

# Market Access Costs and the New Consumers Margin in International Trade\*

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(JOB MARKET PAPER)

First Draft: June 5, 2006  
This Version: December 30, 2006

## Abstract

I develop a new theory of marketing and introduce it into a model of trade with product differentiation and firm productivity heterogeneity. In this model, a firm enters a market if it makes profits by reaching a single consumer there and pays an increasing marginal cost to access additional consumers. This access cost introduces an extensive margin of new consumers in firms' sales. I calibrate the key parameters of the model to match data on French firms from Eaton, Kortum and Kramarz, in particular the higher sales in France of firms that choose to export to more destinations. The model predicts that most firms do not export, and that a large proportion of firms that export in particular markets do so in small amounts. These predictions are in line with the French data, but together create a puzzle for models with a fixed cost of exporting, such as those of Melitz and Chaney. Looking at the comparative statics of trade liberalization, I find that the model predicts large increases in trade in goods with positive but little previous trade, in line with Kehoe and Ruhl.

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\*I am grateful to my advisors Timothy Kehoe and Samuel Kortum for their continued guidance and their support. I am also grateful to Cristina Arellano and Jonathan Eaton for continuous encouragement and various discussions on the topic. I am indebted to Jonathan Eaton, Samuel Kortum and Francis Kramarz for providing me with statistics from their data. For their suggestions and comments, I also would like to thank Ariel Burstein, V.V. Chari, John Dalton, Thomas Holmes, Christos Ioannou, Patrick Kehoe, Erzo G.J. Luttmer, Ellen McGrattan, Fabrizio Perri, Edward C. Prescott, James Schmitz, Ina Simonovska, the members of the Trade and Development, and Trade and IO, workshops at the University of Minnesota as well as seminar participants at the 2006 North American Econometric Society Summer Meetings, 5th Conference on Economic Theory and Econometrics, Federal Reserve Bank of Minneapolis, and McGill University. Financial support from the Heller Dissertation Fellowship is gratefully acknowledged. All remaining errors are mine.

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# 1 Introduction

Recent empirical research using firm and plant level data has established that firms face substantial hurdles when selling to foreign markets: exporters tend to be in the minority, are on average more productive and larger, and usually export only a small fraction of their output. Classical and “new” trade theory are silent about this heterogeneity of performance of exporting firms observed in the data. To come to grips with these new facts, recent new theories such as those proposed by Eaton and Kortum (2002) and Bernard, Eaton, Jensen, and Kortum (2003) incorporate product differentiation and heterogeneity in firms’ productivities together with standard “iceberg” variable costs of trade. In addition, Melitz (2003) and Chaney (2006) add a fixed cost associated with exporting to a country (market access cost), thus generating the prediction that most firms do not obtain access to foreign markets.<sup>1</sup>

This paper proposes a new formulation of market access costs in a model of trade with product differentiation and firm productivity heterogeneity. It does so by developing a new theory of marketing based on ideas from the advertising literature such as those of Butters (1977) and Grossman and Shapiro (1984). Market access costs are interpreted as marketing costs that are endogenous rather than fixed in the sense that paying higher marketing costs allows firms to reach an increasing number of consumers in a country. Yet, once a consumer is reached, these costs remain fixed with the amount sold per consumer. The interaction between the per consumer marketing cost and the variable cost of trade excludes firms with low productivity from individual export markets, if their per consumer revenue is not sufficient to cover the cost to reach the very first consumer there.

Motivated by empirical evidence indicating diminishing returns to marketing outlays of firms, this paper assumes that there exist increasing marginal costs to reach additional consumers in each market. In particular, I assume that with each additional marketing effort a firm reaches a smaller number of new consumers. Furthermore, in order to capture effects of market saturation,

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<sup>1</sup>Melitz (2003) pioneered the analysis of fixed costs of exporting in a general equilibrium trade model with heterogeneous firms. However, the idea of fixed costs goes back to Dixit (1989), Baldwin (1989) and Baldwin and Krugman (1989). Fixed costs have also been more recently used by Roberts and Tybout (1997a) and Clerides, Lach, and Tybout (1998). Fixed costs of trade refer to one time (sunk) market entry costs firms face. In a static model, as the one I consider here, the fixed costs of exporting are the modeling equivalent of one time market entry costs of trade amortized per period.

I also assume that this number becomes smaller at some geometric rate as the firm reaches larger fractions of consumers in a market. Therefore, the proposed marketing technology also results to a particular convexity of the marginal cost function. Related to the implications of these assumptions, increasing marginal costs introduce a new margin in the sales of a firm. This is the extensive margin of consumers, namely the number of consumers that firms with different productivities sell to. The convexity of the marginal cost function implies that each additional marketing effort allows firms with a smaller consumer base to reach many more new consumers. Thus, adjustments in the extensive margin of consumers are more pronounced for these firms.

Previous literature has postulated that firms incur significant fixed costs to export. For example, Das, Roberts, and Tybout (2006), examine a sample of Colombian exporters for the period of 1981 to 1991. Using a dynamic model, they estimate (one-time) fixed costs for new exporters ranging between \$300,000 and \$500,000 per firm. Yet, Eaton, Kortum, and Kramarz (2005) (henceforth EKK05) report that in 1986, the smallest 25% of French exporters in a particular market each sold below \$10,000 in that market. My model reconciles the typically large estimates of fixed costs with evidence on the existence of many firms exporting small amounts to particular markets through the extensive margin of consumers mechanism. Relatively productive firms choose to reach a large number of consumers in a market, thus incurring large market access costs there. Relatively unproductive firms (yet productive enough to reach the very first consumer in the market) choose to reach only a few consumers in the market and thus export tiny amounts.

The assumptions of product differentiation and firm productivity heterogeneity under monopolistic competition allow my model to retain the main desirable predictions of the fixed cost models of Melitz (2003) and Chaney (2006).<sup>2</sup> In fact, I prove that the fixed cost model postulated by the previous literature corresponds to a version of my model with constant marginal costs to reach additional consumers. However, the key ingredient of a theory of marketing adds another dimension to the analysis present in the previous literature, namely the extensive margin of consumers in the sales of the firm. Thus, the new margin is present in addition to the extensive margin of exporting firms and the intensive margin of sales per consumer of each firm.

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<sup>2</sup>See, for example, Bernard, Jensen, and Schott (2003) for a comparison of the main theoretical predictions of the new models of international trade to micro-level data on exporters.

To quantitatively assess the model, I calibrate its key parameters to match data on French firms from EKK05. In particular, I calibrate the parameters of the model determining the relative sales of different firms to match the higher sales per firm in France of firms that also export to more markets. The remaining parameters of the model are calibrated to generate the relationship between the number of French firms entering exporting markets and the size of these markets, as reported by Eaton, Kortum, and Kramarz (2004) (henceforth EKK04) and EKK05. In particular, the number of French firms, normalized by French market share, and the average sales per firm increase with the size of the exporting market.

In order to match the last fact, EKK05 find it essential to incorporate market specific fixed costs that increase with the size of the market with an elasticity less than one. Instead, I model market access costs as a common marketing technology available to all firms. I use two realistic assumptions related to this technology, namely that there are increasing returns to scale with respect to population size of each market and that marketing costs are partially paid in terms of the importing country's wages. Given these assumptions, my model provides an intuitive explanation of the finding reported by EKK05 as the result of the optimal marketing decision of firms aiming to reach consumers in markets with different population or per capita income.

The calibrated model with endogenous market access costs is able to deliver a series of new predictions and I use this new approach to address existing puzzles in international trade theory. First, the introduction of the extensive margin of consumers in the sales of a firm substantially alters the distribution of sales predicted by the fixed cost model. This comes about because relatively unproductive firms endogenously select a small number of consumers. While, the model correctly predicts that most French firms do not export, it also quantitatively accounts for the small amounts exported by a large proportion of the French firms in each market. The small export volume of many firms has been especially puzzling to the fixed cost model, which assumes that firms that do export to a particular market sell to all the consumers in that market.

Second, the introduction of the extensive margin of consumers has important implications regarding the comparative statics of trade liberalization. To illustrate that I extend the methodology of Kehoe and Ruhl (2003) to data on positively goods traded prior to the US-Mexico liberalization episode. I find that the growth rate of the volume of trade of goods is larger the less traded the goods are before the liberalization. This feature of the data is in sharp contrast

with the predictions of existing models of trade that rely solely on the Dixit-Stiglitz demand specification, such as the fixed cost model. These models predict constant growth rates of trade for all previously positively traded goods, given uniform elasticity of substitution between goods. In fact, models of this kind were used to predict trade patterns in the case of the NAFTA episode and they were unable to predict the high growth rates of sales, especially for goods with little trade prior to the trade liberalization, as Kehoe (2005) points out. Instead, I use my model to look at the comparative statics of trade liberalization, with parameters calibrated to the French data and a symmetric change in the variable trade costs across goods calibrated to match the overall increase in trade following the US-Mexico liberalization episode. My model turns out to capture the large increases in trade for goods with positive but little previous trade for this liberalization episode. This is the result of the large adjustments in the extensive margin of consumers for firms selling their good to a small numbers of consumers before the liberalization.

Finally, given the ability of the model to quantitatively predict the size of small exporting firms and their higher growth rates in trade liberalization episodes, I study a new margin of response of aggregate trade flows to decreases in trade costs. This “new consumers” margin is related to the increase in aggregate flows brought about by previously trading firms that sell to new consumers after a trade liberalization. In my analysis, I decompose the contribution of the three margins to new trade, the “new consumers” margin, the intensive margin of growth in per consumer sales, emphasized by Krugman (1980), and the new firms margin analyzed by Eaton and Kortum (2002), Melitz (2003) and Chaney (2006). I find that a considerable amount of new trade is generated by new firms and by sales of previously exporting firms to new consumers. However, for small changes in variable trade costs, the contribution of the new consumers margin to new export sales is larger than the contribution of the new firms margin. New firms entering a market, although numerous, sell a tiny amount.

In summary, this paper is a continuation of the abovementioned theoretical literature incorporating firm level heterogeneity into international trade theory. This literature has emerged in response to the recent use of firm and plant level data to measure the behavior of exporters along many dimensions (see, for example, Bernard and Jensen (1995), Bernard and Jensen (2004), Clerides, Lach, and Tybout (1998), Aw, Chung, and Roberts (2000), or Tybout (2001) for a review). The empirical facts summarized by this literature indicate that there exist substantial

costs of exporting, as EKK04 point out. EKK05 find that in order to account for a variety of facts related to French exporters, export costs have to take the form of both variable costs, that rise in proportion to the amount shipped, as well as fixed costs as in Melitz (2003) and Chaney (2006). In this paper, I propose a new approach to modeling market access costs of exporting based on a new theory of marketing. This approach, while consistent with the trade data, departs from the assumption of fixed costs of exporting.

The outline of the rest of the paper is as follows: In section 2, I describe the model and the new theory of marketing in detail. In section 3, I calibrate the model using a methodology developed by EKK05. In section 4, I quantitatively assess the model with the extensive margin of consumers. Section 5 evaluates the importance of the adjustments in the extensive margin of consumers for the increase in trade in the event of a trade liberalization. Section 6 concludes.

## 2 Model

In this section I introduce the model with endogenous (market access) costs. This model incorporates the assumptions of product differentiation and firm productivity heterogeneity using the monopolistic competition framework proposed by Melitz (2003) and Chaney (2006). It departs, however, from the existing literature in the demand structure since the number of consumers who have access to a firm's good is the result of a decision on the part of the firm. Each firm has to pay an increasing cost to reach additional consumers in a given market and chooses the number of its consumers in order to maximize its profit.

### 2.1 One-country model

I begin by describing the one-country model. This enables me to lay out the main features of the model and the dimensions in which it differs from existing trade models.

#### 2.1.1 Consumer problem and demand for goods

I assume that there exists a continuum of consumers of measure  $L$ . Consumers derive utility from the consumption of goods according to a symmetric CES utility function over a continuum

of goods indexed by  $\omega$ ,

$$U^l = \left( \int_{\omega \in \Omega^l} x(\omega)^\rho d\omega \right)^{\frac{1}{\rho}}, \quad 0 < \rho < 1,$$

where  $\Omega^l$  is the set of goods consumer  $l \in L$  has access to.  $\Omega^l$  is a potential subset of the set of all the goods produced in the economy  $\Omega$ .

Each good is produced by a single firm and firms differ ex-ante only in their productivities. Firms with the same productivity choose the same price,  $p(\phi)$ , as well as the same probability that they reach a consumer,  $n(\phi)$ , in a manner that I will describe in the next paragraph. Since there is a large number of firms of each productivity, each consumer has access to a fraction  $n(\phi)$  of the goods of firms with productivity  $\phi$ .<sup>3</sup> I denote the density of firms conditional on operating by  $\mu(\phi)$ , with support  $[b, +\infty)$ , and the measure of operating firms by  $M \leq J$ , where  $J$  is the measure of potential entrants.<sup>4</sup> Therefore, each consumer has access to a different set of goods,  $\Omega^l$ , but to the same measure of goods produced by firms with productivity  $\phi$ ,  $n(\phi)\mu(\phi)M$ . I will therefore refer to the type of the firm (good) by its productivity,  $\phi$ .

The income of the consumer consists of wage  $w$  from (inelastically) supplying her unit labor endowment to the labor market and profit flows from the firms,  $\pi$ .<sup>5</sup> The solution to the maximization problem of the consumer gives rise to the usual CES Dixit-Stiglitz demand for each good  $\phi$  (conditional on the consumer having access to it)

$$x(\phi) = y \frac{p(\phi)^{-\sigma}}{P^{1-\sigma}} \tag{1}$$

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<sup>3</sup>This is essentially a statement of the Glivenko-Cantelli theorem, which in turn is a direct application of the Law of Large Numbers (LLN) for i.i.d random variables. In order to apply the LLN, I assume that firms reach consumers independently of each other. In the application of the LLN to the case of a continuum of i.i.d. random variables technical problems may arise (see for example the discussion in Hopenhayn (1992)). Various remedies have been suggested by different authors (e.g. Judd (1985) and Uhlig (1996)). As is usual in the economics literature, I assume the applicability of the LLN without proving the exact conditions under which it applies. This is a highly technical issue beyond the scope of this paper.

<sup>4</sup>Alternatively, one can think of  $J$  as the measure of differentiated varieties of goods available to firms to produce. For simplicity, I assume that this measure is fixed as in Chaney (2006) The extension to a context with an unbounded pool of entrants, as in Melitz (2003), is straightforward.

<sup>5</sup>I assume that consumers own equal share of each firm originating in their country. Thus, in the multi-country context, profits of firms will be equally distributed among the consumers of their country.

where

$$P^{1-\sigma} = M \int_b^\infty p(\phi)^{1-\sigma} n(\phi) \mu(\phi) d\phi, \quad \sigma = \frac{1}{1-\rho} > 1, \quad (2)$$

and  $y = w + \pi$  denotes the per capita spending which equals the output per capita.

Similarly to the previous argument, and given the existence of a large number of consumers, each firm  $\phi$  reaches a fraction  $n(\phi)$  of the consumers. Thus, the demand for the good of a firm with productivity  $\phi$  is

$$n(\phi) Ly \frac{p(\phi)^{-\sigma}}{P^{1-\sigma}} = n(\phi) Lx(\phi). \quad (3)$$

### 2.1.2 Firm

Each operating firm has to make two choices in order to maximize its profit. The first is to produce the good. This is done using a constant returns to scale production function  $q(\phi) = \phi l$ , where  $l$  is the amount of labor used in production and  $\phi$  is the labor productivity of the firm. This process creates the good that can be used for consumption conditional on a particular consumer having access to it. The second procedure is to pay a cost to reach a number of consumers in the market. This market access cost is described below.

**A theory of marketing and the market access technology** Marketing expenditures constitute a considerable amount of the overall spending of the economy. In fact, media advertising amounts to almost 2% of total GDP in the US for the years 2001 to 2004. Taking into account estimates indicating that media advertising spending accounts for only 40% of overall marketing spending for 2001-2004, the amount of marketing spending could be as much as 5% of GDP for these years.<sup>6</sup> In order to understand the role that the marketing costs play in international trade, I begin by modeling them at the level of the firm. In doing so, I take into account evidence related to the nature of these costs: the response function of sales to marketing expenditures is often postulated to exhibit diminishing returns (DR). A large body of evidence from studies on advertising expenditures, which are part of the overall marketing spending, supports the DR

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<sup>6</sup>See the report on “US Advertising Volume” from Universal McCann available at <http://www.universalmccann.com> and the “Marketing Expenditure Trends” reports of the London Business School, available at [www.london.edu/marketing/met](http://www.london.edu/marketing/met).



postulate.<sup>7</sup> To incorporate this evidence into the model, I assume that the firm faces increasing marginal costs to reaching additional consumers through marketing. To formulate the above argument, I assume a particular functional form for the marketing technology. This technology is explicitly modeled later in this section and, depending on its parameterization, allows for the possibility of increasing or constant marginal costs of reaching additional consumers. The same parameterization also regulates the convexity of the marginal cost function. Since the interpretation of the market access technology as an advertising technology is more straightforward, I will proceed with this description. However, the results go through for a general marketing technology in an environment where firms pay a cost to reach the consumers in a market and this is how they should be interpreted.

