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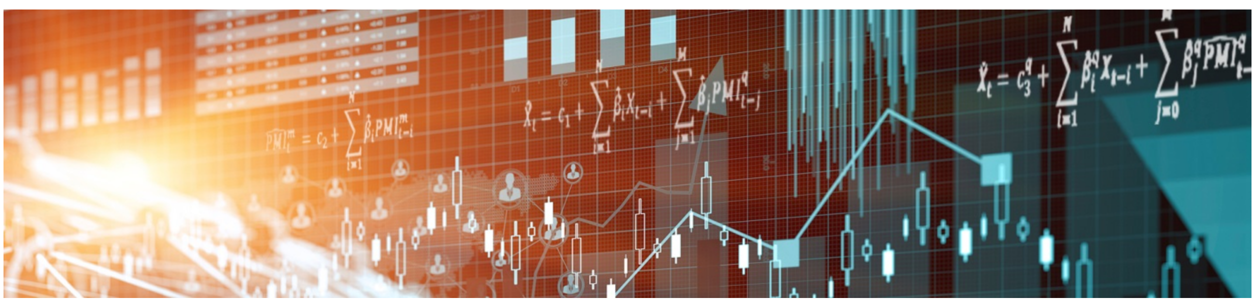

by Walter Steingress

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Market Size and Entry in International Trade: Product Versus Firm Fixed Costs

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Abstract

This paper develops a theoretical framework to infer the nature of fixed costs from the relationship between entry patterns in international markets and destination market size. If fixed costs are at the firm level, firms take advantage of an *intrafirm spillover* by expanding firm-level product range (scope). Few firms enter with many products and dominate international trade. If fixed costs are at the product level, an *interfirm spillover* reduces the fixed costs to export for all firms producing the product. Using cross-country data on firm and product entry, I find empirical evidence consistent with product-level costs. More firms than products enter in larger markets, offering their consumers lower prices and a greater variety of goods within the product category.

Bank topics: Firm dynamics; International topics; Trade integration
JEL codes: F12, F14, F23

Résumé

Cette étude développe un cadre théorique afin de déduire la nature des coûts fixes de la relation entre l’entrée sur les marchés internationaux et la taille des marchés de destination. Si les coûts fixes se situent au niveau des entreprises, celles-ci peuvent tirer profit d’externalités intraentreprises pour élargir leur gamme de produits. Les marchés internationaux sont dominés par des entreprises qui y entrent en moins grand nombre, mais avec plus de produits. Si, par contre, les coûts fixes se situent au niveau du produit, il en résulte des externalités interentreprises qui font baisser les coûts fixes d’exportation de toutes les entreprises fabriquant un même produit. Obtenus à partir de données sur l’entrée des entreprises et les produits de nombreux pays, mes résultats corroborent empiriquement l’hypothèse de la présence de coûts fixes au niveau du produit : les entreprises entrent en plus grand nombre que les produits sur les marchés de taille importante et offrent aux consommateurs de plus bas prix et une plus grande variété de produits de même catégorie.

Sujets : Dynamique des entreprises; Questions internationales; Intégration des échanges
Codes JEL : F12, F14, F23

Non-technical summary

In the presence of fixed costs to export, destination market size matters for firms' decision to enter. Larger markets offer more demand and allow firms to slide down the average cost curve and produce at a more efficient scale. In larger markets there will be more firms and consumers will benefit from lower prices and a greater variety of goods compared to consumers in small markets.

To analyze the relationship between destination market size and entry, I extend a standard multi-product general equilibrium framework with endogenous firm and product entry. Within this model, I consider two different types of fixed costs. The first scenario considers the standard view in the literature; namely, fixed costs at the firm level, examples of such costs are advertising the firm brand in the destination market or setting up a distribution network. The key assumption is that the firm privately benefits from an *intrafirm spillover* by expanding firm-level product range (scope). Consequently, multi-product firms have a cost advantage through lower per-product fixed costs. Given this assumption, one should observe greater product entry in comparison with firm entry resulting in more products per firm in larger markets.

The second scenario considers fixed costs operating at the product level. The main difference with respect to firm fixed costs is the presence of an *interfirm spillover,* which reduces the costs to export for all firms producing different varieties of the same product. For example, firms form trade associations to foster collaboration within a specific product category in order to advertise their products to foreign consumers (e.g., association of French wine producers); likewise firms define common product standards to lower technical barriers to trade. Alternatively, firms can share the fixed costs to export by arranging a common distribution networks (for instance, a US car dealership that sells different brands of Japanese cars). In this case, product entry is accompanied by lots of entrants and we expect substantially more firms than product entry as market size increases. The testable implication is that the entry elasticity of firms with respect to market size should be greater than for products. This implies that the number of firms per-product is higher in larger markets.

Using bilateral data for 40 exporting countries in 180 destinations for more than 15 years, we test the theoretical implications by estimating the elasticities of the number of exporting firms and exported products with respect to destination market size. The results show that the entry elasticity of the number of firms is significantly higher than that for the number of products. This holds for a broad set of countries at different levels of development. My findings also show that larger markets have, on average, more firms per exported product, while the number of products per firm does not vary with market size. When considered collectively, these findings support the view that product fixed costs characterize entry in international markets.

These findings can have important policy implications. Export promotion policies can encourage new product entry - for example, advertising new products in destination markets through export promotion agencies. This could potentially lead to spillover effects that translate into a higher levels of firm participation and overall export growth.

1 Introduction

Fixed costs to export create entry barriers that restrict trading opportunities. Larger markets allow firms to slide down the average cost curve and produce at a more efficient scale. As a result, countries with a larger market size have more firms entering and their consumers benefit from lower prices and a greater variety of goods compared with consumers in small markets.

The current view of the literature[1] is that fixed costs to export are mainly at the firm level - for example, advertising a firm brand or setting up a distribution network. Given this cost structure, multi-product firms have a cost advantage and dominate international trade. Anecdotal evidence[2] suggests an alternative view, in which firms benefit from an externality between exporters that reduces the fixed costs of exporting for a given product. For example, trade associations advertise a product to foreign consumers (e.g., association of French wine producers) or define common product standards to lower technical barriers to trade. In this case, fixed costs are mainly at the product level, leading to large markets being populated by many firms selling different varieties of the same product.

This paper develops a theoretical framework to infer the nature of fixed costs from the different effects they have on entry patterns in international trade. The model suggests that the elasticities of the number of exporting firms and exported products with respect to destination market size are informative on the presence of fixed costs at the firm or at the product level. Taking the theoretical predictions to the data, I find supportive empirical evidence of the view that fixed costs operate mainly at the product level and induce an interfirm spillover that reduces fixed costs for all firms producing the product.

To start with, I extend the multi-product general equilibrium framework of Bernard et al. (2011) to feature two different scenarios of cost spillovers. The first assumes fixed costs are at the firm level. In this case, firms take advantage of an *intrafirm spillover* when introducing their product(s) in the destination market. The spillover reduces the firm's per-product fixed cost and generates economies of scale and scope. In the second scenario, fixed costs are at the product level. The important difference is that, in this case, firms benefit from an *interfirm spillover* that lowers the fixed costs to export for all other firms exporting the same product, similar to the aggregate spillover across exporters in Krautheim (2012).

In order to allow for zero trade flows as well as variation in the number of exporting firms and exported products across destination countries, I follow Helpman et al. (2008) and assume a truncated distribution. Within this framework, I then derive the elasticity of firm and product entry with respect to destination market size for both scenarios. With fixed costs at the firm level, relatively more products enter because multi-product firms have a cost advantage. Their lower per-product fixed cost allows them to expand their product range (scope) with market size. On the other hand, with fixed costs at the product level, the presence of the interfirm spillover implies that relatively more firms than products enter once market size increases.

[1] See, for example, Arkolakis and Muendler (2010), Eaton et al. (2011) and Bernard et al. (2011).

[2] See Hausmann and Rodrik (2003) and Artopoulos et al. (2013).

Using bilateral data for 40 exporting countries in 180 destinations, I find that larger markets have significantly more firm entry than product entry. The average firm elasticity is 0.39, while the average product elasticity is 0.29. The significant difference holds for a broad set of countries at different levels of development. Two potential explanations for a higher firm than product entry elasticity are as follows: either the average number of firms per-product increases with market size or the average number of products per firm decreases with market size. The first effect points to more product varieties in larger markets and is consistent with product fixed costs. The second effect suggests that multi-product firms enter in small and large markets. However, in larger markets, multi-product firms export fewer products compared with the small market because of more competition from single-product firms, as in Mayer et al. (2011). The results in this paper show that larger markets have, on average, more firms per exported product and that the average number of products per firm does not vary with market size.

The fact that the number of firms per exported product increases with market size suggests that consumers in larger markets will be offered not only more products compared with consumers in small markets but also products at lower prices and a greater variety of goods within the product category. The estimated elasticity of 0.1 implies that doubling the destination market size increases the number of exported varieties per product category by 10 percent. According to the model, the implied reduction in the price index of the exported product with an elasticity of substitution of 5 is 56 percent.[3]

This work relates to the empirical literature that analyzes the relationship between market size and firm entry; for single-product firms, see the seminal paper by Campbell and Hopenhayn (2005), as well as Helpman et al. (2008), Melitz and Ottaviano (2008), Arkolakis (2010), Eaton et al. (2011); and for multi-product firms, see Arkolakis and Muendler (2010) and Bernard et al. (2011). The papers most closely related to this one are Eaton et al. (2011), Bernard et al. (2011) and Krautheim (2012). Eaton et al. (2011) argue that the variation in the number of French exporters with respect to destination market size is informative of fixed costs of exporting at the firm level. Bernard et al. (2011) extend the general equilibrium framework of Eaton et al. (2011) to multi-product firms and analyze how firms adjust their product scope across destination markets. This paper builds on the insight in Eaton et al. (2011) that fixed costs can be inferred from the elasticity of firm penetration and proposes an alternative view of fixed costs by relating firm penetration to product entry within a generalized version of the Bernard et al. (2011) framework. The key difference is that in this paper fixed costs are associated with a positive spillover either within the firm or across firms as in Krautheim (2012).

Several papers in the literature indicate potential spillover across firms upon entry. Hausmann and Rodrik (2003) argue that export pioneers create spillovers by making investments in attempts to open foreign markets that can be used by rival firms within the same product category. Rivals may also acquire knowledge about the potential demand of their own products in the foreign market once they observe the success of the pioneer; see Eaton et al. (2012). While the theoretical model is based on a reduced form of this interfirm spillover through lower fixed costs to export,

[3]The value of the elasticity of substitution corresponds to the sector average in US data; see Imbs and Méjean (2015).

additional empirical evidence shows support for this assumption. By analyzing firm entry within products over time and across countries, I find that firm entry increases significantly the year after an export pioneer has introduced a product into a destination. The lower fixed cost allows rival firms to exploit scale and increase their export revenue and the survival probability in international markets. These results are consistent with micro-evidence of spillovers among exporters, as found in the case of France (Koenig (2009) and Koenig et al. (2010)), Argentina (Artopoulos et al. (2013)), China (Fernandes and Tang (2014)) and Bangladesh (Kamal and Sundaram (2016)).

Overall, understanding the nature of fixed costs is an important guide for trade policy. This is because different sets of policies can reduce product-related fixed costs rather than firm fixed costs to encourage exports. For example, the exporting country can stimulate product entry by advertising new products in destination markets through export promotion agencies; see Lederman et al. (2010) and Görg et al. (2008) for the empirical evidence. In addition, one aspect of free trade negotiations is the reduction of product-related fixed costs by alleviating technical barriers to trade and establishing common product standards. Kehoe and Ruhl (2013) and Dutt et al. (2013) provide empirical evidence that trade agreements increase trade flows mainly through new product entry by reducing primarily the fixed rather than the variable costs of trade. Schmidt and Steingress (2018) find evidence of significant product entry after countries harmonize existing product standards because of changes in fixed costs and higher product demand. In the light of this paper, the presence of spillover effects may be one explanation why new product entry is an important margin in export growth after a trade agreement or standard harmonization.

The rest of the paper is organized as follows. Section 2 describes the conceptual framework. Section 3 presents the methodology together with the testable implications. Section 4 presents the data with the relevant summary statistics and the empirical results. Section 5 illustrates an empirical framework to shed further light on the presence of spillovers induced by product fixed costs. Section 6 concludes.

