

# Sequential Exporting\*

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## Abstract

Exporters usually “start small,” selling small quantities to neighbor countries. Yet despite significant sunk entry costs, many exit foreign markets immediately, while others shoot up their export volumes and enter new destinations. We investigate a simple theoretical mechanism that can explain these patterns. Firms discover their profitability as exporters only after actually engaging in exporting. According to what the firms learn about themselves, they adjust quantities and decide whether to exit and whether to serve new destinations. Employing a census of Argentine firm-level manufacturing exports from 2002 to 2007, we find empirical support for several implications of our proposed mechanism, suggesting that the practice of “sequential exporting” is pervasive. These findings have broad and subtle implications for trade policy. For example, a reduction in trade barriers in a country will have delayed entry effects in its own market, while also promoting entry in *other* markets. This poses challenges for the empirical analyses of trade liberalization, especially those involving several countries, as in the context of trade agreements.

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Preliminary. Comments welcome.

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# 1 Introduction

How do firms break in foreign markets? If we want to understand patterns of international trade and the aggregate impact of trade liberalization, answering this question convincingly is of central importance. Yet existing trade theories are largely silent about firms' exporting strategies. In fact, recent empirical research has uncovered patterns of entry in foreign markets that available trade theories would find difficult to explain. For example, Eaton, Eslava, Kugler and Tybout (2008, EEKT henceforth) show evidence suggesting that firms in Colombia often start exporting to a single neighbor country, but subsequently most of them either enter in additional markets or cease all exporting activities. Similar patterns have been observed in other countries.<sup>1</sup>

What could explain this sequential entry pattern? A possibility is that firms are uncertain about their success as exporters, i.e. domestic profitability is an imperfect signal of success abroad. Since breaking in new markets entails significant and unrecoverable costs, firms could use neighbors' markets, presumably less costly to enter, as "testing grounds" for future bolder steps, such as serving the American or European markets. This "experimentation" can explain the sequential nature of entry across markets provided that there is a correlation between the profitability of exporting to different markets. Such a correlation could be due to demand similarities or, perhaps more likely, to firms' characteristics that are associated with success in exporting, but which the firms themselves learn only after actually engaging in exporting activities. We develop what is perhaps the simplest model that can formalize this idea. The underlying assumption is that a firm's success in foreign markets is uncertain, but that the uncertainty is correlated across time and across markets. Despite its parsimony, our model rationalizes several of the recent empirical findings of the literature on export dynamics, such as the small size and the high exit rates of new exporters, as well as the rapid expansion of those who survive, at both the intensive and the extensive margins. Our mechanism also has a number of specific empirical implications.

First, if indeed firms fully learn about their export profitability only once they have exported, then those that survive should experience higher growth in their early exporting years than in subsequent years. Moreover, if export profitabilities are positively correlated across destinations, this high initial growth should be most pronounced in the first market the firm exports to, since there is where the firm has most to learn. Second, the likelihood of breaking into new markets should be higher for first-time exporters than for experienced ones, since the latter will already have learned about their potential, and therefore entered all markets they deem profitable—unlike the fledgling exporters. Third, exit from new markets should be more likely for first-time exporters than for experienced ones, exactly as with entry.

We test these predictions using Argentinean customs data comprising the universe of the country's manufacturing exports from 2002 to 2007, disaggregated by firm and destination country. We find strong support for each of our predictions, even after controlling for firms'

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<sup>1</sup>Buono, Fadinger, and Berger (2008) extend the findings by EEKT in a detailed study of the intensive and extensive margins of French exports. Lawless (2009) carries out a similar exercise for a survey of Irish firms. Alvarez, Faruq and Lopez (2008), examining Chilean firms, find evidence that exporting a product to a country increases the likelihood of selling the same product to another foreign market.

heterogeneity and for year-destination fixed effects. Whereas those empirical findings do not provide a direct test of our model, we are unaware of alternative mechanisms that can rationalize the uncovered empirical facts, on the whole at least. Hence, while uncertainty correlated across time and markets is surely only one of several possible forces shaping firms' export strategies, our evidence indicates it plays an unequivocal role. For brevity, we refer to the trade implications of this uncertainty simply as "sequential exporting."