In my analysis, I have to pay particular attention to how the advertising cost to reach a number of consumers in a country varies across countries (assuming that the cost of sending an ad is the same across countries). I view countries as distinct markets such that information incorporated in advertisements cannot diffuse from one market to another. The crucial assumption of diminishing returns in advertising expenditure has to be modeled carefully for countries with different populations. In particular, I have to allow the possibility that the advertising technology exhibits increasing returns to scale with respect to the population size of each market. To simplify the argument, I lay out two extreme examples. First, I describe the case of advertising with flyers where each flyer can be given to at most one consumer. This implies that in order to reach a given number of consumers, the total spending is the same and is independent of the size of the market. Second, I describe the case of TV advertisements, which I assume reach a given fraction of the consumers in any given market. In this case, a firm can reach double the number of consumers in a country that is twice as large using the same number of advertisements. My analysis incorporates both extremes as well as all intermediate cases.

I start my exposition by laying out the simplest form that the advertising technology can take employing the flyers example laid out above. I will first consider the case where variables are discrete. As previously described, the number of consumers is denoted by  $L$ . I denote by  $S$  the

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<sup>7</sup>For a more extensive discussion on the evidence of DR to advertising expenditures see Lambin (1976), Simon and Arndt (1980), and Sutton (1991) (e.g. p. 51) and Jones (1995). For a discussion regarding DR to marketing expenditures, see Saunders (1987).

number of advertising signals sent by a firm. Further, I assume that the firm sends advertising signals to the consumers independently of other firms. Following the tradition of informative advertising, I assume that the advertisement (ad) sent by a firm is essentially a posting that contains information about the existence of the good and its price.<sup>8</sup> I assume that potential consumers are not aware of the price a particular firm charges unless they observe an signal sent by the firm. I denote by  $n(S)$  the probability that a consumer sees the ad at least once after  $S$  signals have been seen and I let  $n(0) = 0$ .<sup>9</sup> Assuming that each new ad reaches one consumer and that the probability that each ad is seen for the first time by a consumer is proportional to the percentage of people that did not see the ad up to now (ad is randomly thrown),

$$[n(S + 1) - n(S)] L = 1 - n(S) .$$

The discrete example, thought intuitively appealing, it cannot be directly adapted in the context of my model. Thus, I consider the analog of the above expression for  $S, L$  being continuous variables and  $n(S)$  a continuous and differentiable function,

$$n'(S) L = 1 - n(S) .$$

Solving this differential equation subject to the initial condition  $n(0) = 0$  gives  $n(S) = 1 - \exp\{-S/L\}$ . Inverting this function implies that the number of ads needed to reach a fraction  $n$  of the consumers in a market of size  $L$  is given by  $S = -L \log(1 - n)$ .

To generalize the simple case above, I make two distinct assumptions:

**Assumption 1** The probability that a consumer sees an ad she has not seen before is given

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<sup>8</sup>See for example Butters (1977), Grossman and Shapiro (1984), and Stegeman (1991). A more recent paper that comes closer to my approach is Dinlersoz and Yorukoglu (2006). The authors introduce informative advertisement of a homogeneous good produced by a continuum of firms with heterogeneous productivities. I extend many of the ideas established in the advertising literature to a macro-trade context. The market access cost function I introduce and give explicit foundations for allows me to accomplish this task.

<sup>9</sup>In the context of the maximization problem of the firm, the amount of advertising of the firm is ultimately a function its productivity and thus,  $S = S(\phi)$ ,  $n = n(\phi)$ . Here, I describe a general advertising technology and suppress the  $\phi$  notation until I consider the optimal decision of a type  $\phi$  firm.

by

$$[1 - n(S)]^\beta, \beta \in [0, +\infty) .$$

**Assumption 2** The number of consumers who see each ad is given by

$$L^{1-\alpha}, \alpha \in [0, 1] .$$

The first assumption captures the diminishing returns to advertising expenditures. Notice that higher values of  $\beta$  correspond to more intense diminishing returns to advertising expenditures. In the case of  $\beta = 0$ , the returns to advertising are constant, which implies a constant marginal cost to reach additional consumers.

The second assumption captures the possibility that, given an ad a firm can potentially inform a larger number of consumers about its good in a larger market. The example of TV ads outlined above corresponds to letting the parameter  $\alpha = 0$ , while the flyers example to that of  $\alpha = 1$ . The intermediate cases emerge when  $\alpha \in (0, 1)$ .

Using the two assumptions stated earlier, the technology for reaching new consumers through ads becomes

$$n'(S) L = L^{1-\alpha} [1 - n(S)]^\beta , \tag{4}$$

which incorporates the possibility of returns to scale in marketing technology ( $L^{1-\alpha}$ ) and also allows for increasing marginal costs to reach additional consumers ( $[1 - n(S)]^\beta$ ). Solving this differential equation with subject to the initial condition  $n(0) = 0$  gives

$$n(S) = 1 - \left( 1 - (-\beta + 1) \frac{S}{L^\alpha} \right)^{1/(-\beta+1)} .$$

Inverting this last expression, and solving as to  $S$ , we get the amount of advertising required by a firm aiming to reach a fraction  $n$  of the consumers in a market of size  $L$ . Assuming the labor requirement for each ad is  $1/\psi$ , the labor cost of reaching  $n$  consumers in a market of size  $L$  (market access cost) becomes

$$f(n, L) = \frac{L^\alpha 1 - (1 - n)^{-\beta+1}}{\psi (-\beta + 1)}, \alpha \in [0, 1] . \tag{5}$$

Since this function is an important part of my theory, I will delve into its properties. For the case of  $\beta > 0$ , the following conditions hold:

$$f_1(n, L) > 0, f_{11}(n, L) > 0, \quad (6)$$

$$\lim_{nL \rightarrow 0} \frac{\partial f(n, L)}{\partial(nL)} \Big|_{L=\bar{L}} = \frac{L^{\alpha-1}}{\psi} > 0. \quad (7)$$

Expression (6) implies that the marginal cost of reaching new consumers is positive and is increasing in the fraction of consumers reached. In fact, for  $\beta > 0$ , the limit of the marginal cost function as  $n \rightarrow 1$ , tends to infinity.<sup>10</sup> Expression (7) indicates that the cost to reach the very first, or marginal, consumer is positive. Finally, I define the elasticity of reach as the percentage change of the fraction of consumers reached related to a corresponding percentage change of the marginal cost to reach a consumer, namely  $\partial \ln n / \partial \ln f_1(n, L)$ . In fact, function (5) embodies diminishing elasticity to reach (DER) additional consumers: the elasticity of reach is smaller the larger the fraction of consumers already reached. The above expressions for  $n$  broadly capture the empirical regularity that the “reach” of advertising is subject to diminishing returns or else the marginal cost of advertising increases as  $n$  increases, for  $\beta > 0$ .<sup>11</sup> In figure 1, I draw the marginal cost as a function of the fraction of consumers reached for different  $\beta$ 's. Notice that, for  $\beta = 0$ , the marginal cost of reaching additional consumers is constant. In the context of the problem of the firm analyzed below, I will show that the case in which  $\beta = 0$  corresponds to the case of the theory with a fixed cost of exporting.

**Firm's problem** Using the market access cost function (5) and the production technology specified earlier, the maximization problem for an individual firm with productivity  $\phi$  becomes:

$$\begin{aligned} \pi(\phi) = \max_{n,p} & \left\{ nLy \frac{p^{1-\sigma}}{P^{1-\sigma}} - nLy \frac{p^{-\sigma} w}{P^{1-\sigma} \phi} - w \frac{L^\alpha}{\psi} \frac{1-(1-n)^{-\beta+1}}{-\beta+1} \right\} \\ \text{s.t. } & n \in [0, 1]. \end{aligned}$$

This maximization problem of the firm is similar to the one initially studied by Melitz (2003). The difference lies in the fact that the firm can choose to reach a certain fraction of consumers

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<sup>10</sup>In the context of the problem of the firm, this implies that no firm will choose to saturate the market by choosing to reach all the consumers there.

<sup>11</sup>The convexity of the marginal cost function could reflect the inherent randomness that marketing search efforts entail or that preferred marketing vehicles become saturated.

through ads by paying a market access cost. Reaching additional consumers brings extra revenue to the firm; a revenue that increases linearly with the number of consumers reached,  $nL$ . However, for  $\beta > 0$ , the firm faces increasing marginal costs to reach additional consumers. Notice also that I do not assume any fixed costs of operation, but, as I show below, I can still determine a lower bound threshold productivity of the operating firms in the economy,  $\phi^*$ . Throughout the remainder of my analysis I treat the threshold firms with productivity  $\phi = \phi^*$  as operating.

As is standard, the first order condition (FOC) with respect to  $p$  delivers the constant markup rule

$$p(\phi) = \tilde{\sigma} \frac{w}{\phi} . \quad (8)$$

where

$$\tilde{\sigma} = \frac{\sigma}{\sigma - 1} .$$

Given this markup rule, the optimal advertising decision for a firm with productivity  $\phi$ ,  $n(\phi)$ , for the case in which  $\beta > 0$ , is given by the FOC with respect to  $n$ . Thus, for  $\phi \geq \phi^*$ ,  $n(\phi)$  solves<sup>12</sup>

$$\underbrace{\frac{y \left( \tilde{\sigma} \frac{w}{\phi} \right)^{1-\sigma}}{\sigma P^{1-\sigma}}}_{\text{marginal revenue (net of labor production cost) per consumer}} = \underbrace{\frac{wL^{\alpha-1}}{\psi} \frac{1}{[1 - n(\phi)]^\beta}}_{\text{marginal cost per consumer}} , \quad (9)$$

where  $\phi^*$  solves

$$\phi^* = \sup_{\phi \geq b} \{ \pi(\phi) = 0 \} . \quad (10)$$

In order to decide whether to enter a market or not, a firm compares the marginal revenue received from the very first consumer with the corresponding marginal cost of reaching her. The LHS of equation (9) represents the marginal revenue (net of labor production costs) from selling to an additional consumer. Due to elastic demand, more productive firms can charge lower prices and extract higher marginal revenue per consumer. The RHS of the same equation captures the corresponding marginal cost to reach an additional consumer. The marginal cost of reaching the very first consumer is the RHS of expression (9) evaluated at  $n(\phi) = 0$  (as in equation

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<sup>12</sup>In order to interpret the LHS and RHS of expression (9) as marginal revenue and marginal cost per consumer, the derivative with respect to  $nL$  has to be applied.

(7)). Alternatively, one can think of this marginal cost as the expected cost of sending the first advertisement divided by the number of people that see this first advertisement,

$$\frac{\text{cost of the first ad}}{\text{expected number of people that see the ad}} = \frac{\frac{w}{\psi}}{L^{1-\alpha}}. \quad (11)$$

For the case in which  $\alpha < 1$ , the cost to reach the first consumer falls as the population increases since the denominator in expression (11) increases. This allows firms with lower productivities, which have smaller sales per consumer (see the RHS of (9)), to enter a market with a larger population. Thus, for  $\alpha < 1$ , bigger markets will attract more firms.

Figure 2 plots the marginal revenue per consumer (net of labor costs) and the marginal cost per consumer. The point of intersection corresponds to the solution to equation (9). This intersection gives  $n(\phi)$  as a function of  $\phi$  for the case of  $\beta > 0$ . Notice that since marginal revenue per consumer is higher for higher values of  $\phi$ , more productive operating firms find it profitable to pay the cost to reach a higher fraction of consumers.<sup>13</sup> Moreover, given the price level  $P$ , there exists a threshold productivity  $\phi^*$  such that  $\forall \phi \leq \phi^*$ ,  $n(\phi) = 0$ . This results from the fact that for such low  $\phi$ 's, the very low marginal revenue net of labor production costs from the first consumer is not sufficient to cover the cost to reach her. However, when the marginal cost to reach an additional consumers is constant, namely when  $\beta = 0$ , the decision rule is no longer continuous. Firms with  $\phi \leq \phi^*$  choose  $n(\phi) = 0$  and firms with  $\phi > \phi^*$  choose  $n(\phi) = 1$ , resulting in the decision rule of the theory with fixed costs. The following proposition summarizes the above discussion:

**Proposition 1**

a) *If  $\beta > 0$ , then*

i) *there exists a threshold  $\phi^*$  such that  $\forall \phi \leq \phi^*$ ,  $n(\phi) = 0$ .*

ii)  *$\phi_1 > \phi_2 \implies n(\phi_1) > n(\phi_2)$ ,  $\forall \phi_1, \phi_2 \geq \phi^*$ .*

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<sup>13</sup>A direct implication of the combination of the assumption of the diminishing returns to marketing expenditures and firm heterogeneity is that the marketing to sales ratio will be higher for firms with lower sales. There is a large body of evidence in the literature supporting that firms with higher sales have lower marketing to sales ratios (see for example Farris and Buzzell (1979) and Arndt and Simon (1983)). Interestingly enough, this empirical evidence led many researchers to hypothesize that larger firms are more efficient in marketing, a claim not supported in any convincing way by other empirical tests as Arndt and Simon (1983) point out. My model generates lower marketing to sales ratios for firms with higher sales, even though every firm has access to the same marketing technology.

b) If  $\beta = 0$ , then

$n(\phi) \in \{0, 1\}$  and there exists  $\phi^*$  such that  $\forall \phi \leq \phi^*$ ,  $n(\phi) = 0$ , and  $\forall \phi > \phi^*$ ,  $n(\phi) = 1$ .

**Proof.** a) Part *i*) This part is proved formally in appendix A. Also, notice that by solving (9) for  $n(\phi)$ ,  $n(\phi) > 0$ , we have

$$n(\phi) = 1 - [L^{1-\alpha} y \phi^{\sigma-1} (\tilde{\sigma} w)^{1-\sigma} \psi P^{\sigma-1} / (w\sigma)]^{-1/\beta} . \quad (12)$$

Define

$$(\phi^*)^{\sigma-1} = [L^{1-\alpha} y (\tilde{\sigma} w)^{1-\sigma} \psi P^{\sigma-1} / (w\sigma)]^{-1} , \quad (13)$$

such that  $\forall \phi > \phi^*$ ,  $n(\phi) > 0$ . For  $\phi \leq \phi^*$ , as shown in appendix A,  $n(\phi) = 0$ . The above proves part *i*) of *a*).

a) Part *ii*) From equation (9) and the proof of uniqueness in appendix A, part *ii*) follows.<sup>14</sup>

b) As long as  $\beta = 0$ , the marginal cost of reaching an additional consumer  $wL^{\alpha-1}/\psi$  is constant with respect to  $n(\phi)$ . Thus, every consumer brings the same marginal profit to the firm. Therefore, the firm chooses  $n(\phi) = 1$  if this profit is positive for all the consumers, and  $n(\phi) = 0$  otherwise. Since this marginal profit is strictly increasing in  $\phi$ , part *b*) follows.<sup>15</sup> ■

In the subsequent analysis I will refer to the case of  $\beta = 0$ , that corresponds to the theory of Melitz (2003) and Chaney (2006), as the fixed cost model and to the case of  $\beta > 0$  as the endogenous (market access) cost model.

### 2.1.3 Equilibrium

I define the cdf and the pdf of the distribution of the productivities of firms by  $G(\phi)$  and  $g(\phi)$  respectively, with support  $[b, +\infty)$ . The probability that a firm is actually operating in the

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<sup>14</sup>In a model with heterogeneous productivity firms but homogeneous goods, Dinlersoz and Yorukoglu (2006) also arrive at the conclusion that more productive firms reach a higher number of consumers in the country. However, their mechanism is different. In their model, each new advertisement is seen by one consumer with certainty, but costs of sending additional advertisements are considered to be convex. Firms that charge lower prices have higher probability of being the cheaper ones among the ones that a consumer sees an advertisement of. Thus, the expected revenue of each advertisement is higher for more productive firms that can charge lower prices, and they choose to reach more consumers.