2 A simple correlation

I start my investigation with an assessment of the destinations that exporting firms reach and the characteristics of the destinations that attract many exporters. First, take the perspective of the largest exporting country in my sample, Spain, and its firms. Following Eaton et al. (2011), Figure 2(a) plots the log of the number of Spanish firms selling to a particular market d against the log of destination market size proxied by gross domestic product (GDP). The number of firms selling to a market tends to increase with the size of the market. A regression line establishes a slope of 0.77 and an $R^2 = 0.69$. Eaton et al. (2011) interpret the positive relationship between firm penetration and market size as evidence of market-specific fixed costs. Larger markets offer more demand and thus it is easier for firms to recover fixed costs. As Bernard et al. (2003) show, other trade models based on variable trade costs without fixed costs can also account for the fact that firms select themselves into exporting.

— Figure 1 about here —

An alternative view of the relationship in Figure 2(a) is that fixed costs operate at the product rather than at the firm level. To investigate this idea further, Figure 2(b) repeats the previous graph. But instead of the log number of firms, it plots the log number of products that Spain exports to a destination against the market size of the destination along the horizontal axis. The number of products exported to a destination increases systematically with market size, $R^2 = 0.65$, and an elasticity of 0.63. Following the argument of Eaton et al. (2011), an explanation that reconciles the relationship in Figure 2(b) is the presence of market-specific fixed costs at the product level. Exporting products is possible only at a huge expense in fixed costs and the demand for most of the products at the destination is not sufficient to export all of them profitably.

While both figures display a positive relationship between entry and market size, the slope of the log number of products with respect to market size is significantly lower than in the case of firms. In the following paragraphs, I argue that the difference in elasticities can be informative on whether fixed costs operate on the firm or on the product margin. To shed light on this question, I evaluate how the number of firms and products varies with destination market size, controlling for origin, time and bilateral characteristics. Before describing the empirical model, I define the cost structure and derive testable implications.

3 Theoretical framework

In order to model the different types of fixed costs and their implications on the elasticity with respect to market size, I base myself on the model from Bernard et al. (2011). I keep their demand structure. Utility in country j is given by a continuum of products that are substitutable with elasticity κ

$$U_j = \left[\int_0^1 C_{jk}^{\frac{\kappa-1}{\kappa}} dk \right]^{\frac{\kappa}{\kappa-1}} \tag{1}$$

where C_{jk} denotes consumption of product k in country j. The product-specific consumption itself depends on the varieties consumed from other countries in the world:

$$C_{jk} = \left[\sum_{i=1}^{J} \int_{\omega \in \Omega_{ijk}} \left[\lambda_{ijk}(\omega) c_{ijk}(\omega) \right]^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}} \tag{2}$$

$\lambda_{ijk}(\omega)$ denotes the product attribute of variety ω. The corresponding price index is defined as follows:

$$P_{jk} = \left[\sum_{i=1}^{J} \int_{\omega \in \Omega_{ijk}} \left[\frac{p_{ijk}(\omega)}{\lambda_{ijk}(\omega)} \right]^{1-\sigma} d\omega \right]^{\frac{1}{1-\sigma}} \tag{3}$$

I assume a monopolistic competition framework, where firms set their price independent of other firms and charge a constant mark-up. The price a firm charges is a function of the underlying productivity and is given by:

$$p_{ij}(\varphi,\lambda) = \frac{\sigma}{\sigma-1}\frac{t_{ij}w_i}{\varphi}$$

and does not depend on the product attribute (λ). Given prices, we can write firm revenues as

$$r_{ij}(\varphi,\lambda) = \left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi \lambda\right)^{\sigma-1}$$

These equations describe the demand side of the model, and I refer to Bernard et al. (2011) for a more detailed exposition. Concerning the supply side, I extend Bernard et al. (2011) to feature two different types of cost spillovers. The first scenario assumes the presence of an *intrafirm* spillover that reduces the per-product fixed cost of the firm and generates economies of scope. The second scenario considers an *interfirm* spillover that reduces the fixed cost to export for all firms exporting the same product. In the absence of these spillovers, the model collapses to the standard Bernard et al. (2011) framework. To have closed-form predictions on the entry elasticities with respect to market size as well as variation in the number of exporting firms and exported products across destination countries, I assume a truncated distribution. Without this assumption, the most productive firm would introduce all products in all destination markets, and there would be no variation in the number of products across markets. Next, I consider two scenarios of fixed costs.

3.1 Fixed cost at the firm level

Under entry barriers to export at the firm level, I consider market-specific fixed costs that the firm needs to pay in order to export its products to a destination market. Such costs can take the form of information costs to acquire knowledge about the market at a destination (Chaney (2011)), advertising costs to establish the firm brand (Arkolakis (2010)) or adaptation costs in the form of building a distribution network. Additional sources of adaptation costs can be cost in order to accommodate to business practices in the export destination (Artopoulos et al. (2013)). The key characteristic of the firm fixed cost is that incurring the cost benefits only the firm. Under this assumption, multi-product firms will benefit from economies of scope. This may be one explanation for why multi-product firms are dominant in international trade.[4]

Product entry is decided by the most productive firm, which chooses with how many products it wants to enter. Similar to Allanson and Montagna (2005), the fixed cost depends on the number of products the firm wants to export. The profit function of the most productive firm (φ_{max}) is given by:

$$\max_{\lambda^*_{ij}} \pi_{ij}(\varphi_{max}) = \int_{\lambda^*}^{\lambda_{max}} r_{ij}(\varphi_{max},\lambda^*)dG(\lambda^*_{ij},\varphi_{max})N_i - w_i f_{ij}\left(N_{ij}(\lambda^*_{ij},\varphi_{max})\right)^{\gamma}$$

[4] Based on US trade data in 2000, Bernard et al. (2011)) show that firms exporting more than five products at the HS 10-digit level make up 30 percent of exporting firms and account for 97 percent of all exports. Looking at Brazilian exporter data in the year 2000, Arkolakis and Muendler (2010) find that 25 percent of all manufacturing exporters ship more than 10 products at the internationally comparable HS six-digit level and account for 75 percent of total exports.

by the sum over all products and depends on the number of products ($N_{ij}(\lambda^*_{ij}, \varphi_{max}) = (1 - G(\lambda^*_{ij}, \varphi_{max})N_i)$ the firm φ_{max} chooses to export. Given the truncated Pareto distribution,[5] I can solve for the optimal number of products that firm φ_{max} wants to export as:

$$N_{ij}\left(\varphi_{max}\right)^{\frac{(z-(\sigma-1))}{z}+\gamma} = \left(\Lambda \frac{w_i f_{ij}}{w_j L_j}\right)\left(\frac{t_{ij} w_i}{\rho P_j \varphi_{max}}\right)^{\sigma-1} \tag{4}$$

where Λ defines a constant.[6] The choice of the firm product scope is a maximum if the following condition is satisfied: $\gamma > \left(1 - \frac{\sigma-1}{z}\right)$. Next, I combine all the terms that depend on market size: $X_j = \left(w_j L_j\right)^{\frac{1}{\sigma-1}} P_j$, which includes the price index P_j in destination county j. The price index depends on the number of firms and products that enter the market, which themselves depend on market size. Since I am interested in the magnitude of the firm elasticity relative to the product elasticity and the change in the price index with respect to market size is the same for both firm and product entry, I do not need to solve for the price index explicitly. Conditional on country-of-origin fixed effects and bilateral trade costs, the resulting elasticity of the number of products with respect to market size is equal to:

$$\frac{d \log N_{ij}}{d \log X_j} = z\left(\frac{(\sigma-1)}{(\sigma-1) - z(1-\gamma)}\right)$$

which is positive because $\gamma > \left(1 - \frac{\sigma-1}{z}\right)$. To derive the corresponding total number of firms that export to destination j, I have to determine the cut-off of the marginal firm that is willing to enter destination j. The marginal firm will be indifferent between entering or not if the expected profit from selling the product with the highest attribute λ_{max} is zero; more formally:

$$\pi_{ij}(\varphi^*_{ij}, \lambda_{max}) = r_{ij}(\varphi^*_{ij}, \lambda_{max}) = w_i f_{ij}.$$

and the corresponding cut-off productivity is:

$$\varphi^*_{ij} = \left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}} \left(\frac{t_{ij} w_i}{\rho P_j \lambda_{max}}\right) \tag{5}$$

As stated above, the firm productivity distribution is bounded above; i.e., there is a firm with a maximum and finite productivity draw.[7] Integrating the previous equation of the productivity distribution gives the mass of firms that are willing to enter destination j. As before, we gather all

[5]We assume the following density function for the product cut-off λ^*: $G\left(\lambda^*\right) = \left(1 - \left(\lambda_{min}\right)^z\right)\left(1 - \left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z\right)^{-1}\left(\left(\lambda^*\right)^{-z} - \lambda_{max}^{-z}\right)$ with the minimum product attribute λ_{min} and the maximum product attribute λ_{mac}.

[6]$\Lambda = \left(\frac{z}{z-(\sigma-1)} \frac{\left(\lambda_{min}\right)^z}{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}\right)^{-1} \left(\frac{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}{\left(\lambda_{min}\right)^z}\right)^{1-\frac{(z-(\sigma-1))}{z}}$

[7]The corresponding CDF of the marginal firm that is willing to enter φ^*_{ij} is defined as $G\left(\varphi^*_{ij}\right) = \left(1 - \left(\varphi_{min}\right)^\theta\right)\left(1 - \left(\frac{\varphi_{min}}{\varphi_{max}}\right)^\theta\right)^{-1}\left(\left(\varphi^*_{ij}\right)^{-\theta} - \varphi_{max}^{-\theta}\right)$, where the firm with the lowest productivity is φ_{min} and the firm with the highest productivity draw is defined by φ_{mac}.

demand variables in X_j and obtain the elasticity of the number of exporting firms with respect to destination market size:

$$\frac{d \log M_{ij}}{d \log X_j} = \theta$$

3.2 Fixed cost at the product level

Fixed costs at the product level can take the form of technical barriers to trade (in the form of product standards or certification procedures to ensure the quality) or product advertising. Firms have to pay a fixed cost to advertise the product at the destination because consumers are not aware of the product. Technical barriers to trade imply modifications to the offered product in order to customize it to particular local tastes or legal requirements imposed by national consumer protection laws. Note that the use of technical barriers to trade is subject to the Agreement on Technical Barriers to Trade administered by the World Trade Organization (WTO).

The key implication of the product fixed costs is that once a product is established in an export market, many firms start to export differentiated varieties of that product. Incurring the fixed cost to introduce a new product induces a spillover that lowers fixed costs for all firms within the product category. One reason is that *ex ante* consumers are unaware of the existence of the product. Once a firm ("the export pioneer") has introduced the product successfully at the destination market, product market rivals may benefit from lower fixed costs because they acquire knowledge about the potential demand of their own products since they observe the success of the pioneer. Alternatively, the rival firms may also take advantage of established contacts, distribution chains and/or other costly activities that the pioneer invested into when opening up the market.[8] To access the export market and overcome the negative effects for the export pioneer, firms can also share the fixed product costs in the form of trade associations formed to foster collaboration between companies within a specific product category; i.e., through export promotion policies. See Lederman et al. (2010) and Görg et al. (2008) for the empirical evidence.

To model these positive spillovers from rival firms, I follow Krautheim (2012) and assume that the fixed cost depends on the number of firms that produce the product from the same country. The corresponding profit function of a firm with productivity φ and selling product λ is given as follows:

$$\pi_{ij}(\varphi, \lambda) = r_{ij}(\varphi, \lambda) - \frac{w_i f_{ij}}{\left(M_{ij}(\lambda)\right)^{\eta}}$$

where f_{ij} is the product fixed cost and $M_{ij}(\lambda)$ is the reduction in fixed costs for any firm that introduces the product into the market.[9] Exporters benefit from an information externality that increases in the number of firms exporting a particular product. The number of products entering

[8] Khanna et al. (2009) study the concrete example of Metro Group, a German retail company that fought for years to have access to the Indian market. Once the Foreign Direct Investment permit was granted, rival retail firms like Wal-Mart and Tesco entered immediately by benefiting from the created legal framework and the observed business opportunities in the Indian retail market.

