Why Do Firms Export? Dumping, Marginal Costs, and the Gains from Trade.

Bernardo S. Blum
Rotman School of Management, Univesrity of Toronto

Sebastian Claro
Pontificia Universidad Catolica de Chile

Ignatius J. Horstmann
Rotman School of Management, University of Toronto

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Abstract

We find that Chilean manufacturing plants are more likely to enter foreign markets when domestic demand is low and are more likely to exit them when domestic demand is high. We argue that this behavior is the result of costs created by limited firm-level capacity. To demonstrate our point, we build a heterogeneous firm model in which firms are endowed with different levels of fixed capacity. The fixed capacity gives firms (different) upward sloping marginal cost curves. With increasing marginal cost, a decline in domestic demand makes exporting cheap at the margin and so firms that didn't export begin to do so. When dometic demand is strong, exporting is expensive at the margin and so some firms exit exporting. The model has a number of additional predictions that are supported by the data. Specifically, i) domestic and export sales are predicted to be negatively correlated, ii) domestic sales are predicted to fall when a firm enters exporting and to rise when a firm exits exporting and iii) firms should export to few destinations. The existence of increasing costs also have implications for predictions about the impact of free trade on firm level and aggregate productivity.

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1 Introduction

What limits a firm's ability to export? Our current understanding of firm level exporting behavior tells us that the limits to a firm's exporting activities are basically the firm's inherent productivity and distance/trading costs. In essence exporting firms are those that, due to their relatively high productivity and low trading costs, can either sell sufficient quantities of their differentiated product abroad to cover the fixed cost of entering foreign markets (Roberts and Tybout (1997), Clerides et al (1998), Bernard and Jensen (1999), Melitz (2003), Das et al (2007)) or can sell a homogeneous goods at a lower landed price than their competitors (Eaton and Kortum (2002) and Bernard et al (2003)).

While the importance of inherent productivity and trading costs in limiting firm-level exporting activity seems indisputable, we argue in this paper that there is an additional element that plays a key role here. That element is the firm's level of capacity. Quite simply, we argue that a firm limits its exporting activity because lack of capacity makes exporting too costly and that it expands its exports / enters exporting because excess capacity makes exporting inexpensive. We demonstrate the importance of this effect using plant-level data from Chile.

To capture the effect of capacity on firm-level exporting behavior, we introduce fixed capacity into a standard Melitz trade model. Specifically, we assume that firms are heterogeneous in their endowment of fixed capacity and that this fixed capacity results in each firm facing increasing marginal cost. Firms endowed with larger capacities have lower marginal cost than those endowed with less capacity. Firms sell in their domestic market and can choose whether or not to export. To highlight the importance of capacity for exporting, we assume that firms also face an industry-level demand shock in one country. Within this setting, we can explore the exporting decision and how the demand shock affects who exports, how much is exported and the relation between domestic sales and exports.

We find, consistent with other studies, that the firms with large capacity, and so large output, export while those with small capacity do not. More importantly, we show that i) the probability of a firm entering exporting is negatively correlated with domestic industry-level demand; ii) a formerly non-exporting firm that enters exporting reduces domestic sales; iii) a formerly exporting firm that exits exporting increases domestic sales; iv) mid-sized firms should have multiple rounds of entry into and exit from exporting that are correlated with domestic demand shocks; v) an exporting firm should export relatively large amounts to relatively few countries. We also argue that these predictions are not ones that would arise in a standard constant returns-to-scale model of trade.

To check the model's predictions, we examine plant-level data from a panel of Chilean manufacturers over the period 1990 - 2000. We find that, in the year that plants enter foreign markets, they experience on average an 11% reduction in their domestic sales when compared to plants that decided not to enter. Plants that exit foreign markets increase their domestic sales by 8.2% relative to the ones that continued exporting. We also find that a significant fraction of plants have multiple rounds of entry into and exit from exporting. Between 22%

and 28% of all plants export in some years but not in others, and 26% of these plants entered or exited foreign markets 3 or more times over the 11 years covered in our sample. Further, we show that a decrease in domestic sales at the industry level significantly increases the probability that plants in that industry will enter foreign markets. Conversely, an increase in the industry's domestic sales lower this probability. Specifically, we find that a 1% decrease in domestic sales at the industry levels is associated with an increase in the probability that a plant will export that varies between .11% and .19%. We note, finally that prediction v) is consistent with studies by Eaton, Kortum, and Kramarz (2004, 2007) and Eaton, Eslava, Kugler, and Tybout (2007) using French and Colombian data respectively.

The rest of the paper is organized as follows. The next section develops the model and presents predictions on exporting and domestic sales behavior. Section 3 describes the data while Section 4 presents tests of the model predictions. Section 5 concludes. An Appendix contains proofs of various results from Section 2.

2 A Fixed Capacity Model

To facilitate the description of the basic model and its properties, we begin with a simple closed economy model with deterministic demand. Subsequently, we develop and analyze the open economy model and trade behavior with stochastic demand.

2.1 A Closed Economy Model

To begin, consider an economy with 2 final goods sectors, a perfectly competitive sector producing a homogeneous good, X, and a monopolistically competitive sector with a continuum of firms producing differentiated products indexed by i. Demand is described by a representative consumer with utility function $U = X^{\alpha}Y^{1-\alpha}$, where Y is a CES aggregator defined as $Y = \left[\int y(i)^{\rho} di\right]^{1/\rho}$ and $y(i)$ is the quantity consumed of variety i. We assume that $\alpha \in (0,1)$ and $\rho \in (0,1)$. The good X is produced with a constant returns to scale technology utilizing only labor. Units are defined so that one unit of labor produces one unit of X. We assume that X is the numeraire good with the price of X normalized to 1. Together, these assumptions imply that the wage rate is also 1.

