal cost and firms' markups. As a consequence, high marginal cost firms exit and market shares are disproportionately reallocated towards the lowest marginal cost survivors. In the multi-product firm model by Mayer, Melitz and Ottaviano (2011) those reallocations between firms are compounded by within-firm reallocations whereby survivors drop some of their higher marginal cost products and shift resources disproportionately towards their lower marginal cost products.

Here similar between- and within-firm reallocations take place but there is an additional round of adjustment. As survivors retreat from segments distant from their core ones, they stop serving some customers whose ideal varieties are too far away from their core segments, and also reallocate resources disproportionately towards these segments. The result is a better alignment between consumers' ideal varieties and firms' core competencies, which generates a new channel through which larger market size leads to higher productivity and higher welfare thanks to lower c_D (see (19) and (20)).

In particular, from (13) we see that larger L compresses c_D . By (14), lower c_D increases the number of entrants, producers and sellers in each segment. This happens despite the associated fall in the total sales of each producer as entailed by (17) as well as in the number of customers served by each producer

and in the number of producers tapped by each customer as entailed by (16). Lower c_D also skews the distribution of sales away from higher marginal cost towards lower marginal cost variants, which implies that: lower marginal cost firms gain market share; among the customers of a firm, the output and revenue shares of those closer to the core segment increase; among the producers tapped by a consumer, the consumption and expenditure shares of those closer to her ideal variety increase.

To see how skewness is affected, consider two variants of a firm's product at distance m and m' from its core segment with $m > m'$. Given (15), their output ratio evaluates to

$$\frac{q^{m'}(c)}{q^m(c)} = \frac{c_D - e^{\delta m'} c}{c_D - e^{\delta m} c}$$

which is a decreasing function of c_D as long as $m > m'$ and thus lower c_D fosters the skewness of export sales towards the closer segment to the core. A similar behavior characterizes the revenue ratio $r^{m'}(c)/r^m(c)$. It is driven by the fact that falling c_D puts a stronger downward pressure on the markups of low marginal cost variants than on the markups of high marginal cost variants as the demand elasticity faced by the former rises more than that faced by the latter. This leads to a parallel increase in the price ratio

$$\frac{p^{m'}(c)}{p^m(c)} = \frac{c_D + e^{\delta m'} c}{c_D + e^{\delta m} c}$$

Hence, in a larger market all firms with $c_D e^{-\delta} < c \leq c_D$ cover fewer segments with a larger fraction of sales concentrated in their core segment and a wider price dispersion across the segments they serve. Note, however, that the average number of segments these firms cover does not depend on c_D . The reason is perfect compensation between two opposing effects. On the one hand, all firms with $c_D e^{-\delta} < c \leq c_D$ reduce the number of segments they serve, which tends to push the average down. On the other hand, firms with $c > c_D$ leave the market and this pulls the average up. No change in the average number of segments a firm covers then implies that in a larger market firms serve a larger average number of consumers.

4 The Model in Open Economy

We now turn to the open economy in order to examine how market size and geography determine differences in the toughness of competition across markets and how this in turn determines the buyer margins of exporters. In so doing, we follow Melitz and Ottaviano (2008) as well as Mayer, Melitz and Ottaviano (2011) and consider an arbitrary number of countries allowing for asymmetric bilateral trade costs. We use J to denote the number of countries, we index them by $l = 1, \dots, J$, and call L_l country l 's population. All countries share the same characterization of demand with taste heterogeneity modeled in terms of

an address model in which consumers' ideal varieties are located around a circle C of circumference 2 and are indexed $s \in [0, 2]$ in a clockwise manner starting from noon. Consumers are assumed to be uniformly distributed across segments so that in country l each segment consists of $L^l/2$ consumers. Within-segment preferences are again given by (1).

