

# Market Penetration Costs and the New Consumers Margin in International Trade

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This paper develops a novel theory of marketing costs within a trade model with product differentiation and heterogeneity in firm productivities. A firm enters a market if it is profitable to incur the marginal cost to reach a single consumer. It then faces an increasing marginal penetration cost to access additional consumers. The model, therefore, can reconcile the observed positive relationship between entry and market size with the existence of many small exporters in each exporting market. Comparative statics of trade liberalization predict a large increase in trade for goods with positive but low volumes of previous trade.

## I. Introduction

A recent literature has exploited firm- and plant-level data to uncover a set of stylized facts for exporters. At this level of analysis, the monop-

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, Francis Kramarz, and Marc Muendler for providing me with statistics from their data. For their suggestions and comments, I would also like to thank George Alessandria, Marios Angeletos, Ariel Burstein, Thomas Chaney, V. V. Chari, Arnaud Costinot, John Dalton, Thomas Holmes, Christos Ioannou, Patrick Kehoe, Erzo G. J. Luttmer, Giovanni Maggi, Ellen McGrattan, Marc Melitz, Marc Muendler, Fabrizio Perri, Edward C. Prescott, Ananth Ramanarayanan, Andres Rodríguez-Clare, James Schmitz, Robert Shimer, Ina Simonovska, Rachel Stampfli, Farid Toubal, and various seminar participants. Treb Allen and Olga Timoshenko provided excellent research assistance. The comments of two editors and two referees substantially improved the paper. Financial support from the Heller Dissertation Fellowship is gratefully acknowledged. The views expressed herein are those of the author and not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System. All remaining errors are mine.

*[Journal of Political Economy, 2010, vol. 118, no. 6]*

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olistic competition model with product differentiation, Dixit-Stiglitz demand, and Pareto distribution of productivities has arisen as an extremely useful quantitative tool. The assumption of a market-specific fixed entry cost allows this model to explain the fact reported by Eaton, Kortum, and Kramarz (2004) that the number of exporters systematically increases with market size.<sup>1</sup> Nevertheless, the nature of these entry costs remains largely unexplained, and the model predictions are at odds with the data in some key dimensions, such as the size and growth of exporters to individual destinations.

This paper provides formal foundations for these entry costs. The basic idea put forward is that firms reach individual consumers rather than the market in its entirety. Paying higher costs allows firms to reach an increasing number of consumers in a country. Yet, once a consumer is reached, the costs remain fixed with respect to the amount sold per consumer. I formulate these market penetration costs as marketing costs that consist of two main elements. The cost to reach a certain number of consumers in a market decreases with the population size of the market. This assumption is supported by evidence that I have collected on the cost of advertising in markets with different populations. Moreover, I assume that, within a given market, the marginal cost of marketing increases with the number of consumers reached. This assumption is in line with evidence on the decreasing returns to scale of advertising spending within a market.

The model provides a generalization of the constant elasticity of substitution (CES) demand model of Melitz (2003) and Chaney (2008). In particular, with constant marginal costs to reach additional consumers it is observationally equivalent to the Melitz-Chaney framework. Moreover, I show that with increasing marginal costs it has two key implications for international trade.

First, the model can reconcile the robust positive association between firm entry and market size with the existence of many small exporters in each exporting destination reported by Eaton, Kortum, and Kramarz (2010). The uniform fixed-cost model requires large fixed costs to explain firm entry patterns, which contradicts the existence of many small exporters. The new model reconciles these two facts owing to its distinct implications of marketing costs for firm entry and sales patterns. On the one hand, in larger markets the cost to reach the very first consumer is lower because of returns to scale of marketing with respect to population size. Thus, whereas more firms enter into markets with larger population size, the per-consumer marketing cost excludes firms with very low productivity from an individual export market if their per-

<sup>1</sup> Hummels and Klenow (2005) report related findings for the number of exported goods.

consumer revenue is not sufficient to cover the cost to reach the very first consumer there. Assuming also that marketing costs are partially incurred in the destination country, this model explains the relationship between the number of entrants and the overall size of the exporting markets. On the other hand, because of the increasing cost to reach additional consumers, 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.

Second, the model predicts that firms/goods with low volumes of trade prior to a trade liberalization episode grow more when trade costs decline. Since the CES model implies a uniform elasticity of substitution between goods, it predicts equal growth rates of trade for all previously traded goods. In my framework, I assume that the number of consumers reached with each additional marketing effort becomes smaller at some geometric rate. This assumption allows for an increasing convexity of the marginal cost function to reach additional consumers. In turn, the increasing convexity implies that the elasticity of sales with respect to variable trade costs declines with firm size in a market and asymptotically tends to the CES demand elasticity for the largest firms.

To test this prediction, I use data on disaggregated product categories for the United States–Mexico North American Free Trade Agreement (NAFTA) liberalization episode in the 1990s. I extend the methodology of Kehoe and Ruhl (2003) to data on goods that were positively traded before the liberalization. Consistent with the theory, I find that the growth rate of the volume of trade is larger the lower the initial sales of goods.

To quantitatively assess the model, I assume that the productivities of firms are Pareto distributed and calibrate its parameters to match data on French firms from Eaton et al. (2004, 2010). In particular, the parameters that relate entry costs to market size are chosen to match the average sales of French firms in each exporting market. The parameters that determine the relative sales of different firms are calibrated to match the average sales advantage in France and the median export intensity for firms that are able to penetrate less popular destinations relative to other firms. The calibrated model with endogenous market penetration costs is able to quantitatively generate a number of key facts in international trade theory.

First, I look at the sales distribution to a given market. In both the model and the data, the sales of firms that sell large amounts to that market are Pareto distributed whereas the sales of firms that sell small amounts exhibit large deviations from that distribution. As a result, the calibrated model quantitatively accounts for the small amounts exported by a large proportion of the French firms in each market, but it still predicts that most French firms do not export.

I also perform a comparative statics analysis of trade liberalization. I use the 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 United States–Mexico liberalization episode. The model quantitatively captures the higher growth rate in trade for goods with positive but little previous trade. Thus, it offers a resolution to the critique of Kehoe (2005) of models with CES demand regarding their predictions of trade patterns in the case of the NAFTA episode. Kehoe points out the inability of the CES models to predict the high growth rates of sales, especially for goods with little trade prior to the trade liberalization.

Finally, I study a new margin of response of aggregate trade flows to decreases in trade costs. This “new consumers” margin is meant to capture the higher growth rate of small existing exporters after a trade liberalization. In particular, I decompose “new trade” into three margins: the new consumers margin; the “intensive margin” of growth in per-consumer sales, emphasized by Anderson (1979) and Krugman (1980); and the “new firms”—new goods—margin, analyzed by Eaton and Kortum (2002), Melitz (2003), and Chaney (2008). In the model, 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. Consistent with this prediction, I find that in the United States–Mexico NAFTA episode, goods with little previous trade had a significant impact on new trade but the contribution of new goods was small.

Eaton et al. (2010) find that in order to account for a variety of recently uncovered exporting facts, the export costs have to take the form of both variable costs, which rise in proportion to the amount shipped, and fixed marketing costs as in Melitz (2003) and Chaney (2008).<sup>2</sup> The modeling of marketing costs that I propose generates a demand system that departs from the CES demand specification, with constant marginal costs of production, while retaining the desirable properties of the Melitz-Chaney framework at the aggregate level. In essence, this modeling of marketing costs is a metaphor of market penetration costs as CES demand is for variety-loving preferences or productivity is a stylized description of things that allow firms to sell more. In turn, the new model substantially improves the quantitative predic-

<sup>2</sup> See, e.g., Bernard and Jensen (1995), Clerides, Lach, and Tybout (1998), Aw, Chung, and Roberts (2000), and Tybout (2001) for a review.

tions on the size and growth of exporters of the Melitz-Chaney framework.

The rest of the paper is organized as follows. In Section II, I describe the model and the new formulation of marketing costs. In Section III, I discuss the theoretical predictions of the model and relate them to stylized facts on firm entry and sales. In Sections IV and V, I calibrate the model, assess its quantitative predictions, and perform counterfactual exercises. Section VI presents conclusions.

## II. Model

The model is based on the monopolistic competition framework proposed by Melitz (2003) and augmented by Chaney (2008). Goods are differentiated, and each good is produced by a firm. Firms are heterogeneous in their productivity and use a constant returns to scale production technology. The main departure from the previous literature is that firms incur marketing costs to reach individual consumers in each country. I start with a description of these costs and then incorporate them into the monopolistic competition framework.

### A. *A Theory of Marketing Costs and the Market Penetration Technology*

Marketing costs are incurred by a firm during the process of promoting its product, identifying and reaching consumers, and establishing the related distribution channels.<sup>3</sup> All these costs are incurred in both the domestic and the exporting markets. Estimates of marketing costs (reviewed in App. A) indicate that the amount of marketing spending in a certain market is 4–5 percent of GDP or even as high as 7.7 percent when broader definitions of marketing are used.

Starting from first principles, I derive a marketing technology that is a generalization of a simple theory of informative advertisement by Butters (1977) and Grossman and Shapiro (1984). Independently of other firms, each firm uses this technology to send advertisements (ads) to consumers. Each ad is essentially a posting that contains information about the presence of a good in a market and its price. Consumers are aware of the good only if they observe the ad. Denote by  $S$  the number of ads sent by a firm and by  $L$  the number of consumers, where both  $S$  and  $L$  are continuous variables. The term  $n(S)$  is the probability that a particular consumer sees the ad at least once after  $S$  ads have been sent, where  $n(0) = 0$ . The variable  $S$  will be endogenously chosen by each firm in the optimization problem that I will set up later on. For

<sup>3</sup> Evidence about these activities for the case of exporting is provided by Keesing (1983) and Roberts and Tybout (1997).

convenience, I formulate that problem and the marketing technology below in terms of the probability  $n(S)$ .

Three simple assumptions are made for the specification of the marketing technology. The first assumption allows for the possibility that the marketing technology exhibits increasing returns to scale with respect to the population size of the market.

**ASSUMPTION 1.** The number of consumers who see each ad is given by  $L^{1-\alpha}$ ,  $\alpha \in [0, 1]$ .

Intuitively, the case  $\alpha = 1$  corresponds to the example of advertising with flyers, where each flyer is read by one consumer. To reach a given number of consumers, the total number of ads that a firm has to send is independent of the size of the market. The case  $\alpha = 0$  can be described with the example of television ads, which reach a given fraction of consumers in any given market. In this case, a firm can reach twice the number of consumers in a country that is twice as large using the same number of ads.

Evidence suggests that returns to scale are present in the operation of advertising media, such as television, newspapers, and radio (Mathewson 1972). Thus, the cost to reach a certain number of consumers can be lower in markets with a larger population. To provide support for assumption 1, I also collected evidence regarding the effective cost of reaching 1,000 consumers, the so-called CPM. The CPM is typically constructed by dividing the cost of ads by a measure of their viewership and multiplying by 1,000. The evidence was collected for television, newspapers, and radio advertising across different regions or countries and is summarized in Appendix A. The main finding is that the CPM is systematically lower in markets with a larger population size, even accounting for income per capita of the market.<sup>4</sup> The coefficients estimated indicate that CPM drops with an elasticity around .10–.65 with respect to the population size of the market. The magnitude of this negative relationship corresponds, in the theory, to an  $\alpha$  that lies approximately in the range of .35–.90.

The second assumption states that within a given market, the cost per consumer may differ depending on how many consumers have already been reached.

**ASSUMPTION 2.** The probability that a new ad is seen by a consumer for the first time is given by  $[1 - n(S)]^\beta$ ,  $\beta \in [0, +\infty)$ .

Assumption 2 captures the idea that initial search efforts use the most efficient marketing methods, but as marketing expenditures increase, efficiency declines. Notice that higher values of  $\beta$  correspond to more

<sup>4</sup> To the best of my knowledge, a comprehensive analysis of the effects of population on CPM has not been performed. Some evidence suggests that CPM drops with the population for individual media; see, e.g., the correlations reported in table 2 in Campbell and Hopenhayn (2005).

intense diminishing returns. Mostly by using advertising data, previous literature has provided ample evidence that supports this assumption. For instance, Bagwell (2007) reviews the literature on the economics of advertising and concludes that most of the studies find that advertising's effectiveness is subject to diminishing returns.<sup>5</sup>

Under assumptions 1 and 2, the marginal change in the number of consumers reached through new ads,  $n'(S)L$ , is

$$n'(S)L = L^{1-\alpha}[1 - n(S)]^\beta. \quad (1)$$

Solving this differential equation subject to the initial condition  $n(0) = 0$  implies that

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

Inverting the last expression and solving for  $S$  gives the amount of advertising required by a firm aiming to reach a fraction  $n$  of consumers in a market of size  $L$ . Assuming that the labor requirement for each ad is  $1/\psi$ , the amount of labor required to reach these consumers becomes

$$f(n, L) = \begin{cases} \frac{L^\alpha}{\psi} \frac{1 - (1 - n)^{1-\beta}}{1 - \beta} & \text{if } \beta \in [0, 1) \cup (1, +\infty) \\ \frac{L^\alpha}{\psi} \log(1 - n) & \text{if } \beta = 1. \end{cases} \quad (2)$$

The function is always zero at  $n = 0$ .<sup>6</sup>

For  $\beta > 0$  the crucial properties of this function are as follows:

$$f_1(n, L) > 0 \quad \forall n \in [0, 1], \quad (P1)$$

$$f_{11}(n, L) > 0 \quad \forall n \in [0, 1], \quad (P2)$$

$$\lim_{n \rightarrow 1} f_1(n, L) = \infty. \quad (P3)$$

To provide an insight into what these properties entail, notice that P1 implies that the marginal cost to penetrate any fraction of consumers in the market, even the very first ones, is positive. In turn, P1 implies that only those firms that generate enough revenue will enter a market.

<sup>5</sup> Simon and Arndt (1980), Sutton (1991, 51), and Jones (1995) share a similar view. For a discussion on diminishing returns to marketing expenditures, see Saunders (1987).

<sup>6</sup> Diminishing returns can also be modeled by assuming a concave production function for advertisements as in Stigler (1961) and Dinlersoz and Yorukoglu (2008). Bagwell (2007, 1734) points out that "advertising often entails diminishing returns beyond a threshold level, where the threshold level varies across circumstances and may be small." Interpreting this statement within my model would suggest adding an extra fixed cost of entry in the proposed specification. A fixed cost that is small in magnitude will not affect my results. Assuming that this fixed cost is substantial is in contrast to the existence of many small French exporters in the data.

Additionally, given P2, conditional on entering a market, firms with varying levels of revenues will make different marketing decisions. Finally, P3 implies that no firm can saturate the market,  $n = 1$ , since the marketing cost will be prohibitively high.

The case of  $\beta \rightarrow 1$  and  $\alpha = 1$  is of special interest. This case corresponds to the example in which flyers are randomly thrown to consumers. The probability that a consumer is reached is simply  $n(S) = 1 - \exp(-S/L)$ . The cost function (2) with  $\beta \rightarrow 1$  and  $\alpha = 1$  results by inverting this function.<sup>7</sup> Another interesting case is when  $\beta = 0$  and the costs to reach additional consumers remain constant. I prove later on that, in this case, the problem of the firm in my model corresponds to that of the fixed-cost model of Melitz (2003). Thus, the theory of entry costs proposed in this study is a generalization of the fixed-cost structure considered by the previous literature.