<sup>15</sup>In the case of  $\beta < 0$  there are decreasing marginal cost to reach additional consumers. Thus, firms choose either  $n(\phi) = 0$  or  $n(\phi) = 1$  as in the case where  $\beta = 0$ . Therefore, without loss of generality, I do not have to analyze the case where  $\beta < 0$ .

economy corresponds to the probability that a firm has a productivity draw  $\phi$  such that  $\phi \geq \phi^*$ , namely  $1 - G(\phi^*)$ . Thus, the measure of operating firms is given by  $J[1 - G(\phi^*)]$ . The pdf of the conditional distribution of firms is given by

$$\mu(\phi) = \begin{cases} \frac{g(\phi)}{1-G(\phi^*)} & \text{if } \phi \geq \phi^* \\ 0 & \text{otherwise.} \end{cases} \quad (14)$$

I can now summarize the above discussion and define an equilibrium for the closed economy.

Given the number of potential entrants  $J$ , an equilibrium is given by a lower bound threshold productivity  $\hat{\phi}^*$ ; the measure of firms operating in the economy  $\hat{M}$ ; the pdf of the distribution of firms productivities, conditional on operating,  $\hat{\mu}(\phi)$ , prices  $\hat{p}(\phi)$ ,  $\forall \phi \in [b, +\infty]$ ; a wage rate  $\hat{w}$ ; a per consumer profit  $\hat{\pi}$ ; a price index  $\hat{P}$ ; a consumption plan for the representative consumer  $\hat{x}(\phi)$  and a production plan for each firm  $\hat{q}(\phi), \hat{l}(\phi), \hat{n}(\phi), \hat{l}^m(\phi)$ ,  $\forall \phi \in [b, +\infty]$  such that:

- Given  $\hat{P}$ ,  $\hat{w}$ ,  $\hat{\pi}$  and  $\hat{p}(\phi)$ , the representative consumer solves her maximization problem by choosing  $\hat{x}(\phi)$  for the goods  $\phi$  she has access to according to

$$x(\phi) = \hat{y} \frac{\hat{p}(\phi)^{-\sigma}}{\hat{P}^{1-\sigma}}, \quad \hat{y} = \hat{w} + \hat{\pi}.$$

- Given  $\hat{P}$ ,  $\hat{w}$ ,  $\hat{\pi}$  and the indirect demand function  $\hat{p}(y(\phi), n(\phi); \hat{P}, \hat{w}, \hat{\pi})$  that comes from solving the representative consumer's utility maximization problem, firm  $\phi$ ,  $\forall \phi \in [b, +\infty]$ , chooses  $\hat{q}(\phi), \hat{n}(\phi)$  to solve

$$\begin{aligned} \pi(\phi) = \max & \left\{ \hat{p}(q(\phi), n(\phi); \hat{P}, \hat{w}, \hat{\pi}) q(\phi) - \hat{w} \frac{q(\phi)}{\phi} - \hat{w} \frac{L^\alpha}{\psi} \frac{1 - [1 - n(\phi)]^{-\beta+1}}{-\beta+1} \right\} \\ \text{s.t. } & q(\phi) \leq n(\phi) L \hat{y} \frac{\hat{p}(y(\phi), n(\phi); \hat{P}, \hat{w}, \hat{\pi})^{-\sigma}}{\hat{P}^{1-\sigma}}, \quad \hat{y} = \hat{w} + \hat{\pi} \\ & n(\phi) \in [0, 1] \end{aligned}$$

- $\hat{l}(\phi) = \frac{\hat{y}(\phi)}{\phi}$  and  $\hat{l}^m(\phi) = \frac{L^\alpha}{\psi} \frac{1 - [1 - \hat{n}(\phi)]^{-\beta+1}}{-\beta+1}$ .

- $\hat{\phi}^* = \sup_{\phi \geq b} \{\pi(\phi) = 0\}$ .

- The measure of operating firms  $\hat{M} = J \left[ 1 - G(\hat{\phi}^*) \right]$ .

- The pdf of the conditional distribution of operating firms  $\hat{\mu}(\phi)$  is given by (14).



- The price index satisfies  $\hat{P}^{1-\sigma} = \hat{M} \int_b^\infty \hat{p}(\phi)^{1-\sigma} \hat{n}(\phi) \hat{\mu}(\phi) d\phi$ .
- Per consumer profit satisfies  $\hat{\pi} = \hat{M} \int_b^\infty \hat{\pi}(\phi) \hat{\mu}(\phi) d\phi / L$ .
- The individual goods market clear  $\hat{n}(\phi) L \hat{x}(\phi) = \hat{q}(\phi), \forall \phi \in [b, +\infty]$ .
- The labor market clears  $\hat{M} \int_b^\infty \hat{l}(\phi) \hat{\mu}(\phi) d\phi + \hat{M} \int_b^\infty \hat{l}^m(\phi) \hat{\mu}(\phi) d\phi = L$ .

To derive stark predictions from the model, I make a particular assumption regarding the distribution of productivities. Similar to Helpman, Melitz, and Yeaple (2004) and Chaney (2006), I assume that the productivity of firms is drawn from a Pareto distribution with shape parameter  $\theta > \sigma - 1$ , cdf  $G(\phi) = 1 - b^\theta / \phi^\theta$ , pdf  $g(\phi) = \theta b^\theta / \phi^{\theta+1}$  and support  $[b, +\infty)$ , where  $b$  can be interpreted as the level of technology.<sup>16</sup> Thus, we have  $G(\phi^*) = 1 - b^\theta / (\phi^*)^\theta$ , and the measure of operating firms becomes  $M = Jb^\theta / (\phi^*)^\theta$ .

Substituting the optimal decision rules (8) and (9), equation (13), the measure of entrants  $M$  and the conditional density defined above into the price index (2), I obtain

$$(\phi^*)^\theta = \frac{Jb^\theta}{L^{1-\alpha}} \frac{1}{\tilde{\psi}} \left( \frac{1}{1 - 1/\tilde{\theta}} - \frac{1}{1 - 1/(\tilde{\theta}\tilde{\beta})} \right), \quad (15)$$

where

$$\tilde{\theta} = \frac{\theta}{\sigma - 1}, \quad \tilde{\beta} = \frac{\beta}{\beta - 1}, \quad \tilde{\psi} = \frac{\psi}{\sigma(1 - \eta)}$$

and  $\eta = (\sigma - 1) / (\theta\sigma)$  is the share of profits out of total income (see appendix B).<sup>17</sup> The case of  $\beta = 0$  results when taking  $\beta \rightarrow 0$ . The above equation, together with the price index,

$$P^{\sigma-1} = \left[ L^{1-\alpha} (\tilde{\sigma}w)^{1-\sigma} \tilde{\psi} (\phi^*)^{\sigma-1} \right]^{-1} \quad (16)$$

and the normalization  $w = 1$ , delivers two equations and two unknowns,  $\phi^*$  and  $P$ , that determine the equilibrium of the model.

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<sup>16</sup>In addition, this assumption allows the model to match the empirically observed distribution of the sales of firms. See Kortum (1997), Gabaix (1999), Eaton and Kortum (2002), Luttmer (2006) and Eaton, Kortum, and Kramarz (2005) for justifications of using this distribution of productivities.

<sup>17</sup>I assume that the parameters are such that  $\phi^* \geq b$ .

## 2.2 Multi-country model

This section extends the endogenous cost model to a multi-country setting.

### 2.2.1 Environment

**Consumer** I assume that there exist  $i, j = 1, \dots, N$  countries. Country  $j$  has population of measure  $L_j$  and there is a measure of  $J_j$  goods that can be potentially produced by that country. The productivities of firms originating in country  $j$  are drawn from  $[b_j, +\infty)$ . Each household has a unit labor endowment and earns labor income  $w_j$  and profit flows  $\pi_j$ . The problem of the consumer is the same as in the one-country model, except that each consumer has access to imported goods as well as domestic ones. Therefore, the effective price index for country  $j$  becomes

$$P_j^{1-\sigma} = \sum_{v=1}^N J_v \frac{b_v^\theta}{(\phi_{vj}^*)^\theta} \int_{b_v}^{+\infty} p_{vj}(\phi)^{1-\sigma} n_{vj}(\phi) \mu_{vj}(\phi) d\phi, \quad (17)$$

where  $p_{vj}(\phi)$  is the price that a firm with productivity  $\phi$  from source country  $v$  charges in country  $j$ ,  $n_{vj}(\phi)$  represents the fraction of consumers from country  $j$  who have access to the good of a firm from country  $v$  that has productivity  $\phi$ , and  $\mu_{vj}(\phi)$  is the pdf of the distribution of productivities of firms from country  $v$  conditional on selling to country  $j$ . Finally, firms from source country  $v$  that have drawn  $\phi$  below the productivity threshold  $\phi_{vj}^*$  choose not to sell to country  $j$ .

The demand of a representative consumer from country  $j$  for a type  $\phi$  good from country  $i$  is given by

$$x_{ij}(\phi) = y_j \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}}, \quad (18)$$

where  $y_j = w_j + \pi_j$ . Total demand for a firm with productivity  $\phi$  from source country  $i$  and selling to country  $j$  is given by

$$n_{ij}(\phi) L_j y_j \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}}.$$

**Firm** Similarly to the one-country model, I assume that firms wanting to export must incur market access costs, interpreted as marketing expenditures, in order to reach a fraction of the consumers of a particular market. Evidence about the exact nature of these costs is provided

by Keesing (1983) and Roberts and Tybout (1997b). The authors discuss a number of costs reported by managers of exporting firms in a series of interviews. These data indicate that firms must research the foreign market by identifying and contacting the potential consumers of their good. Hence, they must develop new goods or adapt their existing products to foreign consumers' tastes. Finally, the firms must set up direct or indirect distribution channels in order to make the good available to the foreign consumers and to inform them about the existence of the good.<sup>18</sup>

Melitz (2003) and Helpman, Melitz, and Yeaple (2004) were the first to incorporate fixed market access costs in a general equilibrium model with international trade. The authors treat the amount of these costs as fixed and as independent of the export volume of the firm. However, this assumption is inconsistent with the observation of many small exporters in the trade data (see EKK05) and the existence of small producers in general.

Departing from other trade models, I assume that there are increasing marginal costs to reaching additional consumers in a given country  $j$ . Thus, similarly to the one-country case, the amount of labor needed to reach  $n_{ij}(\phi) L$  consumers is

$$\frac{L_j^\alpha}{\psi} \frac{1 - [1 - n_{ij}(\phi)]^{-\beta+1}}{-\beta + 1} .$$

For simplicity, I assume that the parameters  $\beta, \alpha$  and  $\psi$  governing the market access technology are the same for all countries.

For the marketing activities related to exporting described above, importing country's labor is oftentimes employed (see Keesing (1983) and Roberts and Tybout (1997b)). For example, creating distribution channels in importing countries may require hiring foreign labor for advertising purposes. Hence, the market access costs are paid in terms of importing country's wages. Yet, there is still substantial evidence that part of the labor costs for marketing expenditures are paid in terms of exporting country's wages. Therefore, I choose to combine this evidence and consider a general case in which the market access cost of each firm is denominated both in importing and exporting country's wages. I make the following assumption:

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<sup>18</sup>Roberts and Tybout (1997b) mention that firms can hire for a fee third parties to handle the distribution, which, reportedly, is very frequently the case. If this last activity is characterized by free entry then the market access activity, which I formulate above, can simply be reinterpreted as being done from a third party hired by the firm.

**Assumption 3** The production of advertisements requires a bundle of labor services from source country  $i$  and destination country  $j$ :

$$S = l_j^\gamma l_i^{1-\gamma}, \quad 0 < \gamma < 1 .$$

For simplicity, I also assume that  $\gamma$  is the same across countries. I will estimate the value of all the parameters using trade data in section 3. The total cost of a firm from source country  $i$  to reach a fraction  $n_{ij}(\phi)$  of the consumers of country  $j$  with population size  $L_j$  is given by the following expression (taking into account cost minimization by the firm):<sup>19</sup>

$$w_j^\gamma w_i^{1-\gamma} \frac{L_j^\alpha}{\psi} \frac{1 - [1 - n_{ij}(\phi)]^{-\beta+1}}{-\beta + 1} .$$

In addition to the marketing cost to reach consumers, the firm has to pay a variable trade cost modeled in the standard iceberg formulation. This implies that, for a firm operating in country  $i$  and selling to country  $j$ ,  $\tau_{ij} > 1$  units of the good must be shipped in order for one unit of the good to arrive at the export destination. For simplicity, I assume that  $\tau_{ii} = 1$ .<sup>20</sup>

Given the above, the problem that a firm with productivity  $\phi$  from source country  $i$  solves when considering whether to sell to market  $j$  is given by

$$\begin{aligned} \pi_{ij}(\phi) = & \max_{n_{ij}, p_{ij}} \left\{ n_{ij} L_j y_j \frac{p_{ij}^{1-\sigma}}{P_j^{1-\sigma}} - n_{ij} L_j y_j \frac{\tau_{ij} p_{ij}^{-\sigma} w_i}{P_j^{1-\sigma} \phi} - w_j^\gamma w_i^{1-\gamma} \frac{L_j^\alpha}{\psi} \frac{1 - (1 - n_{ij})^{-\beta+1}}{-\beta+1} \right\} \\ \text{s.t. } & n_{ij} \in [0, 1] . \end{aligned}$$

Total profits of a particular firm are the summation of the profits from exporting activities in all the  $j = 1, \dots, N$  countries (or a subset thereof). For the case where  $\beta \geq 0$ , the optimal decisions of the firm in the multi-country model are (using the results of Proposition 1):

$$p_{ij}(\phi) = \tilde{\sigma} \frac{\tau_{ij} w_i}{\phi} . \quad (19)$$

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<sup>19</sup>For simplicity, I redefine per unit advertisement costs  $1/\psi$  to incorporate an extra term  $\gamma^\gamma (1 - \gamma)^{1-\gamma}$ .

<sup>20</sup>I further assume  $\tau_{iv} \leq \tau_{iv} \tau_{vj} \forall (i, v, j)$  to exclude the possibility of transportation arbitrage.

For  $\phi \geq \phi_{ij}^*$ ,

$$n_{ij}(\phi) = 1 - [L_j^{1-\alpha} y_j w_j^{-\gamma} \phi^{\sigma-1} (\tilde{\sigma} \tau_{ij} w_i)^{1-\sigma} \psi P^{\sigma-1} / (w_i^{1-\gamma} \sigma)]^{-1/\beta}, \quad (20)$$

and  $n_{ij}(\phi) = 0$  for  $\phi < \phi_{ij}^*$ , where  $\phi_{ij}^*$  is given by<sup>21</sup>

$$\phi_{ij}^* = \sup_{\phi \geq b_i} \{\pi_{ij}(\phi) = 0\}. \quad (21)$$

### 2.2.2 Equilibrium analysis

Similarly to the one-country setup the productivity of the firms is drawn from a Pareto distribution with shape parameter  $\theta$  and support  $[b_i, +\infty)$ ,  $i \in 1, \dots, N$ . More technologically advanced countries have higher  $b_i$ . I denote by  $\mu_{ij}(\phi)$  the pdf of the conditional distribution of productivities of firms from source country  $i$  selling in country  $j$ .

An equilibrium in this model is defined similarly to the one-country case. The only difference lies in the fact that for each country  $i$ , there exist  $j = 1, \dots, N$  cutoffs  $\phi_{ij}^*$  that determine the minimum productivity of a firm that sells to country  $j$ . In addition, balance trade requires that condition (24) below holds, which imposes restrictions on the relative wages of the countries.

Using the FOCs for the firm, the price index and the labor market clearing condition, I can characterize the equilibrium by the following set of equations:

$$(\phi_{ij}^*)^{\sigma-1} = [L_j^{1-\alpha} y_j^{1-\gamma} (\tilde{\sigma} \tau_{ij} w_i)^{1-\sigma} \tilde{\psi} P_j^{\sigma-1} / y_i^{1-\gamma}]^{-1} \quad \forall i, j \in 1, \dots, N, \quad (22)$$

$$P_i^\theta = \frac{(\tilde{\sigma})^{(\sigma-1)\tilde{\theta}} [L_i^{1-\alpha} y_i^{1-\gamma} \tilde{\psi}]^{1-\tilde{\theta}}}{\left(\frac{1}{1-1/\tilde{\theta}} - \frac{1}{\theta-1/(\tilde{\theta}\beta)}\right) \sum_{v=1}^N J_v b_v^\theta y_v^{1-\gamma} [(\tau_{vi} w_v)^{1-\sigma} / y_v^{1-\gamma}]^{\tilde{\theta}}} \quad \forall i \in 1, \dots, N, \quad (23)$$

$$w_i L_i = (1 - \eta) \sum_{v=1}^N \lambda_{iv} \frac{w_v L_v}{1 - \eta} \quad \forall i \in 1, \dots, N. \quad (24)$$

where  $\lambda_{ij}$  is the fraction of spending by country  $j$  on goods from country  $i$ , and  $\eta = (\sigma - 1) / (\theta\sigma)$

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<sup>21</sup>Similarly to the one country case, I choose parameters such that  $b_i \leq \min_j \phi_{ij}^*$ .

is the share of profits out of total income (see appendix B).<sup>22</sup> Finally, the measure of firms from source country  $i$  selling to market  $j$  is given by  $M_{ij} = J_i b_i^\theta / (\phi_{ij}^*)^\theta$ .