As for technology, we maintain the same assumptions as in the closed economy. Firms choose a production location and a segment before entering and paying the sunk entry cost f . We assume that the entry cost f and the cost distribution (2) are common across countries.⁵ We further assume that the homogeneous good is freely traded and choose it as our numeraire good. This implies that the wage equals one in all countries. International trade in differentiated products is, instead, hampered by iceberg costs and the national markets of these products are assumed to be segmented. Any variant produced for segment s in country l can be exported to the same segment s in country h subject to an iceberg trade cost $\tau_{lh} > 1$. Local delivery is, instead, free: $\tau_{ll} = 1$. As segments are symmetric, from the viewpoint of a firm what matters for its delivered cost is their shortest arc distance m from its core segment $m = 0$. This cost equals $\tau_{lh}e^{\delta m}c$ for variant m of a firm with core cost c producing in country l and delivering to country h .

4.1 Buyers' and Sellers' Selection

Exploiting again segments' symmetry, let p_l denote the price threshold for positive demand in any segment of country l . Then (5) implies

$$p_l = \frac{1}{\eta N_l + \gamma} (\gamma\alpha + \eta N_l \bar{p}_l), \quad (21)$$

where N_l is the total number of variants (and thus firms) selling in each segment of country l and \bar{p}_l^s is their average price. The maximized values of profits from domestic and export sales to country h for a variant m produced by a firm with core cost c in country l are:

$$\begin{aligned} \pi_{ll}^m(c) &= \frac{L_l}{4\gamma} (c_{ll} - e^{\delta m}c)^2, \\ \pi_{lh}^m(v) &= \frac{L_h}{4\gamma} \tau_{lh}^2 (c_{lh} - e^{\delta m}c)^2 = \frac{L_h}{4\gamma} (c_{hh} - \tau_{lh}e^{\delta m}c)^2 \end{aligned} \quad (22)$$

where $c_{ll} = p_l$ and $c_{lh} = p_h/\tau_{lh}$ are the marginal cost cutoffs for positive domestic and export sales: a firm with core cost c will produce all variants m such that $\pi_{ll}^m(c) \geq 0$ and export to h the subset of variants m such that $\pi_{lh}^m(c) \geq 0$. Accordingly, the total numbers of variants produced and exported

⁵These assumptions can be relaxed as in Melitz and Ottaviano (2008).

by the firm are determined by the firm's domestic and export 'cutoff segments'

$$\begin{aligned}
m_{ll}(c) &= \begin{cases} 1 & \text{if } c \leq c_{ll}e^{-\delta} \\ \frac{1}{\delta} \ln\left(\frac{c_{ll}}{c}\right) & \text{for } c_{ll}e^{-\delta} < c \leq c_{ll} \\ 0 & \text{for } c > c_{ll} \end{cases} \\
m_{lh}(c) &= \begin{cases} 1 & \text{for } c \leq c_{lh}e^{-\delta} = c_{hh}e^{-\delta}/\tau_{lh} \\ \frac{1}{\delta} \ln\left(\frac{c_{lh}}{c}\right) & \text{for } c_{hh}e^{-\delta}/\tau_{lh} < c \leq c_{hh} \\ 0 & \text{for } c > c_{hh} \end{cases}
\end{aligned} \tag{23}$$

where we have used the fact that $c_{hh} = p_h$ and $c_{lh} = p_h/\tau_{lh}$ imply $c_{lh} = c_{hh}/\tau_{lh}$. In each market there are two cutoff segments, one on each side of the circle starting from the firm's core segment. The corresponding combined numbers of consumers served are $m_{ll}(c)L_l$ and $m_{lh}(c)L_h$, and their combined consumption levels equal $2q_{ll}^m(c)L_l$ and $2q_{lh}^m(c)L_h$ with individual consumption

$$q_{lh}^m(c) = \frac{L_h}{4\gamma} (c_{hh} - \tau_{lh}e^{\delta m}c) \tag{24}$$

and associated revenue

$$r_{lh}^m(c) = \frac{L_h}{4\gamma} [(c_{hh})^2 - (\tau_{lh}e^{\delta m}c)^2]. \tag{25}$$