Production in the monopolistically competitive sector is described by the production function $y_i = AK_i^{.5}L_i^{.5}$, where K_i is the i'th producer's (fixed) capacity and L_i its labor utilization. We assume that firms are heterogeneous and are described by their capital endowment K_i, with $K_i \in [\underline{K}, \overline{K}]$, $\underline{K} > 0$. The distribution of K_i is given by the distribution function $G(K)$ with density $g(K)$. The measure of firms is assumed equal to N and is, for now, exogenous. Given the assumed production structure, the cost function for firm i is given by $C_i = (1/A^2)\ (1/K_i)y(i)^2$. Because capacity is fixed, each firm operates with increasing marginal costs. The prices for the varieties i are given by the function $p(i)$.

Given the Cobb-Douglas preference structure, consumption of X is given by αM, where M is aggregate income. The remaining $(1-\alpha)M$ is spent on the differentiated products. Given the CES preference structure for the differentiated product, Y, demand for variety i is given by the expression $y(i) = (1-\alpha)Mp(i)^{-\sigma}P^{\sigma-1}$, where $P = \left[\int p(i)^{1-\sigma} di\right]^{1/1-\sigma}$ is the CES price index and $\sigma = 1/(1-\rho) > 1$. For a firm with capacity K_i, profits are given by the expression

$$\pi(K_i) = p(i)y(i) - (1/A^2)(1/K_i)y(i)^2. \tag{1}$$

Profit maximization implies that the price charged by a firm with capacity K_i is given by

$$p(K_i) = \left[\frac{\sigma - 1}{2\sigma}\frac{A^2 K_i}{(1-\alpha)M}\right]^{-1/(1+\sigma)} P^{(\sigma-1)/(1+\sigma)}. \tag{2}$$

Substitution of the above expression into the expression for the price index yields

$$P = \left[\int [\psi^{-1/(1+\sigma)} K_i^{-1/(1+\sigma)} P^{(\sigma-1)/(1+\sigma)}]^{1-\sigma} g(K_i)di\right]^{1/1-\sigma},$$

where $\psi = \frac{\sigma-1}{2\sigma}\frac{A^2}{(1-\alpha)M}$. This expression simplifies to

$$P = \psi^{-1/2\sigma}\left[\int K_i^{(\sigma-1)/(1+\sigma)} g(K_i)di\right]^{(1+\sigma)/2\sigma(1-\sigma)} \tag{3}$$

Substitution of equations (2) and (3) into the expression for demand gives the output of a firm with capacity K_i, referred to subsequently as $y(K_i)$.

Finally, income is simply the sum of labor income and firm profits in the Y-sector. The latter will be positive given the assumption of increasing costs and fixed numbers of firms in this sector. Given our normalization, aggregate labor income is simply given by L. Thus, aggregate income is defined implicitly by the expression

$$M = L + \int \pi(K_i)g(K_i)di. \tag{4}$$

For future reference, it will be useful to know what impact changes in α and K_i have on the relevant variables. From (2) and (3), price can be written as

$$p(K_i) = K_i^{-1/(1+\sigma)}\psi^{-(3\sigma-1)/2\sigma(1+\sigma)}\left[\int K_i^{(\sigma-1)/(1+\sigma)} g(K_i)di\right]^{-1/2\sigma}, \tag{5}$$

while quantity is

$$y(K_i) = (1-\alpha)MK_i^{\sigma/(1+\sigma)}\psi^{(1-\sigma+2\sigma^2)/2\sigma(1+\sigma)}\left[\int K_i^{(\sigma-1)/(1+\sigma)}g(K_i)di\right]^{-1/2\sigma}. \tag{6}$$

Notice that, income constant, $p(K_i)$ is declining in α; that is, as demand shifts toward the homogeneous goods sector and away from the differentiated products sector, prices of the differentiated products decline (income constant). Although it takes a little more work, one can show that, income constant, $y(K_i)$ is also declining in α; that is, the reduction in demand for the differentiated product sector more than offsets the price reduction and so quantity sold declines. Together, these two facts imply that gross revenue, $p(K_i)y(K_i)$ also declines in α, income constant. With gross revenue declining in α, profits also decline. To see this, note that by the envelope theorem,

$$\frac{d\pi(K_i)}{d\alpha} = [p(K_i) - \frac{2}{A^2K_i}y(K_i)]\frac{\partial y(K_i)}{\partial \alpha} < 0$$

since $y(K_i)$ is declining in α and the term in brackets is just price minus marginal cost, which is positive. To sum up, income constant, $p(K_i), y(K_i)$ and $\pi(K_i)$ all decline with α.

Notice also that, since α and M enter in an identical but inverse fashion, all three variables also are increasing in M. Finally, from equation (4), we have that

$$\frac{dM}{d\alpha} = \frac{\int \frac{\partial\pi(K_i)}{\partial\alpha}g(K_i)di}{1-\int \frac{\partial\pi(K_i)}{\partial M}g(K_i)di} < 0.$$

Too see this, note that from above, the numerator is negative; the denominator is positive since the derivative of aggregate firm profits with respect to M must be less than $(1-\alpha)$, the derivative of aggregate firm revenue with respect to M. Thus, including general equilibrium effects, we have that an increase in α lowers aggregate income, M, and causes a decline in prices, firm output and profits in the Y sector.

We can also analyze how firm profits vary across firms with different endowments of capital. Inspection of equations (5) and (6) reveal that firms with larger amounts of capital charge lower prices and sell more output. Firms with larger values of K_i also earn higher profits since an increase in K_i lowers costs for any given value of y_i. A revealed preference argument then proves that $\pi(K_i)$ is increasing in i.