[9] We can assume that the spillover does not depend on the product, instead only on the number of firms selling the

destination j depends on whether the most productive firm is willing to pay the fixed cost to introduce the product. In other words, it introduces so many products that the revenue from the marginal product equals the fixed cost.

$$\pi_{ij}(\varphi_{max}, \lambda^*_{ij}) = r_{ij}(\varphi_{max}, \lambda^*_{ij}) - w_i f_{ij} = 0$$

Given that the export pioneer is the only firm exporting the marginal product, there is no spillover for this product. Given these assumptions, the product cut-off equals:

$$\lambda^*_{ij} = \left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}} \left(\frac{t_{ij} w_i}{\rho P_j \varphi_{max}}\right) \tag{6}$$

Next, we integrate over product attributes and express the total number of products that enter the destination as a function of market size ($w_j L_j$). As before, we gather all demand variables in X_j. Conditional on country-of-origin fixed effects and bilateral trade costs, the elasticity for the number of products that enter with respect to market size is:

$$\frac{d \log N_{ij}}{d \log X_j} = z$$

Firm entry is given by the marginal firm that just breaks even selling the product with the maximum level of demand. Note that we assume that the marginal firm benefits from an informational spillover that depends on the number of firms selling to the same destination and reduces the fixed cost to export the product with the maximal demand λ_{max}.

$$\pi_{ij}(\varphi^*_{ij}, \lambda_{max}) = r_{ij}(\varphi^*_{ij}, \lambda_{max}) = \frac{w_i f_{ij}}{\left(M_{ij}(\lambda_{max})\right)^{\eta}}$$

Note that $M^{\eta}_{ij}(\lambda_{max}) = M^{\eta}_{ij}$, which is the total number of firms that enter destination j. The productivity cut-off of the marginal firm that is willing to pay the fixed cost to enter is:

$$\varphi^*_{ij} = \left(\frac{w_j L_j M^{\eta}_{ij}}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}} \left(\frac{t_{ij} w_i}{\rho P_j \lambda_{max}}\right) \tag{7}$$

The corresponding expression for the elasticity of the number of exporting firms with respect to market size conditional on exporter fixed effects and bilateral trade costs is:

$$\frac{d \log M_{ij}}{d \log X_j} = \theta \left(\frac{\sigma - 1}{(\sigma - 1) - \eta\theta}\right)$$

product. The magnitude of the spillover is given by $M_{ij}(\lambda) = \int_{\varphi^*_{ij(\lambda)}}^{\varphi_{max}} f(\varphi) d\varphi = \left(1 - G(\varphi^*_{ij}(\lambda))\right) M_i$ with the assumption that there is only one firm exporting the marginal product, and hence $M_{ij}(\lambda^*) = 1$.

3.3 Comparing entry dynamics

Table 1 summarizes the model implied entry elasticities for firm and product fixed costs. Comparing across the different specifications of fixed costs, I observe that the elasticity of the number of firms with respect to market size is strictly larger in the case of fixed costs at the product level compared with fixed costs at the firm level. The reason is the presence of the positive spillover, which encourages the entry of rival firms that export the same product. Regarding product entry, the elasticity with respect to market size is higher in the case of fixed costs at the firm level. The presence of fixed costs reduction for multi-product firms ($\gamma < 1$) implies a cost advantage compared with single-product firms. They can spread the fixed cost across more products and obtain lower per-product average costs, similar to Feenstra and Ma (2007) and Eckel and Neary (2010). In the absence of this cost advantage, ($\gamma = 1$), the elasticity of product entry would be the same in both models and we are back in the Bernard et al. (2011) framework.

Table 1: Elasticities with respect to market size for different moments of the extensive margin under the assumption of fixed costs at the firm and product level.

	Firm fixed costs	Product fixed costs
	(1)	(2)
Elasticity of number of firms	θ	$\theta\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$
Elasticity of number of products	$z\left(\frac{(\sigma-1)}{(\sigma-1)-z(1-\gamma)}\right)$	z
Elasticity of average number of products per firm	0	$z\left(\frac{\eta\theta(h(\bar{\varphi})-1)}{(\sigma-1)-\eta\theta}\right)$
Elasticity of median number of products per firm	$z\left(\frac{(\sigma-1)(1-a)}{(\sigma-1)-z(1-\gamma)}\right)$	$z\left(\frac{(\sigma-1)(1-a)}{(\sigma-1)-\eta\theta}\right)$

While the comparison of firm and product elasticities increases the likelihood of shedding light on the underlying nature of fixed costs, there exists a range of parameters such that the firm elasticity is higher than the product elasticity in both scenarios.[10] To tighten the empirical implications, we calculate two additional entry moments: the elasticity of average and the median number of products per firm with respect to market size. The change in the average and the median number of products per firm will inform on how multi-product firms adjust their product scope with market size. Under the assumption of fixed costs at the firm level (see column (1) in Table 1), the average number of products per firm (1) does not change with market size and (2) is lower than the elasticity of the median number of products per firm.[11] The reason the average firm does not change its product scope is that, as market size increases, new single-product firms enter the export market, while firms already present in the market increase their product scope. For the average firm, these two dynamics balance out. The fact that the median firm increases its product

[10]For example, if the parameters are such that $\theta\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right) > \theta > \frac{z(\sigma-1)}{(z(\gamma-1)+(\sigma-1))} > z$.

[11] The parameter a lies in the unit interval and implies that the median number of products per firm increases with market size.

range suggests that smaller firms (the productivity of the median firm is below the average firm) benefit relatively more from economies of scope than the average firm.

On the other hand, if fixed costs are at the product level, the relationship between the elasticity for the average and the median number of products per firm reverses because $h(\bar{\varphi}) > 1$; see column (2) in Table 1. The presence of the positive spillover from rival firms reduces the importance of fixed costs and the incentive to add new products. Only the most productive firms are willing to pay the fixed cost for low-attribute products and increase their product range. The median firm exports only products with fairly high product attributes, which many other firms export as well.

Next, I explain how I distinguish empirically the nature of fixed costs; namely, whether they operate at the firm or at the product level. The key elements for this distinction are the comparison of firm entry and product entry elasticities as well as the firm's adjustment of its product range as market size increases.

3.4 Empirical specification

According to the model in the previous section, the entry cut-offs defined in equations 4 and 5 for firm fixed costs as well as equations 6 and 7 for product fixed costs depend on variables related to market size (w_j, L_j, P_j), trade costs (τ_{ij}), fixed costs (f_{ij}) and exporting country-specific effects ($w_i, \lambda_{max,i}, \varphi_{max,i}, M_i, N_i$). To test for significant difference in the entry elasticities, we first estimate how the number of exporters changes with market size

$$\log M_{d,c,t} = \alpha_1 \log \pi_{d,c,t} + \alpha_2 \log X_{d,t} + f_{c,t} + v_{d,c,t} \tag{8}$$

and how the number of products changes with market size

$$\log N_{d,c,t} = \beta_1 \log \pi_{d,c,t} + \beta_2 \log X_{d,t} + f_{c,t} + u_{d,c,t} \tag{9}$$

where $\pi_{d,c,t}$ denotes the import expenditure share in destination d on goods from country c, $X_{d,t}$ the market size measured by GDP of destination d in year t and f_{ct} a country of origin-specific fixed effects. Import expenditure shares proxy for changes in bilateral trade or fixed costs. If trade or fixed costs between c and d fall, then the importing country d will switch expenditure toward c. The overall increase in income due to the fall in these costs will then be captured by a change in overall expenditure (X_{dt}). The time-varying exporter fixed effect will control for any supply-side changes (changes in exporter's competitiveness due to aggregate productivity shocks or exchange rate shocks) that are common to all importing destinations. In order to take the distribution effects of market size on product scope of the firm into account, we also run regressions 8 and 9 with the average and median number of products per firm as dependent variables. We estimate equations 8 and 9 jointly within a seemingly unrelated regressions (SUR) model to allow for unobserved correlation between firm and product entry. To test whether the firm entry elasticity ($\hat{\alpha}_2$) is larger than the product entry elasticity ($\hat{\beta}_2$), I perform a one-sided Wald test ($H_0 : \hat{\alpha}_2 > \hat{\beta}_2$).

4 Data and empirical estimates

To build the empirical evidence, I use the Exporter Dynamics Database from the World Bank; see Cebeci et al. (2012). It contains firm characteristics per destination and per-product for 40 exporting countries for the period from 1997 to 2010.[12] Following the literature (see Broda and Weinstein (2006)), I consider a six-digit HS code per country as a product category and refer to individual firm products within the product category as varieties of the same product. Given this perspective, a product can be exported by multiple firms and a firm can potentially export multiple products. Firms can be viewed as providing their brand, and the brand in turn provides the platform for specific products to be launched. The Exporter Dynamics Database does not contain information on the "Oil and Fuels" sector (HS code 27) leaving a total of 4912 tradable products for each country.

To examine product and firm entry into export markets, I include market size and and import expenditure as the main destination characteristic. Bilateral distance, sharing a border and income per capita are additional control variables that are included in the robustness section. Distance and border measures come from Centre d'Etudes Prospectives et d'Informations Internationales (see Mayer and Zignago (2011)) and are in kilometers from capital city in country i to capital city in country j, calculated by the great circle method. Openness, market size and income measurements, defined as GDP and GDP per capita, are taken from the Penn World Table; see Heston et al. (2009). Data on total CIF import expenditure spend by destination on exporters' goods are taken from the Comtrade data set collected by the United Nations.[13] In total the baseline sample covers 40 exporting countries and 180 destination markets.

— Table 4 about here —

Table 4 describes the summary statistics of the combined data set. The average number of exporters in a destination across all 40 exporting countries is 344, and the average number of exported products per destination is 298. Since firms can export multiple products and a product can be exported by multiple firms, we can decompose the extensive margin of exports further. Line 3 in Table 4 shows that the average number of products per firm is 2.5, suggesting that the majority of firms are multi-product firms. The average number of firms per-products is 2.1, implying that

[12] I exclude Botswana, Brazil, Egypt, New Zealand and Kuwait because of missing firm characteristics by export destinations. Table 1 and 2 contain a complete list of the countries used.

[13] To construct import expenditure shares, I use data from both the Penn World Table and the UN Comtrade database. To avoid any potential measurement errors in the exchange rate when combining nominal values from the two data sets, I compute the import expenditure share of destination d on goods from country c, $\pi_{d,c}$, as follows. Using the UN Comtrade data set, I first compute the share of imports with respect to total trade flows. More precisely, I divide bilateral CIF imports, $X_{d,c}$, by the sum of total FOB exports plus total CIF imports for each country, $(Im_p + Ex_p)$. From the Penn World Table, I then take openness, defined as total exports plus total imports divided by GDP. Hence, I can calculate the share of total CIF imports expenditure with respect to GDP as:

$$\pi_{d,c} = \left(\frac{X_{d,c}}{Imp_d + Exp_d} \right) \left(\frac{Imp_d + Exp_d}{X_d} \right)$$

strategic interactions between exporters from the same origin country can be important. In the majority of destinations, a product is exported by more than one firm and the average firm sells more than one product.

— Table 5 about here —

Table 5 displays the results from the estimation of specification 8. Focusing on columns (1) and (2), we see that both the number of firms and products are increasing in destination market size and import expenditure share. In comparison with the literature, the firm entry elasticity of 0.40 with regard to destination market size is significantly lower than values found in other papers. Bernard et al. (2011) report a value of 0.70 for the United States in the year 2002 and Eaton et al. (2011) report an elasticity of 0.66 for France in the year 1992 and 0.68 for Denmark and Uruguay in 1993.[14] The results are more comparable with Bernard et al. (2011) because I also use total GDP as a measure of market size, whereas Eaton et al. (2011) use manufacturing absorption.[15] Although there are significant differences in the point estimate of the entry elasticity with respect to the literature, all values are significantly above 0.[16]

Focusing on differences in the elasticities with respect to market size, the entry elasticity for firms is higher than for products. A one-sided Wald test with the null hypothesis being that the entry elasticity regarding to market size is larger for firms than for products ($H_o : (\hat{\alpha}_2 > \hat{\beta}_2)$) confirms this hypothesis. The p-value at the bottom of Table 5 shows that we cannot reject the null hypothesis at the 1 percent level. In addition, Table 5 also reports the entry elasticities using the average number of products per firm (column (3)) and the median number of products per firm (column (4)). As market size increases, the average firm does not change its product range (in accordance with the findings of Arkolakis and Muendler (2010) in the case of Brazil), while the median firm reduces its product range. A Wald test confirms that the difference between the elasticity of the average and the median number of products per firm is positive and statistically significantly different from zero at the 1 percent level.

Note that the accounting identity of firm/product entry implies that the average number of products per firm times the number of firms equals the average number of firms per-product times the number of product. For this reason, column (5) in Table 5 reports the elasticity of the average number of firms per-product with respect to market size, which, by the identity, equals the elasticity in column (1) plus the elasticity in column (3) minus the elasticity in column (2). The

[14] I do not have data for the countries mentioned and cannot compare the results by running the same regression for the respective countries.

[15] If I use manufacturing absorption as a proxy for market size, I obtain a firm entry elasticity of 0.45. Absorption is calculated from gross manufacturing output plus imports minus exports. Due to data limitations on gross manufacturing output, the number of destinations shrinks to 150.