### 2.2.3 Implication for firms' sales

I now proceed to study the total sales of firms as functions of their productivities. The total sales of a firm from country  $i$  selling to country  $j$  and having productivity  $\phi$  are given by

$$\underbrace{n_{ij}(\phi) L}_{\text{extensive margin of consumers}} \underbrace{y_j \frac{\left(\tilde{\sigma} \frac{w_i}{\phi}\right)^{1-\sigma}}{P_j^{1-\sigma}}}_{\text{intensive margin of sales per consumer}}.$$

In the fixed cost model, firms choose  $n_{ij}(\phi) = 1 \forall \phi \geq \phi_{ij}^*$ , and, thus, their sales inherit the shape of the intensive margin which is of the standard CES Dixit-Stiglitz form. The sales in the intensive margin—even for firms with  $\phi = \phi_{ij}^*$ —begin at a positive threshold, as can be seen in figure 4. However, in the endogenous cost model, the simple addition of increasing marginal costs to reach additional consumers introduces a new margin in the firm's sales: the extensive margin of consumers. Low productivity firms not only have small sales per consumer but also choose to reach a small fraction of the consumers, which could be arbitrarily close to zero as seen in figure 3. This choice alters the distribution of sales predicted by the fixed cost model by generating a number of exporters to each particular market selling small amounts in that market. Another observation that is worth noting in these figures is that high productivity firms choose  $n(\phi)$  close to one in the endogenous cost model. Thus, the distribution of sales of large firms, given the CES Dixit-Stiglitz form of the intensive margin per consumer, inherits the Pareto distribution of productivities, as in the fixed cost model of Chaney (2006).<sup>23</sup>

Finally, substituting in for the equilibrium conditions, the sales of a firm with productivity  $\phi$

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<sup>22</sup>The exact form of  $\lambda_{ij}$  will be given later on. For an in-depth analysis of the derivation of the labor market equilibrium in models with heterogeneous firms, see Eaton and Kortum (2005).

<sup>23</sup>Axtell (2001) reports that the distribution of US firms' sales, especially for firms with relatively large sales, follows the Pareto distribution with coefficient close to 1.

from source country  $i$  selling to country  $j$  can be expressed as:

$$r_{ij}(\phi) = \begin{cases} L_j^\alpha y_j^\gamma y_i^{1-\gamma} \frac{1}{\tilde{\psi}} \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1} - \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \right] & \text{if } \phi \geq \phi_{ij}^* \\ 0 & \text{otherwise.} \end{cases} \quad (25)$$

Observe that the case of Melitz (2003) and Chaney (2006) emerges by setting  $\alpha = 0$  and  $\gamma = 0$  and taking  $\beta \rightarrow 0$ :

$$r_{ij}(\phi) = \begin{cases} y_i \frac{1}{\tilde{\psi}} \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1} & \text{if } \phi \geq \phi_{ij}^* \\ 0 & \text{otherwise,} \end{cases}$$

with the parameter  $1/\psi$  incorporated in the term  $1/\tilde{\psi}$  being the corresponding fixed cost of exporting.<sup>24</sup>

### 3 Calibration

The model is particularly simple to calibrate by following a methodology similar to the one developed by EKK05. The parameters of the model can be calibrated directly by looking at 1) the relationship between the number of firms selling to at least some given number of markets and the sales of these firms in France and 2) the relationship between the number of French entrants per country, and the population and income per capita of that country.

#### 3.1 Parameters determining the relative sales of firms

I will consider the sales of French firms in France as a function of the number of other destinations countries they serve. I Denote by  $M_{FF}^{(k)}$  the measure of French firms selling to France and to at least  $k$  additional countries. These firms' total sales in France,  $T_{FF}^{(k)}$ , are given by the following expressions (see appendix D)

$$\beta = 0 : T_{FF}^{(k)} = M_{FF}^{(0)} L_{FF}^\alpha y_F \frac{1}{\tilde{\psi}} \frac{\left( \frac{M_{FF}^{(k)}}{M_{FF}^{(0)}} \right)^{1-1/\tilde{\theta}}}{1 - 1/\tilde{\theta}} , \quad (26)$$

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<sup>24</sup>Chaney (2006) solves the model with  $\beta = 0$  allowing for market specific fixed costs  $1/\psi_{ij}$ .

$$\beta > 0 : T_{FF}^{(k)} = M_{FF}^{(0)} L_F^\alpha y_F^{\frac{1}{\psi}} \left[ \frac{\left( \frac{M_{FF}^{(k)}}{M_{FF}^{(0)}} \right)^{1-1/\tilde{\theta}}}{1-1/\tilde{\theta}} - \frac{\left( \frac{M_{FF}^{(k)}}{M_{FF}^{(0)}} \right)^{1-1/(\tilde{\theta}\tilde{\beta})}}{1-1/(\tilde{\theta}\tilde{\beta})} \right], \quad (27)$$

where  $\tilde{\theta} = \theta / (\sigma - 1)$ .

In the model  $\tilde{\theta}$  determines the sales advantage of more productive firms in the intensive margin of per consumer sales. The parameter  $\beta$ , that regulates adjustments in the extensive margin of consumers governs the ability of firms to reach a larger fraction of the consumers in a market, given that they enter that market.

Figure 6, plots the logarithm of total sales of French firms in France as a function of the number of firms selling to  $k$  or more countries. The relationship suggests a slope of 0.35 indicating that firms that export to more markets sell also on average more in France. The slope of 0.35 implies a value of  $\tilde{\theta}$  around 1.5 for the model with  $\beta = 0$  (more details are given in appendix D). However, the fixed cost model overpredicts (by around 77%) the total sales of all French firms. Given the parameter  $\tilde{\theta} = 1.5$ , the model with  $\beta = 1$  delivers a better fit to the relationship in the right tail as depicted in Figure 6. The reason for the better fit of the endogenous cost model is that firms that sell to only a few destinations are not only the least productive ones, but also choose to reach only a few consumers in France, that is,  $n_{FF}(\phi)$  is close to 0. When one accounts for these firms, the total sales in France increase much slower as a function of the number of destinations served than the simple fixed cost model would predict. The results of the above analysis suggest a  $\beta$  closer to 1 rather than to 0. Thus, I choose the value of  $\beta = 1$  as a benchmark value for the endogenous cost model throughout the remainder of my analysis.

### 3.2 Parameters determining total exports and number of exporters

The use of the Pareto distribution allows for analytical expressions for the fraction of spending by country  $j$  on goods from country  $i$ ,

$$\lambda_{ij} = \frac{(\tau_{ij})^{-\theta} (b_i)^\theta w_i^{(1-\gamma)(1-\tilde{\theta})-\theta}}{\sum_{v=1}^N (\tau_{vj})^{-\theta} (b_v)^\theta w_v^{(1-\gamma)(1-\tilde{\theta})-\theta}}. \quad (28)$$



where the  $\lambda_{ij}$  is a function of trade barriers  $\tau_{ij}$ , the technology  $b_i$ , and the wages  $w_i$  of the countries.<sup>25</sup> Notice that this expression is comparable to the one used by Eaton and Kortum (2002) in their estimation of the parameter that governs the extent of heterogeneity in the productivities of firms,  $\theta$ . I will use their estimate and set  $\theta = 8$ .<sup>26</sup> Notice that given  $\theta = 8$ , the estimation of  $\tilde{\theta} = 1.5$  implies  $\sigma = 6.33$ .<sup>27</sup>

To calibrate the remaining parameters,  $\alpha$  and  $\gamma$ , I begin by expressing the total export sales of French firms ( $F$ ) to country  $j$  as:

$$T_{Fj} = \lambda_{Fj} L_j y_j . \quad (29)$$

Alternatively, I can express export sales as the measure of exporting firms times average export sales per firm:

$$T_{Fj} = \underbrace{M_{Fj} L_j^\alpha y_j^\gamma y_F^{1-\gamma} \frac{1}{\tilde{\psi}} \left( \frac{1}{1-1/\tilde{\theta}} - \frac{1}{1-1/(\tilde{\theta}\tilde{\beta})} \right)}_{\text{average sales per firm}} . \quad (30)$$

Combining the two expressions above, I obtain:

$$\frac{M_{Fj}}{\lambda_{Fj}} = L_j^{1-\alpha} y_j^{1-\gamma} \left[ (y_F)^{1-\gamma} \frac{1}{\tilde{\psi}} \left( \frac{1}{1-1/\tilde{\theta}} - \frac{1}{1-1/(\tilde{\theta}\tilde{\beta})} \right) \right]^{-1} . \quad (31)$$

Expression (31) relates the number of French firms exporting to country  $j$ , normalized by French market share in country  $j$ , to the population and output per capita of that country. Output per capita is related to the wage rate since  $y_j = w_j / (1 - \eta)$ . In fact, this expression

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<sup>25</sup>For simplicity, I set  $J_i = J$ .

<sup>26</sup>Eaton and Kortum (2002) use data on bilateral trade shares, prices, and distance as a proxy for trade costs for a cross section of countries. Their estimation corresponds to estimating the parameter governing the elasticity of substitution between goods for models with the Armington aggregator. Romalis (2005) estimates the later elasticities using data on trade and tariffs studying the countries that joined the NAFTA. He finds parameter values for the elasticity of substitution in the range of 6.2 to 10.9, which are consistent with the estimate of Eaton and Kortum.

<sup>27</sup>The value of  $\sigma = 6.33$  is higher than values used in the business cycles literature (around 2) or values previously estimated using models of trade with heterogeneous firms (e.g. Bernard, Eaton, Jensen, and Kortum (2003) report that  $\sigma = 3.79$  is the value that allows their model to match the sales advantage of exporters in the US data). However the value of  $\sigma = 6.33$  yields a mark-up of around 1.2, which is consistent with mark-ups reported in the data (see Martins, Scarpetta, and Pilat (1996)).

implies that higher entry of firms in a market is related to higher returns to scale with respect to population size for the marketing technology (lower  $\alpha$ ) and lower fraction of marketing costs paid in terms of importing country's wages (lower  $\gamma$ ). Therefore, by modeling a common marketing technology across all firms and making realistic assumptions related to this marketing technology (assumptions 2 and 3) the model is able to capture a robust finding of EKK05: the number of French firms in a market, normalized by French market share, increases with the size of the market with an elasticity less than one.

For my estimation I use data on French firm entry per market from EKK04 and EKK05, and on population and manufacturing absorption per capita (as a proxy for output per capita) which I describe in appendix E. Taking natural logarithms of expression (31) I run the following regression, indicating the data counterpart of the variables with the use of an upper bar (robust standard errors in parentheses)

$$\ln(M_{Fj}/\lambda_{Fj}) = \underset{(.628)}{-2.74} + \underset{(.034)}{0.56} \ln \bar{L}_j + \underset{(.028)}{0.69} \ln \bar{y}_j . \quad (32)$$

The  $R^2$  of the regression is .89. The coefficients are less than one, as predicted by the theory. A formal econometric test rejects the hypothesis that these coefficients are the same at the 1% level, further supporting the validity of assumptions 2 and 3. The estimation implies that the cost to reach a given number of consumers decreases with an elasticity of .56 with the size of the population. It also suggests that around 1/3 of the marketing costs to reach foreign consumers are paid in terms of importing country's wages. The value of  $\gamma = .31$  is different than the ones typically assumed in the literature i.e.  $\gamma = 0$  –in terms of exporting country's wages only– as in Ghironi and Melitz (2005) or  $\gamma = 1$  –in term of importing country's wages only– as is implicit in EKK05. Finally, I use the constant of the regression to determine  $1/\psi$  (see equation (30)).

## 4 Extensive Margin of Consumers and Puzzles in International Trade

In this section I gauge the ability of the endogenous cost model, to predict the export behavior of French firms and trade flows in the event of a trade liberalization episode using the mechanism

of the extensive margin of consumers. Notice that throughout the rest of my analysis I keep the parameters of the model that were calibrated using the French data.

#### 4.1 Distribution of sales and the extensive margin of consumers

In figure 7 I plot the sales distribution of French firms to Portugal, it being one of the 113 exporting markets that EKK05 have studied. The authors report that the characteristics of the sales distribution of French firms across markets are very robust. Thus, the choice of an average size exporting market, such as Portugal, is very representative. A noticeable feature of the sales distribution across markets is the large proportion of French firms selling to a particular market, which sell small amounts in that market.

In the model, the sales of a firm with productivity  $\phi$  from country  $i$  to  $j$  are given by equation (25). I define the smallest sales (revenues) of firms from country  $i$  to  $j$  as  $r_{ij}^{\min}$ . In the fixed cost model, the minimum sales in country  $j$  that correspond to firms with productivity  $\phi = \phi_{ij}^*$  are given by

$$r_{ij}^{\min} = L_j^\alpha y_j^\gamma y_i^{1-\gamma} / \tilde{\psi} .$$

In the case of endogenous cost model, when  $\beta > 0$ , the minimum sales for firms with productivity  $\phi = \phi_{ij}^*$  are

$$r_{ij}^{\min} = 0 .$$

The distribution of sales,  $\Pr [R < r | R \geq r_{ij}^{\min}] = F_{ij}(r)$ , assuming productivities Pareto distributed, can be solved analytically for the two models (see appendix C):

$$\beta = 0 : F_{ij}(r) = 1 - \left( \frac{r}{L_j^\alpha y_j^\gamma y_i^{1-\gamma} / \tilde{\psi}} \right)^{-\tilde{\theta}} \quad r \geq r_{ij}^{\min} , \quad (33)$$

$$\beta = 1 : F_{ij}(r) = 1 - \left( \frac{r}{L_j^\alpha y_j^\gamma y_i^{1-\gamma} / \tilde{\psi}} + 1 \right)^{-\tilde{\theta}} \quad r \geq r_{ij}^{\min} . \quad (34)$$

In figure 7, I show that the fixed cost model, parameterized to match the fact that most firms do not export, overpredicts the size of the smallest exporters (1<sup>st</sup> percentile) by a factor of 150. Thus, the model also underpredicts the size of the largest exporters (99<sup>th</sup> percentile) by a

factor of around 1.7. However, the predictions of the endogenous cost model are closely aligned with the data. In particular, the model predicts the large number of small exporters—for the 1<sup>st</sup> percentile only overpredicts sales by a factor 1.5—and improves upon the predictions of the fixed cost model across all percentiles.

The reason for the improved prediction of the endogenous cost model is the mechanism illustrated in section 2: firms with lower productivities not only sell less per consumer, but also to fewer consumers. Therefore, given the diminishing elasticity to reach (DER) additional consumers market access cost function, the decrease in the sales of less productive firms is faster than what the simple monopolistic competition model with fixed costs and Pareto distribution of productivities would predict. Thus, the endogenous cost model generates a large proportion of small exporters to each market. In terms of a sales distribution in a logarithmic scale, the model with  $\beta = 1$  would imply that the sales distribution is very nonlinear for relatively small firms. Thus, it correctly predicts the curvature of the sales distribution that EKK05 report. However, it would still retain a linearity for the larger firms as is observed in the data (see Axtell (2001) and Luttmer (2006)). Summarizing, the model with the extensive margin of consumers, calibrated to match the size advantage in France of prolific exporters, is able to reproduce the sales distribution of French exporters in each particular exporting markets.

## 4.2 Trade liberalizations and the extensive margin of consumers

Using the parameters inferred from the size advantage in France of prolific exporters, I will subject the model to a further test by looking at its predictions in a trade liberalization episode. The analysis in this dimension is constraint from the unavailability of firm level data on the sales of exporting firms before and after a liberalization episode. Therefore, I will use the best available proxy which is very disaggregated goods data. I will also make use of the strict mapping that my model implies meaning that each firm produces only one good. Thus, in the rest of this section I will treat each goods category as if it was produced by one firm.

I measure the increase in trade flows for the previously traded goods extending the methodology of Kehoe and Ruhl (2003). In particular, Kehoe and Ruhl study the contribution, of least traded goods (including previously nontraded), to the total increase in trade after trade liberal-

ization. Instead, I consider the particular contribution of the least traded goods, conditional on being positively traded before liberalization, to the total increase in trade after the liberalization.