The third assumption implies that firms originating from different markets may pay different marketing costs for the same number of consumers reached in a given market.

**ASSUMPTION 3.** The production of marketing requires a Cobb-Douglas bundle of labor services from source country  $i$ ,  $l_i$ , and destination country  $j$ ,  $l_j$ . Formally,

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

Sanford and Maddox (1999) provide evidence that exporters use foreign advertising agencies, and Leonidou, Katsikeas, and Samiee (2002) review some direct evidence of the use of domestic labor for foreign advertising. For simplicity, I assume that  $\gamma$  is the same across countries. Empirically, this will not turn out to be a bad approximation. When assumption 3 is combined with expression (2), the total marketing cost for a firm from  $i$  reaching consumers with probability  $n$  in a country with population size  $L_j$  can be written as  $w_j^{\gamma} w_i^{1-\gamma} f(n, L_j)$ , where  $w_i$  denotes the wage rate of country  $i$ .<sup>8</sup>

### B. Consumer Demand

I denote the source country by  $i$  and the destination country by  $j$ , where  $i, j = 1, \dots, N$ . Country  $j$  is populated by a continuum of consumers of measure  $L_j$ . Each consumer  $l \in [0, L_j]$  has access to a potentially different set of goods  $\Omega_j^l$ . In each source country  $i$ , there is a continuum of firms of measure  $J_i$  that ex ante differ only in their productivity level,

<sup>7</sup> This is essentially the seminal case explored by Butters (1977) and Grossman and Shapiro (1984). It can also be thought of as a discrete “urn-ball” example, where urns are the mailboxes of the consumers and flyers are the balls that are assigned to the urn with equal probability.

<sup>8</sup> I redefine per-unit advertisement costs  $1/\psi$  to incorporate an extra term  $\gamma'(1 - \gamma)^{1-\gamma}$ .



$\phi$ . I consider a symmetric equilibrium in which all firms of type  $\phi$  from country  $i$  choose to charge the same price in  $j$ ,  $p_{ij}(\phi)$ , and also reach consumers there with a certain probability,  $n_{ij}(\phi) \in [0, 1]$ . The existence of a large number of firms implies that every consumer from country  $j$  faces the same distribution of prices for goods of different types. The existence of a large number of consumers in country  $j$  implies that the fraction of consumers reached by a firm of type  $\phi$  from  $i$  is  $n_{ij}(\phi)$  and the total measure of consumers reached is  $n_{ij}(\phi)L_j$ .<sup>9</sup>

Each consumer from country  $j$  consumes a composite good that is made by combining a continuum of differentiated commodities according to a CES aggregator with elasticity  $\sigma > 1$ . The consumer earns labor income,  $w_j$ , by selling her unit labor endowment in the labor market and earns profits,  $\pi_j$ , from the ownership of domestic firms. These assumptions result in the demand for each individual variety (conditional on buying it):

$$c_{ij}(\phi) = \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}} y_j, \quad (3)$$

where  $y_j = w_j + \pi_j$  and

$$P_j^{1-\sigma} = \sum_{v=1}^N J_v \int_0^{+\infty} p_{vj}(\phi)^{1-\sigma} n_{vj}(\phi) g_v(\phi) d\phi, \quad (4)$$

with  $g_i(\phi)$  being the probability density of productivities of firms in  $i$ .<sup>10</sup> The previous results imply that the total effective demand in country  $j$  for a firm of type  $\phi$  from  $i$  is

$$q_{ij}(\phi) = n_{ij}(\phi) L_j \frac{p_{ij}(\phi)^{-\sigma}}{P_j^{1-\sigma}} y_j. \quad (5)$$

### C. Firm Problem

Firms use a constant returns to scale production technology with productivity  $\phi$ . Labor is the only factor of production. I make the standard iceberg cost assumption that delivering one unit of a good from  $i$  to destination  $j$  requires  $\tau_{ij} > 1$  units of the good to be produced and

<sup>9</sup> This statement is essentially an implication of the Glivenko-Cantelli theorem, which is a direct application of the law of large numbers (LLN) for independent and identically distributed (i.i.d.) random variables. In order to apply the LLN, I assume that firms reach consumers independently of each other. When applying the LLN to the case of a continuum of i.i.d. random variables, technical problems may arise (see, e.g., the discussion in Hopenhayn [1992]). Various remedies have been suggested by different authors (see, e.g., 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 proof is a highly technical issue beyond the scope of this paper.

<sup>10</sup> As I will show later,  $n_{ij}(\phi) = 0$  endogenously for some productivities  $\phi$ , limiting the types of varieties available to a consumer.

shipped. Without loss of generality, I assume that  $\tau_{ii} = 1$ .<sup>11</sup> Conditional on entering market  $j$ , a firm  $\phi$  that chooses the price,  $p$ , and the fraction of consumers to be reached,  $n$ , earns profits

$$\pi_{ij}(p, n; \phi) = nL_j y_j \frac{p^{1-\sigma}}{P_j^{1-\sigma}} - nL_j y_j \frac{p^{-\sigma} \tau_{ij} w_i}{P_j^{1-\sigma} \phi} - w_j^\gamma w_i^{1-\gamma} \frac{L_j^\alpha}{\psi} \frac{1 - (1-n)^{1-\beta}}{1-\beta}. \quad (6)$$

Total profits of a firm are given by the sum of the profits from its sales in all the  $j = 1, \dots, N$  countries (or a subset thereof). I now turn to characterize the profit maximization choices of the firm.

*Firm optimization.*—The optimal pricing decision of the firm is given by

$$p_{ij}(\phi) = \tilde{\sigma} \frac{\tau_{ij} w_i}{\phi}, \quad \tilde{\sigma} = \frac{\sigma}{\sigma - 1}. \quad (7)$$

Given this markup rule, the optimal market penetration decision for a firm with productivity  $\phi$ ,  $n_{ij}(\phi)$ , can be determined. If  $\beta > 0$ , this rule is given by the first-order condition (FOC) with respect to  $n_{ij}$ , provided that the firm can make positive profits from entering market  $j$ . Thus, for  $\phi \geq \phi_{ij}^*$ , the optimal  $n_{ij}$  solves<sup>12</sup>

$$\frac{y_j}{\sigma} \frac{[\tilde{\sigma}(\tau_{ij} w_i / \phi)]^{1-\sigma}}{P_j^{1-\sigma}} = \frac{w_j^\gamma w_i^{1-\gamma}}{\psi L_j^{1-\alpha}} \frac{1}{(1 - n_{ij})^\beta}, \quad (8)$$

with the left-hand side the marginal revenue (net of labor production cost) per consumer and the right-hand side the marginal cost per consumer; the entry threshold  $\phi_{ij}^*$  is defined by setting  $n_{ij} = 0$  and solving the previous equation for  $\phi$ :

$$(\phi_{ij}^*)^{\sigma-1} = w_j^\gamma w_i^{1-\gamma} L_j^{\alpha-1} \left\| \frac{y_j}{\sigma} \frac{(\tilde{\sigma} \tau_{ij} w_i)^{1-\sigma}}{P_j^{1-\sigma}} \psi \right\|. \quad (9)$$

To understand how entry is determined, notice that a firm compares the marginal revenue received from the very first consumer (the left-hand side of [8]) to the corresponding marginal cost of reaching her (the right-hand side of [8] for  $n_{ij} = 0$ ). In fact, owing to elastic demand, more productive firms charge lower prices and extract higher marginal revenue per consumer so that they choose higher levels of marketing, conditional on entering. The case of  $\beta = 0$  is special in that the marginal cost to reach additional consumers is constant. Therefore, firms with  $\phi \geq \phi_{ij}^*$  choose to enter the market and always set  $n_{ij} = 1$ . This outcome is observationally equivalent to assuming a fixed cost of entry as in Melitz (2003). For means of exposition, I will indicate the model with  $\beta > 0$

<sup>11</sup> I further assume  $\tau_{ij} \leq \tau_{iv} \tau_{vj}$  for all  $i, v, j$  to exclude the possibility of transportation arbitrage.

<sup>12</sup> In order to interpret the left-hand and right-hand sides of expression (8) as marginal revenue and marginal cost per consumer, the derivative with respect to  $n_{ij} L_j$  has to be applied.

as the endogenous-cost model and the model with  $\beta = 0$  as the fixed-cost model. Proposition 1 summarizes these results.

**PROPOSITION 1** (Firm entry and market penetration decisions). (a) If  $\beta > 0$ , then there exists a  $\phi_{ij}^*$  such that

$$\phi \leq \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 0 \quad \text{and} \quad \phi_1 > \phi_2 \geq \phi_{ij}^* \Rightarrow n_{ij}(\phi_1) > n_{ij}(\phi_2) \geq 0.$$

(b) If  $\beta = 0$ , then there exists a  $\phi_{ij}^*$  such that

$$\phi \leq \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 0 \quad \text{and} \quad \phi > \phi_{ij}^* \Rightarrow n_{ij}(\phi) = 1.$$

*Proof.* See Appendix B.

Inverting expression (8) to solve for  $n_{ij}(\phi)$ , where  $\phi \geq \phi_{ij}^*$ , and using proposition 1 together with (9) implies that the optimal market penetration choice of a firm for  $\beta \geq 0$  can be written as a function of  $\phi$  and  $\phi_{ij}^*$ :

$$n_{ij}(\phi) = \max \left\{ 1 - \left( \frac{\phi_{ij}^*}{\phi} \right)^{(\sigma-1)/\beta}, 0 \right\}. \quad (10)$$

The marginal cost of reaching the first consumer can be expressed as the cost of sending the first ad, divided by the expected number of people that see this first ad:

$$\frac{\text{cost of the first ad}}{\text{expected number of people that see the ad}} = \frac{w_j^\gamma w_i^{1-\gamma/\psi}}{L_j^{1-\alpha}}. \quad (11)$$

For  $\alpha < 1$ , the cost to reach the first consumer falls with population size, since the denominator in expression (11) increases. Equation (8) implies that this lower cost allows firms with lower productivities and smaller per-consumer sales to enter markets with larger population size. Thus, for  $\alpha < 1$ , these markets will attract more firms. Moreover, as I will show later, in equilibrium, the per capita income of a destination,  $y_j$ , is a linear function of a worker's income,  $w_j$ . All else equal, if  $\gamma < 1$ , the cost to reach the first consumer would increase more slowly than the increase in the expected revenue from that consumer, implying that more firms enter richer markets. In my analysis, I do allow for the values typically assumed in the literature. That is,  $\gamma = 0$ , in terms of the exporting country's wages only, as in Ghironi and Melitz (2005), or  $\gamma = 1$ , in terms of the importing country's wages only, as is implicit in Eaton et al. (2010).

#### D. Equilibrium

To derive stark predictions from the equilibrium of the model, I specify the distribution of firm productivities following Helpman, Melitz, and Yeaple (2004) and Chaney (2008). In particular, I assume that the productivity of firms in country  $i$  is drawn from a Pareto distribution with shape parameter  $\theta > \sigma - 1$ , probability density function (pdf)  $g_i(\phi) =$

$\theta b_i^\theta / \phi^{\theta+1}$ , cumulative density function  $G_i(\phi) = 1 - b_i^\theta / \phi^\theta$ , and support  $[b_i, +\infty)$ , where  $b_i$  can be interpreted as the level of technology.<sup>13</sup> This assumption allows the model to generate the empirically observed distribution of sales of firms (see Axtell 2001).<sup>14</sup>

The probability that a firm operates in a market  $j$  corresponds to the probability that a firm has a productivity  $\phi$  such that  $\phi \geq \phi_{ij}^*$ , namely,  $1 - G_i(\phi_{ij}^*)$ . Thus, the measure of entrants from  $i$  to  $j$ ,  $M_{ij}$ , is given by

$$\begin{aligned} M_{ij} &= J_i [1 - G_i(\phi_{ij}^*)] \\ &= J_i b_i^\theta / (\phi_{ij}^*)^\theta. \end{aligned} \quad (12)$$

Furthermore, the pdf of the conditional distribution of firms is given by

$$\mu_{ij}(\phi) = \begin{cases} \theta \frac{(\phi_{ij}^*)^\theta}{\phi^{\theta+1}} & \text{if } \phi \geq \phi_{ij}^* \\ 0 & \text{otherwise.} \end{cases} \quad (13)$$

With equations (5), (7), (9), and (10), the sales of a firm with productivity  $\phi$  to country  $j$  can be expressed as

$$r_{ij}(\phi) = p_{ij}(\phi) q_{ij}(\phi) \quad (14)$$

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

Conditional on entry, more productive firms sell more at the intensive margin and also at the extensive margin of consumers, the second parenthetical term of expression (14). When  $\beta \rightarrow 0$ , that term approaches one allowing adjustments only at the intensive margin of firm adjustment, as in the Melitz-Chaney setup. In general that term is naturally bounded above by one, which means that adjustments in that margin will play a dominant role for smaller firms.

Total exports to country  $j$  equal average sales, obtained by integrating the expression (14) across the pdf (13) for productivities that exceed the threshold level  $\phi_{ij}^*$ , multiplied by the number of entrants,  $M_{ij}$ :

$$X_{ij} = \frac{\sigma L_j^\alpha w_j^\gamma w_i^{1-\gamma}}{\psi} \left[ \frac{1}{1 - 1/\theta} - \frac{1}{1 - 1/(\theta\beta)} \right] \times M_{ij}; \quad (15)$$

I define for simplicity

<sup>13</sup> Notice that I also assume that parameters of the model are such that  $b_i \leq \min_j \phi_{ij}^*$ , which effectively requires  $\psi$  to be low enough.

<sup>14</sup> See Kortum (1997), Gabaix (1999), Luttmer (2007), Arkolakis (2009), and Eaton et al. (2010) for theoretical justifications of using this distribution of productivities.

$$\tilde{\theta} = \frac{\theta}{\sigma - 1}, \quad \tilde{\beta} = \frac{\beta}{\beta - 1}.$$

In Appendix B I illustrate that the Pareto distribution assumption implies that marketing spending is a constant share of firm sales:

$$m = \frac{\theta - (\sigma - 1)}{\theta\sigma}. \quad (16)$$

I also illustrate that from assumption 3, profits and wages can be expressed as a constant share of income,

$$\pi_i = \eta y_i, \quad w_i = (1 - \eta)y_i, \quad (17)$$

where  $\eta = (\sigma - 1)/(\theta\sigma)$ . Finally, with this result, the labor market-clearing condition takes the form

$$w_i L_i = (1 - \eta) \sum_{v=1}^N X_{iv}. \quad (18)$$

I can now define an equilibrium in this economy. Given  $\tau_{ij}$ ,  $J_i$ ,  $g_i(\phi)$ , and the definitions (12) and (13), for all  $i, j = 1, \dots, N$ , an equilibrium is a set of wages,  $\hat{w}_i$ , allocations for the representative consumer,  $\hat{c}_{ij}(\phi)$ , and prices and allocations for the representative firm,  $\hat{p}_{ij}(\phi)$ ,  $\hat{n}_{ij}(\phi)$ , such that (i) equation (3) is the solution of the representative consumer optimization program; (ii) equations (7) and (10) solve the firm profit maximization programs; (iii)  $\hat{p}_j$  and  $\phi_{ij}^*$  jointly satisfy equations (4) and (9), and  $y_i$  is given by equation (17), for all  $i, j = 1, \dots, N$ ; and (iv) the labor market-clearing condition (18) holds for each  $i$ .