The lower c , the larger the numbers of segments ($m_{ll}(c)$ and $m_{lh}(c)$) and consumers ($m_{ll}(c)L_l$ and $m_{lh}(c)L_h$) a firm serves, and the larger the output sold and the revenue earned at any given distance from its core segments ($m \leq m_{ll}(c)$ and $m \leq m_{lh}(c)$). Firms with lower core marginal cost thus have wider and thicker domestic and export markets, and only firms whose core marginal cost is low enough are able to serve all consumers in all markets. Moreover, according to (23), trade costs create a wedge in the coverage of domestic and export markets. In particular, $m_{hh}(c) - m_{lh}(c) = \ln(\tau_{lh})/\delta$ reveals that the number of segments covered (and thus the number of customers served) is larger in the domestic than in the foreign markets. The more so, the higher the trade barriers (the larger τ_{lh}) and the lower the heterogeneity in consumers' tastes (the smaller δ).

Due to free entry, expected profits of entrants have to be zero in equilibrium. Hence, we impose a free entry condition analogous to (18)

$$\int_0^{c_{ll}} \Pi_{ll}(c) dG(c) + \sum_{h \neq l} \int_0^{c_{lh}} \Pi_{lh}(c) dG(c) = f \tag{26}$$

where

$$\begin{aligned}
\Pi_{ll}(c) &= 2 \int_0^{m_{ll}(c)} \pi_{ll}^m(c) dm = \frac{L}{4\gamma} \int_0^{m_{ll}(c)} (c_{ll} - e^{\delta m}c)^2 dm \\
\Pi_{lh}(c) &= 2 \int_0^{m_{lh}(c)} \pi_{lh}^m(c) dm = \frac{L}{4\gamma} \int_0^{m_{lh}(c)} (c_{lh} - \tau_{lh}e^{\delta m}c)^2 dm
\end{aligned}$$

are a firm's total domestic and export profits as obtained aggregating across the segments it serves. Given (2), the free entry condition (26) can then be rewritten as

$$\sum_{h=1}^J \rho_{lh} L_h c_{hh}^{k+2} = \gamma \phi \frac{k\delta}{1 - e^{-k\delta}} \quad (27)$$

where $\phi \equiv 2(k+2)(k+1)(c_M)^k f$ is again the bundle of technological parameters and $\rho_{lh} \equiv \tau_{lh}^{-k} < 1$ is a measure of the 'freeness' of trade from country l to country h that varies inversely with the trade costs τ_{lh} .

The free entry conditions (27) yield a system of J equations that can be solved for the J equilibrium domestic cutoffs using Cramer's rule

$$c_{hh} = \left(\frac{k\delta}{1 - e^{-k\delta}} \frac{\gamma \phi \sum_{l=1}^J |C_{lh}|}{L_h |\mathcal{P}|} \right)^{\frac{1}{k+2}} \quad (28)$$

where $|\mathcal{P}|$ is the determinant of the trade freeness matrix

$$\mathcal{P} \equiv \begin{pmatrix} 1 & \rho_{12} & \cdots & \rho_{1M} \\ \rho_{21} & 1 & \cdots & \rho_{2M} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{M1} & \rho_{M2} & \cdots & 1 \end{pmatrix}$$

and $|C_{lh}|$ is the cofactor of its ρ_{lh} element. Cross-country differences in cutoffs now arise from two sources: own country size (L_h) and geographical remoteness, captured by $\sum_{l=1}^J |C_{lh}| / |\mathcal{P}|$. Central countries benefiting from a large local market have lower cutoffs, and exhibit tougher competition, than peripheral countries with a small local market. When trade costs are prohibitively large, (28) boils down to the closed economy result (13).