In my analysis, I use data from the OECD International Trade by Commodity database (see appendix E for details) on US imports from Mexico recorded in 6-digit Harmonized System (HS) encoding.<sup>28</sup> Below I construct a classification of the goods. I call the goods traded before the liberalization and throughout 1990-92 “previously traded” goods. I divide the “previously traded” goods in 10 categories with equal number of goods. These categories include goods in an increasing order of volume of trade: category 10 includes the “previously traded” goods that were on average most traded in 1990-92, while category 1 the least traded ones. The goods that were traded in 1997-99 (at least once in these three years) but not throughout all the years of 1990-92 are referred to as “newly traded” goods. I also divide the “newly traded” goods into two categories depending on whether they were continuously traded throughout 1997-99 (category 1) or traded in some of these years (category 2). Finally, I will refer to the goods that were traded in some of the years of 1990-92 but were not traded in 1997-99 as “newly nontraded” goods.

The OECD database provides information on US imports from Mexico for 5402 goods. 2298 of these goods that were traded throughout all years of 1990-92 and thus each category of “previously traded” goods consists of 230 goods (with category 10 consisting of 229 goods). The number of “newly traded” goods is 1767 and 907 of these belong to category 1 of “newly traded” goods, while the remaining 860 constitute category 2 of the “newly traded” goods. Finally, the dataset contains 230 “newly nontraded” goods and 1107 goods that were never traded.

Table 1 provides information on the share of trade for of each the categories of traded goods defined in the previous paragraph. It reports the share out of total trade in 1990-92 and 1997-99. It also reports the contribution of each of the categories of “previously traded” and “newly traded” goods to new trade among these goods. In fact, as table 2 shows the share of the 15% least traded goods from the “previously traded” goods in 1990-92 increased to almost 25% amongst the same goods. This finding shows that a large part of new trade is coming from the least traded of “previously traded” goods. The new trade from the least traded goods is substantial even when compared to new trade coming from “newly traded” goods. “Newly traded” goods

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<sup>28</sup>In general the reporting of import flows from importing countries is more accurate. The results of my analysis remain the same if I used reports on exports from Mexico by good category instead.

are numerous but of small trade volume on average. Thus, a large part of the new goods trade accounted by Kehoe and Ruhl (2003) can actually be interpreted as new trade of “previously traded” goods that were least traded before liberalization.

In order to further interpret the findings in the previous paragraph, I plot in figure 8 the natural logarithm of the ratio of imports from 1997-99 to imports from 1990-92 for each category of “previously traded” goods. A striking pattern emerges: the percentage increase of trade flows is higher the less tradable the good is in 1990-92, a fact that directly implies the results reported in table 2. The models of trade based on the Dixit-Stiglitz specification, such as the Applied General Equilibrium (AGE) models of trade and the fixed cost models, predict that the response of trade flows of previously traded goods to international price differences depends only on the elasticity of substitution between goods. In fact, Kehoe (2005) in an evaluation of AGE models used to predict NAFTA, arrives to the conclusion that no plausible parameterization can make models based solely on the Dixit-Stiglitz specification match the trade flows after the NAFTA liberalization. He points out that this failure is exactly due to their inability to predict high growth in trade for goods with low volume of trade prior the liberalization.

The model with endogenous costs, provides an explanation for the puzzling behavior previous models exhibited when trying to explain the patterns of trade flows of goods with little, but positive, trade after liberalization. In this model there are increasing marginal costs to reach additional consumers, an assumption motivated by the diminishing returns in the marketing technology. These diminishing returns are very intense particularly for goods with a large consumer base due to the very convex marginal cost to reach additional consumers, a fact implied by the DER market access cost function. However, these costs increase slowly for goods with a small consumer base preceding the trade liberalization. Therefore, even a small decrease in variable trade costs that brings about a small increase in the marginal revenue per consumer makes a large expansion of the consumer base of these goods profitable.<sup>29</sup> The following proposition

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<sup>29</sup>DER is a necessary condition to obtain the quantitative results of this paper given constant returns to labor in production, the Dixit-Stiglitz demand, and the assumption of the Pareto distribution of productivities. Observationally equivalent results could potentially be produced by incorporating diminishing returns in the production function that resemble the properties of the DER market access cost function for the one country case. However, the market access technology exhibits diminishing returns per country in a multi-country context, an assumption which would be clearly unrealistic if it was to be extended to the diminishing returns to production case.

formalizes the above argument.

**Proposition 2**

Assume that all countries are symmetric with  $\tau_{ii} = 1 \forall i$  and  $\tau_{ij} = \tau_{iv} > 1 \forall j, v, s.t. j, v \neq i$ .

Define a symmetric trade liberalization as,  $\tau'_{ii} = 1 \forall i$ , and  $\tau'_{ij} \forall i \neq j$  such that  $\tau_{ij} > \tau'_{ij} \geq 1 \forall i \neq j$  and  $\tau'_{ij} = \tau'_{iv} \forall j, v$  s.t.  $j, v \neq i$ . Then:

The elasticity of trade flows of a good with respect to  $\tau_{ij}, \forall i \neq j$ , is higher the lower the productivity  $\phi$  that the good is produced with, for all  $\phi$  s.t.  $\phi \geq \phi_{ij}^*$ .

**Proof.** Normalize  $w_j = 1 \forall j = 1, \dots, N$ . It can be shown that the new  $\tau'_{ij}, i \neq j$ , given  $\tau'_{ii} = 1$ , results in a decrease of  $\phi_{ij}^* \forall i \neq j$ . The exact elasticity of trade flows depends on the model's parameters and initial level of  $\tau_{ij} \forall i, j$ . It is, therefore, sufficient to focus our analysis on the effect of a decrease in  $\phi_{ij}^*$  to trade flows  $r_{ij}(\phi)$ . Rewriting (25) and using the normalization  $w_i = 1, \forall i$ :

$$r_{ij}(\phi) = \underbrace{L_j^\alpha \frac{\sigma}{\psi} \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1}}_{\text{intensive margin of sales per consumer}} \underbrace{\left( 1 - \left( \frac{\phi_{ij}^*}{\phi} \right)^{(\sigma-1)/\beta} \right)}_{\text{extensive margin of consumers}}, \phi \geq \phi_{ij}^*, i \neq j.$$

The objective is to compute the elasticity of trade flows with respect to a change in  $\phi_{ij}^*$ , namely  $\zeta = -d \ln r_{ij}(\phi) / d \ln \phi_{ij}^*$ . This elasticity is higher for low initial productivity  $\phi$ ,<sup>30</sup>

$$\zeta = \underbrace{(\sigma - 1)}_{\text{intensive margin of sales per consumer elasticity}} + \underbrace{\frac{\sigma - 1}{\beta} \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\beta} - 1 \right]^{-1}}_{\text{extensive margin of consumers elasticity}}.$$

Notice that  $\zeta = \zeta(\phi)$  and is decreasing in  $\phi$  and, thus, decreasing in initial export sales. In fact, as  $\beta \rightarrow 0$ ,  $\zeta(\phi) \rightarrow (\sigma - 1) \forall \phi \geq \phi_{ij}^*$ . ■

To quantitatively assess the ability of the models to match the patterns of trade flows after trade liberalizations I choose the reduction in variable trade costs so that the two models match the total growth in the trade in “previously traded” goods. The fixed cost model requires a 12.5%

<sup>30</sup>Since the general equilibrium effect is the same across goods I set for simplicity  $\partial \ln \phi_{ij}^* / \partial \ln \tau_{ij} = 1$ .

decrease in variable trade costs, while the endogenous cost requires only a 9.5% decrease (further details are given in appendix E). In figure 8, I plot the two models' predicted increase in growth for each category of "previously traded" goods along with the actual data. The endogenous cost model delivers a close match to the data, while the fixed cost model falls short of predicting the empirical pattern.

The interaction between the extensive margin of consumers and Dixit-Stiglitz preferences, allows the endogenous cost model to successfully replicate the increase in trade flows after the introduction of NAFTA providing a solution of the puzzle reported by Kehoe (2005). In the next section, I analyze the role the new consumers margin plays in international trade. This margin is defined as the growth in trade flows due to sales to new consumers by firms trading prior to a trade liberalization.

## 5 How important is the new consumers margin in international trade?

In the above analysis, I have introduced a new margin of adjustment in export sales, namely the extensive margin of consumers of each firm. I refer to the extensive margin of firms as the number of firms exporting. The intensive margin of sales per consumer is the sales of the firm to each consumer that the firm reaches in a market. Essentially, previous literature referred to the intensive margin in what I refer to here as the extensive margin of consumers multiplied by what I have defined as the intensive margin of sales per consumer. In the endogenous cost model, as a source country becomes more expensive each firm of this country exports to a narrower set of consumers. In contrast, in models with adjustments mainly in the extensive margin of firms, more expensive countries mainly export in a narrower set of goods (as in Eaton and Kortum (2002)).<sup>31</sup> Finally, in models with monopolistic competition but homogeneous firms, as in Krugman (1980), the only adjustment is through the intensive margin of sales per consumer.

Given this terminology, I proceed to define the three margins of adjustment of **aggregate trade flows** that the model features in the event of a trade liberalization:

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<sup>31</sup>Evidence on the existence of an extensive margin of firms exporting is provided by Hummels and Klenow (2005) and EKK05.



- i) Intensive margin growth (total growth in sales per consumer)
- ii) The new consumers margin (total growth in the extensive margin of consumers)
- iii) The new firms margin (total growth in the extensive margin of firms)

In recent years an increased amount of attention has been given to the new firms margin. This attention stems partly from the ability of models that have this margin of adjustment to exhibit large increases in trade with small decreases in trade costs, without assuming unrealistically high elasticities of substitution.<sup>32</sup> In a Ricardian model of trade with heterogeneous firms, Eaton and Kortum (2002) show that the elasticity of trade flows with respect to variable trade costs does not depend on the elasticity of substitution of goods (denoted by the parameter  $\sigma$ ) but on the parameter that determines the extent of heterogeneity in the productivities of firms,  $\theta$ . Chaney (2006), using a version of the Melitz (2003) model, arrives to a similar conclusion for the elasticity of trade with respect to variable trade costs.<sup>33</sup> The model with endogenous cost also predicts that the price elasticity of trade is  $\theta$ . However, when decomposing the importance of each of the margins, as is done in the next proposition, the contribution of the new firms margin is minimal (at least for small reductions in the variable trade costs). The following proposition formalizes the above discussion.

**Proposition 3**

- i) The elasticity of substitution ( $\sigma$ ) has no effect on the elasticity of trade flows with respect to variable trade costs  $\tau_{ij}$ .*
- ii) For small changes in variable trade costs  $\tau_{ij}$ , changes in the new consumers margin always dominate the changes in the new firms margin.*

**Proof.** Both parts of the proof will be shown by performing a decomposition using the Leibniz rule to separate the three margins. We have that total export sales of country  $i$  to  $j$  are:

$$T_{ij} = J \int_{\phi_{ij}^*}^{\infty} n_{ij}(\phi) x_{ij}(\phi) g_i(\phi) d\phi .$$

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<sup>32</sup>Ruhl (2005) using a model with adjustment in the extensive margin of firms proposes a solution to the so called elasticity puzzle, namely the contrast of the low elasticity needed to explain the patterns of international business cycles with the high elasticity needed to explain the growth of trade following reductions in trade costs.

<sup>33</sup>Chaney (2006) arrives at different conclusions for the elasticity of trade with respect to fixed costs.

The change in total export sales of country  $i$  to country  $j$  due to a change in variable trade cost is given by (following methodology similar to Chaney (2006)):

$$\begin{aligned} \frac{dT_{ij}}{d\tau_{ij}} = & \underbrace{J \int_{\phi_{ij}^*}^{\infty} n_{ij}(\phi) \frac{\partial x_{ij}(\phi)}{\partial \tau_{ij}} g_i(\phi) d\phi}_{\text{Intensive margin growth}} + \underbrace{J \int_{\phi_{ij}^*}^{\infty} \frac{\partial n_{ij}(\phi)}{\partial \tau_{ij}} x_{ij}(\phi) g_i(\phi) d\phi}_{\text{New consumers margin}} + \\ & \underbrace{J n_{ij}(\phi_{ij}^*) x_{ij}(\phi_{ij}^*) g_i(\phi_{ij}^*) \frac{\partial \phi_{ij}^*}{\partial \tau_{ij}}}_{\text{New firms margin}}. \end{aligned}$$

I rewrite this decomposition in terms of elasticities:

$$\frac{d \ln T_{ij}}{d \ln \tau_{ij}} = - \underbrace{(\sigma - 1)}_{\text{Intensive margin growth elasticity}} - \underbrace{(\theta - \sigma + 1)}_{\text{New consumers margin elasticity}} + \underbrace{0}_{\text{New firms margin elasticity}} \quad (35)$$

First, notice that  $d \ln T_{ij} / d \ln \tau_{ij} = -\theta$ , proving part i). For part ii), given the assumption  $\theta > \sigma - 1$  that is required for the integrals to converge, small decreases in variable trade costs cause a substantial increase in trade flows attributed to the new consumers margin. The corresponding contribution of the new firms margin is tiny. This can be verified from the expression that represents the part of the derivative related to the new firms margin: because the extensive margin of consumers is close to 0 for small firms ( $n_{ij}(\phi_{ij}^*) = 0$ ), any small change that causes new firms to trade ( $\partial \phi_{ij}^* / \partial \tau_{ij}$ ) has minimal contribution in the increase in total export sales. ■

The reason for the small importance of the new firms margin in the event of a trade liberalization lies in the existence of the extensive margin of consumers. To provide further intuition of the above result I look at the comparative statics of trade liberalization and in particular I look at the density of exports for firms with different productivities before and after a trade liberalization. Figure 9 graphs the density of exports for each level of productivity (total amount exported by firms of the given productivity) for the endogenous cost and the fixed cost model, before the event of a trade liberalization. In the fixed cost model, the density of exports inherits the Pareto distribution of productivities given the Dixit-Stiglitz demand specification. However, in the endogenous cost model the extensive margin of consumers is small for firms with relatively low productivities, and thus the density of sales is hump-shaped. This indicates that the con-

tribution of small firms is minor in total export sales. In figure 10, I graph the three margins' contribution to the change in aggregate trade flows after a trade liberalization episode, namely a decrease in the variable costs of trade. The first effect is an intensive margin growth of trade. This is the result of a proportional change to the sales per consumer, for all previously trading firms. The second margin of adjustment is the new consumers margin, where adjustments are substantially larger for firms with small (but positive) numbers of consumers before the trade liberalization. Finally, the decrease in variable trade costs will also affect the new firms margin. However, the extensive margin of consumers for these new exporting firms is tiny. As long as the decrease of variable trade costs is not so large, to bring about a substantial number of new firms to trading, the overall contribution of new firms will be small and the new consumers margin will dominate.

To assign quantitative magnitudes to the previous discussion, I can use my model (with  $\beta = 1$ ) to perform a quantitative decomposition of new trade in the event of a trade liberalization. For the case of a 9.5% decrease in trade costs, the percent contribution to new trade of the intensive margin growth, the new firms margin, and the new consumers margin is 52%, 14.7%, and 33.3%, respectively. In contrast, the fixed cost model would predict that the percent contribution to new trade of the intensive margin growth and the new firms margin is 52% and 48%, respectively. Thus, my model implies that up to 1/3 of new trade was not correctly accounted by previous theory.

## 6 Conclusion

In this paper, I develop a theory of marketing based on ideas from the advertising literature. Using this theory, I propose a new formulation of market access costs. The basis for this formulation is a marketing technology where with each additional marketing effort a firm reaches a smaller number of new consumers in a market and this number becomes smaller at some geometric rate as the firm saturates the market. The model provides a deeper understanding of the barriers individual firms face when selling to foreign markets and features an extensive margin of consumers in the sales of a firm. The new theory can account for a number of observations in trade data which seemed particularly puzzling in the view of models with a fixed cost of exporting. Thus,

the theory of marketing adds another key ingredient to the models of international trade that, together with product differentiation and firm productivity heterogeneity, allows these models to account for a series of observations in the trade data.

An important new prediction of the model is that a significant amount of new trade in the event of trade liberalization comes from previously small, rather than new, exporters. This prediction comes in sharp contrast to the previous theory's findings, which emphasize the importance of new firms for the overall increase in trade after a liberalization. With the increasing availability of firm level data, future research can shed light on the empirical validity of the different theories.