2.2 An Open Economy Model with Stochastic Demand

Consider, next, a world with two countries: Home and Foreign. Foreign is as described above, with relevant variables labelled with an asterisk (*). Home is essentially as above with one difference: Y-sector demand is stochastic. For simplicity, we assume that there are two possible demand realizations in this sector, High and Low. To capture this feature of demand , we assume that the utility parameter α is a random variable that can take on values, α_1 or $\alpha_2 < \alpha_1$. The probability that $\alpha = \alpha_1$ is given by $\phi > 0$ so that ϕ represents the probability that the Y-sector experiences low demand. Firms are assumed to know the demand realization prior to making any decision on price and exporting. Y-sector demand in Foreign is assumed to be deterministic, with the utility parameter in Foreign given by $\alpha^* = \alpha_2$. We also assume that there is free trade between the two economies in both X and Y and that transport costs are zero. For the Y-sector, we assume that there is a fixed cost of exporting, labelled as $E > 0$. There are no fixed or variable costs of exporting in the X-sector. Finally, we assume that, in the Y-sector, markets are segmented internationally and that labor endowments in the two countries, L and L^*, are the same.

Given this set-up, we can describe the pricing and export decisions of a representative Y-sector firm, assuming the firm exports, in both Home and Foreign. For a Home firm with capacity K_i, the pricing decisions involves setting a price $p_H(K_i)$ at Home and a price $p_F(K_i)$ for Foreign to maximize overall profits given by:

$$\begin{aligned}\pi_H &= p_H(K_i)^{1-\sigma}(1-\alpha_j)MP_H^{\sigma-1} + p_F(K_i)^{1-\sigma}(1-\alpha^*)M^*P_F^{\sigma-1} \\ &\quad -\frac{1}{A^2K_i}[(1-\alpha_j)Mp_H(K_i)^{-\sigma}P_H^{\sigma-1} + (1-\alpha^*)M^*p_F(K_i)^{-\sigma}P_F^{\sigma-1}]^2 - E.\end{aligned}$$

where α_j gives the demand realization in Home and P_H, P_F represent the Home Country and Foreign Country price indices respectively.[1] The profit maximizing prices are given implicitly by the conditions:

$$\begin{aligned}(\sigma-1)p_H(K_i) &= \frac{2\sigma}{A^2K_i}[(1-\alpha_j)Mp_H(K_i)^{-\sigma}P_H^{\sigma-1} + (1-\alpha^*)M^*p_F(K_i)^{-\sigma}P_F^{\sigma-1}] \\ (\sigma-1)p_F(i) &= \frac{2\sigma}{A^2K_i}[(1-\alpha_j)Mp_H(K_i)^{-\sigma}P_H^{\sigma-1} + (1-\alpha^*)M^*p_F(K_i)^{-\sigma}P_F^{\sigma-1}].\end{aligned}$$

Analogous conditions apply for a representative Foreign firm setting prices $p_H^*(K_i)$ for Home and a price $p_F^*(K_i)$ for Foreign. Solving the above for $p_H(K_i)$ and $p_F(K_i)$, we obtain

$$p_H(K_i) = p_F(K_i) = [\frac{\sigma-1}{2\sigma}A^2K_i]^{-1/(1+\sigma)}[(1-\alpha_j)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{1/(1+\sigma)}. \quad (7)$$

Prices set by a representative Foreign firm are defined identically.

Should the firm choose not to export, then it's pricing problem is as defined in equation (2) above. A firm chooses to export if the extra variable profits it obtains from exporting

[1] Note that these price indices can contain prices for both Home and Foreign firm products.

more than cover the exporting cost E. For a given realization of α_j, the difference in variable profits between exporting and not for a Home firm with capacity K_i is given by

$$\begin{aligned}\Delta\pi_H(K_i) &= p_H(K_i)^{1-\sigma}(1-\alpha_j)MP_H^{\sigma-1} + p_F(K_i)^{1-\sigma}(1-\alpha^*)M^*P_F^{\sigma-1} \\ &\quad -\frac{1}{A^2K_i}[(1-\alpha_j)Mp_H(i)^{-\sigma}P_H^{\sigma-1} + (1-\alpha^*)M^*p_F(i)^{-\sigma}P_F^{\sigma-1}]^2 \\ &\quad -p(K_i)^{1-\sigma}(1-\alpha_j)MP_H^{\sigma-1} + \frac{1}{A^2K_i}[(1-\alpha_j)Mp(K_i)^{-\sigma}P_H^{\sigma-1}]^2. \qquad (8)\end{aligned}$$

From the envelope theorem, $\dfrac{d\Delta\pi_H(K_i)}{dK_i}$ is given by

$$\begin{aligned}\frac{d\Delta\pi_H(K_i)}{dK_i} &= \frac{1}{A^2K_i^2}\{[(1-\alpha_j)Mp_H(i)^{-\sigma}P_H^{\sigma-1} + (1-\alpha^*)M^*p_F(i)^{-\sigma}P_F^{\sigma-1}]^2 \\ &\quad -[(1-\alpha_j)Mp(K_i)^{-\sigma}P_H^{\sigma-1}]^2\}.\end{aligned}$$

Since the term in the first square bracket is simply total output if exporting while the term in the second square bracket is total output if not exporting, $\Delta\pi_H(K_i)$ is increasing in K_i as long as total output if exporting is larger than total output if not exporting. Since marginal revenue is decreasing in output, this must be the case, however. As a result, we have that the return to exporting is increasing in K_i and so, for any realization of α_j, the firms with large capacity export while the firms with small capacity do not. For future reference, we define the marginal exporting firm in Home as $\widehat{K}_H(E,\alpha_j)$ and the marginal exporting firm in Foreign as $\widehat{K}_F(E,\alpha_j)$. From the previous section, if $\alpha^* < \alpha_j$, then profits for a Foreign country firm choosing not to export are larger than the profits for a Home country firm choosing not to export. Since profits from exporting are the same for both a Foreign and Home country firm, it must be that $\widehat{K}_F(E,\alpha_j) > \widehat{K}_H(E,\alpha_j)$ if $\alpha^* < \alpha_j$. Analogously, $\widehat{K}_F(E,\alpha_j) < \widehat{K}_H(E,\alpha_j)$ if $\alpha^* > \alpha_j$.