### III. Qualitative Predictions and Empirical Regularities

Although the model just described is simple, it yields a number of analytical and rather intuitive results regarding firm behavior. In this section, I discuss these predictions and compare them with evidence on the cross-sectional sales and growth of firms and goods. The data used here are detailed in Appendix A.

#### A. Exporting Participation and Firm Sales

I first discuss how the cross-sectional predictions of the model connect to the empirical regularities in the French data reported by Eaton et al. (2010). These data provide information on the entry and sales of French manufacturing firms in 113 destinations, including France. I will set  $i = F$  for the rest of this subsection since France is always the exporting country.

*Firm entry.*—Notice that total French exports to country  $j$ ,  $X_{Fj}$ , can be written as

$$X_{Fj} = \lambda_{Fj} L_j y_j, \quad (19)$$

where  $\lambda_{Fj}$  is defined as the market share of France in  $j$ ,

$$\lambda_{Fj} = \frac{X_{Fj}}{\sum_v X_{vj}} = \frac{(\tau_{Fj})^{-\theta} J_F(b_F)^{\theta} w_F^{(1-\gamma)(1-\bar{\theta})-\theta}}{\sum_{v=1}^N (\tau_{vj})^{-\theta} J_v(b_v)^{\theta} w_v^{(1-\gamma)(1-\bar{\theta})-\theta}}, \quad (20)$$

computed using equations (15), (12), and (9).

Combining this definition of total export sales with expressions (15) and (17), I obtain a relationship between the number of French firms exporting to a country, normalized by French market share, to the population and income per capita of that country:

$$\frac{M_{Fj}}{\lambda_{Fj}} = L_j^{1-\alpha} y_j^{1-\gamma} \left\{ (y_F)^{1-\gamma} \frac{1}{\bar{\psi}} \left[ \frac{1}{1-1/\bar{\theta}} - \frac{1}{1-1/(\bar{\theta}\bar{\beta})} \right] \right\}^{-1}, \quad (21)$$

where  $\bar{\psi} = \psi/[\sigma(1-\eta)]$ .

The flip side of relationship (21) is the relationship between average sales and market size:

$$\bar{X}_{Fj} = \frac{\lambda_{Fj} L_j y_j}{M_{Fj}} = I_{Fj}^{\alpha} y_j^{\gamma} \left\{ (y_F)^{1-\gamma} \frac{1}{\bar{\psi}} \left[ \frac{1}{1-1/\bar{\theta}} - \frac{1}{1-1/(\bar{\theta}\bar{\beta})} \right] \right\}. \quad (22)$$

An increase in market size,  $L_j$  or  $y_j$ , leads to an increase in the sales of exporters when  $\alpha, \gamma > 0$ . However, as long as  $\alpha < 1$  and  $\gamma < 1$ , new entry implies that this increase in the sales of incumbents is less than proportional to the increase in market size.<sup>15</sup> Notice that the model is parsimonious in that it delivers predictions on aggregate bilateral sales (eqq. [15] and [22]) and entry (eq. [21]) based on three parameters,  $\alpha, \gamma$ , and  $\psi$ . In the case of the Melitz-Chaney framework, as many fixed costs as destinations would have to be specified.<sup>16</sup>

Assumptions 1 and 3 allow the model to generate the robust relationship between French entry and market size, pointed out by Eaton et al. (2004). In fact, as suggested by equation (21), the logarithm of the normalized French market share is positively correlated with both the logarithm of the population,  $L_j$ , and the logarithm of income per capita,  $y_j$ . Empirically, the corresponding correlations for French firms are .49 and .80.<sup>17</sup> Figure 1 illustrates that there is also a tight association

<sup>15</sup> The mechanism implies that sales of firms increase in larger markets, but their market shares decline. This intuition is reminiscent of the analysis of Sutton (1991). Sutton states that a given firm's market share might increase or decrease with market size. In the trade data, across all industries, average sales of firms always increase less than proportionally with market size (in a very systematic way), as Eaton et al. (2004) argue. This result indicates a decline in their market shares due to entry.

<sup>16</sup> The term  $1/\bar{\psi}$  incorporates  $1/\psi$ , which corresponds to the fixed cost of entry in the case in which  $\beta = 0$ .

<sup>17</sup> I approximate income per capita using manufacturing absorption from Eaton et al. (2004) divided by country population. Notice that the correlation between log population and log absorption per capita is very close to zero (-.03).

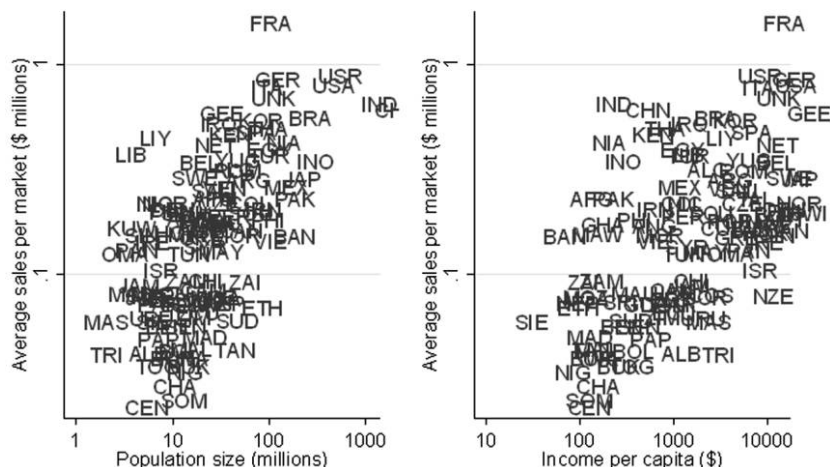


Fig. 1.—Average sales in a market and market size (source: Eaton et al. [2010] and World Bank World Development Indicators).

between the logarithm of average sales and the logarithm of population and income per capita. The correlations in this case are .62 and .57, respectively.

*Firm sales distribution.*—The assumption that firm productivities follow a Pareto distribution implies that  $\phi/\phi_{Fj}^* = (1 - \text{Pr}_{Fj})^{-1/\theta}$ , where  $\text{Pr}_{Fj}$  denotes the sales percentile of a French firm in market  $j$  relative to other French firms in that market (see App. B). Substituting this expression and equation (17) into (14), we can write sales as

$$r_{Fj}(\text{Pr}_{Fj}) = L_j^\alpha y_j^{1-\gamma} \frac{1}{\psi} (1 - \text{Pr}_{Fj})^{-1/\theta} [1 - (1 - \text{Pr}_{Fj})^{1/(\theta\beta)}]. \quad (23)$$

Thus, in the model, the distribution of exporting sales is robust across markets and changes only with the population,  $L_j$ , and income per capita,  $y_j$ , of the market. For the largest exporters in market  $j$ , as  $\text{Pr}_{Fj} \rightarrow 1$ , the term in the brackets tends to one and their sales follow a Pareto distribution with slope coefficient  $-1/\theta$ . The sales distribution of small exporters varies considerably with the parameter  $\beta$ . For  $\beta > 0$ , the distribution of sales exhibits deviations from the Pareto distribution. In particular, low-productivity firms sell less per consumer and (endogenously) reach fewer consumers. The same mechanism also induces the sales of the smallest firms to tend toward zero, since for these firms,  $n_{Fj}(\phi) \rightarrow 0$ . In contrast, if  $\beta \rightarrow 0$ , the sales are bounded below by  $L_j^\alpha y_j^{1-\gamma} / \tilde{\psi}$  since  $n_{Fj}(\phi) = 1$  for all entrants.

Figure 2 depicts the sales distribution across markets for the 25th, 50th, 75th, and 95th percentiles. Conditional on the systematic increase





determines the advantage in the sales per consumer in France of more productive firms. If  $\beta > 0$ , these firms also reach more consumers in France, which implies that the second parenthetical term is positive, adding curvature to the relationship for high  $M_{Fj}/M_{FF}$ .

I now compute the export intensity of firms normalized by the domestic sales intensity. For a firm that sells in both the domestic market and destination  $j$ , its relative percentiles in the two markets are related through the equation

$$1 - \Pr_{FF} = (1 - \Pr_{Fj}) \frac{M_{Fj}}{M_{FF}}.$$

Using this equation and equation (23), we can write the normalized export intensity of a French firm that belongs in percentile  $\Pr_{Fj}$  in market  $j$  as

$$\frac{r_{Fj}(\Pr_{Fj})}{\bar{X}_{Fj}} \bigg/ \frac{r_{FF}(\Pr_{FF})}{\bar{X}_{FF}} = \frac{1 - (1 - \Pr_{Fj})^{1/(\tilde{\theta}\beta)}}{(M_{Fj}/M_{FF})^{-1/\tilde{\theta}} - (1 - \Pr_{Fj})^{1/(\tilde{\theta}\beta)}(M_{Fj}/M_{FF})^{-1/(\tilde{\theta}\beta)}}. \quad (25)$$

The relationship is an identity for  $j = F$ . It is increasing in  $M_{Fj}/M_{FF}$  since for high-productivity firms a lower share of sales is of domestic origin. When  $\beta > 0$ , additional curvature is added to the relationship since the extensive margin of consumers is always greater in the domestic market. Finally, if  $\beta \rightarrow 0$ , there are no differences in the export intensity across different percentiles. This result merely reflects that, when  $\beta \rightarrow 0$ , the demand is of constant price elasticity.

Figure 3 depicts the normalized average sales in France as a function of how many firms sell to market  $j$ . The normalized average sales are decreasing in the number of firms selling to a market. The relationship is roughly log linear for these destinations, but there is curvature as more popular destinations are included. The shape of the relationship is consistent with the endogenous-cost model.

In figure 4, I plot the normalized export intensity of the 25th, 50th, and 75th percentiles for all the destination markets. The values that the normalized export intensity takes are significantly below one, implying a large degree of sales heterogeneity (lower  $\tilde{\theta}$ ) or additional curvature (higher values of  $\beta$ ). Figure 4 also shows the distinct shift in the export intensity values for higher percentiles in each destination market, as the model with  $\beta > 0$  would predict.

### B. Trade Costs and Trade Growth

I now analyze the responses of firm sales to variable trade cost changes. Two important features of the endogenous-cost model are crucial to understanding the growth of firms in this setting: the demand is asymptotically elastic, and the elasticity of exports is higher for firms with

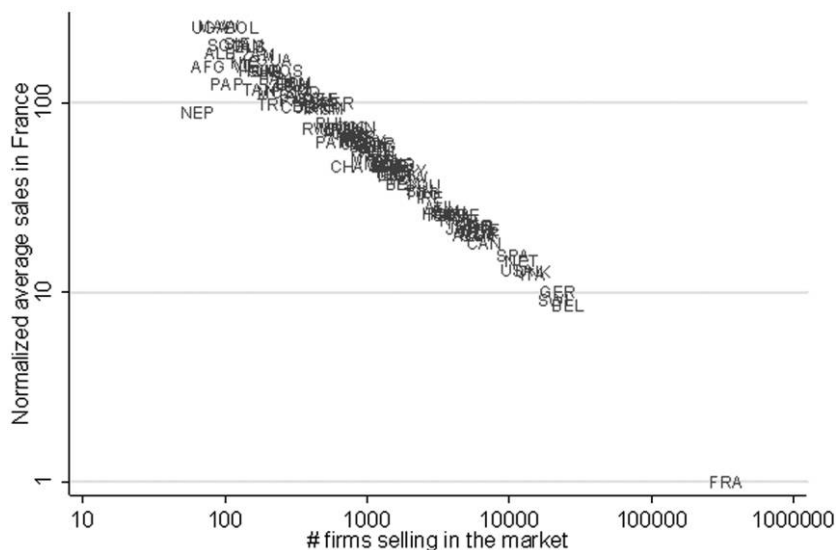


FIG. 3.—Normalized average sales (source: Eaton et al. 2010)

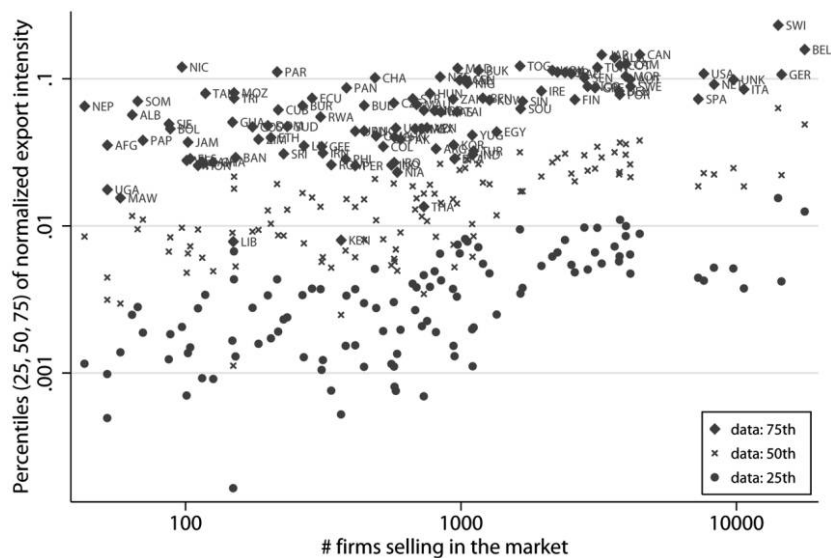


FIG. 4.—Normalized export intensity by market (source: Eaton et al. 2010)

lower sales. The first feature implies that after a trade cost reduction, the largest firms in a market grow at a positive rate that (asymptotically) depends only on the price elasticity of demand,  $\sigma - 1$ . The second feature implies that firms with little previous trade will achieve higher growth when variable trade costs fall. In the endogenous-cost model, these firms face a marginal cost to reach additional consumers that is increasing slowly.<sup>18</sup> Thus, a small decrease in variable trade costs brings about a large expansion of their consumer base. The following proposition formalizes this argument.

**PROPOSITION 2** (Elasticity of trade flows and firm size). The partial elasticity of a firm's sales in market  $j$  with respect to variable trade costs,  $\varepsilon_{ij}(\phi) = |\partial \ln r_{ij}(\phi) / \partial \ln \tau_{ij}|$ , is decreasing with firm productivity,  $\phi$ , that is,  $d\varepsilon_{ij}(\phi)/d\phi < 0$  for all  $\phi \geq \phi_{ij}^*$ .