The policy implications of sequential exporting are far-reaching. Consider the impact of trade liberalization in different countries for the firms of a "Home" country. When a nearby country lowers its trade barriers, it will attract new exporting firms from Home. As these new exporters learn about their ability to serve foreign markets, some will endure unsuccessful experiences while others will realize that they are capable of serving foreign markets very profitably. The former will give up exporting, whereas the latter will expand to other foreign markets. As a result, trade liberalization in the nearby country will not only promote entry in that market; it will also induce entry in *third* markets, albeit with a lag. Similarly, the reduction of trade barriers in a distant country will initially induce entry of some Home firms not in the liberalizing country, but in the markets of Home's neighbors. Put simply, lower trade barriers in the distant country raise the value of an eventual entry there; this enhances the value of "export experimentation," thereby fostering entry in third markets in the short run. Once some of the entrants realize a high export potential in the neighbors' markets, they move on to the market of the liberalizing country as well.

Correlated export profit uncertainty has important implications in particular for assessing the impact of regional trade agreements. A regional trade agreement would tend to boost "export experimentation" by lowering the costs of exporting to bloc partners. But as a result of more experimentation, a greater number of domestic firms would eventually find it profitable to export also to bloc outsiders. In that sense, regional integration generates a type of "trade creation" that is very different from the concept economists often emphasize: in addition to promoting intra-bloc trade, a regional trading bloc also stimulates *exports to non-member countries*.

These third-country and lagged effects of trade liberalization can be equally useful in explaining an enduring puzzle in the trade literature: while world trade has almost quadrupled in the last fifty years, tariffs on manufactured goods in developed countries have fallen during the same period by little more than ten percentage points. Attempts to explaining this phenomenon, such as the rise of vertical specialization (Yi 2003) or the role of offshoring under contract incompleteness (Ornelas and Turner 2008), remain quantitatively unsatisfactory.<sup>2</sup> But if correlated export profit uncertainty explains observed sequential export entry, modest domestic tariff reductions could have much larger impacts on global trade flows than existing models suggest. Third-country and delayed effects could help as well to explain the difficulty in identifying significant trade effects of multilateral liberalization undertaken under the GATT and the World Trade Organization (Rose 2004), despite well-entrenched beliefs that the GATT/WTO system has been crucial in promoting international trade. Neglect

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<sup>2</sup>For instance, Yi (2003) concludes that vertical specialization can resolve at most fifty percent of the excessive responsiveness of trade flows to trade barriers.

of these effects may also be behind the perennial failure of computable general equilibrium models in predicting the impact of trade liberalization programs.

The growing documentation of firm's exporting patterns sparked by EEKT's study has generated an increasing research interest on the dynamics of firms' exporting strategies.<sup>3</sup> Most related to our analysis is the current work of Eaton, Eslava, Krizan, Kugler and Tybout (2008) and Freund and Pierola (2008), who emphasize learning mechanisms. Eaton, Eslava, Krizan, Kugler and Tybout develop a model where producers learn about the appeal of their products by devoting resources to finding consumers and by observing the experiences of competitors. Unlike here, uncertainty is market-specific in their model. Market uncertainty plays a central role in the decision to export also in the analysis of Freund and Pierola, where the uncertainty is producer-specific, as in our model. However, their focus is on the incentives of firms to develop new products for exporting. Using data on exports of non-traditional agricultural products in Peru, Freund and Pierola uncover interesting patterns of trial and error based on the frequency of entry and exit from foreign markets.

Our work is also related to earlier empirical findings at the product and country levels. Evenett and Venables (2002) document a "geographic spread of exports" for 23 developing countries between 1970 and 1997. Importing a certain product from a certain country is more likely if the origin country is supplying the same product to nearby markets, share the same language, or have a common border. Besedes and Prusa (2006) find that the median duration of exporting a product to the US is very short, with a hazard rate that decreases over time. This finding holds at various levels of product disaggregation.<sup>4</sup> Our model offers a possible micro-foundation for these findings which, as we will argue, is consistent with a number of other empirical regularities previously uncovered.

The remaining of the paper is organized as follows. Section 2 presents the setup of our model, to derive a firm's optimal export strategy. In Section 3 we test the distinguishing features of our theoretical mechanism using Argentinean customs data. In Section 4 we develop our model further to study the implications of our mechanism for trade liberalization. Section 5 concludes.