[16] Below, I provide a sensitivity analysis in which I investigate differences in the entry elasticities. The analysis shows that the entry elasticities increase with home market size, implying that larger economies have higher entry elasticities. The reason my estimate of firm entry is lower than the literature is that my sample consists predominately of small economies compared with the literature, therefore biasing the estimate downward. Based on the estimated relationship between home market size and entry elasticity from below, the results imply a firm entry elasticity of 0.74 for the United States and 0.62 for France.

results show that the average number of firms per product increases significantly as the market size increases. Higher demand in larger economies leads to more entry, increases the positive spillover of lower fixed costs for rival firms and leads to even more entry. Taken together and through the lenses of the theoretical framework in section 3, I consider these results as evidence suggesting that fixed costs are mainly at the product level.

4.1 Discussion of results

One identification thread is the potential correlation of unobserved destination characteristics with market size. According to the model, the import expenditure variable $\pi_{d,c,t}$ will capture most of these factors, like distance, trade cost or fixed cost differences. Nevertheless, other unobserved factors might still be at play. For this reason, we re-estimate equations 8 and 9 with bilateral fixed effects. These exporter-importer pair fixed effects account for any time-constant differences, like distance or sharing a common border, etc., between the trading partners. Consequently, the identifying variation comes from changes in the number of exporting firms and exported products due to changes in destination market size. The resulting estimates in Table 6 are slightly lower compared with the baseline results in Table 5 but the qualitative results remain unchanged. The elasticity of the number of firms with respect to market size is statistically significantly higher than for the number of products. The same holds for the elasticity of the average number of products per firms relative to the median number of products per firm.

— Table 6 about here —

Another concern with respect to the identification of significant differences in the elasticities across countries is that the results are driven by one particular country. To address this concern, we not only include country of origin-year dummies but also estimate equations 8 and 9 for each country separately and test the null hypothesis $H_o : (\hat{\alpha}_{2,i} > \hat{\beta}_{2,i})$ on a country-per-country basis. Columns (1) to (4) in Table 8 report the estimated coefficients and standard errors of the firm and product elasticity together with the p-value of the one-sided Wald test.[17] The entry elasticity for firms is significantly higher than for products at the 10 percent level for 35 out of 40 countries. For Laos, Jordan, Macedonia, Mali and Niger, we reject the null of a larger firm elasticity. As for the elasticity of the average relative to the median number of products per firm, the results show that for 28 out of 40 countries, the elasticity of the average is significantly higher. However, at the same time, for no country the elasticity for median number of products per firm is significantly higher than for the average. Overall, these results suggest that the conclusions drawn above regarding the entry behavior of firms and products are not driven by a particular country.

— Table 8 about here —

[17] Figure 2 plots the country-specific estimated firm entry elasticity against the product entry elasticity as well as the elasticity of the average against the median number of products per firm.

One explanation might be that larger markets are more difficult to penetrate because of higher fixed costs; for example, setting up a distribution network is costlier. In this case we would have a positive correlation between entry and market size because market size proxies for fixed costs. To analyze whether the positive entry elasticities are triggered by a correlation between market size and fixed costs, I use additional control variables ($F_{d,t}$) that proxy for fixed costs. The resulting regression equation for firms becomes

$$\log M_{d,c,t} \quad = \quad \alpha_1 \log(\pi_{d,c,t}) + \alpha_2 \log(X_{d,t}) + \alpha_3 \log(F_{d,t}) + d_{c,d} + d_{c,t} + \epsilon_{d,c,t} \tag{10}$$

and for products:

$$\log N_{d,c,t} \quad = \quad \beta_1 \log(\pi_{d,c,t}) + \beta_2 \log(X_{d,t}) + \beta_3 \log(F_{d,t}) + d_{c,d} + d_{c,t} + \epsilon_{d,c,t} \tag{11}$$

We expect that the coefficients α_3 and β_3 are negative; i.e., higher fixed costs decrease the presence of firms and products. Important are the coefficients on α_2 and β_2. If $\hat{\alpha}_2$ differs from $\tilde{\alpha}_2$, previously estimated in Table 5, then fixed costs are correlated with market size. To assess the relationship between market size and the proxies of fixed costs, we use the fact that $\tilde{\alpha}_2 = \hat{\alpha_2} + Corr(F_{d,t}, X_{d,t})$. If larger markets have higher fixed costs, then the estimated coefficient of market size should be lower, given the presence of fixed costs.

To proxy fixed costs, I include urban population (percentage of total), land area (sq. km), rail lines (total route-km), number of Internet and cell phone subscribers (per 100 persons) and electric power consumption (kWh per capita) from the World Development Indicators data set provided by the World Bank. Urban population and land area proxy for retail distribution costs. A higher percentage of urban population facilitates distribution. On the other hand, a larger land area increases the costs to reach consumers. Rail lines proxy for transportation infrastructure. While transportation costs are also part of marginal costs, I use them as proxies for infrastructure fixed costs.[18] The number of Internet subscribers controls for networking and communication costs. Finally, energy consumption proxies for higher retail costs. Because of missing observations, the sample reduces to 16084 observations.

— Table 7 about here —

Table 7 reports the detailed results for each dependent variable. Note that the elasticities of the number of firms and products with respect to destination market size decreases significantly. The reason is that market size is positively correlated with distribution costs; i.e., larger markets have higher fixed costs and thus reduce the importance of market size on fixed costs. Overall, the *p*-values of the Wald test show that the firm elasticity is still significantly higher than the product elasticity, suggesting that fixed costs operate preliminarily on the product rather than firm level even when we control for "observable" fixed costs.

[18] Removing rail lines and container port traffic from regression 10 does not change the results.

The key aspect of my analysis is that the product fixed cost is not firm specific. This assumption differs from Bernard et al. (2011), who consider product fixed costs at the firm level without spillover. Parameterized accordingly, their quantitative model can account for differences in the firm and product elasticity reported above. However, their model cannot explain why the median firm reduces its product range with market size. The presence of a positive interfirm spillover at the product level leads to more entry of single-product firms and reduces the incentives of firms to expand their product scope as market size increases. The first effect dominates the latter and explains why the elasticity of the number of products per firm with respect to market size is negative for the median firm. In the following section, I present empirical evidence that suggests spillovers, and I show that these effects are important in explaining the entry behavior of firms.

5 Firm entry within products

In the previous section, I presented evidence consistent with fixed costs operating at the product level. An important implication is that the presence of product fixed costs induces a positive externality for firms producing that product. Once a firm or a group of firms has paid the fixed cost to introduce a product into a market, subsequent exporters of that product face lower fixed costs.

To shed light upon this mechanism, I analyze how firm entry evolves over time after a product has entered a destination for the first time. Given the example of Metro Group entering the Indian retail market, described in Khanna et al. (2009), I expect that once a firm has successfully introduced a product at a destination market, rival firms will follow. As a result, firm entry will increase significantly in the following periods. Alternatively, firms can also cooperate to pay the product fixed costs. In this case, I expect that after the introduction of the product, firm entry declines because many exporters have already entered the market in the year that the product was introduced.

To test the effect, I investigate how the entry rate of firms varies over time. I define entry of a new product k from country c in a destination d at time t if the product is not exported in any period prior to the year of the first entry. The first year of product data I observe is 1995, and the first year of firm entry is 1998. Therefore, I will focus only on products that have not been exported to a destination prior to 1998 and define new product entry as products that have not been exported for at least three consecutive years.[19] Another issue with the data is that they do not contain information that is specific to the country of origin, destination, product and year; i.e., we do not know how many exporters from a particular country sell a particular product in a particular destination in a given year. To address this problem, I specify two regression models. In the first regression, I analyze the firm entry rate, aggregated over all products within a destination. In the second model, I consider the firm entry rate per product, aggregated over all destinations.

[19] Berman et al. (2015) look at the learning of firms in export markets and find that exporters who left export markets for two consecutive years are statistically indistinguishable from new exporters. In addition, I experimented with defining new product entry after four and five years. The results are quantitatively very similar to those reported below.

The first regression model analyzes the entry rate of firms from country c exporting to destination d at time t:

$$n_{d,c,t} = \sum_{s=1}^{6} \alpha_s l_{s,k,d,c} + d_{c,d} + d_{c,t} + d_{k,t} + \epsilon_{k,d,c,t} \tag{12}$$

Firm entry, $n_{d,c,t}$, is defined as the number of new exporters divided by the total number of exporters in that destination. I regress the firm entry rate on a set of dummies, ($l_{s,k,d,c}$), that capture firm entry after a product is exported for the first time to a destination. I set the dummy $l_{s,k,d,c}$ equal to 1 if product k from country c is exported to destination d s years after the product is introduced. The coefficient α_s captures the difference to the average firm entry in year s after the product is introduced. Given this specification, I expect that the entry increases significantly right after a product is introduced in an export market; i.e., $\alpha_1 > 0$. To test whether $\alpha_1 > 0$, I include a large set of control dummies: destination-origin ($d_{c,d}$), origin-time ($d_{c,t}$) and destination-time ($d_{d,t}$) specific dummies. Origin-destination dummies control for geography. The origin-time dummies control for any country-of-origin specific effects that generate easier firm entry into international markets; for example, institutions and infrastructure. Destination-time dummies control for macroeconomic conditions in the destination common to all products. In the second regression model, I analyze the firm entry rate within a product group across destinations. I estimate the following equation:

$$n_{k,c,t} = \sum_{s=1}^{6} \beta_s l_{s,k,d,c} + d_{c,k} + d_{k,t} + d_{c,t} + \epsilon_{k,d,c,t} \tag{13}$$

Firm entry, $n_{k,c,t}$, is defined by the number of new exporters divided by the total number of exporters of product k from country c in year t. I regress the entry rate on the same set of time dummies ($l_{s,k,d,c}$). The only difference is that I include origin-product ($d_{c,k}$) and product-time ($d_{k,t}$) fixed effects instead of destination-origin ($d_{c,d}$) and destination-time ($d_{d,t}$) dummies. The origin-product dummies account for supply-side effects. For example, firm entry may be higher because a country is very productive in a particular product. Product-time dummies account for exporter's supply effects and destination demand effects common across countries.

— Table 9 about here —

Table 9 plots the results of the two regression specifications. Average firm entry is given by the constant. The year dummies describe the estimated time effects on firm entry after a product is exported for the first time with respect to the mean. When I look at the coefficient of year 1 and year 2, firm entry increases significantly the first 2 years and then becomes either negative (column (1)) or insignificant (column (2)). Dividing the estimated coefficient by the average, I obtain that the entry rate in a destination increases by 2.5 percent and by 7 percent within the product group one year after a product is introduced. Given that the average number of firms per destination is 343, as shown in the summary statistics, the number of new firms in a destination increases on average by 8.6 firms. On the other hand, the average number of exporters per-product is 27, implying that two additional new firms start to export after a product is exported for the first time. This entry pattern is consistent with spillover effects from lower fixed costs for subsequent exporters and the definition of product fixed costs.

To strengthen the evidence of spillovers across firms, the next paragraph discusses additional empirical implications. According to the theoretical framework, under the presence of a product spillover, I should observe that products with a higher number of exporters per destination should be negatively correlated with the average price charged by these exporters. Also, the magnitude of the spillover depends on the type of product. I expect stronger spillover effects for products with high product attributes and that these products are exported to many destinations. Because the number of destinations does not control for the market size of the export markets penetrated, I also include the rank of the export market with the largest and the lowest size as additional control variables. To investigate whether these correlations are present in the data, I use the following regression specification:

$$\begin{aligned} \log N_{k,c,t} &= \beta_1 \log \bar{p}_{k,c,t} + \beta_2 \log s_{k,c,t} + \beta_3 \log \bar{q}_{k,c,t} + \\ &+ \beta_4 \log M_{k,c,t} + d_k + d_{c,t} + \epsilon_{d,c} \end{aligned} \tag{14}$$

where $N_{k,c,t}$ is the average number of exporters per destination in product class k from country c in period t, $\bar{p}_{k,c,t}$ is the unit value and proxies for the average export price of the product, $s_{k,c,t}$ is the survival probability of an exporter remaining an exporter the following year, $\bar{q}_{k,c,t}$ represents the average quantity exported per firm and $M_{k,c,t}$ stands for the number of destinations product k is exported to. d_k and $d_{c,t}$ are product and country-time fixed effects. Product fixed effects control for any characteristics that are common across export destinations like demand, substitutability and potentially common fixed costs. Country-time fixed effects control for institutional differences and macroeconomic trends that are common across products.[20]

— Table 10 about here —

Table 10 plots the results. The number of firms per destination for a given product is significantly negatively correlated with the average export price. Since I control for demand by product fixed effects, the number of export destinations and the firm's average quantity exported, I consider this as supportive evidence for the spillover; i.e., the entry of more firms reduces the fixed costs to export and the average price. With respect to volumes, the quantity coefficient in Table 10 is significant and positive. In addition, the quantity effect is larger than the price effect, implying that the average firm sells more in terms of volume and value. Combined, these effects are indicative of lower fixed costs. The lower fixed cost allows firms to slide down the average cost curve, increase production efficiency and export more.