Overall, I propose a new demand specification for the firm by incorporating an extensive margin of consumers together with the Dixit-Stiglitz demand specification for each consumer. The parsimonious formulation I develop omits many important features of the world. Future extensions could include introducing the proposed demand formulation into a dynamic framework or using it to deliver predictions on sectorial trade after a liberalization episode. However, the new theory has taken important steps toward understanding the role that marketing costs play in the context of a macroeconomic trade model.

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# Appendix

## Appendix A: the maximization problem of the firm

First, notice that for the case where  $\beta > 0$  the market access cost function inherits an interiority condition when  $n \rightarrow 1$  since  $\lim_{n \rightarrow 1} \frac{1-(1-n)^{-\beta+1}}{-\beta+1} = +\infty$ . Therefore, when solving for the maximization problem of the firm, that is given in the main text, I need only to consider the restriction  $n \geq 0$ .

Rewriting the problem of a type  $\phi$  firm in a Langrangian formulation with the additional constraint that  $n \geq 0$ :

$$\mathcal{L}(\phi) = nLy \frac{p^{1-\sigma}}{P^{1-\sigma}} - nLy \frac{p^{-\sigma} w}{P^{1-\sigma} \phi} - w \frac{L^\alpha}{\psi} \frac{1 - (1-n)^{-\beta+1}}{-\beta+1} + \lambda n.$$

FOC with respect to  $p$ :

$$p(\phi) = \tilde{\sigma} \frac{w}{\phi}, \quad (36)$$

FOC with respect to  $n$  :

$$Ly \frac{p(\phi)^{1-\sigma}}{P^{1-\sigma}} - Ly \frac{p(\phi)^{-\sigma} w}{P^{1-\sigma} \phi} - w \frac{L^\alpha}{\psi} [1 - n(\phi)]^{-\beta} + \lambda = 0 \quad (37)$$

and  $\lambda n(\phi) = 0$ ,  $\lambda \geq 0$ .

Using equation (36), (37) becomes

$$\frac{y \left( \tilde{\sigma} \frac{w}{\phi} \right)^{1-\sigma}}{\sigma P^{1-\sigma}} - \frac{w L^{\alpha-1}}{\psi} [1 - n(\phi)]^{-\beta-1} + \lambda = 0.$$

Notice that there exists  $\phi^*$ , s.t.  $\forall \phi \leq \phi^*$  this equation holds only for some  $\lambda > 0 \implies n(\phi) = 0$  (the constraint  $n(\phi) \geq 0$  is binding). However,  $\forall \phi > \phi^*$  the constraint is not binding and the corresponding  $n(\phi) \in (0, 1)$  is actually the solution to the above equation for  $\lambda = 0$ . Thus, for  $\phi \leq \phi^*$ ,  $n(\phi) = 0$ . For all  $\phi > \phi^*$ , the optimal  $n(\phi)$  is given by the solving equation (9)

I also check the second order conditions in order to derive sufficient conditions for this problem to have a unique solution for  $n(\phi) \in [0, 1]$ . Evaluating the first and second principle submatrices

of the Hessian matrix,

$$A = \begin{bmatrix} \frac{\partial^2 h}{\partial p^2} & \frac{\partial^2 h}{\partial p \partial n} \\ \frac{\partial^2 h}{\partial n \partial p} & \frac{\partial^2 h}{\partial n^2} \end{bmatrix},$$

results in the following derivations (notice that  $\forall \phi > \phi^* n(\phi) \in (0, 1)$ ):

$$\frac{\partial^2 h}{\partial p^2} = -\sigma(1-\sigma)n(\phi)Ly\frac{p(\phi)^{-\sigma-1}}{P^{1-\sigma}} + (-\sigma-1)\sigma n(\phi)Ly\frac{p(\phi)^{-\sigma-2}}{P^{1-\sigma}\phi} < 0,$$

$$\frac{\partial^2 h}{\partial n^2} = (-\beta-1)w\frac{L^\alpha}{\psi}\frac{1}{[1-n(\phi)]^{\beta+1}} < 0 \text{ only if } \beta > 0,$$

$$\frac{\partial^2 h}{\partial n \partial p} = \frac{\partial^2 h}{\partial p \partial n} = (1-\sigma)Ly\frac{p(\phi)^{-\sigma}}{P^{1-\sigma}} + \sigma Ly\frac{p(\phi)^{-\sigma-1}}{P^{1-\sigma}\phi} = 0.$$

Therefore, the principle submatrices satisfy  $|A_1| < 0$ ,  $|A_2| > 0$ .

Since the second order condition holds, the unique pair  $(n(\phi), p(\phi))$  that solves the equations (36) and (37), for a given  $\phi > \phi^*$ , is the unique maximum solving the firm's optimization problem (given the effective price index  $P$ ). Therefore, the above formulation gives  $n(\phi)$  as the solution of equation (37)  $\forall \phi > \phi^*$ . In addition, for  $\phi \leq \phi^*$ ,  $n(\phi) = 0$ .

## Appendix B: the share of profits

In this appendix, I will show that the share of profits out of total income is constant and equal to  $\eta = (\sigma - 1) / (\theta\sigma)$ .<sup>34</sup> Notice that sales in  $j$  for a firm with productivity  $\phi$  from country  $i$  are given by (25). Total export sales in  $j$  from firms originating in country  $i$  are given by expression (30). The total variable profit from production is simply  $T_{ij}/\sigma$  and thus labor income from production is  $T_{ij}(\sigma - 1)/\sigma$ . Total market access costs are

$$m_{ij} = M_{ij} \int_{\phi_{ij}^*}^{\infty} L_j^\alpha w_j^\gamma w_i^{1-\gamma} \frac{1}{\psi} \frac{1 - [1 - n_{ij}(\phi)]^{-\beta+1}}{-\beta + 1} \frac{\theta (\phi_{ij}^*)^\theta}{\phi^{\theta+1}} d\phi = T_{ij} \frac{[\theta - (\sigma - 1)]}{\theta\sigma}.$$

Total labor income of country  $i$  from the bilateral trade relationship with country  $j$  equals income from production of goods and market access costs:

$$w_{ij}L_{ij} = (\sigma - 1)T_{ij}/\sigma + (1 - \gamma)T_{ij}[\theta - (\sigma - 1)]/(\theta\sigma) + \gamma T_{ji}[\theta - (\sigma - 1)]/(\theta\sigma).$$

Summing over all  $j$  and using

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<sup>34</sup>For more details, see Eaton and Kortum (2005).

- a) the equality of income and total expenditure  $\sum_{j=1}^N T_{ij} = X_i$ ;
- b) the fact that the total labor income of country  $i$  is the sum of labor incomes generated in order to produce and sell the good to all the  $N$  countries  $w_i L_i = \sum_{j=1}^N w_{ij} L_{ij}$ ;
- c) and that the trade balance condition that implies that  $\sum_{j=1}^N T_{ij} = \sum_{j=1}^N T_{ji}$ ,
- we have that

$$X_i = y_i L_i = w_i L_i / (1 - \eta) .$$

Finally, given the above expression, trade balance also implies expression (24).

### Appendix C: sales' distribution

I consider the case of sales of firms from country  $i$  in market  $j$ . I proceed to represent the results as in EKK04 and EKK05 in order to compare the predictions of the model with the data they report.

Define by  $r_{ij}^{\min}$  the sales for the firm with threshold productivity  $\phi_{ij}^*$ . The objective is to derive the distribution of sales denoted by  $F_{ij}(r)$ . Sales  $r$ , for firms with  $\phi \geq \phi_{ij}^*$ , are given by expression (25). Notice the following:

$$\Pr [R \geq r | R \geq r_{ij}^{\min}] = \frac{\Pr [\Phi \geq \phi]}{\Pr [\Phi \geq \phi_{ij}^*]} = \frac{(\phi_{ij}^*)^\theta}{(\phi)^\theta} .$$

However, this can also be written as

$$\Pr [R \geq r | R \geq r_{ij}^{\min}] = 1 - \Pr [R < r | R \geq r_{ij}^{\min}] = 1 - F_{ij}(r) ,$$

which implies that

$$1 - F_{ij}(r) = \frac{(\phi_{ij}^*)^\theta}{(\phi)^\theta} . \tag{38}$$

Replacing (38) into (25) obtains that sales for firms with  $r \geq r_{ij}^{\min}$  are given by

$$r = L_j^\alpha y_j^\gamma y_i^{1-\gamma} \frac{\sigma}{\psi} \left( [1 - F_{ij}(r)]^{-1/\tilde{\theta}} - [1 - F_{ij}(r)]^{-1/(\tilde{\theta}\tilde{\beta})} \right) , \quad r \geq r_{ij}^{\min} .$$

For  $\beta \rightarrow 0$ , I can solve for the distribution of sales analytically and derive the expression (33). Therefore, in this case, the sales distribution is Pareto with coefficient  $-1/\tilde{\theta}$  as in EKK05 and Chaney (2006). However, the cases that I introduce emerge for  $\beta > 0$ . I can solve for the sales distribution for some cases analytically. For example, when  $\beta = 1$ , the distribution of sales is given by expression (34).

## Appendix D: calibration

**Parameters determining the relative sales of firms** First, notice that in the model there is a strict hierarchy of destinations depending on  $\phi_{ij}^*$ , so that no firm is observed to sell to a less popular without selling to a more popular one. However, this prediction is not always observed in the data as EKK05 point out. EKK05 using entry shocks can generate patterns of entry that violate hierarchy. Their general setup can also be adapted in the context of the model I propose.

Denote by  $M_{ij}^{(k)}$  the measure of firms from country  $i$  selling to country  $j$ , also selling to  $k$  or more less popular markets. The probability that a firm from country  $i$  selling in  $j$  also sells to  $k$  or more less popular markets is

$$\frac{M_{ij}^{(k)}}{M_{ij}^{(0)}}.$$

Define the minimum productivity of a firm from  $i$  selling to  $j$  and at least  $k$  more markets by  $\phi_{ij}^{(k)}$ . The probability of selling to at least  $k$  markets conditional on selling in  $j$  can also be written

$$\left( \frac{\phi_{ij}^*}{\phi_{ij}^{(k)}} \right)^\theta,$$

and thus,

$$\frac{\phi_{ij}^*}{\phi_{ij}^{(k)}} = \left( \frac{M_{ij}^{(k)}}{M_{ij}^{(0)}} \right)^{\frac{1}{\theta}}. \quad (39)$$

Total sales in market  $j$  of firms from market  $i$  selling also to at least  $k$  other destinations are equal to (exploiting the market hierarchy)

$$T_{ij}^{(k)} = M_{ij}^{(k)} L_j^\alpha y_j^\gamma y_i^{1-\gamma} \frac{1}{\tilde{\psi}} \int_{\phi_{ij}^{(k)}}^\infty \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1} - \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \right] \frac{\theta \left( \phi_{ij}^{(k)} \right)^\theta}{\phi^{\theta+1}} \implies$$

$$T_{ij}^{(k)} = J_i \frac{b_i^\theta}{(\phi_{ij}^*)^\theta} L_j^\alpha y_j^\gamma y_i^{1-\gamma} \frac{1}{\tilde{\psi}} \left[ \frac{1}{1 - 1/\tilde{\theta}} \left( \frac{\phi_{ij}^{(k)}}{\phi_{ij}^*} \right)^{\sigma-1-\theta} - \frac{1}{1 - 1/(\tilde{\theta}\tilde{\beta})} \left( \frac{\phi_{ij}^{(k)}}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}-\theta} \right].$$

The last expression delivers expressions (26), (27) in the main text with the use of (39) and setting  $i, j = F$ .

Regarding the estimation of  $\beta$  using the relationships derived above, an OLS regression of the natural logarithm of total sales in France on the natural logarithm of the number of firms selling to at least a given number of countries, yields a coefficient of 0.353 and constant of 13.42. This implies that  $\tilde{\theta}$  is around 1.546.

**Parameters determining total exports and number of exporters** The data on population are from the World Development Indicators of the World Bank. In the case of missing values I use data from Penn World Tables. Data on manufacturing absorption and share of French firms' sales in particular markets are taken from EKK04 (see their paper for details).

A regression of  $\ln \bar{M}_{Fj}$  on  $\ln \bar{\lambda}_{Fj}$ ,  $\ln \bar{w}_j$  and  $\ln \bar{L}_j$ , will result to the following coefficients (robust standard errors in parentheses, I suppress the constant since it is of no interest)

$$\ln \bar{M}_{Fj} = \underset{(.030)}{0.87} \ln \bar{\lambda}_{Fj} + \underset{(.028)}{0.52} \ln \bar{L}_j + \underset{(.025)}{0.67} \ln \bar{y}_j .$$

The  $R^2$  is 0.913 and the coefficients on  $\ln \bar{L}_j$ ,  $\ln \bar{y}_j$  are statistically significantly different from each other at the 1% level. The coefficient on  $\ln \bar{\lambda}_{Fj}$  is close to 1, consistent to what is reported by EKK04, but not exactly 1 as my theory would imply. Thus, to be able to extract coefficients that are consistent with the overall analysis based on my model, I used the ones obtained from the regression reported in the text (which are the coefficients of running the regression reported in this note but restricting the coefficient of  $\ln \bar{\lambda}_{Fj}$  to be 1).

## Appendix E: data description

**Trade by goods data** I use data from the OECD International Trade by Commodity database ([www.sourceoecd.org](http://www.sourceoecd.org)) on imports by good of US from Mexico.<sup>35</sup> The data are recorded using

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<sup>35</sup>A similar pattern to the one I report for the Mexico-US case emerges for the Canada-Mexico trade liberalization episode.

the Harmonized System (HS) 1988 revision (rev. 1) at the 6 digit level of detail and potentially can include up to 6873 different commodities (in the case of US imports from Mexico there is information for 5404 goods). Data on HS rev. 1 are available from 1990-2000. I only include data from 1990 to 1999 (10 years) due to inconsistency of the imports of US from Mexico reported by US and the exports of Mexico to US reported by Mexico, particularly for 2000 (note that the results do not change even if I include data for 2000). Also note that trade flows of the 6-digit level add up to aggregate trade flows from 1990-1995. From 1996, there is an average of 1%-2% of trade flows that are not recorded in the 6 digit trade flows. The reason is that the HS was revised in 1996 (rev. 2), and the data on trade flows from 1996 onward were initially reported according to the rev. 2 and then translated to the HS 1988 (rev. 1). In this reclassification, goods that could not be categorized back in rev. 1 were discarded. Even though some of the trade flows are missing at the 6-digit level, there is no observable persistent inconsistency that could lead to a mistaken interpretation of the data. Finally, I drop 2 categories of goods from my sample: special classification provisions (code 980100) and Intrastat estimation of missing declarations of chapter 99 (code 999900).

**Grouping the goods** First, I analyze in detail how I categorize the “previously traded” goods. I first look at the years 1990-92. I keep the goods being traded throughout all the years 1990-92. I group the goods that were traded in 1990-92 into ten categories, each with an equal number of goods. The categories include goods in increasing order of volume of trade during 1990-92 (e.g. category 1 contains the 10% least traded ones in 1990-92 while category 10 contains the 10% most traded goods). I compute the ratio of import sales of 1997-99 to 1990-92 for each category (essentially taking averages over 1990-92 and 1997-99). By considering only the goods that are traded throughout all years of 1990-92 I avoid including goods that are randomly or very rarely traded. With this adjustment I also avoid—to some extent—including new goods that tend to grow for some years after their introduction before reaching steady state levels and could create a bias towards higher growth of least traded goods. By allowing for goods that stopped being traded after 1992 to be in the sample I adjust towards selection of surviving only goods that would create higher growth rates for the least traded goods categories.

Related to the definition of “newly traded” goods, this definition is admittedly more favorable

towards a higher importance of new goods in the event of a trade liberalization. On the other hand, the use of the dataset that provides information on goods rather than firms can create aggregation bias which will work against the importance of newly traded goods. Because of the unavailability of firm level data on trade liberalization episodes, data on goods in very fine categories of disaggregation, as the ones I use, is the best available substitute.