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<sup>3</sup>Segura-Cayuela and Vilarrubia (2008) develop a model where potential exporters are uncertain about country-specific fixed export costs, but learn about them from other firms in the industry that start exporting to the same market. This idea is related to Hausmann and Rodrik's (2003) earlier insight that ex ante unknown export profitability can be learned by followers of an export pioneer, who effectively provides a public good to the rest of the industry, in the spirit of the classic work of Rob (1991). While those authors focus on learning from rivals, we are interested in individual self-discovery. Das *et al.* (2007) offer an elegant structural model of firm heterogeneity and export dynamics, but their goal is to quantify the size of the sunk costs of exporting, independently of the number of destinations. Arkolakis (2008) proposes a model with increasing marketing penetration costs, where a firm's productivity evolves over time according to an exogenous stochastic process. This process determines the firm's entry, exit and production decisions in foreign markets.

<sup>4</sup>Relatedly, Bernard *et al.* (2009) show the different contributions of the intensive and the extensive margins of trade in the short and long runs for US firms.

## 2 Model

### 2.1 The Decision Tree

We consider the decision of a risk-neutral producer to serve two segmented foreign markets, denoted by  $A$  and  $B$ . Countries  $A$  and  $B$  are symmetric except for the unit trade costs that the home firm must pay to export there, denoted by  $\tau^A$  and  $\tau^B$ ,  $\tau^A \leq \tau^B$ . To sell in *each* foreign market, the firm needs to incur in a one-time fixed cost of exporting,  $F$ . This corresponds to the costs of accessing distribution channels, dealing with foreign bureaucracies, customs procedures, complying with different product standards, etc.<sup>5</sup> Similarly, thinking about trade in intermediates which is importer-driven rather than exporter-driven,  $F$  can be thought of the implicit cost for the domestic firm not to be uncovered by an importer, who will fully (or partially) bear the cost; e.g. of searching and/or matching the right supplier.

Variable costs comprise two elements: a unit production cost that is known to the firm (to simplify) and an unknown export unit cost. We set the former to  $\frac{1}{\varphi_i}$ , where  $\varphi_i$  denotes firm  $i$  productivity, and denote the latter by  $c^j$ . Until subsection 2.3, there will be no loss of generality in normalizing the known unit production cost to zero. The producer faces the following demand in each market  $j = A, B$ :

$$q^j(p) = a^j - p^j. \quad (1)$$

We allow for uncertainty in both demand and supply parameters. One can think of several ways in which our parameters  $a$  and  $c$  are reduced forms for various aspects of demand and supply in foreign markets.  $a$  captures foreign consumers' willingness to pay which is affected by shocks to the real exchange rate, national income, consumers' expenditure shares and preference for quality, the number of rival products or the perceived elasticity of substitution.  $c$  captures variable costs incurred only when selling to foreigners, which is affected by shocks to the *variable* costs of marketing, shipping, insuring exported products, and more generally any additional variable costs incurred only when selling to foreigners.

Denoting our measure of export profitability in market  $j$  by

$$\mu^j \equiv a^j - c^j,$$

we assume that  $\mu^j$  is a random variable that has a continuous cumulative distribution function  $G(\cdot)$  on the support  $[\underline{\mu}, \bar{\mu}]$ .  $\bar{\mu}$  obtains when the highest possible demand intercept and the lowest possible total unit cost are realized;  $\underline{\mu}$  obtains under the opposite extreme scenario. We assume the distribution to be identical in both countries. We restrict the analysis to variable and fixed trade costs that satisfy  $\underline{\mu} < \tau^A \leq \tau^B < 2F^{1/2} + \tau^B < \bar{\mu}$ . It will become clear in section 2.2.1 why the analysis becomes interesting only when these inequalities are satisfied.

Since our main goal is to understand entry into foreign markets we evaluate all profits

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<sup>5</sup>Das *et al.* (2007) structurally estimate sunk entry costs to be no less than \$344,000 in 1986 U.S. dollars for Colombian manufacturers of leather products, knitted fabrics, and basic chemicals.

from an *ex ante* perspective, i.e. at their  $t = 0$  expected value. We denote by  $e_t^j$  the firm's decision to enter market  $j$  at time  $t$ ,  $j = A, B$ ,  $t = 1, 2$ . Thus,  $e_t^j = 1$  if the firm enters market  $j$  (i.e. pays the sunk cost) at  $t$ ,  $e_t^j = 0$  otherwise. We denote by  $q_t^j$  the output sold in destination  $j$  at time  $t$ . Quantity  $q_t^j$  can be strictly positive only if either  $e_t^j = 1$  or  $e_{t-1}^j = 1$ .