As in the closed economy, (21) can be used to relate the core marginal cost cutoff with the mass of variants sold in each segment in country h :

$$N_h = \frac{2(k+1)\gamma}{\eta} \frac{\alpha - c_{hh}}{c_{hh}}. \quad (29)$$

Then, given a positive mass of entrants $N_{E,l}$ in country l , there will be $G(c_{lh})N_{E,l}$ firms exporting $[(1 - e^{-k\delta})/k\delta]\rho_{lh}G(c_{lh})N_{E,l}$ varieties to each segment of country h . Summing over all these varieties (including those produced and sold in h) yields

$$\sum_{l=1}^J \rho_{lh} N_{E,l} = \frac{k\delta}{1 - e^{-k\delta}} \frac{N_h}{c_{hh}^k}.$$

The latter provides a system of J linear equations that can be solved for the number of entrants in the J countries using Cramer's rule:⁶

$$N_{E,l} = \frac{k\delta}{1 - e^{-k\delta}} \frac{\phi\gamma}{\eta(k+2)f_E} \sum_{h=1}^J \frac{(\alpha - c_{hh}) |C_{lh}|}{c_{hh}^{k+1} |\mathcal{P}|}. \quad (30)$$

⁶We use the properties that relate the freeness matrix P and its transpose in terms of determinants and cofactors.

As in the closed economy, the cutoff level completely summarizes the distribution of prices as well as all the other performance measures. Hence, the cutoff in each country also uniquely determines welfare in that country. The relationship between welfare and the cutoff is the same as in the closed economy (see (20)).

4.2 Bilateral Trade Patterns

We have now completely characterized the multi-country open economy equilibrium. Selection operates at many different margins: a subset of firms survive in each country, and a smaller subset of those export to any given destination. Within a firm, there is an endogenous selection of customers dictated by the number of segments served. The largest set of segments is covered in the firm's domestic market, while only a subset of those segments are served in each export market.

Putting together all the different margins of trade, we can use our model to generate predictions for aggregate bilateral trade. Assuming its variant m is indeed exported in country l to country h , an exporter with core marginal cost c generates export quantities and export sales of that variant equal to (24) and (25). Aggregate bilateral trade from l to h is then:

$$\begin{aligned} \text{EXP}_{lh} &= N_{E,l} \frac{1 - e^{-k\delta}}{k\delta} \rho^{lh} \int_0^{c_{lh}} 2r_{lh}^m(c) dG(v) \\ &= \frac{1 - e^{-k\delta}}{k\delta} \frac{1}{2\gamma(k+2)c_M^k} \times N_{E,l} \times (c_{hh})^{k+2} L_h \times \rho_{lh}. \end{aligned} \quad (31)$$

Thus, aggregate bilateral trade follows a standard gravity specification based on country fixed effects (separate fixed effects for the exporter and importer) and a bilateral term that captures the effects of all bilateral barriers/enhancers to trade. This is the specification we have run in the empirical section.⁷

4.3 Exporters' Buyer Mix

We previously described how, in the closed economy, firms respond to increases in competition in their market by skewing their product mix towards their core customers. We also analyzed how this product mix response generated increases in firm productivity. We now show how differences in competition across export market destinations induce exporters to those markets to respond in very similar ways: when exporting to markets with tougher competition, exporters skew their exports towards their core customers. We proceed in a similar way as we did for the closed economy by examining a given firm's ratio of exports of two variants m and m' , where m' is closer to the firm's core segment. As in the closed economy, we write the ratio of export quantities, but the ratio of export

⁷This type of structural gravity specification with country fixed-effects is generated by a large set of different modeling frameworks. See Head and Mayer (2013) for further discussion of this topic.

sales responds to competition in identical ways (see (25)). Using (24), we can write this output ratio as:

$$\frac{q_{lh}^{m'}(c)}{q_{lh}^m(c)} = \frac{c_{hh} - \tau_{lh}e^{\delta m'}c}{c_{hh} - \tau_{lh}e^{\delta m}c}. \quad (32)$$

Tougher competition in an export market (lower c_{hh}) increases this ratio, which captures how firms skew their exports toward their core variants (recall that $m' < m$ so variants m' is closer to the core). The intuition behind this result is very similar to the one we described for the closed economy. Tougher competition in a market increases the price elasticity of demand for all variants exported to that market. As in the closed economy, this skews relative demand and relative export sales towards the variants closer to the core segment. It also increases price dispersion as can be seen in terms of the price ratio

$$\frac{p_{lh}^{m'}(c)}{p_{lh}^m(c)} = \frac{c_{hh} + e^{\delta m'}c}{c_{hh} + e^{\delta m}c}$$