*Proof.* I use equation (14) to compute the partial elasticity of trade flows  $r_{ij}(\phi)$  with respect to a change in  $\tau_{ij}$ , namely,  $|\partial \ln r_{ij}(\phi) / \partial \ln \tau_{ij}| = |\zeta(\phi)| \times |\partial \ln \phi_{ij}^* / \partial \ln \tau_{ij}|$ , where

$$\zeta(\phi) = (\sigma - 1) + \frac{\sigma - 1}{\beta} \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\beta} \right]^{-1},$$

with the first term on the right-hand side the intensive margin of per-consumer sales elasticity and the second term the extensive margin of consumers elasticity. Notice that  $\zeta(\phi) \geq 0$  for  $\phi \geq \phi_{ij}^*$ . The function  $\zeta(\phi)$  is also decreasing in  $\phi$  and thus decreasing in initial export sales. In fact, as  $\beta \rightarrow 0$ ,  $\zeta(\phi) \rightarrow \sigma - 1$  for all  $\phi \geq \phi_{ij}^*$ . QED

The proposition implies that trade liberalization benefits relatively more the smaller exporters in a market. The parameter  $\beta$  governs both the heterogeneity of exporters' cross-sectional sales and also the heterogeneity of the growth rates of sales after a trade liberalization.

In recent years, increased attention has been devoted to the growth of aggregate trade due to new exporters (or new goods), namely, the "new firms" (goods) margin. This attention stems partly from the fact that models with this feature can explain the large increases in trade due to trade costs reductions, without assuming unrealistically high elas-

<sup>18</sup> In the online theory appendix, I show that the main results regarding cross-sectional firm sales and entry, related to proposition 1, will hold using any function that satisfies properties P1–P3. For the results of proposition 2 to hold, i.e., small exporters to have a higher elasticity of demand than the large ones, a sufficient condition is that the rate of increase of the convexity of the marketing cost function is larger than the rate of increase of its marginal cost,  $f_{111}/f_{11} > f_{11}/f_1$ . Another function that satisfies all these properties is  $f(n, L) = L^\alpha [1/(1-n) - 1]/\psi$ . As I show in the online theory appendix, a similar result can be achieved by assuming a convex production cost function in the case of perfect competition. The restrictions on the production cost function required are exactly the same as the ones required for the microfounded marketing cost function that I introduce. Additionally, a destination-specific production function is required, which is clearly unrealistic.

ticities of substitution. The mechanism that I propose has drastic effects on the importance of small exporters to overall trade growth, the new consumers margin, compared to the importance of new exporters. In particular, the first-order effect of the new consumers margin is larger than the one of new firms. Notably, whereas the channels of trade growth are different, the partial elasticity of relative import flows,  $X_{ij}/X_{jj}$ , with respect to trade cost changes depends only on the heterogeneity parameter,  $\theta$ , exactly as in the Melitz-Chaney framework.

**PROPOSITION 3** (Trade elasticities in the endogenous-cost model). (a) If  $\beta > 0$ , to a first-order approximation, the elasticity of the new consumers margin with respect to changes in variable trade costs,  $\tau_{ij}$ , is larger than the elasticity of the new firms margin. (b) If  $\beta > 0$ , the partial elasticity of relative import flows,  $X_{ij}/X_{jj}$ , with respect to variable trade costs,  $\tau_{ij}$ , is  $\theta$ , that is,  $|\partial \ln (X_{ij}/X_{jj})/\partial \ln \tau_{ij}| = \theta$ .

*Proof.* I perform a decomposition using Leibnitz's rule to separate the three margins. The change in total export sales of country  $i$  to country  $j$  due to a small change in variable trade costs can be decomposed into three margins:

$$\begin{aligned} \frac{dX_{ij}}{d\tau_{ij}} = & \underbrace{J_i \int_{\phi^*_{ij}}^{\infty} n_{ij}(\phi) \frac{d[p_{ij}(\phi)x_{ij}(\phi)]}{d\tau_{ij}} g_i(\phi) d\phi}_{\text{Intensive margin growth}} \\ & + \underbrace{J_i \int_{\phi^*_{ij}}^{\infty} \frac{dn_{ij}(\phi)}{d\tau_{ij}} p_{ij}(\phi)x_{ij}(\phi)g_i(\phi) d\phi}_{\text{New consumers margin}} \\ & + \underbrace{J_i n_{ij}(\phi^*_{ij}) p_{ij}(\phi^*_{ij}) x_{ij}(\phi^*_{ij}) g_i(\phi^*_{ij}) \frac{d\phi^*_{ij}}{d\tau_{ij}}}_{\text{New firms margin}} \end{aligned} \quad (26)$$

Using equation (26), I can compute the following decomposition in terms of percentage changes (see App. B):

$$\begin{aligned} \frac{d \ln X_{ij}}{d \ln \tau_{ij}} = & \underbrace{(1 - \sigma) \frac{d \ln \phi^*_{ij}}{d \ln \tau_{ij}} + (1 - \gamma) \frac{d \ln w_i}{d \ln \tau_{ij}}}_{\text{Intensive margin growth changes}} \\ & + \underbrace{(-\theta + \sigma - 1) \frac{d \ln \phi^*_{ij}}{d \ln \tau_{ij}}}_{\text{New consumers margin changes}} + \underbrace{0}_{\text{New firms margin changes}} \end{aligned} \quad (27)$$

where  $w_j$  is chosen as the numeraire. For part *a*, the new consumers margin elasticity is the absolute value of the second term of the decomposition. Given the assumption  $\theta > \sigma - 1$ , equation (27) implies that this elasticity is generically positive. Moreover, since  $n_{ij}(\phi_{ij}^*) = 0$ , expression (26) implies that, to a first order, the new firms margin elasticity is zero. As for part *b*, the decomposition obtained in part *a* can be used to obtain the result that the partial elasticity of relative import flows,  $X_{ij}/X_{jj}$ , is only a function of  $\theta$ , as discussed in Appendix B. QED

The model implies that the first-order contribution of the new consumers margin of consumers to trade is significant. Now, I show the model's welfare implications by adapting the methodology of Arkolakis, Costinot, and Rodríguez-Clare (2009) to compute the first-order effects of a change in trade costs to welfare. Thus, I compute the negative of the changes of the ideal price index defined in (4) using the Pareto distribution assumption (derivations in App. B):

$$-\frac{d \ln P_j}{d \ln \tau_{ij}} = \underbrace{-\sum_v \lambda_{vj} \left( \frac{d \ln w_v}{d \ln \tau_{ij}} + 1 \right)}_{\text{Intensive margin}} - \underbrace{\sum_v \lambda_{vj} (\tilde{\theta} - 1) \frac{d \ln \phi_{vj}^*}{d \ln \tau_{ij}}}_{\text{New consumers}} + \underbrace{0}_{\text{New firms}}$$

Proposition 3 implies that the welfare changes due to trade costs, to a first order, are coming only through the intensive and the new consumers margin. Notice that although the new consumers margin affects welfare, the shape of the marketing cost function, governed by  $\beta$ , does not. This effect is precisely because the overall trade elasticity does not depend on  $\beta$ . In fact, as shown in Arkolakis et al. (2009), the overall gains from trade can be computed as a function of the market share of domestic goods before and after the trade cost changes,  $\lambda_{jj}$  and  $\lambda'_{jj}$ . The formula for the welfare changes is given by  $(\lambda'_{jj}/\lambda_{jj})^{-1/\theta} - 1$ , and thus, conditional on trade shares, the normative predictions of the model regarding overall gains from trade are independent of  $\beta$  and  $\sigma$ .<sup>19</sup> This formula can be derived using the price index, the definition of the cutoff productivity (9), and the equation for market shares (20).

### C. Evidence on Trade Growth and Trade Margins

To test propositions 2 and 3, I need to distinguish firms or goods that were positively traded or not traded before a trade liberalization episode. To do so, I extend the methodology of Kehoe and Ruhl (2003).

*Evidence using product-level data.*—I first look at product-level data by making use of the strict mapping that the model implies, namely, that

<sup>19</sup> However, as long as  $\gamma < 1$ , the predictions of the model for changes in trade shares due to a given decline in trade costs will depend on  $\sigma$  as eq. (20) indicates. This point is elaborated in Arkolakis et al. (2009).

each firm produces only one good. The liberalization experiment discussed is the United States–Mexico NAFTA trade liberalization episode, which went into effect on January 1, 1994. In this analysis, I use the International Trade by Commodity database of the OECD.<sup>20</sup> These data cover a period of 11 years, 1990–2000, which encompasses 1994, the year that NAFTA went into effect. The data are recorded at the six-digit Harmonized System (HS) encoding and cover all the imports and exports of OECD countries.

During the decade of reference, the share of manufacturing imports of the United States originating from Mexico increased from 5.2 percent to 10.3 percent. The growth of this share in the years before NAFTA was moderate, around 4.1–5.5 percent per year, whereas the establishment of NAFTA was associated with faster growth from 1994 to 1997, at a rate of 9.0–12.5 percent. As Romalis (2007) points out, the increase was slower during 1998–2000, ranging around 3.5–4.9 percent.

Next, I construct a classification of the goods. I call the goods traded throughout the years 1991–93 “previously traded” goods. I classify the previously traded goods into 10 categories, each composed of an equal number of goods. These categories include goods in an increasing order of volume of trade: category 1 includes the previously traded goods that were on average least traded in 1991–93 and category 10 the most traded ones. The goods that were traded in 1998–2000 (at least once in these 3 years) but not throughout the years 1991–93 are referred to as “newly traded” goods. According to this classification, there are 2,195 previously traded goods and 1,640 newly traded in the HS six-digit data during that period.

Finally, to alleviate issues of mean reversion, taking averages of the growth rate over a set of years is also appropriate. I compute the ratio of trade for each decile of goods between 1991–98, 1992–99, and 1993–2000 and take the average of these numbers. The ratio of imports of the 10 categories of previously traded goods is illustrated in figure 5. This figure also shows the relevant numbers for imports of the United States from France, Germany, and the United Kingdom. During the decade of reference, the United States did not experience any major trade liberalization episodes with these three major trade partners. In line with the theory, the fact that stands out for the United States–Mexico episode is the very large growth of trade, especially in the deciles

<sup>20</sup> The OECD data, to the best of my knowledge, provide the most detailed classification of goods that is consistent over time. Inconsistencies may arise in other data sets because of the continuous introduction of new subcategories of goods, which need to be reclassified to the old ones. This reclassification was done in the OECD data at the six-digit level (see App. A for a discussion), but it is much harder at lower levels of disaggregation. For example, using the 10-digit data of Feenstra, Romalis, and Schott (2002) for the United States, I was not able to reassign more than one-third of the new categories appearing after NAFTA to categories that existed before.

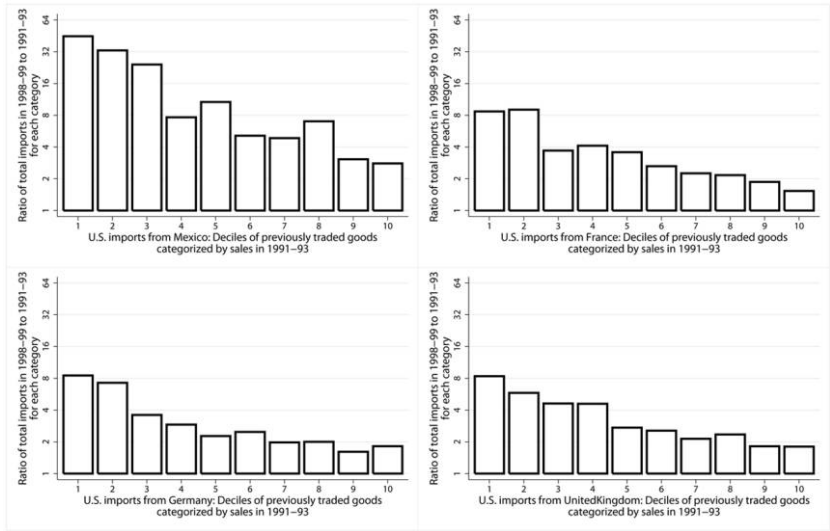


FIG. 5.—Ratio of U.S. imports from four partner countries for goods categorized by initial volume of sales.

TABLE 1  
PERCENTAGE TRADE SHARES OF NEWLY TRADED AND PREVIOUSLY TRADED GOODS

	NEWLY TRADED	PREVIOUSLY TRADED BY DECILE									
		1	2	3	4	5	6	7	8	9	10
Share of 1991–93 trade	.42	.01	.04	.10	.21	.43	.84	1.71	3.47	7.63	85.15
Share of 1998–2000 trade	3.21	.16	.47	.73	.51	1.45	1.36	2.61	7.51	7.34	74.65
Share of new trade	4.50	.23	.67	1.03	.65	1.92	1.60	3.04	9.35	7.21	69.82

with low initial trade.<sup>21</sup> The related shares of imports to total and new trade for each category of goods are reported in table 1. I now illustrate two facts for the United States–Mexico NAFTA liberalization that offer support to the predictions of the model.

F1. Among the previously traded goods, there is a reallocation of

<sup>21</sup> Kehoe and Ruhl (2003) report similar findings by comparing a large number of country pairs with and without major trade liberalizations. The fact that the goods with little trade grow faster than the most traded goods is a feature of the endogenous-cost model for symmetric changes in trade costs. In addition, consistent with the model, the absolute difference in growth rates between these sets of goods increases with the magnitude of the trade cost declines. In the online theory appendix I provide more details on the predictions of the model in the case of the trade of the United States with France, Germany, and the United Kingdom.

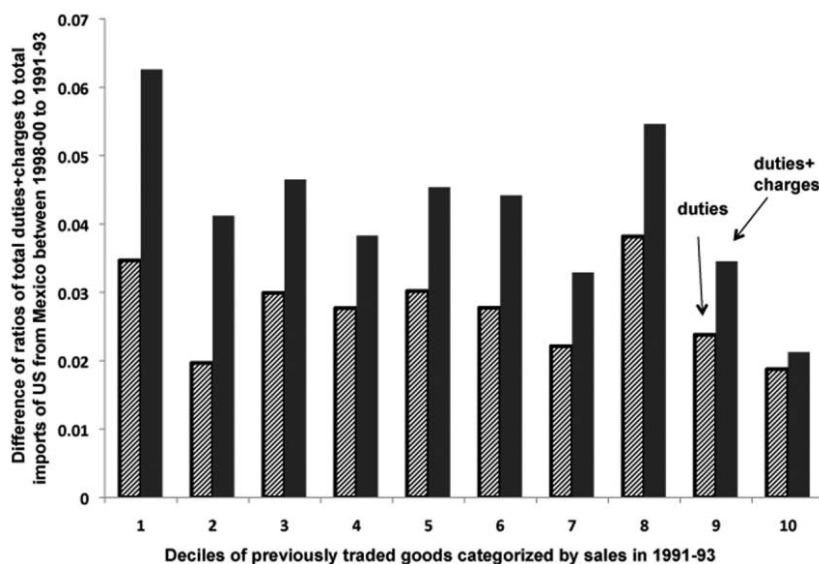


FIG. 6.—Trade costs changes in the United States–Mexico NAFTA liberalization for previously traded goods categorized by initial volume of sales. Data source: Feenstra et al. (2002). The ratio is the average of yearly ratios over 3 years.

trade shares toward the goods with less trade before the NAFTA liberalization.