From the above, the Y-sector price index in Home when $\alpha_j = \alpha_1$ is given implicitly by:

$$P_H^{1-\sigma}\gamma = [(1-\alpha_1)MP_H^{(\sigma-1)}]^{(1-\sigma)/(1+\sigma)} \int_{\underline{K}}^{\widehat{K}_H} K_i^{(\sigma-1)/(1+\sigma)} g(K_i)di +$$

$$[(1-\alpha_1)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{\frac{1-\sigma}{1+\sigma}} \int_{\widehat{K}_H}^{\overline{K}} K_i^{(\sigma-1)/(1+\sigma)}[g(K_i) + I(K_i)g^*(K_i)]di, \quad (9)$$

where $\gamma = [A^2(\sigma-1)/2\sigma]^{(1-\sigma)/(1+\sigma)}$ and $I(K_i) = 0$ for $K_i \in [\widehat{K}_H, \widehat{K}_F)$ and $I(K_i) = 1$ for $K_i \in [\widehat{K}_F, \overline{K}]$. The price index for Foreign when $\alpha_j = \alpha_1$ is given implicitly by

$$P_F^{1-\sigma}\gamma = [(1-\alpha^*)MP_F^{(\sigma-1)}]^{(1-\sigma)/(1+\sigma)} \int_{\underline{K}}^{\widehat{K}_F} K_i^{(\sigma-1)/(1+\sigma)} g^*(K_i)di +$$

$$[(1-\alpha_1)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{\frac{1-\sigma}{1+\sigma}} \int_{\widehat{K}_H}^{\overline{K}} K_i^{(\sigma-1)/(1+\sigma)}[g(K_i) + I(K_i)g^*(K_i)]di. \quad (10)$$

When $\alpha_j = \alpha_2 = \alpha^*$, the expressions are similar except that, in this case, $\widehat{K}_H = \widehat{K}_F$.

Finally, the value of income for Home, M and for Foreign, M^*, are defined as before. Specifically, income in Home is defined implicitly by

$$M = L + \int \pi_H(K_i)g(K_i)di \quad (11)$$

and income in Foreign by

$$M^* = L^* + \int \pi_F(K_i)g^*(K_i)di. \quad (12)$$

The equilibrium of the model when $\alpha_j = \alpha_1$ is defined by the equations (7), (8) (and the analogous condition for a Foreign firm), (9), (10), (11) and (12) and the analogues for Home and Foreign non-exporting firms of equation (2). The equilibrium for the case $\alpha_j = \alpha_2$ is defined by a similar set of equations but in which $\widehat{K}_H = \widehat{K}_F$.

The issue of interest is how a domestic demand shock affects equilibrium outcomes, specifically, the levels of domestic sales by Home firms, the level of exports by Home firms and the set of Home firms that export. We address this question by examining the impact on equilibrium outcomes of a small change in α (i.e., we do a comparative statics analysis with respect to α). Substituting for prices in the Home and Foreign demand equations, we have that domestic and export sales by a Home firm with capacity K_i (and that exports) are given respectively by

$$y_H(K_i) = (1-\alpha_j)MP_H^{\sigma-1}\gamma^{\sigma/(1-\sigma)}K_i^{\sigma/(1+\sigma)}[(1-\alpha_j)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{-\sigma/(1+\sigma)} \quad (13)$$

and

$$y_F(K_i) = (1-\alpha^*)MP_F^{\sigma-1}\gamma^{\sigma/(1-\sigma)}K_i^{\sigma/(1+\sigma)}[(1-\alpha_j)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{-\sigma/(1+\sigma)}. \quad (14)$$

Domestic sales by a non-exporting Home firm are given by the analogue of (6) above. Much as in the previous section, one can check that, P_H, P_F, M constant, $y_H(K_i)$ is decreasing in α_j while $y_F(K_i)$ is increasing in α_j. One can also check that $y_H(K_i)$ is increasing in P_H and M but decreasing in P_F while $y_F(K_i)$ is increasing in P_F and M^* but decreasing in P_H. It is shown in the Appendix that, for fixed M, M^*, $y_H(K_i)$ is decreasing in α_j and $y_F(K_i)$ is increasing in α_j if i) P_H is decreasing in α_j and ii) $P_F\,/P_H$ is increasing in α_j.

As to the impact of α_j on export participation – on the values of $\widehat{K}_H$ and $\widehat{K}_F$ – substitution for $p_H(K_i) = p_F(K_i)$ from equation (7) and for $p(K_i)$ from equation (2) into equation (8) and simplification yields

$$\Delta\pi_H(K_i) = \Upsilon\{[(1-\alpha_j)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{2/(1+\sigma)} - [(1-\alpha_j)MP_H^{\sigma-1}]^{\frac{2}{1+\sigma}} \quad (15)$$

$$\Delta\pi_F(K_i) = \Upsilon\{[(1-\alpha_j)MP_H^{\sigma-1} + (1-\alpha^*)M^*P_F^{\sigma-1}]^{2/(1+\sigma)} - [(1-\alpha^*)M^*P_F^{\sigma-1}]^{\frac{2}{1+\sigma}} \quad (16)$$

where $\Upsilon = K_i^{(\sigma-1)/(\sigma+1)}[\gamma^{-1} - (1/A^2)\gamma^{2\sigma/(1-\sigma)}]$. It is shown in the Appendix that, in the neighborhood of $\alpha_j = \alpha^*$, $\Delta\pi_H(K_i)$ is increasing in α_j as long as i) P_H is decreasing in α_j and ii) P_F/P_H is increasing in α_j. In this case, we have that $\widehat{K}_H$ is decreasing in α_j. An analogous argument demonstrates that, in a neighborhood of $\alpha_j = \alpha^*$, $\widehat{K}_F$ is increasing in α_j.