Hence, when c_{hh} falls, domestic firms with $c_{hh}e^{-\delta} < c \leq c_{hh}$ and exporters with $c_{hh}e^{-\delta}/\tau_{lh} < c \leq c_{hh}$ cover fewer segments with a larger fraction of sales concentrated in their core segment and a wider price dispersion across the segments they serve. Domestic firms with $c \leq c_{hh}e^{-\delta}$ and exporters with $c \leq c_{hh}e^{-\delta}/\tau_{lh}$ still cover all segments but also in their case a larger fraction of sales is concentrated in their core segment with a wider price dispersion across the segments they serve. As in the closed economy the average number of segments firms cover does not depend on c_{hh} while lower c_{hh} implies that the number of consumers each firm serves rises on average.

Finally, as was the case for the closed economy, the skewing of a firm's product mix towards core variants also entails increases in firm productivity. Empirically, we cannot separately measure a firm's productivity with respect to its production for each export market. However, we can theoretically define such a productivity measure in an analogous way to $\Phi(c) \equiv Q(c)/C(c)$ for the closed economy. We thus define the productivity of firm c in l for its exports to destination h as $\Phi_{lh}(c) \equiv Q_{lh}(c)/C_{lh}(c)$, where $Q_{lh}(c)$ are the total units of output that firm c exports to h , and $C_{lh}(c)$ are the total labor costs incurred by firm c to produce those units.⁸ As in Mayer, Melitz and Ottaviano (2011), this export market-specific productivity measure (as well as the associated measure $\Phi_{R,lh}(c)$ based on deflated sales) increases with the toughness of competition in that export market. In other words, $\Phi_{lh}(c)$ and $\Phi_{R,lh}(c)$ both increase when

⁸In order for this productivity measure to aggregate up to overall country productivity, we incorporate the productivity of the transportation/trade cost sector into this productivity measure. This implies that firm c employs the labor units that are used to produce the "melted" units of output that cover the trade cost; Those labor units are thus included in $C_{lh}(c)$. The output of firm c is measured as valued-added, which implies that those "melted" units are not included in $Q_{lh}(c)$ (the latter are the number of units produced by firm c that are consumed in h). Separating out the productivity of the transportation sector would not affect our main comparative static with respect to toughness of competition in the export market.

c_{hh} decreases. Thus, changes in exported buyer mix also have important repercussions for firm productivity.

5 Conclusion

We have used highly disaggregated firm-level export from Costa Rica, Ecuador, and Uruguay over the period 2005-2008 to provide a precise characterization of firms' export margins, across goods, destination countries, and crucially their trading partners. We have found that a firm's number of buyers and the distribution of sales across them systematically vary with the characteristics of its destination markets. While most firms serve only very few buyers abroad, the number of buyers and the skewness of sales across them increases with the size and the accessibility of destinations. To the best of our knowledge, our findings provide novel evidence on the patterns and determinants of firms' exports along the buyer extensive and intensive margins.

Based on these findings, we have explored whether the buyer margins can be expected to be associated with a new channel of welfare gains from international trade. In so doing, we have developed a simple model of selection with heterogeneous buyers and sellers, merging the 'representative consumer approach' to product differentiation that is standard in international trade theory with the 'address (or characteristics) approach' that is standard in industrial organization. In our model the intensity of competition affects the number and market shares of active firms as well as the number of variants of their products and the distribution of sales across these variants. Crucially, it also affects the numbers of their customers and the distribution of sales across those. This last feature is the key novelty of the model. Tougher competition induces a better alignment between consumers' ideal variants and firms' core competencies, generating a new channel through which tougher competition leads to higher productivity and higher welfare. This hints at a new source of gains from trade as long as freer trade fosters competition.