The top left panel of figure 5 implies that the growth rate of trade is higher for the categories of goods with lower initial volume of trade. Figure 6 illustrates the reduction in the ratio of trade costs to total imports for each decile of previously traded goods in 1991–93, using HS six-digit data on imports, duties paid, and insurance and freight costs from Feenstra et al. (2002). The reduction of the ratio of trade costs to total imports is very similar across deciles (except the ratio of charges and freights to total imports for the first decile, where it declined the most, and for the last decile, where it effectively remained constant). Thus, even though the drop in tariffs is associated with trade growth, as Romalis (2007) finds, trade growth depends also on initial trade, as figure 5 suggests. The higher growth rates of the deciles of goods with little previous trade directly imply a reallocation of market shares in total and new trade after NAFTA. Table 1 illustrates the initial and final import shares for each decile. Notice that the market share of the first eight deciles grew from 6.8 percent before NAFTA to 14.8 percent after. Their share of the trade accounted for by all 10 previously traded deciles also more than doubled. Finally, these eight deciles accounted for 18.5



percent of new trade. Overall, the HS-6 goods evidence offers strong support to proposition 2.

F2. The contribution of the new goods to the overall increase in trade is small.

I can now look at the contribution of newly traded goods to new trade and overall trade after the NAFTA liberalization. Table 1 implies that after NAFTA newly traded goods have only a small share in new trade as well as in overall trade. The level of this contribution amounts to 4.5 percent and 3.3 percent, respectively. This finding offers direct evidence for proposition 3 and implies that the modeling of the extensive margin of consumers is crucial for understanding trade flows of goods during a trade liberalization episode.

*Robustness: firm-level data.*—Overall, the results of propositions 2 and 3 are strongly supported by the product-level data. In Appendix A, I discuss related findings using the firm-level data of Molina and Muendler (2008). The liberalization episode that I study there is the gradual elimination of Argentinian tariffs to Brazil, between 1991 and 1994, following the Mercosur agreement.

Fact F1 still stands out in the firm-level data since the growth of the total trade in the least traded of these deciles is still higher. However, the firm-level data show that a disproportionate number of firms exporting to Argentina after the emergence of the Mercosur were not trading before the agreement. This fact is the result of a combination of a large attrition of previously trading firms but also of the fact that many new firms started exporting after the agreement.<sup>22</sup> The findings indicate that fact F2 for NAFTA may not be robust to the analysis using firm data.

An analysis of firm-level dynamics seems to be more appropriate to study firm-level data for a trade liberalization episode. Such an analysis is beyond the scope of this paper. An extension of this model that allows for both higher growth of smaller firms and high levels of attrition is undertaken by Arkolakis (2009). Instead, in the next section, I will investigate the quantitative predictions of the model for the growth of individual goods in the NAFTA liberalization.

#### D. Discussion of the Results

To offer a better understanding of the importance of my assumptions, I summarize the main predictions of the model in relation to these assumptions.

*Firm entry patterns.*—To deliver the positive relation between firm entry

<sup>22</sup> Such attrition is not present in the product-level data, where more than 95 percent of the previously traded goods are traded at least once during 1998–2000.

and market size, monopolistic competition is arguably a key assumption. Monopolistic competition allows the number of varieties consumed in a country to be endogenous and directly related to market size. By using a tractable formulation of market-specific entry costs and appropriately choosing their parameters,  $\alpha$  and  $\gamma$ , the monopolistic competition model with CES demand can generate the correct relationship between firm entry and the size of the market. Alternatively, the CES demand could be replaced by a nonhomothetic demand system. Assuming that demand system would imply that entry is related to income per capita but not necessarily to the population of the market. Intuitively, in a model without entry costs, the benefit of dividing such a cost across a larger number of consumers does not exist. In the online theory appendix, I illustrate this fact for the linear demand case of Melitz and Ottaviano (2008). I also argue that there is little chance for a simple nonhomothetic demand structure to deliver the correct relationship of entry with income per capita.

*CES demand, sales distribution, and trade growth.*—I have argued that this model can provide a justification of the higher elasticity of sales of small firms/goods that sell in a market. Alternatively, demand structures such as the one proposed by Melitz and Ottaviano (2008) depart from the assumption of a CES aggregator by assuming an asymptotically inelastic demand. However, the demand that I propose combines, for the first time, deviations from the CES demand with an asymptotically elastic demand. This model is consistent with the observed distribution and growth of sales of both small and large firms: because of the asymptotically elastic demand, differences in productivity translate to differences in sales even for the largest firms. The elastic demand also implies that a reduction in trade costs induces the largest firms to grow. These facts cannot be captured by a model that assumes an asymptotically inelastic demand.<sup>23</sup>

*Discussion of the market penetration costs story.*—So far, I have focused on a marketing story based on a theory of informative advertising. However, the theory as presented lends itself to a variety of different interpretations of what these market penetration costs are. The key assumption is that each extra dollar spent in a “marketing” activity, whatever this activity might be, leads to decreasing additional revenues either because of decreasing returns into the marketing technology or because of decreasing revenues accrued from sales. Regardless of the source of this reduction, the effect on the overall sales of the firm is the same. For example, a direct reinterpretation of the informative advertisement is

<sup>23</sup> Of course, postulating a demand structure that is asymptotically elastic inevitably involves a modeling of demand similar to CES, as the subsequent work of Simonovska (2009) and Wiseman (2009) has shown. Additionally, the framework that I propose is extremely tractable, making it valuable for quantitative applications.

that of a persuasive advertisement, where it is increasingly more difficult to “convince” potential buyers to purchase more of a firm’s good. A different interpretation would be one in which consumers have different (random) evaluations for each firm’s good and the firm pays the same fixed cost to reach additional consumers. The firm can make more revenue from consumers with a higher evaluation, so it will reach these consumers first.<sup>24</sup> Both isomorphisms are developed and discussed in the online theory appendix. Finally, a partial isomorphism, discussed in Arkolakis and Muendler (2010), is to allow each firm to introduce additional varieties (multiproduct firms) in which each variety would yield decreasing revenues.

#### IV. Quantitative Analysis

I calibrate the model to match the patterns of aggregate bilateral entry and average sales/export intensity of French firms. I look at the predictions of the calibrated model for the size distribution of exporters.

##### A. Calibration

The calibration conditions on the actual population,  $L_j$ , income per capita,  $y_j$ , and the number of French entrants for each of the 112 exporting destinations of French firms. To calibrate the model, I look at the predictions of the model regarding (a) the relationship between the average sales of French entrants in each exporting country as a function of the population and income per capita of that country, equation (22), which will allow me to determine parameters  $\alpha$ ,  $\gamma$ , independently of the other parameters of the model; and (b) the relationship between the number of firms selling to a market and their normalized average sales in France, and their export intensity, equations (24) and (25). Relationships *b* involve only parameters  $\tilde{\theta}$  and  $\beta$  and thus can be used to independently calibrate these parameters as well. All these relationships in the model are largely independent of idiosyncratic sources

<sup>24</sup> A similar behavior might be generated by a model in which firms have random access costs for each consumer. Thus, some consumers will be more remote for a given firm than others. Another possible story would be the existence of foreign trade intermediaries, which are used only by small firms. Large firms would pay higher entry costs to set up their own marketing technology such as foreign wholesale trade affiliates. Evidently, intrafirm exports of foreign firms to their U.S. wholesale trade affiliates account for a dominant part of intrafirm exports to the United States as Zeile (1997) points out. Thus, this type of intrafirm trade could be an important part of global intrafirm trade, which in turn amounts to roughly one-third of total trade according to Antras (2003). An intermediaries theory is discussed, in order to model dynamic marketing frictions, in Drozd and Nosal (forthcoming).

of variation.<sup>25</sup> Thus, they are appropriate to identify how overall productivity advantage translates into more entry and higher sales.

*Parameters determining firm entry and average size.*—The first objective is to pick  $\alpha$ ,  $\gamma$  so that, given the observed  $y_j$  and  $L_j$ , the predictions of the model regarding average sales are as close to the data as possible. The logarithm of equation (22) will be used to estimate  $\alpha$ ,  $\gamma$  using an ordinary least squares (OLS) regression. To substantiate an error term that is orthogonal to the regressors in the right-hand side of relationship (22), I assume that there is classical measurement error in the trade data. Additionally, to address potential endogeneity or measurement error concerns in income, I also use a two-stage least squares (2SLS) methodology, instrumenting for  $y_j$ . In particular, the model implies that the technology of country  $j$ , that is, the parameter  $b_j$ , affects average sales only through its effect on  $y_j$ . Thus, as suggested by the model, I use a proxy of technology, namely, the average years of education, as an instrument for  $y_j$  (again, see App. A for the data description).<sup>26</sup>

The OLS regression on all French exporting destinations delivers  $\alpha = .43$  and  $\gamma = .29$  with an  $R^2$  of .70. The 2SLS estimates are of similar magnitude ( $\alpha = .43$ ,  $\gamma = .28$ ). The coefficients are statistically significant at the 1 percent level, have the correct sign, and lie between zero and one, as predicted by the theory. The coefficients of this regression also predict the logarithm of relationship (21) in the best mean square sense with  $R^2 = .89$ . Since the OLS and 2SLS estimates are very similar, I use the OLS estimates in what follows. The value of  $\alpha = .43$  falls within the lower values of the estimates reported in Section II using data on advertising costs.

The constant of the regression is used to determine  $\psi$  given the estimates of the rest of the parameters below, and the details are discussed in Appendix A.

*Parameters determining firm sales advantage.*—I now turn to determine  $\beta$  and  $\hat{\theta} = \theta/(\sigma - 1)$  by looking at the advantage of prolific exporters uncovered by equations (24) and (25). Notice that parameters  $\theta$  and  $\sigma$  affect equations (24) and (25) (and [23]) only insofar as they affect  $\hat{\theta}$ . Higher  $\theta$  implies less heterogeneity in firm productivities (and thus in firm sales), whereas higher  $\sigma$  translates the same heterogeneity in productivities to a larger dispersion in sales.

<sup>25</sup> In the online theory appendix, I show that eqq. (22) and (24) are not affected by idiosyncratic entry shocks. I also argue that the specification of idiosyncratic entry shocks affects (25) only insofar as it affects the absolute value of each of the percentile terms in that relationship. Heterogeneous entry costs are considered by Ruhl (2005) and Eaton et al. (2010).

<sup>26</sup> See Anderson and Van Wincoop (2004) for a discussion of measurement error in the trade data and the instruments typically used for total income. The choice of my instrument of years of education is adapted by Eaton and Kortum (2002) since this is the best proxy for technology that is available across a large number of countries.

TABLE 2  
CALIBRATION OF THE BENCHMARK MODEL

Parameter	Value	Benchmark Calibration
$\alpha$	.43	Average sales of French firms as a function of population size and manufacturing income per capita of the market
$\gamma$	.29	
$\tilde{\theta}$	1.65	Sales in France and export intensity of French exporters (eqq. [22] and [25])
$\beta$	.915	Broda and Weinstein (2006) and calibrated value of $\theta$
$\sigma$	6	
$\theta$	8.25	

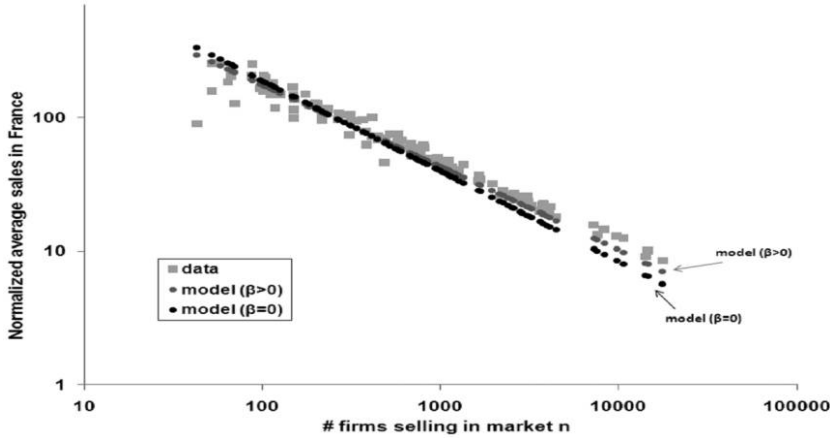


FIG. 7.—Normalized average sales in the French data and the model

For the calibration, I use a simple method of moments estimator. In particular, I pick  $\beta$  and  $\tilde{\theta}$  so that the mean of the left-hand side is equal to the mean of the right-hand side for both equation (7) and equation (25) evaluated at the median percentile in each market  $j$ . The solution delivers  $\beta = .915$  and  $\tilde{\theta} = 1.65$ .<sup>27</sup> This value of  $\beta$  has the appeal of being close to the theoretical value of one. Table 2 summarizes the calibration of the benchmark model.

With equation (24), the method of moments estimator for the fixed model with  $\beta = 0$  gives  $\tilde{\theta} = 1.49$ . I will use this parameterization for the fixed-cost model for means of comparison. The fit of both models is illustrated in figures 7 and 8. In order to predict well the average

<sup>27</sup> Eaton et al. (2010) estimate  $\beta \approx 1.1$ . They allow for firm idiosyncratic sales and entry shocks. Using more moments from the French data, the authors are able to identify how much of the variation in entry and sales is attributed to efficiency and how much from idiosyncratic shocks. In the online theory appendix, I illustrate the robustness of model predictions to different parameterizations.

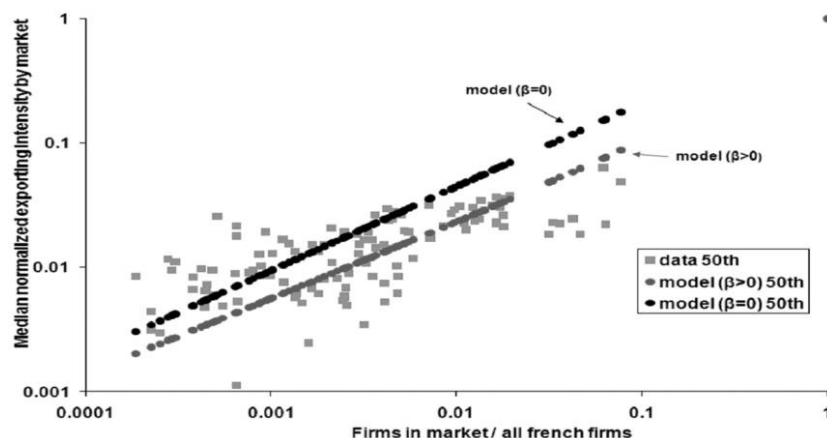


FIG. 8.—Normalized export intensity and model predictions

sales in France of French firms selling to the most popular destinations versus those of all French firms, the fixed-cost model needs a lot of heterogeneity, which results in a lower estimate of  $\tilde{\theta}$ .<sup>28</sup>

To complete the calibration of the model, I will assign magnitudes to  $\sigma$  and  $\theta$ . Broda and Weinstein (2006) estimate the elasticity of substitution for disaggregated categories. The average and median elasticity for Standard International Trade Classification five-digit goods is 7.5 and 2.8, respectively (see their table 4). A value of  $\sigma = 6$  falls in the range of Broda and Weinstein's estimates and yields a markup of around 1.2, which is consistent with those values reported in the data (see Martins, Scarpetta, and Pilat 1996).<sup>29</sup> In addition,  $\tilde{\theta} = 1.65$  and  $\sigma = 6$  imply that the marketing to GDP ratio, given by equation (16), is around 6.6 percent, which is within the range of marketing to GDP ratios reported in the data. Finally, this parameterization implies that  $\theta = 8.25$  for the endogenous-cost model, which is very close to the main estimate of Eaton and Kortum (2002) (8.28) and within the range of estimates of Romalis (2007) (6.2–10.9) and the ones reported in the review of Anderson and Van Wincoop (2004) (5–10). Since the model retains the aggregate predictions of the Melitz-Chaney framework, if  $\theta$

<sup>28</sup> In the French data, 77.5 percent of the total sales of French firms in France are coming from the exporting firms that constitute 14.8 percent of all firms. With the parameterization suggested the endogenous-cost model predicts this number to be 67.2 percent whereas the fixed-cost model predicts 53.8 percent. In the model, a lower  $\tilde{\theta}$  and a higher  $\beta$  imply a higher share of exporters to sales in France.