**Mapping the model to the data** In order to map the model to the data, I use the assumption of the theory that each good is produced by one firm. In the model I am considering the empirical counterpart of the relationship I computed in the data and thus, I map each one of the 10 categories of the goods to 10% of the firms in an increasing order of volume of trade and productivity correspondingly. In particular, I consider the total sales of firms selling the goods that corresponds to each category. In fact, since I keep track of the same number of goods throughout time, I only have to compute the average sales of goods for each category. For the period before liberalization, average sales of each category in the model are given by

$$T_{ij}^{(k)} = L_j^\alpha (y_j)^\gamma (y_i)^{1-\gamma} \frac{1}{\tilde{\psi}} \int_{\phi_i}^{\phi_{i+1}} \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1} - \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \right] \frac{\theta \phi_i^\theta}{\phi^{\theta+1}} d\phi \implies$$

$$T_{ij}^{(k)} = L_j^\alpha (y_j)^\gamma (y_i)^{1-\gamma} \frac{1}{\tilde{\psi}} \left[ \begin{aligned} & \left( \frac{\phi_{i+1}}{\phi_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta-1} \frac{\phi_i^\theta}{\phi_{i+1}^\theta} - \left( \frac{\phi_{i+1}}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \frac{1}{1/(\tilde{\theta}\tilde{\beta})-1} \frac{\phi_i^\theta}{\phi_{i+1}^\theta} \\ & - \left( \frac{\phi_i}{\phi_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta-1} + \left( \frac{\phi_i}{\phi_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \frac{1}{1/(\tilde{\theta}\tilde{\beta})-1} \end{aligned} \right],$$

where  $\phi_i, \phi_{i+1}$  is the threshold productivity corresponding to each percentile of firms and this is determined through the expression (38). Similarly, for the period after the liberalization (abusing notation for the rest of this appendix, I denote with a  $\tilde{\cdot}$  the ex-post variables),

$$\tilde{L}_j^\alpha (\tilde{y}_j)^\gamma (\tilde{y}_i)^{1-\gamma} \frac{1}{\tilde{\psi}} \left[ \begin{aligned} & \left( \frac{\phi_{ij}^* \phi_{i+1}}{\tilde{\phi}_{ij}^* \tilde{\phi}_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta-1} \frac{\phi_i^\theta}{\phi_{i+1}^\theta} - \left( \frac{\phi_{ij}^* \phi_{i+1}}{\tilde{\phi}_{ij}^* \tilde{\phi}_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \frac{1}{1/(\tilde{\theta}\tilde{\beta})-1} \frac{\phi_i^\theta}{\phi_{i+1}^\theta} \\ & - \left( \frac{\phi_{ij}^* \phi_i}{\tilde{\phi}_{ij}^* \tilde{\phi}_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta-1} + \left( \frac{\phi_{ij}^* \phi_i}{\tilde{\phi}_{ij}^* \tilde{\phi}_{ij}^*} \right)^{(\sigma-1)/\tilde{\beta}} \frac{1}{1/(\tilde{\theta}\tilde{\beta})-1} \end{aligned} \right].$$

In order to determine the ratio of average sales between the two periods I have to compute the ratios  $\frac{\phi_{ij}^*}{\tilde{\phi}_{ij}^*}, \frac{\tilde{L}_j^\alpha (\tilde{y}_j)^\gamma (\tilde{y}_i)^{1-\gamma}}{L_j^\alpha (y_j)^\gamma (y_i)^{1-\gamma}}$ . For the ratio  $\frac{\phi_{ij}^*}{\tilde{\phi}_{ij}^*}$  I use the following expression of  $\phi_{ij}^*$  in terms of  $y_i$ ,

$y_j, L_j,$

$$(\phi_{ij}^*)^\theta = \frac{J_i b_i^\theta y_i^{1-\gamma} \left( \frac{1}{1-1/\theta} - \frac{1}{1-1/(\theta\beta)} \right)}{\lambda_{ij} L_j^{1-\alpha} y_j^{1-\gamma} \tilde{\psi}} .$$

Using the assumption that there is no change in  $J_i, b_i$ ,<sup>36</sup>

$$\frac{\phi_{ij}^*}{\tilde{\phi}_{ij}^*} = \left( \frac{\tilde{\lambda}_{ij} (y_i)^{1-\gamma} \tilde{L}_j^{1-\alpha} (\tilde{y}_j)^{1-\gamma}}{\lambda_{ij} (\tilde{y}_i)^{1-\gamma} L_j^{1-\alpha} (y_j)^{1-\gamma}} \right)^{1/\theta} .$$

Therefore, the only required information to determine the yet undetermined ratios  $\frac{\phi_{ij}^*}{\tilde{\phi}_{ij}^*}, \frac{\tilde{L}_j^\alpha (\tilde{y}_j)^\gamma (\tilde{y}_i)^{1-\gamma}}{L_j^\alpha (y_j)^\gamma (y_i)^{1-\gamma}}$  is  $\lambda_{ij}, L_j, y_j$ . I describe how I construct these ratios in the next paragraph.

For the particular calibration exercise that I perform,  $i$  corresponds to Mexico ( $M$ ) and  $j$  to the US ( $U$ ). Data on  $L_M, L_U$  are from World Development Indicators. To obtain  $y_M, W_U$ , I use data on manufacturing absorption obtained from the OECD STAN database for the years 1990-92 and 1997-99 and divide these data by the population of each country. Manufacturing absorption is calculated as gross output minus exports plus imports. I use data for the sectors that appear in the OECD trade by commodity data, namely i) agriculture, hunting, forestry and fishing ii) mining and quarrying iii) total manufacturing and iv) electricity, gas and water supply. Notice that for 1990 the database does not provide data on exports and imports for US for sectors i),ii) and iv). I choose to consider averages over 1991-92 and 1998-99 for the manufacturing absorption of US instead of using exports and imports from another source (–in fact the trade sectors i),ii) and iv) is less than 1/10 of the one of sector iii) and influences the result to a minimal degree–). I finally pick the ratio  $\tilde{\lambda}_{MU}/\lambda_{MU}$  so that I generate the overall increase in trade among goods traded during 1990-92. This corresponds (all else equal) in a change of the variable trade cost by around 9.5% for the model with  $\beta = 1$  and around 12.5 for the model with  $\beta = 0$  (see equation 28).

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<sup>36</sup>Extending to the case where  $J_i, b_i$  change would deliver the same results (but complicate notation).



	“Newly non-traded”	“Newly traded”		“Previously Traded” by category									
		1	2	1	2	3	4	5	6	7	8	9	10
Share of '90-'92 trade	.13	.85	.12	.01	.05	.11	.23	.45	.86	1.78	3.52	7.64	84.28
Share of '97-'99 trade	.00	3.46	.30	.17	.28	.86	.64	1.68	1.67	2.31	7.23	9.26	72.13
Share of new trade	-	4.84	.38	.26	.40	1.25	.86	2.33	2.10	2.58	9.17	10.11	65.71

Table 1: Percentage trade shares of “newly nontraded,” “newly traded,” and “previously traded” goods

	Share of '90-'92 “previously traded” goods trade	Share of '97-'99 “previously traded” goods trade
US imports from Mex (6 digit HS) (%)	15.0	25.1
Endogenous cost model ( $\beta = 1$ )	15.0	24.9
Fixed cost model ( $\beta = 0$ )	15.0	15.0

Table 2: Percentage trade share of the goods that constitute the 15 % Least Traded “Previously Traded” goods in 1990-92

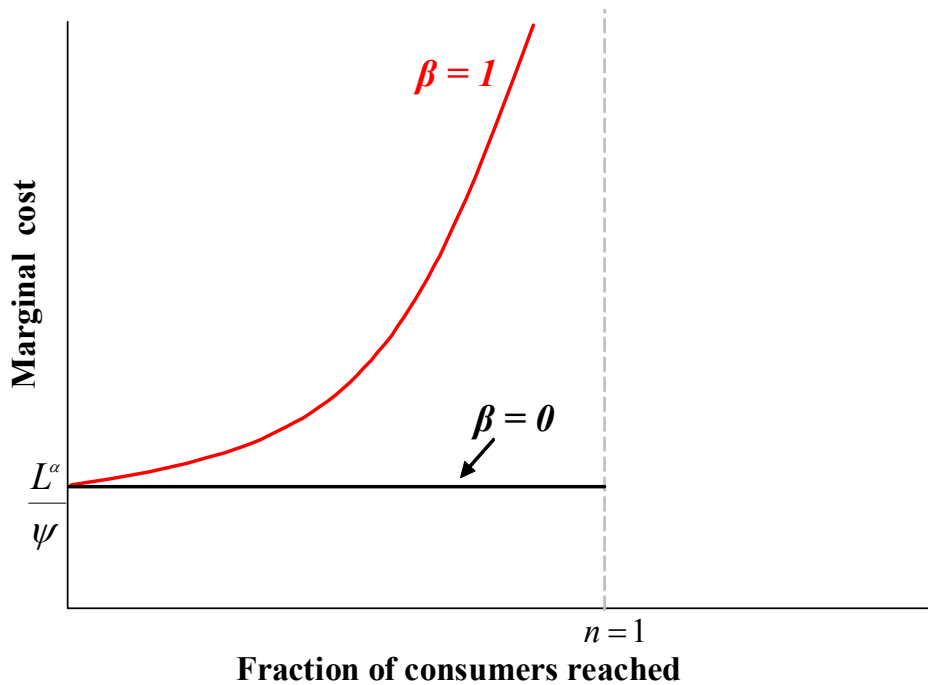


Figure 1: Marginal cost to reach additional consumers under different  $\beta$ 's