Together, equations (15), (16), (9) and (10) essentially determine the behavior of sales and export participation as α_j varies. In the Appendix we show that an increase in α_j – a negative demand shock in the Y-sector – leads to i) a reduction in domestic sales and an increase in export sales among Country H firms that were already exporting, ii) an increase in export participation among Country H firms and iii) among new exporters, a reduction in domestic sales relative to the situation in which these firms did not export.

The intuition for these results is quite simple. The negative demand shock in H reduces the profitability of Country H sales (marginal revenue from H is less than marginal costs at existing output levels). Country H firms (and exporters from Country F for that matter) respond by reducing sales to Country H. In so doing, marginal costs fall and the profitability of selling in Country F is enhanced (marginal revenue from F sales exceeds marginal cost). Country H exporting firms respond by increasing export sales. In addition, those firms in H not exporting find Country F more attractive now (F sales increase and the returns to only selling domestically fall). As a result, participation in exporting among H firms increases. These firms substitute export sales for domestic sales and so domestic sales fall relative to the case in which they would not be exporting. Notice also, that these predictions depend crucially on the fixed capacity assumption. In particular, with constant marginal cost and segmented markets, a negative Y-sector demand shock in H has either no impact or a negative impact on both export sales to F and H firm export participation.

3 Data Description and Summary Statistics

The dataset we use is a survey of Chilean manufacturing plants conducted by Chile's Statistical Agency (INE). The survey – labeled ENIA - covers all manufacturing plants that employ at least 10 workers. On average over the 1994-2000 period these plants represent 12.3% of all manufacturing plants and 81.7% of total sales in manufacturing.[2] The data set is an unbalanced panel since, at any given year, all plants with ten workers or more are surveyed irrespective of whether or not the plant existed in a previous year and/or if it was surveyed previously. For each plant-year observation the data contains information on total nominal output, sales, exports, total employment, age (number of years since first appearance in the survey) and investment, which is used to compute a measure of real capital stock.[3] Each plant is also associated with a 4-digit ISIC Rev.2 classification. For single-product plants this is the code of the product the plant produces. For multi-product plants this is the code of the plant's main product. All nominal variables are deflated using 3-digit level ISIC output

[2] See Crespi (2006).
[3] Crespi (2006) builds the measure of capital stock we use in the paper.

deflators constructed from the wholesale price index compiled by the INE.[4] The first ENIA survey was conducted in 1979 but export activities have only been reported since 1990. In this paper we consider the 1990-2000 period. Our analysis excludes those plants that do not report employment or investment. These plants represent less than 5% of the plant/year observations and none of the results of the paper depend upon this exclusion.

Table 1 shows a first set of summary statistics. The first two columns show the number of plants in the sample and the number of plants that export by year. On average between 16% and 20% of the Chilean manufacturing plants export. This number is similar to the 17% of exporting plants Bernard and Jensen (2004) report for the US and to the levels reported by Bernard et al (2007) for US firms, and slightly higher than the ones reported in Roberts and Tybout (1997) for Colombian plants. The next column shows the number of new exporting plants by year. These are defined as plants that were surveyed but were not exporting in the previous year and start exporting. Between 9% and 22% of all exporting plants in a given year are new exporters. The following column shows the number of plants that exit the exporting market but continue to exist by year. On average between 9% and 20% of exporters stop exporting every year. Both the entry and exit percentages are similar to the ones found in Bernard and Jensen (2004) for US plants.

Table 2 shows the share of domestic revenues of exporters, both for all exporting plants and for new exporters, and the share of exports done by new exporters. On average exporting plants obtain between 70% to 75% of their revenues from domestic sales. For new exporters this number is even higher, varying between 88% and 93%. The last column in the same table

[4] See Bergoeing et al. (2005).

Year	# Plants			
	Total	Exporting	New Exporters	Quit Exporting
1990	4352	711		
1991	4520	850	189	88
1992	4687	922	147	106
1993	4799	990	145	107
1994	4841	1045	145	98
1995	4901	1075	122	118
1996	5235	1110	143	137
1997	4986	1074	121	114
1998	4572	981	93	114
1999	3882	820	76	116
2000	4193	816	91	107

Table 1: Summary Statistics

shows that new exporters account for a sizeable share of all exports. Between 1991 and 2000 the share of all exports in an industry done by new exporters varied between 3% and 18%. In all these statistics there are significant variations across industries. These are reported in Table 3 for each 3 digit industry. Plants that export food products and non-ferrous metals have, on average, a low 50% of their sales coming from domestic sales. Petroleum, chemicals, electric machinery, and glass products plants have 90% or more of their sales originating in the domestic market. The industry data confirms that new exporters usually have larger shares of their sales coming from the domestic market. The share of exports done by new exporters varies substantially by industry. In industrial chemicals only 1% of all exports is done by new exporters. In textiles and electrical machinery 13% and 14% are exported by new exporters, and in tobacco 19% of all exports are done by new exporters.

Table 4 shows, by industry, the share of plants that do not export in any of the years they are in the sample, the share of plants that export in some years but not in others,

Year	Share Domestic Revenues of Exporters	Share Domestic Revenues of New Exporters	Share Exports of New Exporters
1990	0.70		
1991	0.73	0.88	0.18
1992	0.75	0.89	0.10
1993	0.74	0.89	0.07
1994	0.76	0.93	0.08
1995	0.75	0.92	0.06
1996	0.74	0.90	0.10
1997	0.74	0.92	0.03
1998	0.73	0.87	0.04
1999	0.73	0.92	0.08
2000	0.72	0.90	0.09

Table 2: Summary Statistics

and the share that export every year. For all industries combined, 68% of the plants never export, 22% export some years, and only 10% export every year. If we restrict the sample to plants that were in the sample for at least ten years, these numbers become 62%, 28%, and 10% respectively.[5] These numbers vary substantially across industries. For tobacco, for example, only 12% of the plants never export and only 9% of the plants exported every year. The vast majority, 79%, exported in some years but not in others. Another extreme case is petroleum refineries, where 100% of the plants exported every year. Note from Table 3 that petroleum plants have 98% of their revenues originating from domestic sales, suggesting that these plants export always but very small quantities. Very few textile, apparel, leather, footwear, and printing and publishing plants export every year. They either do not export at all or export in some years but not others. The same is true for nonmetallic minerals and

[5] Roberts and Tybout (1997) report that, for Colombian plants, of the plants that ever exported only 36% exported all the years between 1981 and 1989. Bernard and Jensen (2004) report that, over the 1986-1992 period, 29% percent of the US plants in their sample never exported while 28.2% exported every year.