<sup>29</sup> The value of  $\sigma = 6$  is higher than the values used in the business cycles literature (around two) or values previously estimated using models of trade with heterogeneous firms (e.g., Bernard et al. [2003] report that  $\sigma = 3.79$  is the value that allows their model to match the productivity and sales advantage of exporters in the U.S. data).

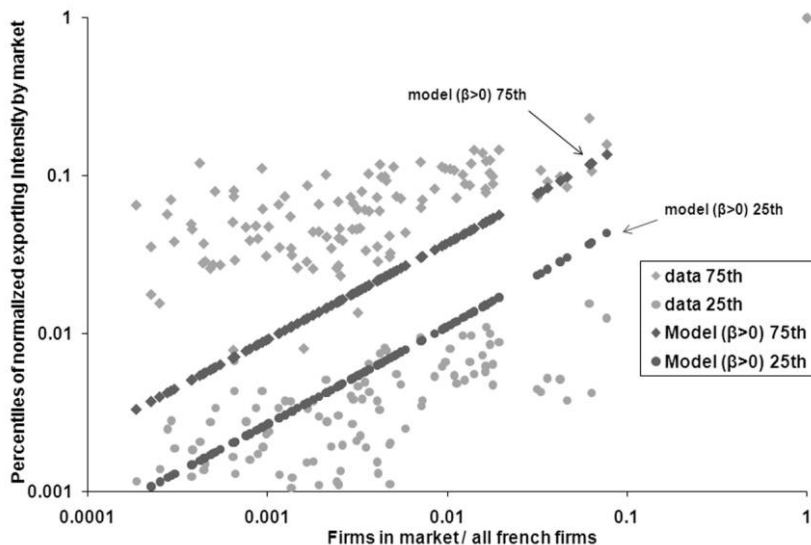


FIG. 9.—Percentiles of normalized export intensity and model predictions

is the same, I will calibrate the two models to have  $\theta = 8.25$ . For the fixed-cost model, the estimated value of  $\hat{\theta} = 1.49$  implies  $\sigma = 6.57$ .

### B. Predictions on the Size Distribution of Firms

Calibrated to match the overall advantage of prolific exporters in terms of sales in France and their median export intensity, the model generates additional testable implications that can be confronted with the data.<sup>30</sup> Careful inspection of expression (25) reveals that the levels of normalized export intensity across percentiles,  $Pr_{ij}$ , differ only if  $\beta > 0$ . Allowing for adjustment in the consumers margin implies that exporting firms will invest systematically more in that margin in the domestic market than in the exporting markets. This effect is apparent for low percentiles in the foreign markets. In fact, for high percentiles in the exporting markets, the predicted export intensities converge to the ones predicted by the theory with  $\beta = 0$ . The variation of export intensity across percentiles is apparent in figure 9. The model calibrated to match the median percentile does very well in predicting the 25th percentile, but it underpredicts the normalized export intensity of the 75th percentile.

<sup>30</sup> These testable implications can be reinterpreted as additional (overidentifying) restrictions in a generalized method of moments estimation of the model's parameters. This approach is essentially followed (on a much larger scale) by Eaton et al. (2010), whereas I choose a calibration methodology to illustrate the predictive power of the new theory.

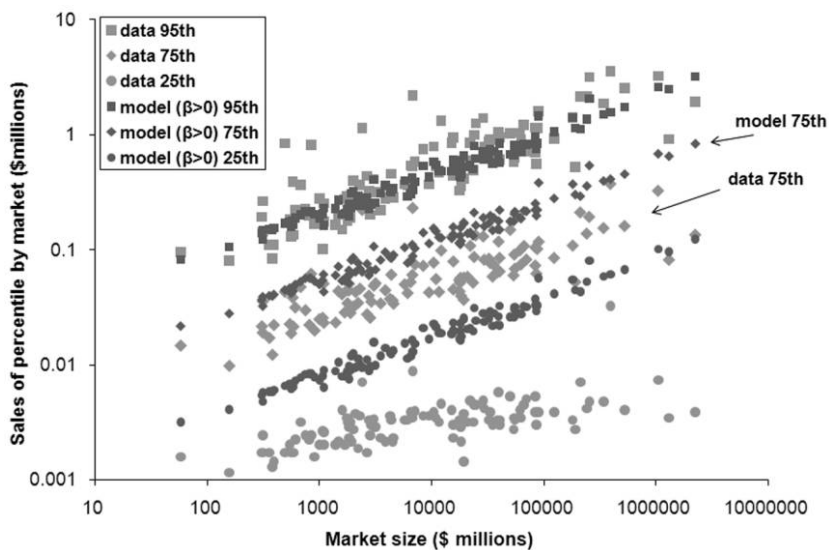


FIG. 10.—Sales distribution by market and the endogenous-cost model

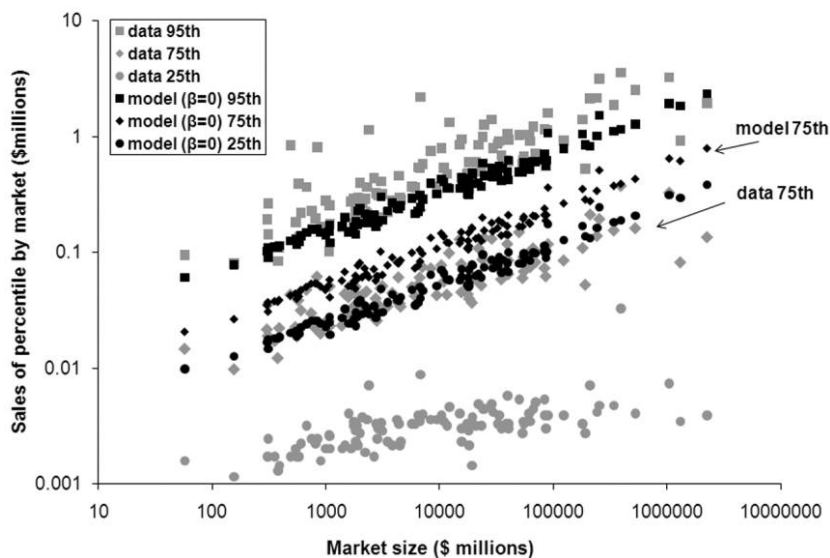


FIG. 11.—Sales distribution by market and the fixed-cost model



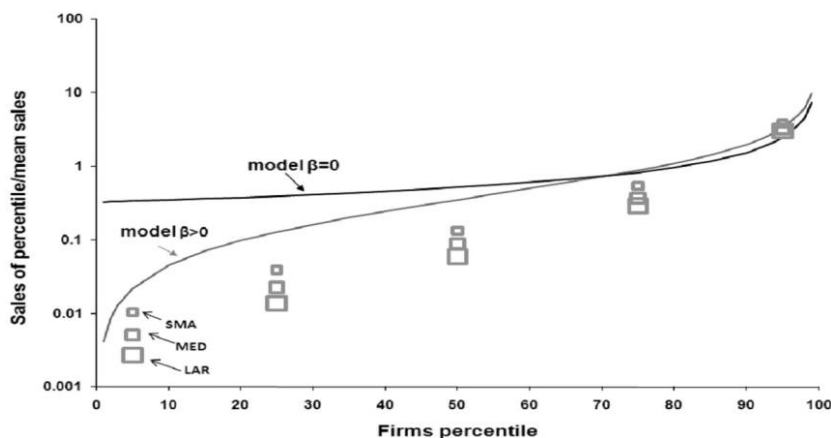


FIG. 12.—Distribution of sales relative to mean sales in calibrated model and in the French data (for small, medium, and larger exporting destinations).

Now I examine the quantitative predictions of the model for the distribution of exporting sales across markets. Figures 10 and 11 illustrate the predictions of the calibrated endogenous-cost and fixed-cost models, respectively. Owing to the identical parameterization of  $\alpha$  and  $\gamma$ , both models capture the increase in sales for each percentile as a function of the size of the market. Moreover, the calibrated endogenous-cost model delivers improved predictions regarding the sales of the 25th percentile.

To separate out the effects of increases in market size to the sales of firms, figure 12 presents the distribution of sales normalized by mean sales. I categorize the markets in three groups depending on the total sales of French firms (Sma, Med, Lar) and present the average of the group for each percentile. The distribution of sales is notably similar across the three categories (except for the slight increase in the variance with the size of the group). In terms of predictions of the theory, both the endogenous and the fixed-cost models imply a Pareto distribution of sales for the highest percentiles and thus can successfully predict the distribution of sales for the larger firms in each market. In addition, the endogenous-cost model predicts well the sales of the firms in the lower percentiles. The fixed-cost model typically overpredicts the size of the smallest exporters (5th percentile) by one or two orders of magnitude.

Finally, notice that lower values of  $\tilde{\theta}$  could improve the predictions of the model for the size distribution of exporters within each destination whereas the fixed-cost model is unable to capture the curvature in the distribution of smaller exporters. Nevertheless, low values of  $\tilde{\theta}$

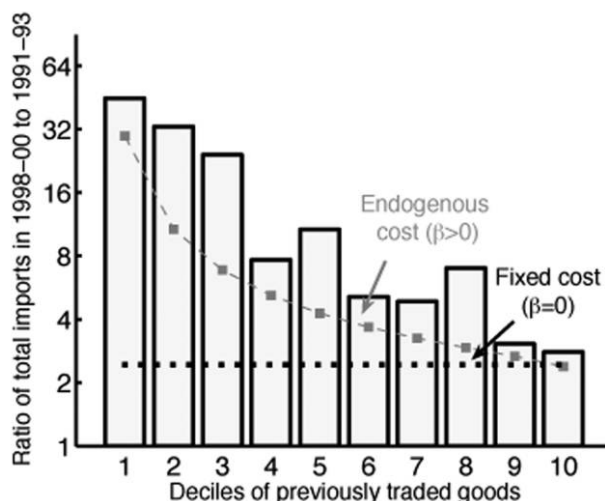


FIG. 13.—Predicted and actual ratio of U.S. imports from Mexico in 1998–2000 to 1991–1993 for each decile of previously traded goods.

imply that the model grossly underperforms in terms of the predictions related to figures 7–9. Therefore, the small discrepancy between the endogenous-cost model and the data in terms of the distribution of sales within a market is symptomatic of unmodeled market-specific heterogeneity. Having successfully evaluated the ability of the model to predict the data, I will now use the model to perform counterfactual experiments of trade cost reductions.

## V. Counterfactual Experiments: Trade Liberalization

I now quantitatively assess the ability of the model to match the patterns of trade flows after trade liberalization episodes. I choose the reduction in variable trade costs so that the two models match the share of Mexican goods in total U.S. manufacturing expenditure, which has risen from 1 percent in 1991 to 2.6 percent in 2000. The additional calibration and data required for this experiment are described in Appendix A. All else equal, the corresponding decrease in trade costs is 8.9 percentage points for both models, which differs from the actual numbers in figure 6 by 5 percentage points on average across categories. In figure 13, I plot the 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, whereas the fixed-cost model falls short of predicting the empirical pattern. Thus, the interaction between the extensive margin of consumers and the CES preferences allows the

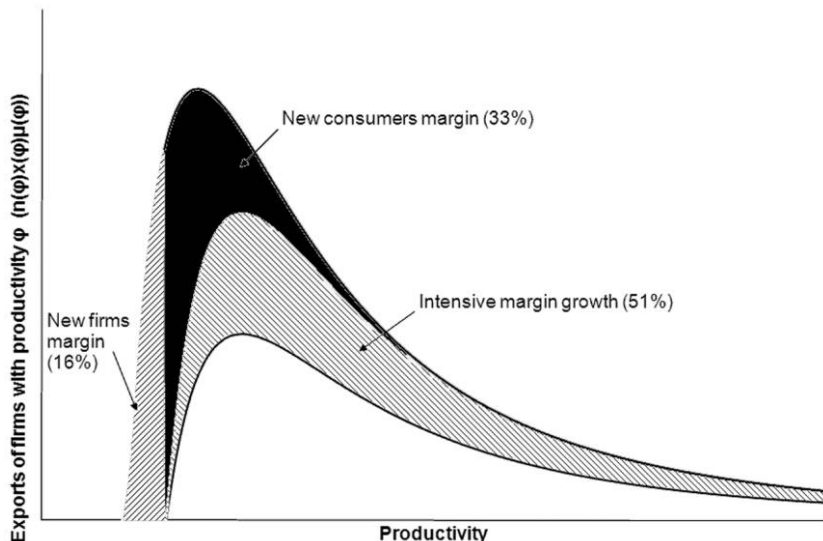


FIG. 14.—Trade liberalization and the margins of trade

endogenous-cost model to successfully replicate the increase in trade flows after the establishment of NAFTA, providing a solution to the puzzle reported by Kehoe (2005).

To evaluate the contribution of the new margin to the increase in total trade flows, I look at the predicted density of exports for firms with different productivities before and after the simulated trade liberalization episode. In figure 14, I graph the predictions of the models for the contribution of intensive margin growth, the new firms margin, and the new consumers margin with respect to the change in aggregate trade flows for the calibrated United States–Mexico trade liberalization episode. Consistent with what the theory predicts, relatively small trade cost changes imply that adjustments in the new consumers margin will be substantially larger for firms with small (but positive) numbers of consumers before the trade liberalization. I also use the model with  $\beta > 0$  to decompose the percentage contribution of the three margins to new trade. The numbers for the intensive, new firms, and consumers margin are 51 percent, 16 percent, and 33 percent, respectively. In contrast, the model with  $\beta = 0$  would predict that the percentage contribution of new firms is 49 percent.

The above calculations imply that up to one-third of new trade was not correctly accounted for by previous theory. Yet the results of Section III.B imply that the model retains the desirable properties of the Melitz–Chaney framework at the aggregate level. Thus, the endogenous-cost

model gives improved predictions for the growth at the disaggregated level while confirming the robustness of previous estimates of the welfare gains from trade.

## VI. Conclusion

I propose a new formulation for the modeling of entry costs into individual markets. This formulation helps to reconcile a number of facts on the size and growth of sales of individual exporters and goods. The proposed framework is notably simple, is amenable to a variety of exercises, and contributes to a better understanding of the data. This context nevertheless ignores a number of aspects of firm behavior, such as firm dynamics or possible variation of the market penetration costs across markets. Together with ideas developed here, these avenues are explored in new theories such as Eaton et al. (2008) and Arkolakis (2009). These theories promise to shed more light on individual exporter behavior and the growth of trade in trade liberalization episodes.