[20] I assume that product demand is common across countries; i.e., that consumers in different destination markets have the same demand for a product. Under this assumption, product fixed effects will control for demand effect.

These findings are also consistent with the anecdotal evidence of Argentinian exporters discussed by Artopoulos et al. (2013). They argue that export pioneers acquire knowledge about foreign markets through their embeddedness in the business community of destination markets. The generated knowledge diffuses to rival firms within the same sector in the domestic market, lowers fixed costs to export and increases their efficiency. As a result, firm participation and export sales per firm increase significantly. An additional implication of the knowledge spillover is that firms learn to conduct international business, helping them to remain an exporter in the next period. Including the survival probability of staying an exporter in the next period as an additional regressor confirms this conjecture. Firms exporting products with many rival firms have on average a 22 percent higher probability of survival in export markets.

Artopoulos et al. (2013) argue that spillover effects are particularly pronounced in sectors with a high degree of product differentiation. In product categories that allow for more product differentiation, firms can react to more product market competition by upgrading their own product through quality. The higher the degree of product differentiation, the lower the competition pressure from product market rivals. I expect the negative relationship between export price and firm entry to be weakened; i.e., differentiated product groups should experience relatively more product entry. In regression 14, I control for product differentiation by including product fixed effects. In a sensitivity analysis I re-estimate equation 14 for different types of products classified according to Rauch (1999)'s product differentiation index. The three groups are homogeneous goods, reference priced goods and differentiated goods. Index 1 refers to homogeneous goods, 2 to reference prices goods and 3 to differentiated goods.

— Table 11 about here —

Table 11 contains the results. I test whether the sensitivity of price on the number of firms per destination is lower for differentiated products than for homogeneous products. In differentiated products, the effect of price on the number of firms per destination is significantly lower than in the other two groups. Also, the probability of staying in export markets and the average export revenues are higher for firms exporting differentiated products. This is additional evidence for the argument of Artopoulos et al. (2013) that positive spillover effects are stronger in differentiated products.

In sum, the results suggest that consistent with product fixed costs, once a firm has introduced a product into a market, subsequent exporters face lower fixed costs. The time series analysis shows that most firms enter the year right after a product was exported the first time. This finding is consistent with lower fixed costs because of the removal of part of the fixed cost to export by the export pioneer. In the cross section, I find that products in which we expect a stronger spillover (and thus lower fixed costs) have more exporting firms and higher average firm export sales. The lower cost allows firms to produce at a more efficient scale and export a larger quantity despite the tougher competition from more entrants. Overall, both the time series and the cross-section results are supportive of the view that the presence of product fixed costs leads to spillovers that increase firm entry and exporter sales.

6 Conclusion

This paper develops a theoretical framework to analyze fixed costs that exporting firms face in order to participate in international markets. The analysis distinguishes between fixed costs on the firm and product level. The main difference between the two types of fixed costs is that firm-level fixed costs generate a cost advantage for multi-product firms through economies of scopes, while product-level fixed costs induce a positive spillover that reduces cost to export for firms producing the same product. When I look at the variation of firm and product entry across markets, the empirical estimates are consistent with the entry pattern predicted by fixed costs at the product level.

To investigate potential spillover effects on firm entry due to product fixed costs, I augment the empirical framework and analyze firm entry after the introduction of a new product into a destination market. The results show that entry of firms increases significantly the year after a product is introduced for the first time. The higher entry of rival firms is suggestive of potential lower entry barriers resulting from the reduction of fixed costs. The empirical findings also show that higher entry is correlated with lower export prices, more quantities exported and a higher probability of staying in international markets the next period. Given that the quantity effect dominates the price effect, these findings are indicative of firms able to produce at a more efficient scale.

In conclusion, these findings have potential policy implications. For the exporting country, policies encouraging new product entry – for example, advertising new products in destination markets through export promotion agencies, rather than firm entry – would potentially lead to spillover effects that translate into higher level of firm participation and export growth. By paying part of the product fixed costs, the government increases incentives for firms to explore new export destinations and offsets part of the negative effects due to free riding of rival firms.

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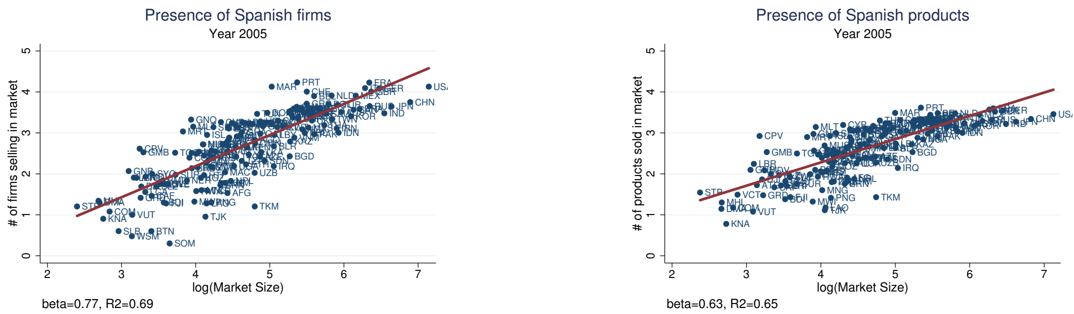
7 Figures

Figure 1: Number of Spanish exporting firms and number of Spanish products exported versus market size in destination d.

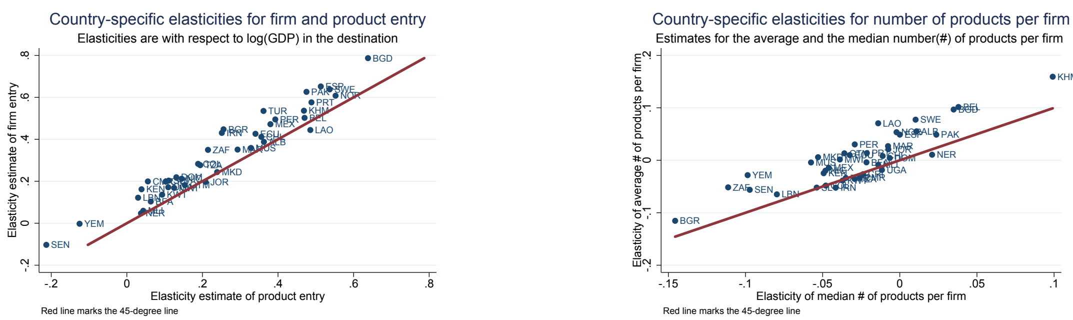


(a) Firm entry by market size for Spain in 2005

(b) Product entry by market size for Spain in 2005

Sources: Exporter Dynamics Database World Bank. Figure (1a) number of firms, Figure (1b) number of six-digit HS products per destination. Market size is absorption of a country's manufacturing sector. The slopes of the fitted lines are 0.77 (standard error 0.038) for exporting firms from Spain and 0.63 (0.034) for exported products from Spain.

Figure 2: Estimated cross-country entry elasticities with respect to market size reported in Table 8.

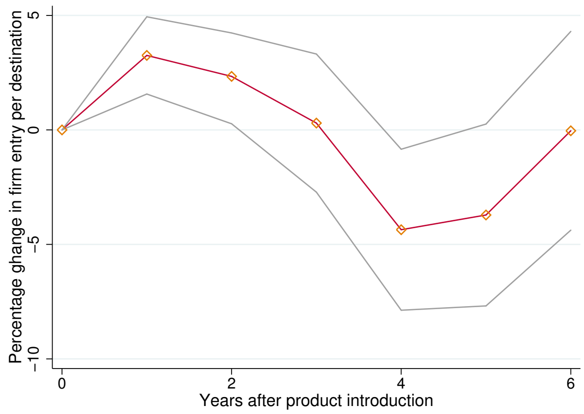


(a) Firm versus product entry

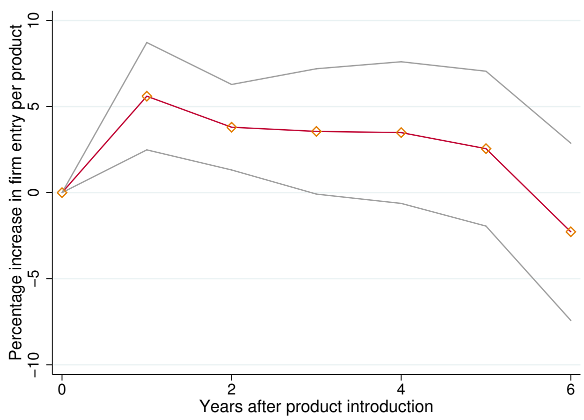
(b) Average versus median number of products per firm

Note: Panel (a) plots the estimated country-specific point estimates of the coefficients $\alpha_2$and β_2 from regressions (8) and (9), using the number of exporting firms and the number of exported products as dependent variables. Panel (b) plots the estimated country-specific point estimates of the coefficients $\alpha_2$and β_2 from regressions (8) and (9), using the average number of products per firm and the median number of products per firm as dependent variables.

Figure 3: The firm entry rate over time after a product is exported to a market for the first time.



(a) Firm entry within a destination



(b) Firm entry within a product group

8 Tables

Table 2: Exporting countries in the sample

Albania	Dominican Republic	Macedonia	Peru
Bangladesh	Ecuador	Malawi	Portugal
Belgium	El Salvador	Mali	Senegal
Bulgaria	Estonia	Mauritius	South Africa
Burkina Faso	Guatemala	Mexico	Spain
Cambodia	Iran	Morocco	Sweden
Cameron	Jordan	Nicaragua	Turkey
Chile	Kenya	Niger	Uganda
Colombia	Laos	Norway	United Rep. Tanzania
Costa Rica	Lebanon	Pakistan	Yemen

Note: Data from the Exporter Dynamics Database provided by the World Bank

Table 3: Importing countries in the sample

Afghanistan	Denmark	Kyrgyzstan	Samoa
Albania	Djibouti	Laos	Sao Tome & Principe
Algeria	Dominica	Latvia	Saudi Arabia
Angola	Dominican Republic	Lebanon	Senegal
Antigua & Barbuda	Ecuador	Liberia	Seychelles
Argentina	Egypt	Libya	Sierra Leone
Armenia	El Salvador	Lithuania	Singapore
Australia	Equatorial Guinea	Macao	Slovak Republic
Austria	Eritrea	Macedonia	Slovenia
Azerbaijan	Estonia	Madagascar	Solomon Islands
Bahamas	Ethiopia	Malawi	Somalia
Bahrain	Fiji	Malaysia	South Africa
Bangladesh	Finland	Maldives	Spain
Barbados	France	Mali	Sri Lanka
Belarus	Gabon	Malta	St. Kitts & Nevis
Belgium	Gambia, The	Marshall Islands	St. Lucia
Belize	Georgia	Mauritania	St. Vincent & Grenadines
Benin	Germany	Mauritius	Sudan
Bermuda	Ghana	Mexico	Suriname
Bhutan	Greece	Micronesia	Sweden
Bolivia	Grenada	Moldova	Switzerland
Bosnia & Herzegovina	Guatemala	Mongolia	Syria
Brazil	Guinea	Morocco	Taiwan
Brunei	Guinea-Bissau	Mozambique	Tajikistan
Bulgaria	Guyana	Nepal	Tanzania
Burkina Faso	Haiti	Netherlands	Thailand
Burundi	Honduras	New Zealand	Togo
Cambodia	Hong Kong	Nicaragua	Tonga
Cameroon	Hungary	Niger	Trinidad & Tobago
Canada	Iceland	Nigeria	Tunisia
Cape Verde	India	Norway	Turkey
Central African Republic	Indonesia	Oman	Turkmenistan
Chad	Iran	Pakistan	Uganda
Chile	Iraq	Palau	Ukraine
China	Ireland	Panama	United Arab Emirates
Colombia	Israel	Papua New Guinea	United Kingdom
Comoros	Italy	Paraguay	United States
Congo, Dem. Rep.	Jamaica	Peru	Uruguay
Congo, Republic of	Japan	Philippines	Uzbekistan
Costa Rica	Jordan	Poland	Vanuatu
Cote d'Ivoire	Kazakhstan	Portugal	Venezuela
Croatia	Kenya	Qatar	Vietnam
Cuba	Kiribati	Romania	Yemen
Cyprus	Korea, Republic of	Russia	Zambia
Czech Republic	Kuwait	Rwanda	Zimbabwe

Note: Data from Comtrade, Penn World Table and CEPII

Table 4: Summary statistics

	Obser.	Mean	Median	St. Dev.	Min	Max
Nr. of exporters	30164	343,8	39	1112,9	2	28981
Nr. of products	30164	297,1	55	564,8	1	4163
Nr. of exporters/product	30164	2,12	1,46	1,87	1	43,23
Nr. of products/exporter	30164	2,54	1,97	2,87	1	104,80
Av. revenues per exporter	30164	1,29	0,58	4,38	8,92E-06	755,4
Av. revenues per-product	30164	1,27	0,49	4,57	2,85E-06	645,6
GDP in destination	1560	451909	65967	1358439	145	14400000
GDP per capita in dest.	1560	13303	92395	14071	192	91707
Expenditure share	30164	0,00125	0,00026	0,00783	1,97E-09	0,40083
Distance	30164	6873	6177	4343	86	19812
GDP in origin country	182	275916	165278	351089	8247	1516755
GDP per capita in origin	182	12105	7978	12090	559	54927

Note: Statistics are aggregated over all export destinations. Average expenditure per firm is total imports of destination per exporting country divided by number of exporting firms. Average expenditure per-product is total imports of destination per exporting country divided by number of exported products. Average expenditure per firm and per-product as well as GDP are measured in million international dollars. Expenditure shares are defined as a country's total value of imports per exporting country divided by the country's total expenditure; i.e., GDP. GDP per capita is measured in international dollars. Distances are in kilometers from capital city in country i to capital city in country j.