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Table 1 - Aggregate Indicators, 2005-2008

COSTA RICA					
Year	Total Exports	Number of Exporters	Number of Countries	Number of Products	Number of Buyers
2005	5,794	2667	138	3,737	13,257
2006	6,960	2808	133	4,039	14,387
2007	8,276	2896	150	4,253	15,020
2008	8,678	2753	143	4,117	14,705
ECUADOR					
Year	Total Exports	Number of Exporters	Number of Countries	Number of Products	Number of Buyers
2005	9,265	2223	127	2,238	8,769
2006	12,400	3052	143	2,579	11,311
2007	12,817	3370	147	3,081	11,782
2008	19,494	3962	151	3,086	12,243
URUGUAY					
Year	Total Exports	Number of Exporters	Number of Countries	Number of Products	Number of Buyers
2005	3,420	1940	140	2,873	11,034
2006	3,984	1997	149	2,874	11,829
2007	4,515	2088	154	2,872	12,071
2008	5,969	2130	160	3,039	11,959

Table 2 - Average Exporter, 2005

COSTA RICA								
	5	10	25	50	75	90	95	Average
Total Exports	0.43	1.20	5.55	34.55	321.52	2155.41	6046.23	2172.65
Number of Buyers	1.00	1.00	1.00	2.00	6.00	14.00	27.00	6.89
Number of Countries	1.00	1.00	1.00	2.00	3.00	6.00	10.00	2.91
Number of Products	1.00	1.00	1.00	2.00	6.00	14.00	22.00	5.89
Number of Buyers per Country	1.00	1.00	1.00	1.00	2.00	3.00	4.50	1.81
Number of Buyers per Product	1.00	1.00	1.00	1.17	2.33	4.50	6.88	2.34
Average Exports per Buyer	0.39	0.90	3.39	13.77	67.66	283.63	635.40	169.73
Average Exports per Country	0.41	1.01	4.17	19.28	121.91	559.64	1133.62	346.34
Average Exports per Product	0.26	0.63	2.61	12.55	85.07	490.87	1273.85	276.57
Average Exports per Country, Product and Buyer	0.24	0.55	2.15	8.23	38.41	170.37	363.59	92.15
ECUADOR								
	5	10	25	50	75	90	95	Average
Total Exports	0.00	0.00	2.60	27.90	259.17	2758.71	7894.96	4167.96
Number of Buyers	1.00	1.00	1.00	1.00	4.00	12.00	21.00	4.85
Number of Countries	1.00	1.00	1.00	1.00	2.00	5.00	8.00	2.25
Number of Products	1.00	1.00	1.00	1.00	3.00	7.00	11.00	3.24
Number of Buyers per Country	1.00	1.00	1.00	1.00	2.00	3.00	4.00	1.71
Number of Buyers per Product	1.00	1.00	1.00	1.00	2.00	5.00	8.33	2.52
Average Exports per Buyer	0.00	0.00	2.30	17.14	81.75	337.87	744.05	353.56
Average Exports per Country	0.00	0.00	2.50	23.24	141.22	758.23	1726.62	777.02
Average Exports per Product	0.00	0.00	1.50	15.24	126.03	917.76	2859.76	1987.56
Average Exports per Country, Product and Buyer	0.00	0.00	1.36	11.73	60.00	233.01	592.12	288.86
URUGUAY								
	5	10	25	50	75	90	95	Average
Total Exports	0.70	1.49	4.88	27.68	242.53	1763.42	7136.30	1762.67
Number of Buyers	1.00	1.00	1.00	1.00	4.00	13.00	26.00	6.91
Number of Countries	1.00	1.00	1.00	1.00	3.00	7.00	11.00	2.89
Number of Products	1.00	1.00	1.00	2.00	4.00	10.00	17.00	4.39
Number of Buyers per Country	1.00	1.00	1.00	1.00	1.56	3.00	4.00	1.60
Number of Buyers per Product	1.00	1.00	1.00	1.00	2.00	4.35	6.95	2.18
Average Exports per Buyer	0.70	1.38	4.00	16.07	60.24	228.83	432.51	138.15
Average Exports per Country	0.70	1.41	4.20	19.24	101.07	494.51	1095.99	264.67
Average Exports per Product	0.44	0.86	2.95	14.04	87.51	464.58	1201.39	308.24
Average Exports per Country, Product and Buyer	0.44	0.79	2.56	10.62	42.43	157.81	283.15	99.04