## Appendix A

### Data

#### A. Evidence on Marketing Costs

*Marketing costs as a fraction of GDP.*<sup>31</sup>—U.S. advertising expenditure, across the years 1919–2007, is publicly available in a data set convenient for extensive analysis (<http://purplemotes.net/2008/09/14/us-advertising-expenditure-data/>). The data indicate that the advertising expenditure to GDP ratio is a balanced figure around 2–2.5 percent of GDP since 1982. These data include advertising on television, newspapers, radio, magazines and other periodicals, telephone directories (Yellowbook), and the Internet. They also quantify expenses on other media used for advertising, such as direct mail, billboard and outdoor advertising, and advertising in business papers (trade press). The main source of these data is universal McCann (<http://www.mccann.com>).

The above data do not include forms of marketing such as brand sponsorship and public relations, sales promotion, and interactive marketing. Barwise and Styler (2003) estimate that the spending on these forms of marketing might be as high as the advertising expenditure for 2001–4. With this expanded definition, marketing spending is as much as 4–5 percent of GDP for 2001–4.

Finally, if the definition of marketing is extended to include marketing events

<sup>31</sup> I am greatly indebted to Rachel Stampfli and Reach Caribbean for kindly preparing CPM information for television, newspapers, and radio for the Caribbean markets and Jeffrey Campbell and Hugo Hopenhayn for sharing the information on advertising cost for U.S. newspapers. I am also grateful to Joseph Butt and Carl Howe for providing me with their 2006 report, Carly Litzenger with AC Nielsen for providing CPM for television across designated markets in the United States, and Jonathan Barnard with Zenith Op-timedia for providing CPM data for television across western Europe.

(such as trade shows, telephone sales, supporting product materials, hiring of outside marketing personnel), the estimated marketing spending can rise up to 7.7 percent of GDP. To compute this figure I used the estimates of Butt and Howe (2006) for an actual \$977 billion spent on marketing in the United States in 2005 and GDP data from the Bureau of Economic Analysis.

*Marketing costs and market size.*—To investigate the relationship between the CPM and the size of the population in a market, I collect data on CPM for television, radio, and newspapers. CPM stands for cost per mille, where *mille* is the Latin word for 1,000. It is constructed as the cost of an advertisement divided by the exposure of the advertisement (audience for television, circulation for newspapers) times 1,000. For the case of multiple media within a market, I take weighted averages in which the weights are the exposure for each medium. In two cases in which information for exposure is not available, I simply divide the cost of the advertisement by population and take a simple average for the case of more than one medium. I run a regression of the logarithm of the CPM on the logarithm of population and income per capita of the market. The estimated coefficient on the logarithm of population is always negative and varies between  $-.107$  and  $-.67$ . It is statistically significant at the 5 percent level at all but the case of television data for western Europe, where the coefficient is negative but not significant. Interestingly, the estimated coefficient for newspapers is less negative than the one for television (when I compare the estimated coefficients for the same set of markets). The newspapers example would be closer to the example of flyers, where the returns to scale are not so strong.

The television data include the CPM for (a) the United States, across 210 designated market areas using ratings data provided by Nielsen; (b) western Europe, across 16 countries using data provided by Zenith Optimedia; and (c) the Caribbean area, across 16 markets using data provided by Rachel Stampfli and Reach Caribbean. The newspaper data include CPM for (a) the United States, across 236 metropolitan statistical areas using advertising rates provided by Campbell and Hopenhayn (2005); and (b) the Caribbean area, across 13 markets. The radio data include CPM for the Caribbean area, across 16 markets. All the rest of the details are described in the online data appendix.

## B. Trade Data Description

*French firm-level data.*—I use moments from the data of Eaton et al. (2010) that include France and 112 exporting destinations. The total number of French firms is 229,000, from which only a subset exports. The information includes the sales of manufacturing firms (with the occupation as declared in the mandatory reports of French firms to the fiscal administration) for their manufacturing products excluding only the firms in construction, mining, and oil.

*Population and manufacturing absorption data.*—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 1986 in particular markets are taken from Eaton et al. (2004); see their paper for details.

*Educational data.*—Data for education for 1985 are obtained from Kyriacou

(1991). There are 15 instances of missing data, which are filled out using the Barro and Lee (2000) databases, and two countries for which data are not available (Albania and Oman), which I treat as missing observations.

*Trade by commodity data.*—I use import data from the OECD International Trade by Commodity database (<http://www.sourceoecd.org>). In general, the reporting of trade flows from importing countries is more accurate. The results of my analysis remain the same if I instead use the data on Mexican exports. The data are recorded using the Harmonized System (HS) 1988 revision (rev. 1) at the six-digit level of detail, and the OECD database contains information on 5,404 goods. Data on HS rev. 1 are available from 1990 to 2000. I report two inconsistencies in the U.S. imports data. First, the imports of the United States from Mexico reported by the United States and the exports of Mexico to the United States reported by Mexico are not the same, particularly for 2000. But since the results do not depend on the choice of the year, I choose to include the year 2000. Also note that trade flows at the six-digit level add up to aggregate trade flows from 1990 to 1995. From 1996, there is an average of 1–2 percent of trade flows that are not recorded in the six-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 six-digit level, there is no observable persistent inconsistency that could lead to a mistaken interpretation of the data.

*Grouping the goods.*—The 10 categories that I define include goods in increasing order of total volume of trade during 1991–93. By considering only the goods that are traded throughout all the years of 1991–93, 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 toward higher growth of least traded goods. By allowing for goods that stopped being traded after 1993 to be in the sample, I adjust toward selection of only surviving goods that would create higher growth rates for the least traded goods categories. Finally, I consider only the manufacturing goods. Thus, I drop all the HS codes below 100,000. I also drop the categories that are not classified, categories 970,000 and above. I construct figures related to aggregate trade data by aggregating commodities reported at the HS six-digit classification to higher levels of aggregation. This aggregation creates a small downward bias due to reclassification issues described in the previous paragraph. The above procedures for grouping the goods are used both for the OECD and also for the Feenstra et al. (2002) data for trade costs and trade flows.

Related to the definition of newly traded goods, the definition allows for goods that appear only 1 or 2 years throughout 1991–93 to be included. Thus, it is more favorable toward a higher importance of new goods in the event of a trade liberalization.

*Domestic absorption data for the United States.*—The share of Mexican imports on U.S. domestic manufacturing absorption is constructed as follows. I first construct manufacturing absorption for the United States using OECD STAN data for total output, total imports, and total exports from the same database (ab-

TABLE A1  
NUMBER OF EXPORTERS AND TRADE GROWTH FOR BRAZILIAN FIRMS PREVIOUSLY  
TRADING TO ARGENTINA

	PREVIOUSLY TRADING BY DECILE									
	1	2	3	4	5	6	7	8	9	10
Exporters 1990–92	98	98	97	98	97	98	98	97	98	97
Surviving exporters 1996–98	57	70	69	81	77	81	79	76	81	83
Imports 1996–98 vs. 1990–92	12.5	4.4	7.1	4.0	4.9	3.3	5.4	4.3	2.8	3.0

sorption = output – exports + imports) to avoid bias from using different data. I then divide the bilateral imports of the United States from Mexico using the aggregated OECD trade data with manufacturing absorption to construct the trade shares.

### C. *Brazilian Exporters*

*Evidence using firm-level data: Brazilian exporters.*—The Brazilian manufacturing data cover the universe of Brazilian exporting transactions at the exporter level. Following the Mercosur, Argentina has become the second-most important exporting destination of Brazil (the top destination is the United States, which was not part of the Mercosur). As a result of the Mercosur free-trade agreement that was signed in March 1991 and became fully implemented by the end of 1994, the share of Brazilian exports allocated to Argentina increased from 2.1 percent to 13.3 percent between the years 1990 and 1998.

I repeat the analysis at the firm level by following the same methodology as I did with the product-level data. The reference years are now 1990–92 to 1996–98 and are chosen mainly because of data limitations: the firm-level data cover the period 1990–2001 and are denominated in U.S. dollars for intertemporal comparisons. However, the Brazilian devaluation of 1999 seriously disrupted the figures of that year. An additional problem is that the start of the agreement coincides with the first set of years, 1990–92, so that trade started growing very early in my sample.

I first look at the previously trading firms in 1990–92 classified into deciles as in the product-level analysis. The results are summarized in table A1, where, for each category, I compute the following numbers: (a) the number of firms selling throughout 1990–92, (b) the number of these firms that sold during at least one of the years of 1996–98 (survivors), and (c) the growth of trade for each of the categories. Two of the main regularities stand out from table A1. Consistent with fact F1, the growth of the total trade in the least traded of these deciles is still higher. However, the number of surviving exporters is low, especially in the deciles with the lowest initial trade. If the survivor rate was as high as in the product-level data (almost 95 percent for the U.S. data across all deciles), the growth rate would be even more amplified for the lowest deciles.

Regarding the robustness of fact F2, the surge of new exporters and the

attrition of previously trading exporters imply that the finding might not be robust to the analysis at the firm level. In particular, I find that only 18.9 percent of the firms that were trading in 1990 were also trading in 1998. Their contribution to total trade in 1996–98 is large (54.3 percent of total trade). Notice that new firms have a large contribution in total trade after the liberalization (45.7 percent). The new firms that were sparsely trading (at least once) in 1990–92 account for 27.9 percent and the firms that were not trading in any of the years 1990–92 account for 17.8 percent. A model with firm-level productivity dynamics can assign a clear role to the sparsely trading firms whereas attempting an interpretation within a static framework is likely to be misleading.

#### D. Calibration

*Parameter estimation: robustness.*—Regarding the constant of the OLS regression, which corresponds to the bracketed term in expression (22), its value is 20.14. Given the rest of the parameters estimated and the value of absorption per capita in France, this number translates to  $\psi = 7.75$  for the model with  $\beta = .915$ . For the fixed-cost model with  $\bar{\theta} = 1.49$ , it implies  $\sigma = 6.57$ , which in turn gives a higher  $\psi = 13.7$ .

In addition to the OLS and 2SLS estimates, I also perform the following robustness checks for the estimate of parameter  $\alpha$ . I first take logs on expression (22) and then move the term  $\gamma \ln y_j$  to the left-hand side. Assuming a wide range of  $\gamma$  (between zero and one), I run a regression and obtain a coefficient for  $\alpha$ . This coefficient always lies between .41 and .46, confirming that the estimate for  $\alpha$  is robust. I also consider  $\ln y_j$  as the dependent variable on the left-hand side, moving all the rest of the terms in the right-hand side. The coefficients that I obtain imply that  $\alpha = .43$  and  $\gamma = .56$  (with an  $R^2$  of .52).

*Trade liberalization.*—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 deciles of the goods to 10 percent of the model's previously trading 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 correspond to each decile. In fact, since I keep track of the same number of goods throughout time, I have to compute the average sales of goods for each decile. For the period before liberalization, average sales of each category in the model are given by

$$\begin{aligned}
 I_j^\alpha(y_j)^\gamma(y_i)^{1-\gamma} \frac{1}{\psi} \int_{\phi_k}^{\phi_{k+1}} \left[ \left( \frac{\phi}{\phi_{ij}^*} \right)^{\sigma-1} - \left( \frac{\phi}{\phi_{ij}^*} \right)^{(\sigma-1)/\bar{\beta}} \right] \frac{\theta \phi_k^\theta}{\phi^{\theta+1}} d\phi = \\
 I_j^\alpha(y_j)^\gamma(y_i)^{1-\gamma} \frac{1}{\psi} \left[ \left( \frac{\phi_{k+1}}{\phi_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta - 1} \frac{\phi_k^\theta}{\phi_{k+1}^\theta} - \left( \frac{\phi_{k+1}}{\phi_{ij}^*} \right)^{(\sigma-1)/\bar{\beta}} \frac{1}{1/(\theta\bar{\beta}) - 1} \frac{\phi_k^\theta}{\phi_{k+1}^\theta} \right. \\
 \left. - \left( \frac{\phi_k}{\phi_{ij}^*} \right)^{\sigma-1} \frac{1}{1/\theta - 1} + \left( \frac{\phi_k}{\phi_{ij}^*} \right)^{(\sigma-1)/\bar{\beta}} \frac{1}{1/(\theta\bar{\beta}) - 1} \right],
 \end{aligned}$$

where  $\phi_k, \phi_{k+1}$  is the threshold productivity corresponding to each percentile of



firms, and this is determined through the expression (B4). Similarly, for the period after the liberalization (abusing notation for the rest of this appendix, I denote with a prime the ex post variables),

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

In order to determine the ratio of average sales between the two periods I have to compute the ratios  $\phi_{ij}^*/\phi_{ij}^{*'}$  and

$$\left( \frac{L_j}{L_j'} \right)^\alpha \left( \frac{y_j}{y_j'} \right)^\gamma \left( \frac{y_i}{y_i'} \right)^{1-\gamma}.$$

For the ratio  $\phi_{ij}^*/\phi_{ij}^{*'}$  I use the following expression of  $\phi_{ij}^*$  in terms of  $y_i$ ,  $y_j$ , and  $L_j$ :

$$(\phi_{ij}^{*'})^\theta = \frac{J b_i^\theta y_i^{1-\gamma} [1/(1-1/\tilde{\theta})] - \{1/[1-1/(\tilde{\theta}\tilde{\beta})]\}}{\lambda_{ij} L_j^{1-\alpha} y_j^{1-\gamma} \tilde{\psi}}.$$

With the assumption that there is no change in  $J$ ,  $b_i$ ,<sup>32</sup>

$$\frac{\phi_{ij}^*}{\phi_{ij}^{*'}} = \left[ \frac{\lambda'_{ij} (y_i)^{1-\gamma} (L_j)^{1-\alpha} (y_j')^{1-\gamma}}{\lambda_{ij} (y_i')^{1-\gamma} L_j^{1-\alpha} (y_j)^{1-\gamma}} \right]^{1/\theta}.$$

Therefore, the required information to determine the yet undetermined ratios  $\phi_{ij}^*/\phi_{ij}^{*'}$  and

$$\left( \frac{L_j}{L_j'} \right)^\alpha \left( \frac{y_j}{y_j'} \right)^\gamma \left( \frac{y_i}{y_i'} \right)^{1-\gamma},$$

is the values of  $\lambda_{ij}$ ,  $L_j$ , and  $y_j$ . I describe how I construct these ratios in the next paragraph. Using the data I describe below, I calculate each of the ratios I need for the years 2000 to 1993, 1999 to 1992, and 1998 to 1991 and take the mean of the three ratios.

For the particular calibration exercise that I perform,  $i$  corresponds to Mexico ( $M$ ) and  $j$  to the United States ( $U$ ). I use data on population for  $L_M$ ,  $L_U$  and data on manufacturing absorption for  $y_M$ ,  $y_U$ , as described above. I finally pick the ratio  $\lambda'_{MU}/\lambda_{MU}$  so that I generate the average increase in manufacturing trade to output for the reference years (2.17 times, which, all else equal and with  $\theta = 8.25$ , requires an 8.9 percent drop in trade costs). Not surprisingly this calibration implies changes in overall trade that are very close to the one observed in the data. Finally, notice that for the decomposition of the margins I apply an 8.9 percent change in trade costs across all goods and compute the contribution of each margin to the increase in total trade separately.