Industry	Share Domestic Revenues		New Exporters
	Exporters	New Exporters	Share Exports
Food Products	0.52	0.76	0.06
Beverages	0.64	0.89	0.05
Tobacco	0.75	0.88	0.19
Textiles	0.88	0.95	0.13
Apparel	0.89	0.96	0.03
Leather	0.88	0.94	0.12
Footwear	0.86	0.97	0.03
Wood Products	0.63	0.86	0.08
Furniture	0.63	0.89	0.02
Paper	0.80	0.95	0.08
Print. & Pub.	0.91	0.93	0.04
Ind. Chemicals	0.67	0.88	0.01
Other Chemicals	0.90	0.96	0.05
Petroleum Refineries	0.98	–	–
Other Petroleum	0.95	0.97	0.05
Rubber Products	0.88	0.97	0.02
Plastic Products	0.91	0.97	0.04
Pottery	0.79	0.95	0.01
Glass Products	0.91	0.86	0.04
Non-Metalic Minerals	0.94	0.97	0.12
Iron & Steel	0.80	0.88	0.03
Non-Ferrous Metals	0.51	0.62	0.05
Fabricated Metals	0.90	0.93	0.09
Machinery	0.87	0.93	0.07
Elect. Machinery	0.90	0.97	0.14
Transport. Equip.	0.83	0.89	0.13
Instruments	0.91	0.90	0.07
Other Manuf.	0.83	0.90	0.07

Table 3: Summary Statistics

fabricated metals.

The first two columns in Table 5 show, for plants that export some years but not others, the unconditional probability (measured by the frequency) that a plant will switch status from exporting to non-exporting or vice-versa between two consecutive years. The first column shows this probability for all plants in the sample, while the second one shows it for plants that were in the sample for 10 or 11 years. For plants in all industries combined there is a 25% chance that a plant that exports some years will switch status. This number varies some by industry but not much. The remaining columns in this table show, for plants that export some years, the share of plants that switched between exporting and not exporting once, twice, and 3 or more times over the 11 years covered in the sample. The striking feature of these columns is that a sizeable share of plants entered or quit the exporting market altogether three or more times over the period. For all industries combined, 26% of the plants do so.[6] For plants in the furniture industry, this number is 46% and for plants producing glass products it is 50%. Combined with the information that 28% of the plants that were in the sample for 10 or 11 years exported in some years but not in others, the information in Table 5 implies that about 7% of *all* plants entered and/or exited the exporting market three or more times over a period of 11 years.[7]

Overall, the evidence presented indicates that the Chilean plant-level data we use share the same main stylized facts reported in other plant-level data used in the trade literature.

[6] Roberts and Tybout (1997) find that, of the plants that switched exporting status 60% switched more than once over the 1981-1989 period. We find the same number for Chilean plants over the 1990-2000 period.

[7] Note that we do not have information on plant exports by country. Howeve, the amount of entering and exiting could only be higher (potentially a lot higher) in plant/country relationships.

Share of Plants that Export:	Never	Some Years	All Years
All Industries	0.68	0.22	0.10
Food Products	0.76	0.12	0.12
Beverages	0.47	0.25	0.28
Tobacco	0.12	0.79	0.09
Textiles	0.63	0.29	0.09
Apparel	0.75	0.21	0.04
Leather	0.51	0.46	0.04
Footwear	0.69	0.23	0.08
Wood Products	0.67	0.20	0.14
Furniture	0.81	0.13	0.06
Paper	0.41	0.36	0.23
Print. & Pub.	0.78	0.20	0.03
Ind. Chemicals	0.39	0.34	0.27
Other Chemicals	0.39	0.43	0.19
Petroleum Refineries	0.00	0.00	1.00
Other Petroleum	0.34	0.39	0.27
Rubber Products	0.67	0.21	0.13
Plastic Products	0.52	0.39	0.09
Pottery	0.60	0.12	0.28
Glass Products	0.39	0.28	0.33
Nonmetallic Minerals	0.87	0.12	0.01
Iron & Steel	0.49	0.30	0.21
Non-Ferrous Metals	0.33	0.40	0.26
Fabricated Metals	0.71	0.24	0.04
Machinery	0.69	0.25	0.06
Elect. Machinery	0.46	0.42	0.11
Transport. Equip.	0.68	0.28	0.03
Instruments	0.41	0.36	0.23
Other Manuf.	0.76	0.17	0.07

Table 4: Summary Statistics: share of plants that never export, export some years, and export every year.