The timing is as follows:

$t = 1$ : At period 1, the firm decides whether to enter each market. If the firm decides to enter market  $j$ , it pays the per-destination fixed entry cost  $F$  and chooses how much to sell there in that period,  $q_1^j$ . At the end of period 1, export profits in destination  $j$  are realized. If the firm has entered and produced  $q_1^j \geq \varepsilon$ , where  $\varepsilon > 0$  is small, it infers  $\mu^j$  from its profit.

$t = 2$ : At period 2, if the firm has entered market  $j$  at  $t = 1$ , it chooses how much to sell in that market,  $q_2^j$ . If the firm has not entered destination  $j$  at  $t = 1$ , it decides whether to enter that market. If the firm enters, it pays  $F$  and chooses  $q_2^j$ . At the end of period 2, export profits are realized.

Notice that market  $j$ 's export profitability parameter  $\mu^j$  is not directly observed but inferred by the firm from its profits. To learn  $\mu^j$  the firm must pay the fixed entry cost  $F$  and export a strictly positive quantity to that market.<sup>6</sup>

In general a firm might need to set its export volume above a certain threshold to reliably uncover its true export profitability  $\mu$ . For simplicity, we impose that no informed decision can be taken without "enough" experimentation, and set this threshold to  $\varepsilon$ , a small but strictly positive number.<sup>7</sup> Similarly, assuming that the fixed cost of exporting must be paid before any foreign sale may seem too restrictive, since a firm could, for example, send samples to a trade fair without incurring any meaningful fixed cost. But that assumption is just a simple way of capturing the idea that it is costly for a firm to learn its export profitability in a certain market. In particular, the assumption rules out the counterfactual outcome where every firm exports at least a tiny quantity to *every* market, which they would if that was enough to gather their export potential to those markets. In our setting, as we will see, firms do not always enter all markets, but they sometimes enter a market even when expecting short-term losses, since there is a positive value from learning.

## 2.2 A Firm's Export Decision

In this section we examine optimal entry patterns when export profitability is correlated across markets, i.e. the  $\mu^j$ 's are *positively correlated* with each other. We will show that under this maintained assumption our model can explain several patterns of exports over time

<sup>6</sup>Although our setup is reminiscent of Jovanovic's (1982), we: (i) consider entry into several destinations (industries), (ii) abstract from competition forces within each, and (iii) restrict firms to fully uncover their profitability right after the first year of producing, without loss of generality for the selection process underlying the sequential entry pattern.

<sup>7</sup>We adopt a drastic simplification of the general setting examined by Aghion *et al.* (1991), where a Bayesian decision maker with an unknown objective function (here profitability) is willing to engage into costly experimentation, provided that it is informative enough.

better than alternative explanations and offer important implications for our understanding of trade liberalization. As a useful benchmark for comparison and for expository purposes, we also describe a world in which draws of  $\mu^j$  are *i.i.d.* across countries, so that the experience in a particular destination is useless in assessing the firm's profitability in other destinations.

Cross-country correlations in export profitability can come from similarities across countries in demand and supply conditions. The relevance of demand components when examining export patterns across countries, like having access to a network of buyers, has been recently advanced by Buono *et al.* (2008) or Kee and Krishna (2008) as the missing ingredient when trying to reconcile the theoretical predictions of models with heterogeneous firms with either detailed micro-evidence or the implications of differences in trade policies between the US and the EU. While both show that demand components are very persistent through time, within destinations, Buono *et al.* (2008) provide descriptive evidence about their persistence also across similar destinations (their fact No. 10). Another non-exclusive interpretation is that some variable costs are known once and for all when the firm starts exporting. These may come from the unforeseen contingencies associated with establishing an efficient distribution channel abroad, or with training, hiring or reorganizing personnel that will affect variable costs permanently. In terms of our model this creates a component of  $c^j$  that is common across all destinations  $j$ .

If export profitability is correlated across markets then exporting to country  $A$  reveals information about the firm's export performance in country  $B$ . To make this point as clearly and simply as possible, we assume the draws of  $\mu^j$  are perfectly correlated across markets:  $\mu^A = \mu^B = \mu$ . Despite our focus on this limiting case of perfect correlation between export profitabilities across markets, our qualitative results generalize to any strictly positive correlation between them, as we show in Appendix B.