Table 3 - Distribution of Exporters over Products, Markets and Buyers: Share of Exporters, 2005-2008

BUYER MARGIN OF EXPORTERS
Distribution of Exporters across Number of Destinations, Products, and Buyers
All Products

Number of Products (Buyers)	COSTA RICA										ECUADOR										URUGUAY																													
	Number of Countries					Number of Countries					Number of Countries					Number of Countries																																		
	Number of Buyers*					Number of Buyers*					Number of Buyers*					Number of Buyers*																																		
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Table 5 – Gravity Regressions: Firms' Exports, Number of Buyers and Buyer Concentration, 2005-2008

	Costa Rica				Ecuador				Uruguay				Pool			
	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer
Distance	-0.728*** (0.145)	-0.266*** (0.054)	-0.461*** (0.097)	-0.012*** (0.003)	-0.444*** (0.097)	-0.159*** (0.037)	-0.285*** (0.070)	-0.011*** (0.003)	-0.138** (0.068)	-0.051* (0.030)	-0.086 (0.053)	0.005 (0.004)	-0.405*** (0.098)	-0.181*** (0.034)	-0.223*** (0.067)	-0.007** (0.003)
GDP	0.228*** (0.030)	0.089*** (0.014)	0.138*** (0.018)	0.004*** (0.001)	0.275*** (0.023)	0.118*** (0.012)	0.157*** (0.016)	0.006*** (0.001)	0.306*** (0.015)	0.158*** (0.007)	0.147*** (0.011)	0.005*** (0.001)	0.243*** (0.022)	0.111*** (0.010)	0.132*** (0.014)	0.004*** (0.000)
Contiguity	0.316*** (0.118)	0.173*** (0.045)	0.143* (0.083)	-0.009** (0.004)	-0.134 (0.190)	0.067 (0.049)	-0.201 (0.199)	0.013** (0.006)	0.214 (0.133)	0.101* (0.057)	0.113 (0.108)	0.017** (0.008)	0.247** (0.119)	0.109** (0.044)	0.139* (0.083)	-0.002 (0.005)
Common Language	-0.534*** (0.174)	-0.245*** (0.069)	-0.289** (0.116)	-0.022*** (0.005)	-0.180 (0.134)	-0.039 (0.061)	-0.141 (0.103)	-0.015** (0.007)	0.081 (0.117)	0.073* (0.039)	0.007 (0.102)	0.004 (0.005)	-0.143 (0.094)	-0.085** (0.034)	-0.059 (0.077)	-0.013*** (0.004)
Colony	0.196 (0.283)	0.117 (0.077)	0.079 (0.242)	0.022** (0.010)	0.589*** (0.127)	0.177*** (0.066)	0.412*** (0.113)	0.016** (0.007)	0.001 (0.124)	0.084* (0.046)	-0.081 (0.112)	-0.004 (0.008)	0.268*** (0.092)	0.167*** (0.043)	0.102 (0.078)	0.009** (0.004)
RTA	0.341** (0.151)	0.161*** (0.060)	0.179* (0.097)	0.002 (0.004)	0.706*** (0.183)	0.019 (0.047)	0.687*** (0.196)	0.000 (0.004)	0.303*** (0.115)	0.230*** (0.042)	0.073 (0.096)	0.014** (0.005)	0.272** (0.113)	0.079** (0.039)	0.193** (0.079)	0.008* (0.004)
Number of Buyers				-0.219*** (0.009)				-0.266*** (0.006)				-0.269*** (0.003)				-0.248*** (0.006)
Firm-Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes							
Observations	31,412	31,412	31,412	31,412	25,843	25,843	25,843	25,843	22,393	22,450	22,392	22,393	79,648	79,705	79,648	79,648