<sup>32</sup> Extending to the case in which  $J$ ,  $b_i$  change would deliver the same results (but complicate notation).

## Appendix B

### Theory

#### A. The Maximization Problem of the Firm

First, notice that for the case in which  $\beta > 0$  the market penetration cost function inherits an interiority condition when  $n \rightarrow 1$  since

$$\lim_{n \rightarrow 1} \frac{1 - (1 - n)^{1-\beta}}{1 - \beta} = +\infty.$$

Therefore, when solving for the maximization problem of the firm, I need only to consider the restriction  $n \geq 0$ .

Rewriting the problem of a type  $\phi$  firm in a Lagrangian formulation with the additional constraint that  $n \geq 0$  (I suppress country notation for simplicity), we get

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

where  $\Lambda$  is the Lagrange multiplier.

The FOC with respect to  $\bar{p}$  is

$$p(\phi) = \tilde{\sigma} \frac{w}{\phi}. \quad (\text{B1})$$

The FOC with respect to  $n$  is

$$Ly \frac{p(\phi)^{1-\sigma}}{P^{1-\sigma}} - Ly \frac{p(\phi)^{-\sigma} w}{P^{1-\sigma} \phi} - w \frac{L^\alpha}{\psi} [1 - n(\phi)]^{-\beta} + \Lambda = 0, \quad (\text{B2})$$

and the complementary slackness condition  $\Lambda n(\phi) = 0$ ,  $\Lambda \geq 0$ .

From equation (B1), (B2) becomes

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

From the definition of  $\phi^*$ , equation (9), for all  $\phi \leq \phi^*$ , the above equation holds only for some  $\Lambda > 0 \Rightarrow n(\phi) = 0$  (the constraint  $n(\phi) \geq 0$  is binding). However, for all  $\phi > \phi^*$ ,  $n(\phi) \in (0, 1) \Rightarrow \Lambda = 0$ . In that case the optimal  $n(\phi)$  is given by solving equation (8).

I also check the second-order conditions in order to derive sufficient conditions for this problem to have a unique solution for  $n(\phi) \in (0, 1)$ . The Hessian matrix is

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

where

$$\begin{aligned}\frac{\partial^2 \pi}{\partial p^2} &= -\sigma(1-\sigma)n(\phi)Ly\frac{p(\phi)^{-\sigma-1}}{P^{1-\sigma}} + (-\sigma-1)\sigma n(\phi)Ly\frac{p(\phi)^{-\sigma-2}}{P^{1-\sigma}\phi} < 0, \\ \frac{\partial^2 \pi}{\partial n^2} &= (-\beta-1)w\frac{L^\alpha}{\psi}\frac{1}{[1-n(\phi)]^{\beta+1}} < 0 \quad \text{only if } \beta > 0, \\ \frac{\partial^2 \pi}{\partial n \partial p} &= \frac{\partial^2 \pi}{\partial p \partial n} = (1-\sigma)Ly\frac{p(\phi)^{-\sigma}}{P^{1-\sigma}} + \sigma Ly\frac{p(\phi)^{-\sigma-1}}{P^{1-\sigma}\phi} = 0.\end{aligned}$$

Therefore, the principle submatrices satisfy  $|A_1| < 0$  and  $|A_2| > 0$ . Since the second-order conditions are satisfied, the unique pair  $(n(\phi), p(\phi))$  that solves equations (B1) and (B2), for a given  $\phi > \phi^*$ , is the unique maximum solving the firm's optimization problem (given the price index  $P$ ). Therefore, the above formulation gives  $n(\phi)$  as the solution of equation (B2) for all  $\phi > \phi^*$ . In addition, for  $\phi \leq \phi^*$ ,  $n(\phi) = 0$ .

### 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>33</sup> The total variable profits of firms from  $i$  in  $j$  are simply  $X_{ij}/\sigma$ , and thus labor income from production is  $X_{ij}(\sigma-1)/\sigma$ . From the definition of total exports, equation (15), total market penetration costs paid by firms of  $i$  selling to  $j$  are

$$M_{ij} \int_{\phi_{ij}}^{\infty} L_j^\alpha w_j^\gamma w_i^{1-\gamma} \frac{1}{\psi} \frac{1 - [1 - n_{ij}(\phi)]^{1-\beta}}{1-\beta} \frac{\theta(\phi_{ij}^*)^\theta}{\phi^{\theta+1}} d\phi = X_{ij} \frac{\theta - (\sigma-1)}{\theta\sigma} = X_{ij} m. \quad (\text{B3})$$

Thus, total profits accrued to country  $i$  are

$$\begin{aligned}\pi_i L_i &= \frac{1}{\sigma} \sum_v X_{iv} - \frac{\theta - (\sigma-1)}{\theta\sigma} \sum_v X_{iv} \\ &= \frac{\sigma-1}{\theta\sigma} \sum_v X_{iv}.\end{aligned}$$

To conclude the proof I need to show that country output,  $\sum_v X_{iv}$ , equals spending,  $\sum_v X_{vi} = y_i L_i$ . Trade balance implies that the total income of  $i$  must be equal to its total spending. Total income is composed of (i) income other than fixed costs, (ii) income from fixed costs from exporting activities, and (iii) income from exporting activities of foreign countries in country  $i$  and equals total spending,

$$\begin{aligned}(1-m) \sum_v X_{iv} + \gamma m \sum_v X_{iv} + (1-\gamma)m \sum_v X_{vi} &= \sum_v X_{vi} \\ \Rightarrow \sum_v X_{iv} &= \sum_v X_{vi},\end{aligned}$$

proving the result. Notice that the right-hand side of the last expression is by definition equal to  $y_i L_i$ . Therefore, profits can be written as

<sup>33</sup> For an in-depth analysis of the derivation of the labor market equilibrium in models with heterogeneous firms, see Eaton and Kortum (2010).

$$\pi_i = \eta y_i, \quad \eta = \frac{\sigma - 1}{\theta \sigma},$$

and the labor market equilibrium can be written as a function of country sales

$$w_i L_i = (1 - \eta) y_i L_i = (1 - \eta) \sum_v X_{vi} = (1 - \eta) \sum_v X_{iv},$$

which gives equation (18) in the text.

### 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 Eaton et al. (2010) 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 as a function of the relative firm percentile in that market,  $\Pr_{ij}$ . Sales  $r_{ij}$ , for firms with  $\phi \geq \phi_{ij}^*$ , are given by expression (14). 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

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

which implies that

$$1 - \Pr_{ij} = \frac{(\phi_{ij}^*)^\theta}{(\phi)^\theta}. \quad (\text{B4})$$

Replacing (B4) into (14) obtains that sales for firms are given by equation (23) in the text.

### D. Proof of Proposition 3

For part *a*, note that

$$\frac{d \ln X_{ij}}{d \ln \tau_{ij}} = \frac{\tau_{ij}}{X_{ij}} \frac{d X_{ij}}{d \tau_{ij}}. \quad (\text{B5})$$

Thus, I compute the terms of the decomposition of  $d \ln X_{ij} / d \ln \tau_{ij}$  by computing each of the terms of equation (26) and multiplying them by  $\tau_{ij} / X_{ij}$ .

The first term of the decomposition is given by

$$\begin{aligned} & \frac{\tau_{ij}}{X_{ij}} J_i \int_{\phi_{ij}^*}^{+\infty} n_{ij}(\phi) \frac{d\{[p_{ij}(\phi)^{1-\sigma}/P_j^{1-\sigma}]y_i\}}{d\tau_{ij}} g_i(\phi) d\phi = \\ & \frac{\tau_{ij}}{X_{ij}} J_i \int_{\phi_{ij}^*}^{+\infty} n_{ij}(\phi) \frac{d\{[\phi^{\sigma-1}/(\phi_{ij}^*)^{\sigma-1}](\sigma/\psi)w_i^\gamma L_j^{1-\gamma} L_j^{\alpha-1}\}}{d\tau_{ij}} g_i(\phi) d\phi = \\ & (1 - \sigma) \frac{d \ln \phi_{ij}^*}{d \ln \tau_{ij}} + \gamma \frac{d \ln w_i}{d \ln \tau_{ij}} + (1 - \gamma) \frac{d \ln L_j}{d \ln \tau_{ij}}, \end{aligned}$$

where the definition of  $\phi_{ij}^*$ , equation (9), is used in the second equality and by setting  $w_j = 1$  as the numeraire, I obtain the expression for the intensive margin.

Computing the second term requires more cumbersome calculations. With the equilibrium choice of  $n_{ij}(\phi)$ , equation (10), and the definition of  $\phi_{ij}^*$ , equation (9),

$$\begin{aligned}\frac{dn_{ij}(\phi)}{d\ln \tau_{ij}} &= \frac{d[1 - (\phi_{ij}^*/\phi)^{(\sigma-1)/\beta}]}{d\ln \tau_{ij}} \\ &= -\frac{\sigma-1}{\beta} \left(\frac{\phi_{ij}^*}{\phi}\right)^{(\sigma-1)/\beta} \frac{d\ln \phi_{ij}^*}{d\ln \tau_{ij}},\end{aligned}$$

so that

$$\begin{aligned}&\frac{\tau_{ij}}{X_{ij}} J_i \int_{\phi_{ij}^*}^{+\infty} \frac{dn_{ij}(\phi)}{d\tau_{ij}} p_{ij}(\phi) x_{ij}(\phi) g_i(\phi) d\phi = \\ &- \frac{J_i}{X_{ij}} \frac{\sigma-1}{\beta} \left[ \int_{\phi_{ij}^*}^{+\infty} \left(\frac{\phi_{ij}^*}{\phi}\right)^{(\sigma-1)/\beta} \frac{[\tilde{\sigma}(w_i/\phi)]^{1-\sigma}}{P_j^{1-\sigma}} y_j \frac{\theta b_i^\theta}{\phi^{\theta+1}} d\phi \right] \frac{d\ln \phi_{ij}^*}{d\ln \tau_{ij}}.\end{aligned}$$

By performing the integration and using the definition of  $\phi_{ij}^*$ , equation (9), this equation equals

$$- \frac{J_i}{X_{ij}} \frac{b_i^\theta}{(\phi_{ij}^*)^\theta} \frac{\sigma-1}{\beta} \frac{\theta\sigma}{\theta - (\sigma-1) + (\sigma-1)/\beta} \frac{w_j^\gamma w_i^{1-\gamma} L_j^{\alpha-1}}{\psi} \frac{d\ln \phi_{ij}^*}{d\ln \tau_{ij}}.$$

With the expression for average sales, equation (22), together with (17), the above equation can be written as

$$\begin{aligned}&- \frac{M_{ij} \bar{X}_{ij}}{X_{ij}} \frac{\sigma-1}{\beta} \frac{\theta/[\theta - (\sigma-1) + (\sigma-1)/\beta]}{\theta/[(\sigma-1)/\beta]/\{[\theta - (\sigma-1)]/[\theta - (\sigma-1)/\beta]\}} \frac{d\ln \phi_{ij}^*}{d\ln \tau_{ij}} = \\ &(-\theta + \sigma - 1) \frac{d\ln \phi_{ij}^*}{d\ln \tau_{ij}},\end{aligned}$$

obtaining the second term of the decomposition.

Finally, for the third term, notice that it involves  $n(\phi_{ij}^*)$ , which from equation (10) equals zero for firms with  $\phi = \phi_{ij}^*$ . Thus, this term equals zero. Adding the three terms gives us the decomposition of (B5) that appears in equation (27).

For part *b*, simply notice that I consider a partial elasticity so that  $\partial \ln w_i / \partial \ln \tau_{ij} = 0$ , which by the definition of  $\phi_{ij}^*$ , equation (9), implies that  $(\partial \ln \phi_{ij}^* / \partial \ln \tau_{ij}) - (\partial \ln \phi_{ij}^* / \partial \ln \tau_{ij}) = 1$ . This last relationship combined with the expression for the decomposition obtained in part *a* can be directly used to compute  $\partial \ln (X_{ij}/\bar{X}_{ij}) / \partial \ln \tau_{ij} = -\theta$ , concluding the proof of part *b*.

In general, notice that by following Chaney (2008) in assuming that the trading relationship of *i* and *j* is remote enough to *j* so that changes in  $\tau_{ij}$  have only a minor effect in the relative wages of *i* to *j*,  $\partial \ln w_i / \partial \ln \tau_{ij} \approx 0$  for all *i* (given the choice of the numeraire) and also a minor effect in the price index of *j*,  $\partial \ln P_j / \partial \ln \tau_{ij} \approx 0$ . Then from equation (9), it is  $\partial \ln \phi_{ij}^* / \partial \ln \tau_{ij} \approx 1$ . These approximations imply that the decomposition becomes

$$\frac{d\ln X_{ij}}{d\ln \tau_{ij}} \approx -(\sigma-1) - (\theta - \sigma + 1) + 0,$$

with the first term on the right-hand side the intensive margin growth elasticity, the second term the new consumers margin elasticity, and the third term the new firms margin elasticity; it is also true that  $d \ln X_{ij} / d \ln \tau_{ij} \approx -\theta$ , which is the result of Chaney (2008).

### E. Welfare

To compute welfare consider the ideal price index, equation (4),

$$\log P_j = \frac{1}{1-\sigma} \log \left[ \sum_v J_v \left( \frac{\sigma}{\sigma-1} w_v \tau_{vj} \right)^{1-\sigma} \int_{\phi^*_{vj}}^{+\infty} \phi^{\sigma-1} \left[ 1 - \left( \frac{\phi^*_{vj}}{\phi} \right)^{(\sigma-1)/\beta} \right] g_v(\phi) d\phi \right].$$

Taking the derivative of this expression with respect to changes in  $\log \tau_{ij}$ , I can write

$$\frac{d \log P_j}{d \log \tau_{ij}} = \sum_v \lambda_{vj} \left[ \left( \frac{d \log w_v}{d \log \tau_{ij}} + 1 \right) - \frac{1}{1-\sigma} \tilde{c}_{vj} \frac{d \log \phi^*_{vj}}{d \log \tau_{ij}} + 0 \right], \quad (\text{B6})$$

where the derivative of the integral is taken using Leibnitz's rule, I have used  $1 - (\phi^*_{ij}/\phi^*_{ij})^{(\sigma-1)/\beta} = 0$ , and I also define

$$\tilde{c}_{ij} = \frac{\sigma-1}{\beta} \left[ \int_{\phi^*_{ij}}^{+\infty} \phi^{\sigma-1} \left( \frac{\phi^*_{ij}}{\phi} \right)^{(\sigma-1)/\beta} g_i(\phi) d\phi \right] \left/ \left[ \int_{\phi^*_{ij}}^{+\infty} \phi^{\sigma-1} \left[ 1 - \left( \frac{\phi^*_{ij}}{\phi} \right)^{(\sigma-1)/\beta} \right] g_i(\phi) d\phi \right] \right.$$

With the Pareto distribution assumption for the productivities  $\tilde{c}_{ij} = \theta - \sigma + 1$ , which completes the derivation.

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