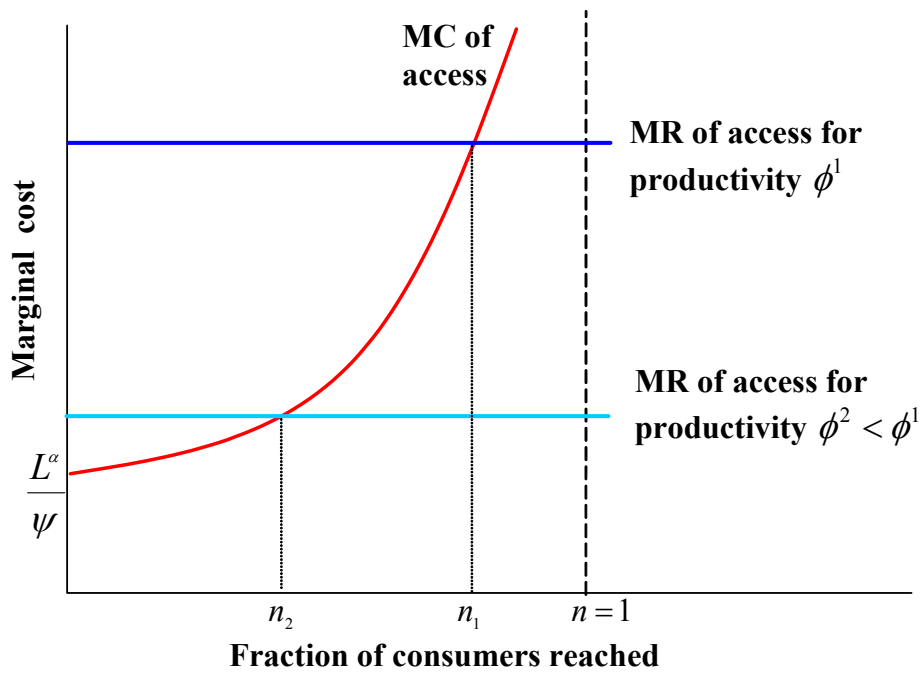


Figure 2: Productivity and market access

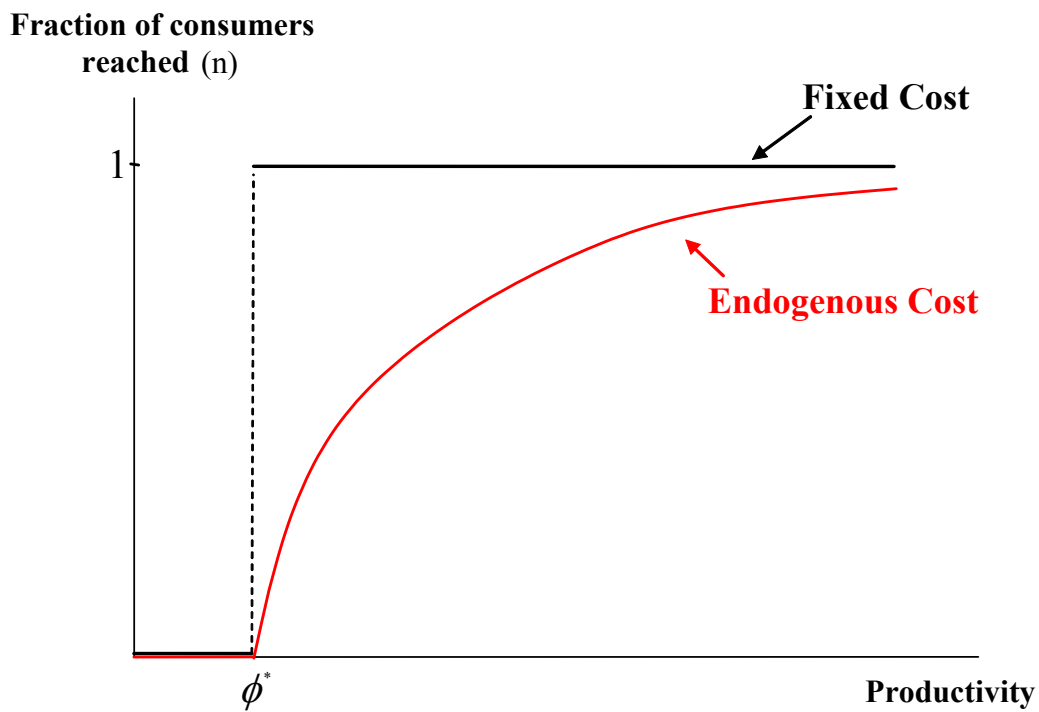


Figure 3: Fraction of consumers reached and productivity

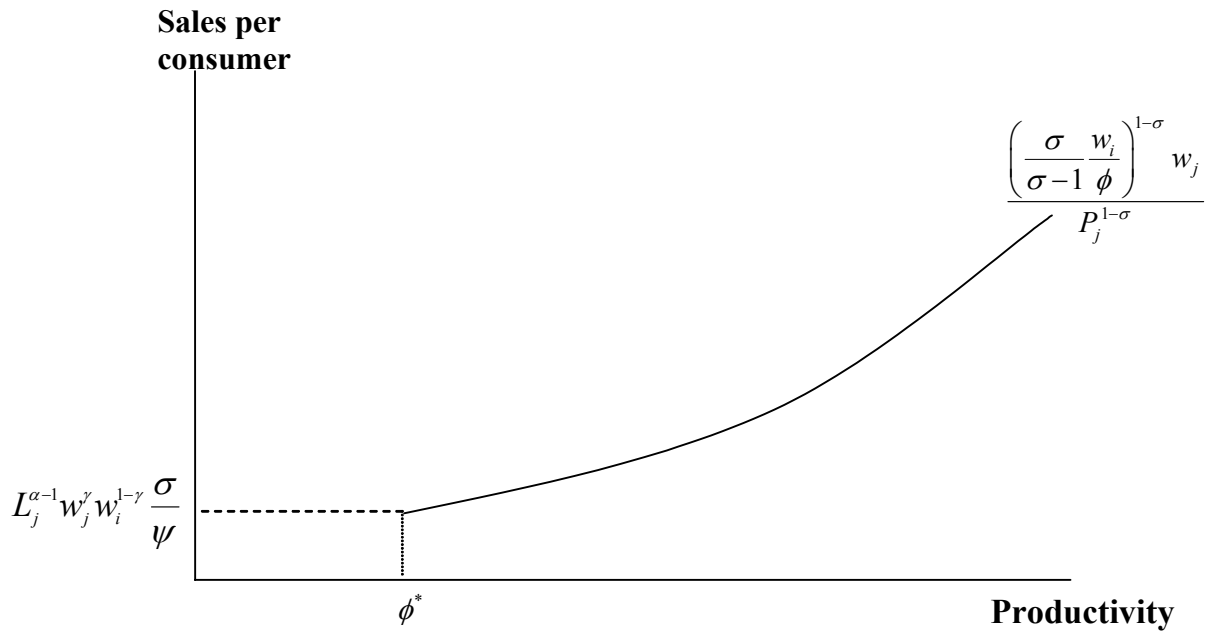


Figure 4: Intensive margin of sales and productivity

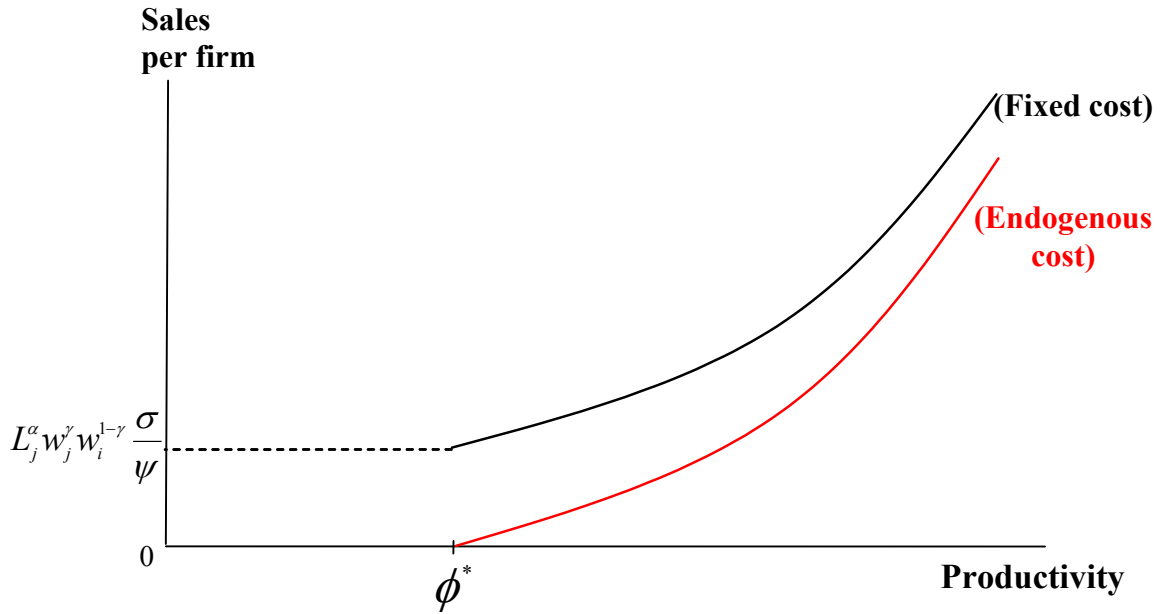


Figure 5: Sales per firm as a function of productivity in the two models

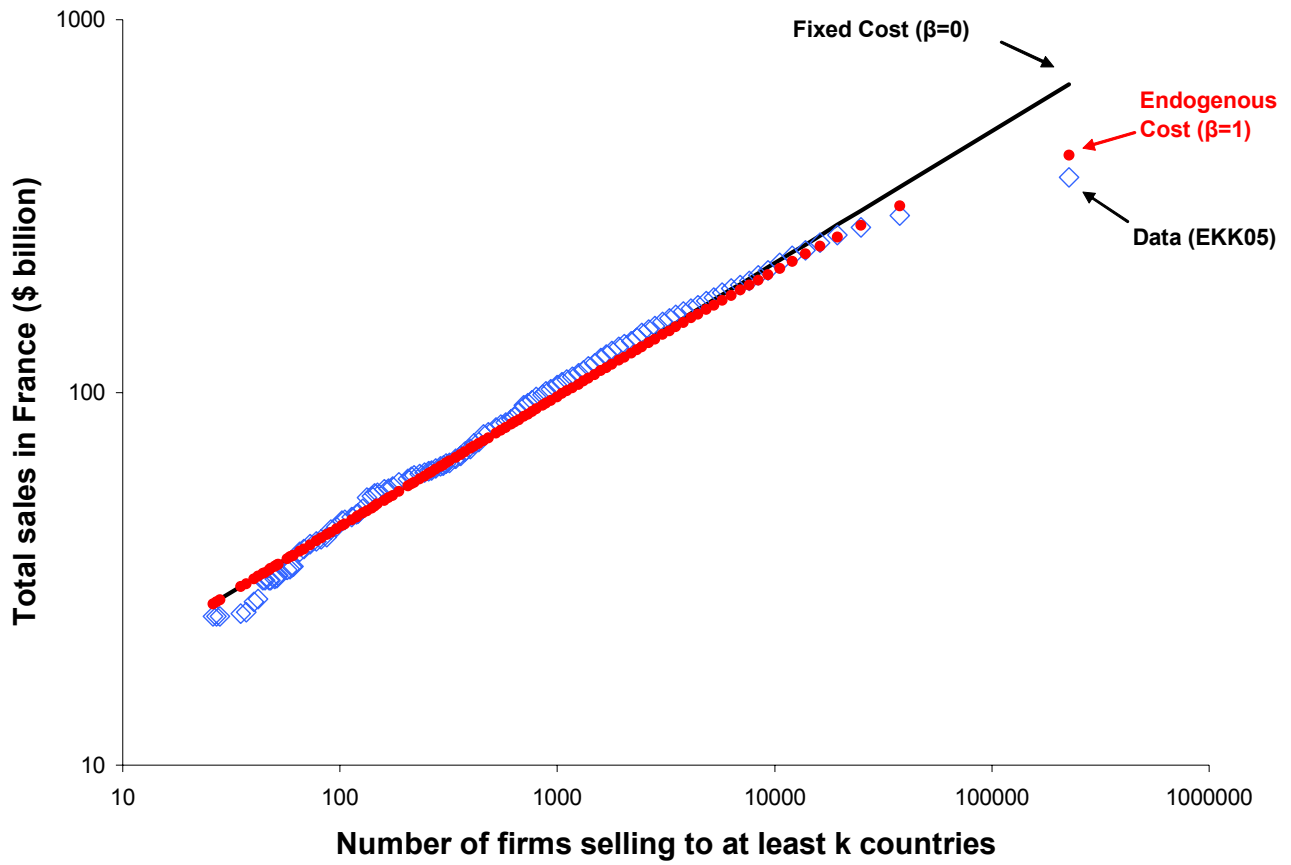


Figure 6: Total sales in France and number of firms selling to at least  $k$  countries

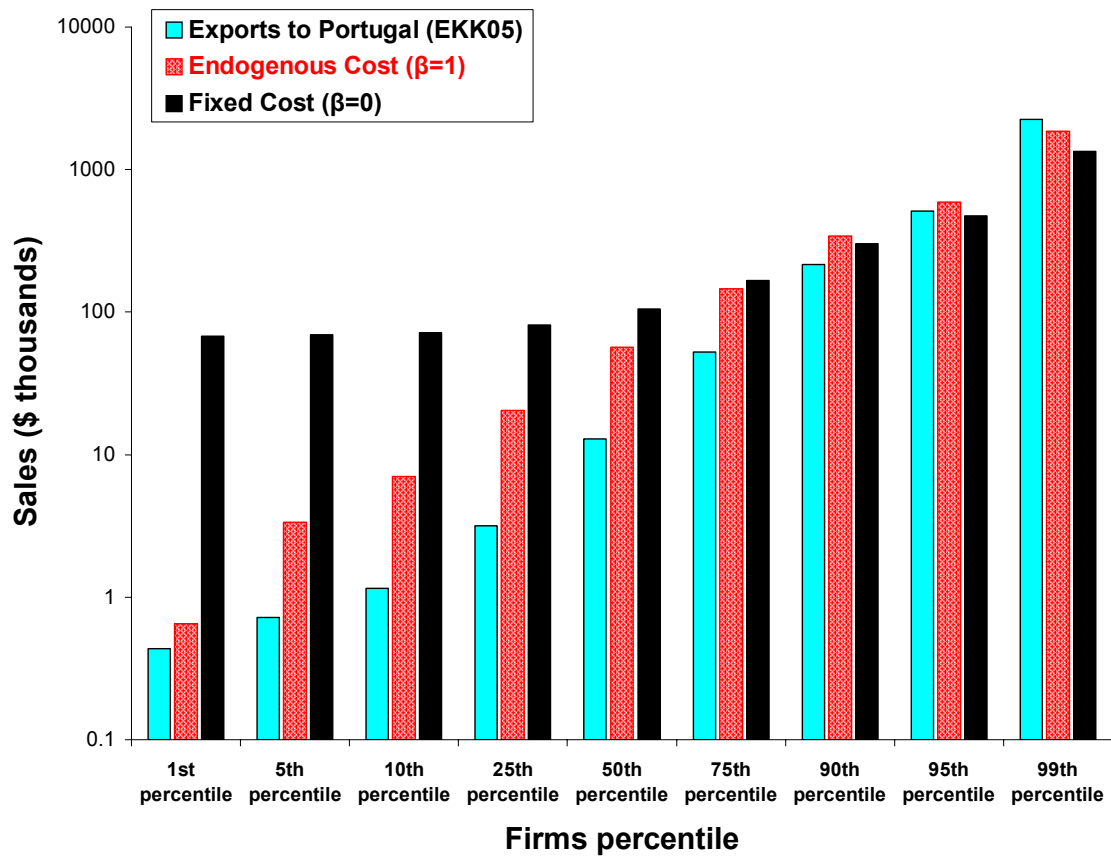


Figure 7: Predicted and actual distribution of export sales of French firms to Portugal

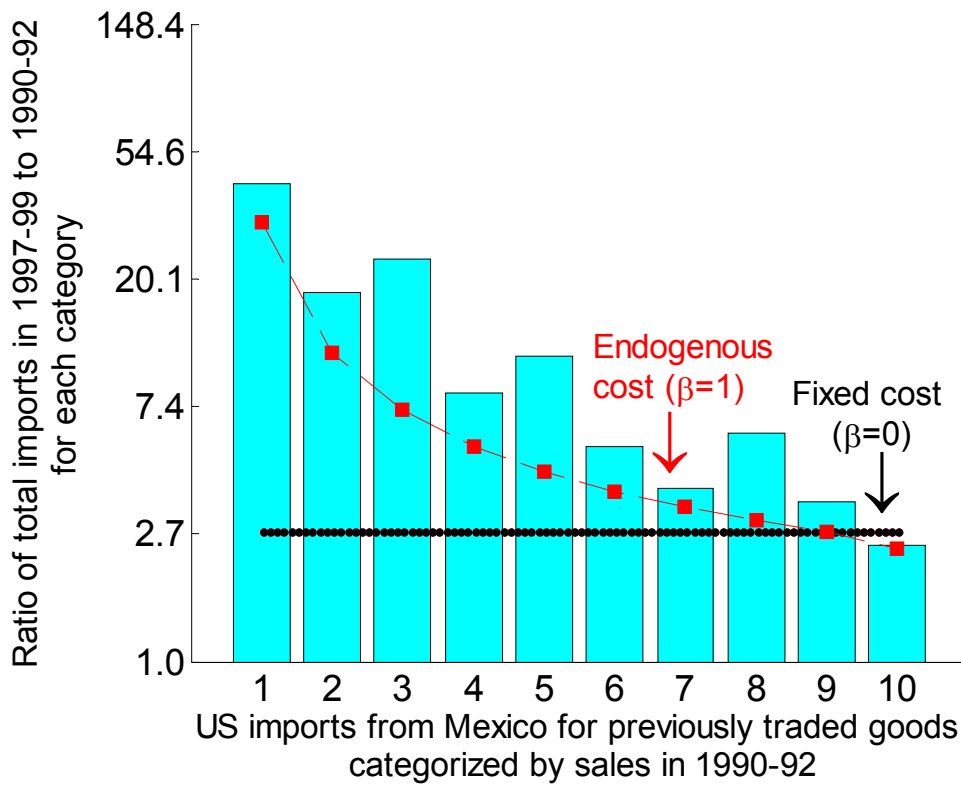


Figure 8: Predicted and actual ratio of US imports from Mexico in '97-99 to '90-92 for each category of goods.

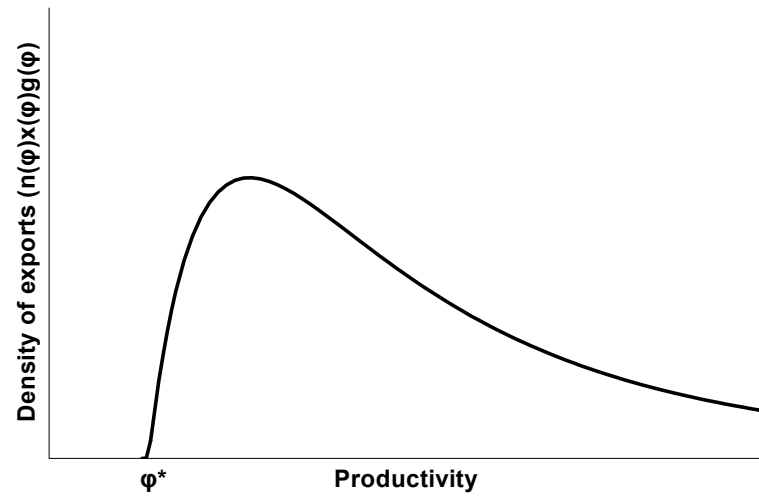
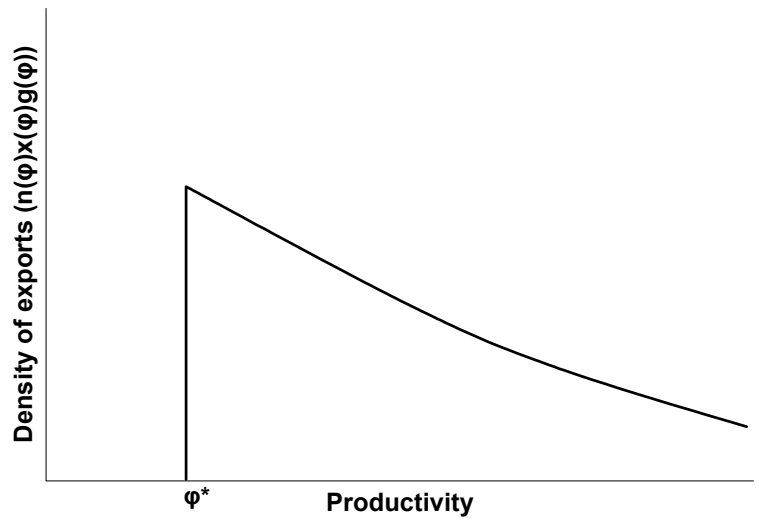


Figure 9: Density of exports in the fixed cost and the endogenous cost models

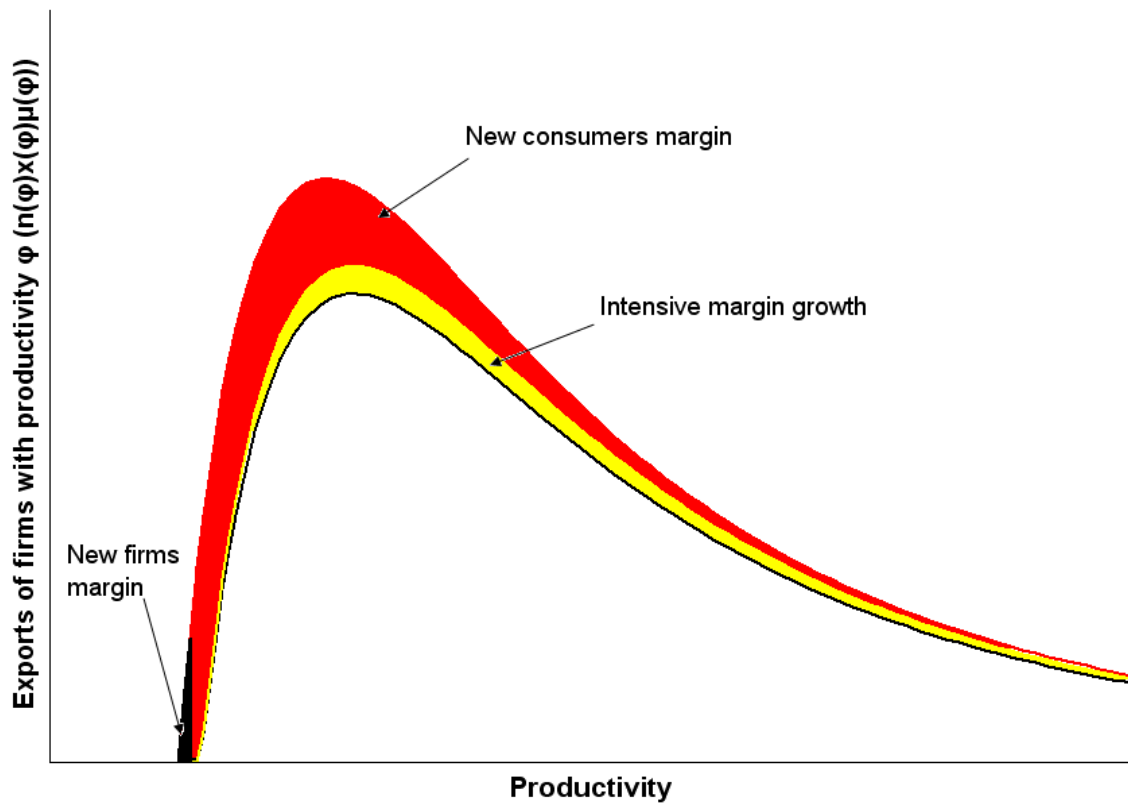


Figure 10: Trade liberalization and the margins of trade