Standard errors clustered by country-year

Table 6 – Gravity Regressions: Firms' Price Dispersion across Buyers, 2005-2008

	Costa Rica	Ecuador	Uruguay	Pool
Distance	-0.167*** (0.056)	-0.025 (0.079)	-0.080 (0.066)	-0.086** (0.034)
GDP	0.082*** (0.020)	0.083*** (0.027)	0.053*** (0.019)	0.069*** (0.013)
Contiguity	0.067 (0.063)	-0.033 (0.168)	0.003 (0.134)	0.021 (0.054)
Common Language	-0.158** (0.077)	0.182 (0.180)	0.028 (0.106)	0.025 (0.057)
Colony	0.082 (0.182)	-0.025 (0.188)	0.184 (0.121)	0.114 (0.078)
RTA	0.050 (0.054)	0.093 (0.178)	-0.018 (0.099)	0.022 (0.042)
Number of Buyers	0.424*** (0.045)	0.676*** (0.064)	0.482*** (0.043)	0.513*** (0.032)
Firm-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	8,436	7,441	6,809	22,686

Standard errors clustered by country-year

Table 7 – Market Size, Market Potential and Buyer Concentration, 2005-2008

	Costa Rica				Ecuador				Uruguay				Pool			
	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer	Exports	Number of Buyers	Exports per Buyer	Share Main Buyer
GDP	0.205*** (0.036)	0.086*** (0.018)	0.120*** (0.020)	0.004*** (0.001)	0.303*** (0.027)	0.125*** (0.014)	0.178*** (0.016)	0.007*** (0.001)	0.316*** (0.016)	0.167*** (0.008)	0.149*** (0.011)	0.005*** (0.001)	0.251*** (0.023)	0.116*** (0.011)	0.136*** (0.014)	0.005*** (0.001)
Supply Potential	0.095** (0.044)	0.023* (0.012)	0.072** (0.034)	0.002* (0.001)	0.026 (0.028)	0.005 (0.009)	0.021 (0.021)	0.002** (0.001)	0.010 (0.018)	-0.012 (0.008)	0.022* (0.013)	0.001 (0.001)	0.045* (0.024)	0.008 (0.008)	0.037** (0.018)	0.002*** (0.001)
Freeness of Trade	0.251*** (0.026)	0.093*** (0.009)	0.158*** (0.018)	0.001** (0.001)	0.195*** (0.018)	0.055*** (0.006)	0.140*** (0.015)	0.003*** (0.001)	0.111*** (0.010)	0.057*** (0.005)	0.054*** (0.006)	0.002*** (0.000)	0.183*** (0.018)	0.072*** (0.006)	0.111*** (0.013)	0.002*** (0.000)
Number of Buyers				-0.218*** (0.010)				-0.266*** (0.006)				-0.269*** (0.003)				-0.247*** (0.006)
Firm-Year Fixed Effects	Yes	Yes	Yes	Yes												
Observations	31,412	31,412	31,412	31,412	25,843	25,843	25,843	25,843	22,393	22,450	22,393	22,393	79,648	79,705	79,648	79,648

Standard errors clustered by country-year

Table 8 – Market Size, Market Potential and Price Dispersion across Buyers, 2005-2008

	Costa Rica	Ecuador	Uruguay	Pool
GDP	0.076*** (0.019)	0.073*** (0.022)	0.046** (0.019)	0.066*** (0.012)
Supply Potential	0.048** (0.022)	0.001 (0.024)	0.037** (0.015)	0.026** (0.010)
Freeness of Trade	0.055*** (0.013)	0.040 (0.025)	0.037*** (0.011)	0.043*** (0.009)
Number of Buyers	0.434*** (0.044)	0.675*** (0.064)	0.490*** (0.041)	0.515*** (0.032)
Firm-Year Fixed Effects	Yes	Yes	Yes	Yes
Observations	8,436	7,441	6,809	22,686

Standard errors clustered by country-year