	Probability of Switching		Share of Plants by # of Switches (Lived 10+):		
Industry	**All Plants**	**Lived 10+**	**1**	**2**	**3+**
All Industries	0.25	0.21	0.40	0.34	0.26
Food Products	0.25	0.20	0.41	0.32	0.27
Beverages	0.20	0.19	0.59	0.18	0.23
Tobacco	0.43	0.45	0.00	0.00	1.00
Textiles	0.26	0.24	0.32	0.34	0.33
Apparel	0.27	0.24	0.30	0.32	0.39
Leather	0.20	0.15	0.61	0.31	0.08
Footwear	0.23	0.18	0.38	0.48	0.13
Wood Products	0.29	0.23	0.41	0.22	0.37
Furniture	0.23	0.23	0.46	0.08	0.46
Paper	0.25	0.19	0.55	0.27	0.18
Print. & Pub.	0.23	0.19	0.39	0.44	0.18
Ind. Chemicals	0.26	0.20	0.36	0.36	0.28
Other Chemicals	0.23	0.19	0.45	0.33	0.22
Other Petroleum	0.32	0.33	0.23	0.00	0.77
Rubber Products	0.18	0.15	0.51	0.49	0.00
Plastic Products	0.24	0.21	0.39	0.35	0.27
Glass Products	0.28	0.25	0.50	0.00	0.50
Nonmetallic Minerals	0.21	0.15	0.58	0.33	0.08
Iron & Steel	0.19	0.16	0.72	0.13	0.14
Non-Ferrous Metals	0.23	0.22	0.61	0.00	0.39
Fabricated Metals	0.25	0.20	0.37	0.43	0.19
Machinery	0.24	0.20	0.27	0.62	0.11
Elect. Machinery	0.24	0.22	0.46	0.25	0.29
Transport. Equip.	0.25	0.25	0.33	0.20	0.47
Instruments	0.23	0.19	0.33	0.50	0.17
Other Manuf.	0.24	0.21	0.43	0.14	0.43

Table 5: Probability of Switch from exporting to non-exporting or from non-exporting to exporting.

	Dependent Variable				
	log(Sales)	log(Employment)	log(Capital)	Share of Industry	
Independent Variables				Sales	Exports
Plants that:					
D_n=1 if Never Export	12.51	3.36	9.70	.006	
	[.031***]	[.019***]	[.039***]	[.001***]	
D_s=1 Export Some Times	14.01	4.26	11.43	.042	.057
	[.109***]	[.073***]	[.112***]	[.008***]	[.012***]
D_a=1 Always Export	15.33	5.20	12.83	.072	.111
	[.082***]	[.059***]	[.095***]	[.008***]	[.011***]
ISIC 4 fixed-effects	Yes	Yes	Yes	Yes	Yes
Observations	25045	25045	25045	25045	24532
Plants	2322	2322	2322	2322	2322
R-Squared	0.76	0.71	0.75	0.12	0.12

Table 6: Data Correlations

This suggests to us that the results we find in the next section should also be present in these other countries.

4 Empirical Evidence

So how well do the predictions of our model conform to the data? One prediction that the model has in common with many models of firm heterogeneity is that the larger firms export and the smaller ones do not. Table 6 shows that this prediction is consistent with the Chilean data. Also of interest in this table is that the firms that export some times are the mid-sized firms, also consistent with our model's predictions.

Our model also predicts a number of data correlations that are not predicted by other models of international trade with firm heterogeneity. Table 7 shows some of these correlations as measured in our data. All the correlations in this table were obtained by regressions that included industry and year fixed-effects and the standard errors were clustered at the industry level. The first column shows the correlation between log-changes in plant *j's* exports and log-changes in its domestic sales. As predicted by the model, because of the existence of a fixed factor, when plants increase their exports they usually decrease their domestic sales and vice-versa. To our knowledge, no other model of international trade with heterogenous firms generates this result. The second column shows the correlation between log-changes in plant *j's* exports and its rate of inventory accumulation. In years when the plant's exports fall it accumulates more inventories. The next column shows the same correlation but now with inventory accumulation in the previous year. The correlation becomes negative suggesting that a firm that accumulates inventories in one year increases exports in the following year and vice-versa.[8] The forth column shows the average log-changes in plant *j's* domestic sales for plants that just entered the exporting market and for plants that continued selling only to the domestic market relative to all other plants (the constant). As predicted by the model, when plants enter the exporting market they reduce their domestic sales (on average by 11% when compared to plants that continued selling to the domestic market only and 8.5% when compared to all other plants). Again, this result is not predicted by any of the other exiting models of international trade with heterogeneous firms. The fifth and final column shows the average log-changes in plant *j's* domestic sales for plants that just exited the exporting market and plants that continued exporting, relative to all other plants (the constant). Plants that just stopped exporting increase their domestic sales relative to other plants (on average by 8.2% relative to plants that continued exporting and 10% relative to

[8] Note that a reversed causality interpretation is also possible. Plants that plan to enter the exporting market might start accumulating inventories the year before.

	Dependent Variable				
	Δ log Exports of Plant j			Δ log Domestic Sales of Plant j	
Independent Variables					
Δ log Domestic Sales of Plant j	-.186 [.050***]				
Invent. Accum. of Plant j		-.039 [.006***]			
Invent. Accum. of Plant j *(t-1)*			.724 [.187***]		
D_e=1 if Plant Start Exporting				-.085 [.017***]	
D_d=1 if Sells Domestic. Only				.025 [.005***]	
D_q=1 if Plant Stop Exporting					.100 [.017***]
D_x=1 if Plant Continue Exporting					.018 [.005***]
Year fixed-effects	Yes	Yes	Yes	Yes	Yes
ISIC 4 fixed-effects	Yes	Yes	Yes	Yes	Yes
Observations	7715	7762	7762	41902	41902
Plants	1579	1584	1584	6939	6939
R-Squared	0.02	0.01	0.02	0.02	0.02

Table 7: Data Correlations

all other plants).

For further confirmation of the predictions of the model one would like to have exogenous measures of the domestic demand shocks faced by plants, the analogue of changes in the α parameter in the model of the previous section. Of course, these are not easy to obtain. In the rest of this section we use changes in industries' aggregate domestic sales as a proxy for changes in the domestic demand faced by plants. With this proxy we can test a key prediction of the model developed in this paper: the domestic demand for products in industry i affect the decision of plants in that industry to enter foreign markets.