Table 5: Elasticity estimates of entry with respect to market size for firms and products

Dependent variable	log(Number of firms) (1)	log(Number of products) (2)	log(Average Nr. of products per firm) (3)	log(Median Nr. of products per firm) (4)	log(Average Nr. of firms per-product) (5)
log(GDP)	0.388***	0.292***	0.001	-0.017***	0.098***
	[0.000]	[0.000]	[0.740]	[0.000]	[0.000]
log(π)	0.355***	0.352***	0.057***	0.009***	0.060***
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Exporter-year FE	yes	yes	yes	yes	yes
Observations	31236	31236	31236	31236	31236
R^2	0.66	0.62	0.29	0.11	0.40
One-sided Wald test (p-value)	0.001		0.001		

Note: The last row reports the p-values of the Wald test: elasticity of log(GDP) in column (1) larger than elasticity of log(GDP) in column (2) and elasticity of log(GDP) in column (3) larger than elasticity of log(GDP) in column (4). All regressions include time-varying exporter fixed effects. Robust standard errors in parentheses (clustered by exporting country-time): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Table 6: Elasticity estimates of entry with respect to market size for firms and products.

Dependent variable	log(Number of firms) (1)	log(Number of products) (2)	log(Average Nr. of products per firm) (3)	log(Median Nr. of products per firm) (4)	log(Average Nr. of firms per-product) (5)
log(GDP)	0.566***	0.524***	0.056**	-0.040**	0.097***
	[0.000]	[0.000]	[0.017]	[0.017]	[0.000]
log(π)	0.003	0.002	0.000	0.004**	0.001
	[0.286]	[0.481]	[0.914]	[0.040]	[0.677]
Exporter-year FE	yes	yes	yes	yes	yes
Exporter-importer FE	yes	yes	yes	yes	yes
Observations	30797	30797	30797	30797	30797
R^2	0.88	0.87	0.69	0.48	0.81
One-sided Wald test (p-value)	0.001		0.001		

Note: The last row reports the p-values of the Wald test: elasticity of log(GDP) in column (1) larger than elasticity of log(GDP) in column (2) and elasticity of log(GDP) in column (3) larger than elasticity of log(GDP) in column (4). All regressions include time-varying exporter and importer-exporter fixed effects. Robust standard errors in parentheses (clustered by exporting country-time): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Table 7: Elasticity estimates of entry with respect to market size for firms and products.

Dependent variable	log(Number of firms) (1)	log(Number of products) (2)	log(Average Nr. of products per firm) (3)	log(Median Nr. of products per firm) (4)	log(Average Nr. of firms per-product) (5)
log(GDP)	0.745***	0.672***	0.092**	-0.061**	0.166***
	[0.000]	[0.000]	[0.016]	[0.023]	[0.000]
log(π)	0.006	0.007	-0.002	0.004	-0.004
	[0.264]	[0.308]	[0.589]	[0.235]	[0.254]
log(Electricity per capita)	0.134***	0.093***	-0.019	-0.015	0.021*
	[0.000]	[0.000]	[0.207]	[0.140]	[0.055]
log(Rail km)	-0.038***	-0.051***	-0.018*	0.002	-0.005
	[0.005]	[0.001]	[0.065]	[0.785]	[0.492]
Share of urban population	-0.001	-0.004**	-0.003***	-0.001	-0.000
	[0.436]	[0.046]	[0.006]	[0.208]	[0.723]
log(Land size km^2)	-1.198**	-1.451**	-0.024	-0.112	0.229
	[0.048]	[0.032]	[0.950]	[0.709]	[0.645]
log(Nr. of Internet subscribers)	-0.006	0.003	0.004*	0.001	-0.005*
	[0.158]	[0.487]	[0.090]	[0.670]	[0.095]
Exporter-year FE	yes	yes	yes	yes	yes
Exporter-importer FE	yes	yes	yes	yes	yes
Observations	16084	16084	16084	16084	16084
R^2	0.88	0.87	0.73	0.55	0.81
One-sided Wald test (p-value)	0.001		0.001		

Note: The last row reports the p-values of the Wald test: elasticity of log(GDP) in column (1) larger than elasticity of log(GDP) in column (2) and elasticity of log(GDP) in column (3) larger than elasticity of log(GDP) in column (4). All regressions include time-varying exporter and importer-exporter fixed effects. Robust standard errors in parentheses (clustered by exporting country-time): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Table 8: Country-specific estimates of entry elasticities with respect to market size

Country ISO code	log(Number of firms) (1)	log(Number of products) (2)	Wald test (p-value) (3)	log(Average Nr. of products per firm) (4)	log(Median Nr. of products per firm) (5)	Wald test (p-value) (6)
ALB	0.388**	0.363**	0.050	0.055**	0.011	0.000
BEL	0.502**	0.470**	0.000	0.102**	0.038**	0.000
BFA	0.103**	0.063	0.000	-0.004	-0.022*	0.020
BGD	0.787**	0.638**	0.000	0.097**	0.035**	0.000
BGR	0.448**	0.256**	0.000	-0.115**	-0.146**	0.000
CHL	0.411**	0.356**	0.000	0.008	-0.011**	0.000
CMR	0.199**	0.056*	0.000	-0.033**	-0.026**	0.890
COL	0.283**	0.189**	0.000	-0.048**	-0.048**	0.510
CRI	0.199**	0.103**	0.000	-0.027**	-0.024**	0.700
DOM	0.219**	0.131**	0.000	0.004	-0.007	0.050
ECU	0.426**	0.340**	0.000	0.010	-0.032**	0.000
ESP	0.652**	0.513**	0.000	0.049**	-0.000	0.000
GTM	0.182**	0.154**	0.035	0.013	-0.036**	0.000
IRN	0.431**	0.251**	0.000	-0.052**	-0.042**	0.910
JOR	0.197**	0.208**	0.985	0.021**	-0.007**	0.000
KEN	0.162**	0.039	0.000	-0.025*	-0.049**	0.000
KHM	0.536**	0.469**	0.000	0.159**	0.099**	0.000
KWT	0.136*	0.093	0.003	-0.039*	-0.037**	0.540
LAO	0.444**	0.485**	0.849	0.071*	-0.014	0.000
LBN	0.122**	0.030	0.000	-0.065**	-0.080**	0.110
MAR	0.351**	0.293**	0.000	0.027**	-0.008	0.000
MEX	0.472**	0.380**	0.000	-0.014*	-0.046**	0.000
MKD	0.244**	0.239**	0.329	0.006	-0.053**	0.000
MLI	0.059	0.043	0.212	-0.009	-0.014	0.340
MUS	0.359**	0.328**	0.003	-0.004	-0.058**	0.000
MWI	0.168**	0.125*	0.049	0.002	-0.039*	0.010
NER	0.047	0.037	0.393	0.011	0.021	0.670
NIC	0.212**	0.145**	0.000	-0.020	-0.048**	0.000
NOR	0.608**	0.552**	0.000	0.054**	-0.002	0.000
PAK	0.626**	0.475**	0.000	0.049**	0.024**	0.000
PER	0.495**	0.393**	0.000	0.030**	-0.029**	0.000
PRT	0.576**	0.488**	0.000	0.014*	-0.021**	0.000
SEN	-0.103**	-0.213**	0.000	-0.056**	-0.097**	0.000
SLV	0.203**	0.111**	0.000	-0.052**	-0.054**	0.430
SWE	0.638**	0.537**	0.000	0.077**	0.010**	0.000
TUR	0.535**	0.362**	0.000	-0.034**	-0.035**	0.390
TZA	0.277**	0.194**	0.000	-0.035**	-0.029**	0.810
UGA	0.171**	0.109**	0.000	-0.018**	-0.012**	0.900
YEM	-0.003	-0.125**	0.000	-0.028*	-0.099**	0.000
ZAF	0.350**	0.215**	0.000	-0.052**	-0.111**	0.000

Note: Columns (1), (2), (4) and (5) contain the estimated elasticity with respect to market size (proxied by log(GDP)). All regressions include the log of import expenditure shares as a control variable as well as year fixed effects. Column (3) reports the p-value of the Wald test: elasticity in column (1) larger than the elasticity in column (2). Column (6) reports the p-value of the Wald test: elasticity in column (4) larger than the elasticity in column (5). All regressions include importer fixed effects. Robust standard errors in parentheses (clustered by exporting country): ***, **, * marks statistically significant difference from zero at the 1%, 5% and 10% level respectively.

Table 9: Fixed costs and the number of exporters per destination

Dependent variable	Firm entry per destination (1)	Firm entry per-product (2)
year_1	0.943***	0.460***
	[0.249]	[0.130]
year_2	0.477**	0.312***
	[0.257]	[0.104]
year_3	0.086	0.292*
	[0.446]	[0.152]
year_4	-1.264**	0.286
	[0.520]	[0.172]
year_5	-1.077*	0.209
	[0.587]	[0.188]
year_6	-0.011	-0.186
	[0.642]	[0.0.215]
Product-year FE	yes	no
Exporter-importer FE	yes	no
Product-exporter FE	no	yes
Importer-year FE	no	yes
Observations	3297489	2703038
R-squared	0,729	0,529

Note: The dependent variable is the number of entrants divided by the total number of exporters in a destination (column (1)) or within a product group (column (2)). The results are based on ordinary least squares regressions. All regressions include origin country-time fixed effects. The destination-specific regression in column (1) includes product-year and exporter-importer fixed effects, whereas the product-specific regression in column (2) includes product-exporter and importer-year fixed effects. Robust standard errors in parentheses (clustered by destination in column (1) and by product in column (2)): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Table 10: Fixed costs and the number of exporters per destination

Dependent variable	log(Av. Nr. Exporters per destination) (1)	(2)
log(Av. unit value)	-0.01025***	-0.01085***
	[0.000703]	[0.000702]
Log(Av. quantity)	0.0399***	0.0394***
	[0.000619]	[0.000625]
log(Nr. of destinations)	0.127***	0.117***
	[0.00154]	[0.00163]
Survival probability	0.225***	0.224***
	[0.00443]	[0.00443]
Rank of largest market		-0.000786***
		[3.14e-05]
Rank of smallest market		0.000322***
		[4.06e-05]
Exporter FE	yes	yes
Product FE	yes	yes
Year FE	yes	yes
Observations	201,788	201,788
R-squared	0.495	0.497

Note: The dependent variable is the average number of exporters per destination. The results are based on ordinary least squares regressions. All regressions include exporter, product and year fixed effects. Robust standard errors in parentheses (clustered by product): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Table 11: Fixed costs and the number of exporters per destination for differentiated, less differentiated and homogeneous products

Dependent variable:	log(Av. Nr. Exporters per destination)		
Differentiation index	1	2	3
log(Av. unit value)	-0.0389***	-0.0138***	-0.0046***
	[0.0033]	[0.0016]	[0.0005]
Log(Av. quantity)	0.0145***	0.0173***	0.0237***
	[0.0017]	[0.0005]	[0.0009]
log(Nr. of destinations)	0.0333***	0.0342***	0.146***
	[0.0073]	[0.0037]	[0.0018]
Survival probability	0.129***	0.152***	0.263***
	[0.0147]	[0.0081]	[0.0055]
Rank of largest market	0.000753***	0.000990***	0.000723***
	[0.0001]	[7.06e-05]	[3.61e-05]
Rank of smallest market	-0,000273	0.000360***	0.000295***
	[0.0001]	[8.49e-05]	[4.76e-05]
Exporter FE	yes	yes	yes
Product FE	yes	yes	yes
Year FE	yes	yes	yes
Observations	9682	40573	151369
R-squared	0,386	0,424	0,532

Note: The dependent variable is the average number of exporters per destination. The product differentiation index assigns a value of 1 to homogeneous goods, 2 to reference prices goods and 3 to differentiated goods. The results are based on ordinary least squares regressions. All regressions include exporter, product and year fixed effects. Robust standard errors in parentheses (clustered by product): ***, **, * mark statistically significant difference from zero at the 1%, 5% and 10% levels, respectively.

Appendix

This appendix contains the technical derivations for the two fixed-cost scenarios in the standard Bernard et al. (2011) model. The first section derives the entry elasticities for the case of fixed costs at the product level. The second section considers the case of fixed costs at the firm level.

Product fixed costs

The hypothesis is that firms exporting a product benefit from an information spillover that lowers the fixed cost for all firms producing this product (a reduced form of positive spillovers due to information asymmetries, similar to Krautheim (2012)). The profit function of a firm with productivity φ and selling product λ is given as follows:

$$\pi_{ij}(\varphi,\lambda) = \left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi \lambda\right)^{\sigma-1} - \frac{w_i f_{ij}}{\left(M_{ij}(\lambda)\right)^{\eta}}$$

where f_{ij} is the product fixed cost and $M_{ij}(\lambda)$ is the reduction in fixed costs for any firm that introduces the product in the market.[21] Given this formulation, I can derive product and firm entry.

The number of products (product entry)

The number of products entering destination j depends on whether the most productive firm is willing to pay the fixed cost to introduce the product. In other words, it introduces the number of products needed such that the revenue from the marginal product equals the fixed cost.

$$\pi_{ij}(\varphi_{max},\lambda^*_{ij}) = \left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi_{max} \lambda^*_{ij}\right)^{\sigma-1} - w_i f_{ij} = 0$$

Note that the most productive firm is the only one exporting the marginal product and there is no spillover for that product. Given these assumptions, the product cut-off equals:

$$\lambda^*_{ij} = \left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}} \left(\frac{t_{ij}w_i}{\rho P_j \varphi_{max}}\right)$$

The resulting share of products is given by the CDF of the upper truncated Pareto distribution: $G(\lambda) = \left[1 - \left(\frac{\lambda_{min}}{\lambda}\right)^z\right] / \left[1 - \left(\frac{\lambda_{min}}{\lambda_{max}}\right)^z\right]$. The cut-off for the marginal product is

$$\left(\lambda^*_{ij}\right)^{-z} = \left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{-z}{1-\sigma}} \left(\frac{t_{ij}w_i}{\rho P_j \varphi_{max}}\right)^{-z}$$

and we can relate the share of products that enter to market size ($w_j L_j$):

[21] One can assume that the spillover does not depend on the product, instead only on the number of firms selling the product. The magnitude of the spillover is given by $M_{ij}(\lambda) = \int_{\varphi^*_{ij(\lambda)}}^{\varphi_{max}} f(\varphi) d\varphi = \left(1 - G(\varphi^*_{ij}(\lambda))\right) M_i$ with the assumption that for the marginal product, there is only one firm exporting it and hence $M_{ij}(\lambda^*) = 1$.

$$\left(\left(1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z\right)\left(1-G(\lambda_{ij}^*)\right)-1\right)^{\frac{1}{z}} = -\left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\lambda_{min}\rho P_j \varphi_{max}}{t_{ij} w_i}\right).$$

For simplicity, I evaluate the derivative when the ratio of the upper to the lower bound of the Pareto distribution goes to zero; i.e., $\lim\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z \to 0$. In this case, the expression for the share of exported products, n_{ij}, becomes:

$$(n_{ij})^{\frac{1}{z}} = \left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\lambda_{min}\rho P_j \bar{\varphi}}{t_{ij} w_i}\right)$$

I gather all the terms that depend on destination market size ($w_j L_j$) in $X_j = f(w_j L_j, P_j(w_j L_j))$. Conditional on country-of-origin fixed effects and bilateral trade costs, the elasticity of products with respect to destination market size equals

$$\frac{d\log n_{ij}}{d\log X_j} = z$$

The number of firms (firm entry)

Firm entry is given by the marginal firm that just breaks even selling the product with the maximum level of demand λ_{max}.

$$\pi_{ij}(\varphi_{ij}^*) = (t_{ij} w_i)^{1-\sigma} w_j L_j \left(\rho P_j \varphi_{ij}^* \lambda_{max}\right)^{\sigma-1} = \frac{w_i f_{ij}}{(M_{ij}(\lambda_{max}))^\eta}$$

Note that $M_{ij}^\eta(\lambda_{max}) = M_{ij}^\eta$, which is the total number of firms that enter destination j. The productivity cut-off for the marginal firm that is willing to pay the fixed cost to enter is:

$$\varphi_{ij}^* = \left(\frac{w_j L_j M_{ij}^\eta}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}}\left(\frac{t_{ij} w_i}{\rho P_j \lambda_{max}}\right)$$

and hence the share of firms that enter is

$$m_{ij} = 1 - G(\varphi_{ij}^*) = 1 - \frac{1-\left(\frac{\varphi_{min}}{\varphi_{ij}^*}\right)^\theta}{1-\left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^\theta} = 1 - \frac{1-\left(\frac{w_j L_j \left(1-G(\varphi_{ij}^*) M_i\right)^\eta}{w_i f_{ij}}\right)^{\frac{\theta}{\sigma-1}}\left(\frac{\rho P_j \lambda_{max}\varphi_{min}}{t_{ij} w_i}\right)^\theta}{1-\left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^\theta}$$

The corresponding firm entry elasticity with respect to demand can be calculated from the following expression:

$$\left(\left(\left(1-\left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^z\right)(m_{ij})-1\right)(m_{ij})^{\frac{-\eta\theta}{\sigma-1}}\right)^{\frac{1}{\theta}} = -\left(\frac{w_j L_j M_i^\eta}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\rho P_j \varphi_{min}\lambda_{max}}{t_{ij} w_i}\right)$$

For simplicity, I evaluate the derivative when the ratio of the upper to the lower bound of the

Pareto distribution goes to zero; i.e., $\lim \left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^z \to 0$. In this case, the expression for firm entry becomes:

$$(m_{ij})^{(1-\frac{\eta\theta}{\sigma-1})\frac{1}{\theta}} = \left(\left(\frac{w_j L_j M_i^{\eta}}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\rho P_j \lambda_{max} \varphi_{min}}{t_{ij} w_i}\right)\right)$$

Again, I gather all the variables that depend on destination market size in $X_j = f(w_j L_j, P_j(w_j L_j))$. Conditional on country-of-origin fixed effects and bilateral trade costs, the elasticity of firms with respect to destination market size equals

$$\frac{d \log m_{ij}}{d \log X_j} = \theta \left(\frac{\sigma - 1}{(\sigma - 1) - \eta\theta}\right)$$

Average number of products per firm

Start with the zero-profit condition that defines the number of products a firm introduces into the market. The product cut-off for the firm with average productivity$\bar{\varphi}$ is given by:

$$\lambda_{ij}^{*}(\bar{\varphi}_{ij}) = \left(\frac{w_j L_j M_{ij}^{\eta}(\bar{\varphi}_{ij})}{w_i f_{ij}}\right)^{\frac{1}{1-\sigma}} \left(\frac{t_{ij} w_i}{\rho P_j}\right) \bar{\varphi}_{ij}^{-1}$$

$$n_{ij}^{\frac{1}{z}}(\bar{\varphi}_{ij}) = (1 - G(\bar{\varphi}_{ij}))^{\frac{\eta}{\sigma-1}} (X_j \bar{\varphi}_{ij})$$

where $\lambda_{ij}^{*} = n_{ij}^{-\frac{1}{z}}$ and $X_j = \left(\frac{w_j L_j M_i^{\eta}}{w_i F_{ij}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\rho P_j}{t_{ij} w_i}\right)$. The elasticity is calculated as follows:

$$\frac{1}{z}\frac{d \log n_{ij}(\bar{\varphi}_{ij})}{d \log X_j} = 1 + \frac{\eta}{\sigma - 1}\frac{\partial \log(1 - G(\bar{\varphi}_{ij}))}{\partial \log X_j} + \frac{\partial \log \bar{\varphi}_{ij}}{\partial \log X_j}$$

Note that we can write the CDF for the average productivity among exporters as:

$$\log(1 - G(\bar{\varphi}_{ij})) = \log \left(1 - \frac{1 - \left(\frac{\varphi_{ij}^{*}}{\bar{\varphi}_{ij}}\right)^{\theta}}{1 - \left(\frac{\varphi_{ij}^{*}}{\varphi_{mac}}\right)^{\theta}}\right)$$

where the CDF is a truncated distribution of the firms that are exproting. Note that $\frac{g(\bar{\varphi}_{ij})}{(1-G(\bar{\varphi}_{ij}))}$ is the hazard rate evaluated at the average procdutivity.

$$\frac{\partial \log(1 - G(\bar{\varphi}_{ij}))}{\partial \log \bar{\varphi}_{ij}} = \frac{g(\bar{\varphi}_{ij})}{(1 - G(\bar{\varphi}_{ij}))}\frac{\partial \bar{\varphi}_{ij}}{\partial \log \bar{\varphi}_{ij}} = \left(1 - \frac{1 - \left(\frac{\varphi_{ij}^{*}}{\bar{\varphi}_{ij}}\right)^{\theta}}{1 - \left(\frac{\varphi_{ij}^{*}}{\varphi_{mac}}\right)^{\theta}}\right)^{-1} \frac{-\theta \left(\frac{\varphi_{ij}^{*}}{\bar{\varphi}_{ij}}\right)^{\theta} \frac{1}{\bar{\varphi}_{ij}} \frac{\partial \bar{\varphi}_{ij}}{\partial \log \bar{\varphi}_{ij}}}{1 - \left(\frac{\varphi_{ij}^{*}}{\varphi_{mac}}\right)^{\theta}}$$

knowing that $\partial \log \bar{\varphi}_{ij} = \frac{\partial \bar{\varphi}_{ij}}{\bar{\varphi}_{ij}}$

$$\frac{\partial \log(1-G(\bar{\varphi}_{ij}))}{\partial \log \bar{\varphi}_{ij}} = -\theta \frac{1}{1-\left(\frac{\bar{\varphi}_{ij}}{\varphi_{mac}}\right)^{\theta}} < -\theta$$

I define $h(\bar{\varphi}_{ij}) = \left(1-\left(\frac{\bar{\varphi}_{ij}}{\varphi_{mac}}\right)^{\theta}\right)^{-1} > 1$ and substitute back

$$\frac{\partial \log(1-G(\bar{\varphi}_{ij}))}{\partial \log X_j} = -\theta h(\bar{\varphi}_{ij}) \frac{\partial \log \bar{\varphi}_{ij}}{\partial \log X_j}$$

The Pareto distribution implies that the ratio of the average to the cut-off is a constant.

$$\partial \log \bar{\varphi}_{ij} = \partial \log \varphi^*_{ij}$$

$$\frac{1}{z}\frac{d \log n_{ij}(\bar{\varphi}_{ij})}{d \log X_j} = 1 + \left(\frac{-\eta}{\sigma-1}\theta h(\bar{\varphi}_{ij}) + 1\right)\frac{d \log \varphi^*_{ij}}{d \log X_j}$$

Given that I know

$$\frac{\partial \log \varphi^*_{ij}}{\partial \log X_j} = -\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$$

the elasticity of product scope with respect to destination market size for the average firm is:

$$\frac{1}{z}\frac{d \log n_{ij}(\bar{\varphi}_{ij})}{d \log X_j} = 1 + \left(\frac{\eta\theta h(\bar{\varphi}_{ij}) - (\sigma-1)}{\sigma-1}\right)\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$$

$$\frac{\partial \log n\left(\bar{\varphi}_{ij}\right)}{\partial \log X_j} = z\left(\frac{\eta\theta\left(h(\bar{\varphi}_{ij})-1\right)}{(\sigma-1)-\eta\theta}\right)$$

So the average number of products inceases with market size. In the limit, as the average becames smaller and smaller, the elasticity converges to 0. If there would not be a spillover, then $\eta = 0$ and one obtains the same result as for the most productive firm, which does not benefit from the spillover.