To do so, let the index function I_{jit} be such that $I_{jit} = 1$ if plant j in industry i exports in period t and zero otherwise. The entry decision rule in equation (8) implies that:

$$P\left(I_{jit}=1\right)=g\left[\theta_j+\theta_t+\alpha_0 D_{it}+\lambda I_{jit-1}\right]+\epsilon_{jit} \tag{17}$$

where θ_j are plant fixed effects, θ_t are time fixed effects and control for shocks that are common to all plants, such as exchange rate fluctuations, and D_{it} measures the domestic demand for products in industry i. Note that, since there is a cost of entering foreign markets, the decision to enter foreign markets may depend also on whether or not the plant exported in the previous period.

We estimate the probability function in equation (17) using three different specifications. First, we estimate a linear probability model with plant fixed effects. The results are shown in the first columns of Table 8. The first specification includes only the variables in equation (17). The second one adds the plant's capital stock and the third adds other plant characteristics like employment, share of the plant's sales in the industry, and number of years the plant has been surveyed (literally measures the number of years since the plant has 10 or more workers). We add these extra plant controls to capture changes in plant's characteristics, especially the ones associated with the decision to enter foreign markets.[9] With all three sets of controls, domestic sales at the industry level significantly impact the likelihood that a plant in that industry will export. The effect goes as predicted by the model, an increase in domestic sales at the industry level makes plants less likely to enter foreign markets. Although it is not the main focus of this paper, the estimates also confirm the importance of

[9] See Bernard and Jensen (2004).

the exporting status of the plant in the previous period as an important determinant of the current status (Roberts and Tybout (1997) and Bernard and Jensen (2004)).

Linear probability models with lagged dependent variables produce, in all likelihood, biased estimates.[10] We deal with that by using lagged dependent variables in levels and differences as instruments, as proposed in Arellano and Bond (1991) and others. The results using all suitable lagged variables as instruments are shown in the second set of columns in Table 8.[11]In all estimated regressions auto-correlation of the residuals of orders one and two were tested for and rejected at 1%. Domestic sales continue to affect the plants' decision to enter foreign markets in the way predicted by the model. Moreover, the point estimates on the effects of domestic sales change very little when we instrument for the lagged decision to export or not (in the specifications with additional plant controls we also instrument for these variables). This builds extra confidence on our results. Note that the coefficient on the lagged decision to export does go up significantly, indicating that the instruments are doing their job. Still, the coefficient on domestic sales is quite stable.

Finally, we estimate the probability function in equation (17) using a Probit specification with random effects. Before showing the estimates, it is important to note that this specification relies on the very strong assumption that the plant specific random effects are independent of the other right-hand-side variables.[12] The last three columns in Table 8 shows the parameter estimates from the Probit specification. As before, increases in domestic sales

[10]See Wooldridge (2002) pages 299-315.
[11]Similar results are obtained when we restrict the lags used to *t-2* and *t-3* only.
[12]There is also the issue of how to model the initial conditon. For now we treat the first observations for each plant as non-stochastic.

significantly lower the probability that plants will enter foreign markets.

In summary, despite the different weaknesses that the alternative estimation methods have, the results in Table 8 robustly confirm that domestic demand (proxied by domestic sales at the industry level) plays an important role determining the likelihood of plants to enter foreign markets.

Independent Variables	Dependent Variable: $I_{jit} = 1$ if Plant j Exports in Time t; $I_{jit} = 0$ otherwise[13]								
	Linear Probability Model			Linear Probability Model			Probit Model		
	Plant Fixed Effects			Arellano-Bond			Plant Random Effects		
log Domestic Sales Industry i	-.026	-.030	-.030	-.024	-.023	-.022	-.053	-.082	-.013
	[0.01347]*	[0.01363]**	[0.01345]**	[0.01226]*	[0.01214]*	[0.01226]*	[0.01064]***	[0.01128]***	[0.01466]***
$I_{jit-1} = 1$	0.26	0.26	0.26	0.37	0.35	0.33	2.93	2.68	2.44
	[0.01250]***	[0.01222]***	[0.01217]***	[0.02408]***	[0.02493]***	[0.02342]***	[0.02147]***	[0.02913]***	[0.03554]***
log Capital Stock Plant j		0.02628	0.02036		0.01667	0.00967		0.20054	0.13057
		[0.00504]***	[0.00509]***		[0.00652]**	[0.00617]		[0.00867]***	[0.00981]***
Share of Plant j in Industry Sales			.25			.13			-.71
			[0.11954]**			[0.19796]			[0.20584]***
log Plant j # Years in the Sample			-.002			-.005			-.083
			[0.00637]			[0.00589]			[0.01458]***
log Employment Plant j			.03			.02			.36
			[0.00701]***			[0.00632]***			[0.01986]***
Constant	0.63225	0.44406	0.38614	0.56626	0.38544	0.37931	-0.8475	-2.46652	-1.94272
	[0.24837]**	[0.25534]*	[0.25721]	[0.22905]**	[0.23326]*	[0.23417]	[0.20204]***	[0.21871]***	[0.27005]***
Year fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Plant fixed-effects	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Plant random-effects	No	No	No	No	No	No	Yes	Yes	Yes
Observations	41959	41959	41959	34770	34770	34770	41959	41959	41959
Plants	6941	6941	6941	6339	6339	6339	6941	6941	6941
R-Squared	0.07	0.07	0.08						

Table 8: The Probability of Plant j Entering Foreign Markets

5 Conclusion

In this paper we have argued that an important, unmodeled determinant of firm level exporting behavior is firm capacity. We provided a model of heterogeneous firm in which firms differed in their endowments of a fixed capacity. The fixed capacity resulted in firms having upward sloping marginal costs. The model predicts that, when faced with a negative domestic demand shock, firms that already export will increase export sales and some firms that do not export enter the export market. The reverse happens with a positive demand shock. The model also predicts that i) export and domestic sales should be negatively correlated, ii) for firms that enter the export market, domestic sales should fall relative to pre-entry levels, iii) for firms that exit the export market, domestic sales should rise relative to pre-exit levels, iv) firms should enter few export markets. We confronted these predictions with data from a panel of Chilean manufacturers and found significant support for the model.

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