Median number of products per firm

I can also check how the median number of firms per product changes with market size. To compute the median number of products per firm, I look at the change of product scope of the median firm, i.e.:

$$n_{ij}^{\frac{1}{z}}(\widetilde{\varphi}_{ij}) = \left(\frac{w_j L_j((1-G(\widetilde{\varphi}_{ij}))M_i)^{\eta}}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\lambda_{min}\rho P_j \widetilde{\varphi}_{ij}}{t_{ij} w_i}\right)$$

where $X_j = \left(\frac{w_j L_j M_i^{\eta}}{w_i F_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\rho P_j}{t_{ij} w_i}\right)$. The elasticity is calculated as follows:

$$\frac{1}{z}\frac{d\log n_{ij}(\widetilde{\varphi}_{ij})}{d\log X_j} = 1 + \frac{\eta}{\sigma-1}\frac{\partial\log(1-G(\widetilde{\varphi}_{ij}))}{d\log X_j} + \frac{d\log\widetilde{\varphi}_{ij}}{d\log X_j}$$

Note that the median number of exporters is always half of the total muber of exporters. This implies that

$$\log(1-G(\widetilde{\varphi}_{ij})) = \log(\frac{1-G(\varphi^*_{ij})}{2})$$

I know from the firm elasticity that the number of firms changes as follows:

$$\frac{\partial\log(1-G(\varphi^*_{ij}))}{\partial d\log X_j} = \theta\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$$

From the calculation at the end of this appendix, I know that the median changes by less than the cut-off

$$\frac{d\log\widetilde{\varphi}_{ij}}{d\log\varphi^*_{ij}} = b < 1$$

and the cut-off elasticity is derived from this equation

$$\frac{d\log\varphi^*_{ij}}{d\log X_j} = -\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$$

Thus, the overall elasticity is given by

$$\frac{1}{z}\frac{d\log n_{ij}(\widetilde{\varphi}_{ij})}{d\log X_j} = 1 + \frac{\eta}{\sigma-1}\theta\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right) - a\left(\frac{\sigma-1}{(\sigma-1)-\eta\theta}\right)$$

$$\frac{d\log n_{ij}(\widetilde{\varphi}_{ij})}{d\log X_j} = z\left(\frac{(1-a)(\sigma-1)}{(\sigma-1)-\eta\theta}\right)$$

which implies that the median number of products per firm increases by less than the number of products because $a < \frac{1}{h(\widetilde{\varphi}_{ij})}$.

Firm fixed costs

Product entry is decided by the most productive firm, which chooses with how many products it wants to enter. Note that the fixed cost depends on the number of products the firm wants to export. If this is not the case, then the firm would want to export all products to all destinations.

The number of products (product entry)

$$\max_{\lambda^*} \pi_{ij}(\varphi_{max}, \lambda^*_{ij}) = \int_{\lambda^*_{ij}}^{\lambda_{max}} \left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi_{max} \lambda^*_{ij}\right)^{\sigma-1} dG(\lambda^*_{ij}) - w_i F_{ij} \left(1 - G\left(\lambda^*_{ij}\right)\right)^{\gamma}$$

In this case, one can solve the integral for product attributes and write the profit function in terms of the number (share) of products. I replace ($n_{ij} = \left(1 - G\left(\lambda^*_{ij}\right)\right) = \frac{(\lambda_{min})^z}{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z} \left(\left(\lambda^*_{ij}\right)^{-z} - \lambda_{max}^{-z}\right)$), or equivalently, $\left(\lambda^*_{ij}\right)^{-z} = n_{ij} \left(\frac{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}{(\lambda_{min})^z}\right) + \lambda_{max}^{-z}$ and obtain the final product function and maximize with respect to the number of products. The first order condition reads as follows:

$$\left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi_{max}\right)^{\sigma-1} \left(\frac{(\lambda_{min})^z}{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}\right) \left(n_{ij}\left(\frac{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}{(\lambda_{min})^z}\right) + \lambda_{max}^{-z}\right)^{\frac{(z-(\sigma-1))}{z}-1} = \gamma \left(n_{ij}N_i\right)^{\gamma-1} w_i F_{ij}$$

To compare with the previous case and to get a closed form solution, we consider the effect of market size on firm entry when λ_{max} is large; i.e., $\lim \lambda_{max}^{-z} \to 0$. The simplified equation becomes

$$n_{ij}^{\frac{(z(1-\gamma)-(\sigma-1))}{z}} = \left(\left(\Lambda \frac{w_i F_{ij} N_i^{\gamma-1}}{w_j L_j}\right)\left(\frac{t_{ij}w_i}{\rho P_j \varphi_{max}}\right)^{\sigma-1}\right)$$

where Λ defines a constant that will not be relevant for the elasticities.[22] Note that in order to ensure that the above is a maximum, the second derivative has to be negative and this is only the case if $\gamma > \left(1 - \frac{\sigma-1}{z}\right)$. In this case, the above equation becomes:

$$n_{ij}^{\frac{(z(1-\gamma)-(\sigma-1))}{z(1-\sigma)}} = \left(\Lambda \frac{w_j L_j}{w_i F_{ij} N_i^{\gamma-1}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\rho P_j \varphi_{max}}{t_{ij} w_i}\right)$$

I gather all the terms that depend on destination market size ($w_j L_j$) in $X_j = f(w_j L_j, P_j(w_j L_j))$. Conditional on country-of-origin fixed effects and bilateral trade costs, the elasticity of product entry with respect to market size:

$$\frac{d \log n_{ij}}{d \log X_j} = \left(\frac{z(\sigma-1)}{(z(\gamma-1)+(\sigma-1))}\right)$$

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$$\Lambda = \left(\frac{z}{z-(\sigma-1)} \frac{(\lambda_{min})^z}{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}\right)^{-1} \left(\frac{1-\left(\frac{\lambda_{min}}{\lambda_{mac}}\right)^z}{(\lambda_{min})^z}\right)^{1-\frac{(z-(\sigma-1))}{z}}$$

The number of firms (firm entry)

Firm entry is as in Bernard et al. (2011); i.e., the marginal firm is indifferent between entering and not:

$$\pi_{ij}(\varphi_{ij}^{*}) = \left(t_{ij}w_i\right)^{1-\sigma} w_j L_j \left(\rho P_j \varphi_{ij}^{*} \lambda_{max}\right)^{\sigma-1} = w_i F_{ij}$$

Solving for the cut-off productivity and integrating over the firm distribution allows me to write the firm elasticity as a function of demand:

$$\left(\left(\left(1-\left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^{\theta}\right)\left(1-m_{ij}\right)-1\right)\right)^{\frac{1}{\theta}} = \left(\frac{\rho P_j \lambda_{max} \varphi_{min}}{t_{ij}w_i}\right)\left(\frac{w_j L_j}{w_i f_{ij}}\right)^{\frac{1}{\sigma-1}}$$

As before, I assume that the firm productivity distribution is bounded above; i.e.; there is a firm with a maximum and finite productivity draw. For simplicity, I evaluate the derivative when the ratio of the upper to the lower bound of the Pareto distribution goes to zero; i.e., $\lim \left(\frac{\varphi_{min}}{\varphi_{mac}}\right)^{z} \to 0$. Conditional on country-of-origin fixed effects and bilateral trade costs, the elasticity firm with respect to market size equals:

$$\frac{d \log m_{ij}}{d \log X_j} = \theta$$

Average number of products per firm

To analyze the product adjustment of the average firm, I take the expression where the number of firms is a function of the underlying productivity:

$$\left(n_{ij}N_i\right)^{\frac{(\sigma-1)-z(1-\gamma)}{z(\sigma-1)}} = \left(\frac{w_j L_j}{w_i F_{ij} N_i^{\gamma-1}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\rho P_j \bar{\varphi}_{ij}}{t_{ij}w_i}\right)$$

I can rewrite the number of products per median firm in the following compact form:

$$n_{ij}(\bar{\varphi}_{ij}) = X_j \bar{\varphi}_{ij}^{1/\alpha}$$

where $\alpha = \frac{z(\gamma-1)+(\sigma-1)}{z(\sigma-1)}$ and $X_j = \left(\frac{w_j L_j}{w_i F_{ij}}\right)^{\frac{1}{\sigma-1}}\left(\frac{\rho P_j}{t_{ij}w_i N_i^{\alpha}}\right)$. In order to assess how the average number of products per firm changes, I simply integrate over the compact relationship. One can show that the following is true

$$\alpha \frac{d \log n(\bar{\varphi}_{ij})}{d \log X_j} = 1 + \frac{d \log \bar{\varphi}_{ij}}{d \log X_j}$$

Note that the average productivity changes the same way as the cut-off.

$$d \log\left(\bar{\varphi}_{ij}\right) = d \log\left(\varphi_{ij}^{*}\right)$$

and the elasticity of the cut-off productivity with respect to RHS is -1.

$$\alpha \frac{d\log n(\bar{\varphi}_{ij})}{d\log X_j} = 1 - 1 = 0$$

Thus, the average number of products per firm does not change with market size.

Median number of products per firm

To analyze the product adjustment of the median firm, I take the expression where the number of firms is a function of the underlying productivity and evaluate the firm's product scope at the median level of productivity:

$$\left(n_{ij}N_i\right)^{\frac{(z(1-\gamma)-(\sigma-1))}{z(1-\sigma)}} = \left(\frac{w_j L_j}{w_i F_{ij} N_i^{\gamma-1}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\rho P_j \widetilde{\varphi}_{ij}}{t_{ij} w_i}\right)$$

I can rewrite the number of products per median firm in the following compact form:

$$n_{ij}^{\alpha}(\widetilde{\varphi}_{ij}) = X_j \widetilde{\varphi}_{ij}$$

where $\alpha = \frac{z(\gamma-1)+(\sigma-1)}{z(\sigma-1)}$ and $X_j = \left(\frac{w_j L_j}{w_i F_{ij}}\right)^{\frac{1}{\sigma-1}} \left(\frac{\rho P_j N_i^{1/z}}{t_{ij} w_i}\right)$. In order to assess how the number of products for that firm changes, I have

$$\alpha \frac{d\log\left(n_{ij}(\widetilde{\varphi}_{ij})\right)}{d\log X_j} = 1 + \frac{d\log\left(\widetilde{\varphi}_{ij}\right)}{d\log X_j}$$

From the calculation at the end of this appendix, I know that the median changes by less than the cut-off (a is smaller than 1)

$$\alpha \frac{d\log\left(n_{ij}(\widetilde{\varphi}_{ij})\right)}{d\log X_j} = 1 + a \frac{d\log \varphi_{ij}^{*}}{d\log X_j}$$

and the respective elasticities

$$\frac{d\log n_{ij}}{d\log X_j} = \frac{1}{\alpha}(1-a)$$

I get the following elasticity

$$\frac{d\log n_{ij}}{d\log X_j} = \frac{z(\sigma-1)(1-a)}{(z(\gamma-1)+(\sigma-1))} > 0$$

The average number of products per firm increases by less than the number of products because the elasticity of the median is strictly positive.

The median productivity changes by less than the cut-off

Next, I show that the median changes by less than the cut-off:

$$G(\widetilde{\varphi}) = \frac{1}{2}$$

where the CDF is defined as the following truncated Pareto distribution $G(\widetilde{\varphi}) = \left(1 - \left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta\right)^{-1} \left(1 - \frac{\varphi^{*\theta}}{\widetilde{\varphi}^\theta}\right)$. Substituting into the previous equation, I get:

$$\varphi^{*\theta} \left(\frac{1}{\varphi^{*\theta}} - \frac{1}{\widetilde{\varphi}^\theta} \right) = \frac{1}{2} \left(1 - \left(\frac{\varphi^*}{\varphi_{mac}} \right)^\theta \right)$$

$$\widetilde{\varphi} = \varphi^* \left(1 - \frac{1}{2} \left(1 - \left(\frac{\varphi^*}{\varphi_{mac}} \right)^\theta \right) \right)^{-1/\theta}$$

Taking the log

$$\log\left(\widetilde{\varphi}\right) = \log\left(\varphi^*\right) + \frac{1}{\theta}\log 2 - \frac{1}{\theta}\log\left(1 + \left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta\right)$$

Taking the derivative of the median with respect to the cut-off productivity

$$\frac{d\log\widetilde{\varphi}}{d\log\varphi^*} = 1 - \frac{1}{\theta}\frac{1}{\left(1 + \left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta\right)}\theta\left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta \frac{1}{\varphi^*}\frac{d\varphi^*}{d\log\left(\varphi^*\right)}$$

and using the fact that $d\log\left(\varphi^*\right) = \frac{d\varphi^*}{\varphi^*}$

$$\frac{d\log\widetilde{\varphi}}{d\log\varphi^*} = \left(1 - \frac{\left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta}{\left(1 + \left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta\right)}\right) = \left(1 + \left(\frac{\varphi^*}{\varphi_{mac}}\right)^\theta\right)^{-1} < 1$$

or, alternatively

$$\frac{d\log\widetilde{\varphi}}{d\log\varphi^*} = a$$