There are three undominated entry strategies. The firm may enter both markets simultaneously at  $t = 1$ ; enter only market  $A$  at  $t = 1$ , deciding at  $t = 2$  whether to enter market  $B$ ; or enter neither market. The other two possibilities, of entering both markets only at  $t = 2$  and of entering market  $B$  before market  $A$ , need not be considered. The latter is dominated by entering market  $A$  before market  $B$ , since  $\tau^A \leq \tau^B$ . The former is dominated by simultaneous entry at  $t = 1$ , because in our setting with segmented markets, there is no option value of waiting. Therefore, postponing entry only entails foregone gains and no foregone losses because the option value of learning is strictly positive.<sup>8</sup>

We solve for the firm's decision variables  $\{e_1^j, e_2^j, q_1^j, q_2^j\}$  using backward induction.

### 2.2.1 Period $t = 2$

At period  $t = 2$  there are three possibilities, depending on whether the firm has exported to countries  $A$  and  $B$  at time  $t = 1$ .

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<sup>8</sup>Essentially, by postponing entry the producer is faced with the same problem as in  $t = 1$ , but is left with a shorter horizon by assumption. This is without loss of generality with segmented markets. If markets were not segmented, a positive option value of waiting emerges because early entry by competitors conveys valuable information about the profitability of the market to those who postpone entry, who in addition need not incur into start-up costs. See Rob (1991) for further details.

i) *No entry.* The firm does not export, earning zero profit.

ii) *Simultaneous entry.* When the firm exports to both destinations at  $t = 1$ , at  $t = 2$  it will have inferred its export profitability  $\mu$ , and will choose its export volumes by solving

$$\max_{q_2^j \geq 0} \left\{ (\mu - \tau - q_2^j) q_2^j \right\}, \quad j = A, B.$$

which yields

$$\hat{q}_2^j(\tau^j) = \mathbf{1}_{\{\mu > \tau^j\}} \left( \frac{\mu - \tau^j}{2} \right), \quad (2)$$

where  $\mathbf{1}_{\{\cdot\}}$  represents the indicator function, here denoting whether  $\mu > \tau^j$ . Second-period output is zero for low  $\mu$ . Profits at  $t = 2$ , expressed in  $t = 0$  expected terms, can then be written as

$$V(\tau^j) = \int_{\tau^j}^{\bar{\mu}} \left( \frac{\mu - \tau^j}{2} \right)^2 dG(\mu).$$

Function  $V(\tau^j)$  represents the option value of being able to continue exporting without incurring start-up costs  $F$ . Right after exporting once, the firm learns its profitability in the foreign market and if it cannot deliver positive profits, it exits to avoid further losses. Otherwise, the firm tunes up its output choice to that market.

Notice that there would be a similar option value if there were no correlation in export profitability across markets. Firms entering both markets simultaneously would still learn about their profitability *in each* market. Function  $V(\tau^j)$  is illustrated in Figure 1 :

iii) *Sequential entry.* When the firm exports to country  $A$  in  $t = 1$ , at  $t = 2$  it will have inferred its export profitability  $\mu$ . Thus,  $q_2^A$  is again given by (2):  $\hat{q}_2^A(\tau^A) = \mathbf{1}_{\{\mu > \tau^A\}} \frac{\mu - \tau^A}{2}$ , generating second-period profit  $V(\tau^A)$ .

The firm chooses to enter market  $B$  at  $t = 2$  if the operational profit is greater than the fixed cost of entering that market. This will be the case when the firm realizes its export profitability is large relative to the entry fixed cost:

$$\left( \frac{\mu - \tau^B}{2} \right)^2 \geq F. \quad (3)$$

Hence, the firm's entry decision in market  $B$  at  $t = 2$  is given by

$$e_2^B(\tau^B) = 1 \Leftrightarrow \mu \geq 2F^{1/2} + \tau^B. \quad (4)$$

Thus, defining  $F_2^B(\tau^B)$  as the  $F$  that solves (3) with equality, the firm enters market  $B$  at  $t = 2$  if  $F \leq F_2^B(\tau^B)$ . It is straightforward to see that  $F_2^B(\tau^B)$  is strictly decreasing in  $\tau^B$ .

If the firm does enter market  $B$ , it will choose  $q_2^B$  much like it chooses  $q_2^A$ , except for market  $B$ 's specific trade cost,  $\tau^B$ . However, conditional on  $e_2^B = 1$ , the firm knows that  $\mu > \tau^B$ . Therefore, it sets  $\hat{q}_2^B(\tau^B) = \frac{\mu - \tau^B}{2}$ .

Expressed in  $t = 0$  expected terms, the firm's profit from (possibly) entering market  $B$

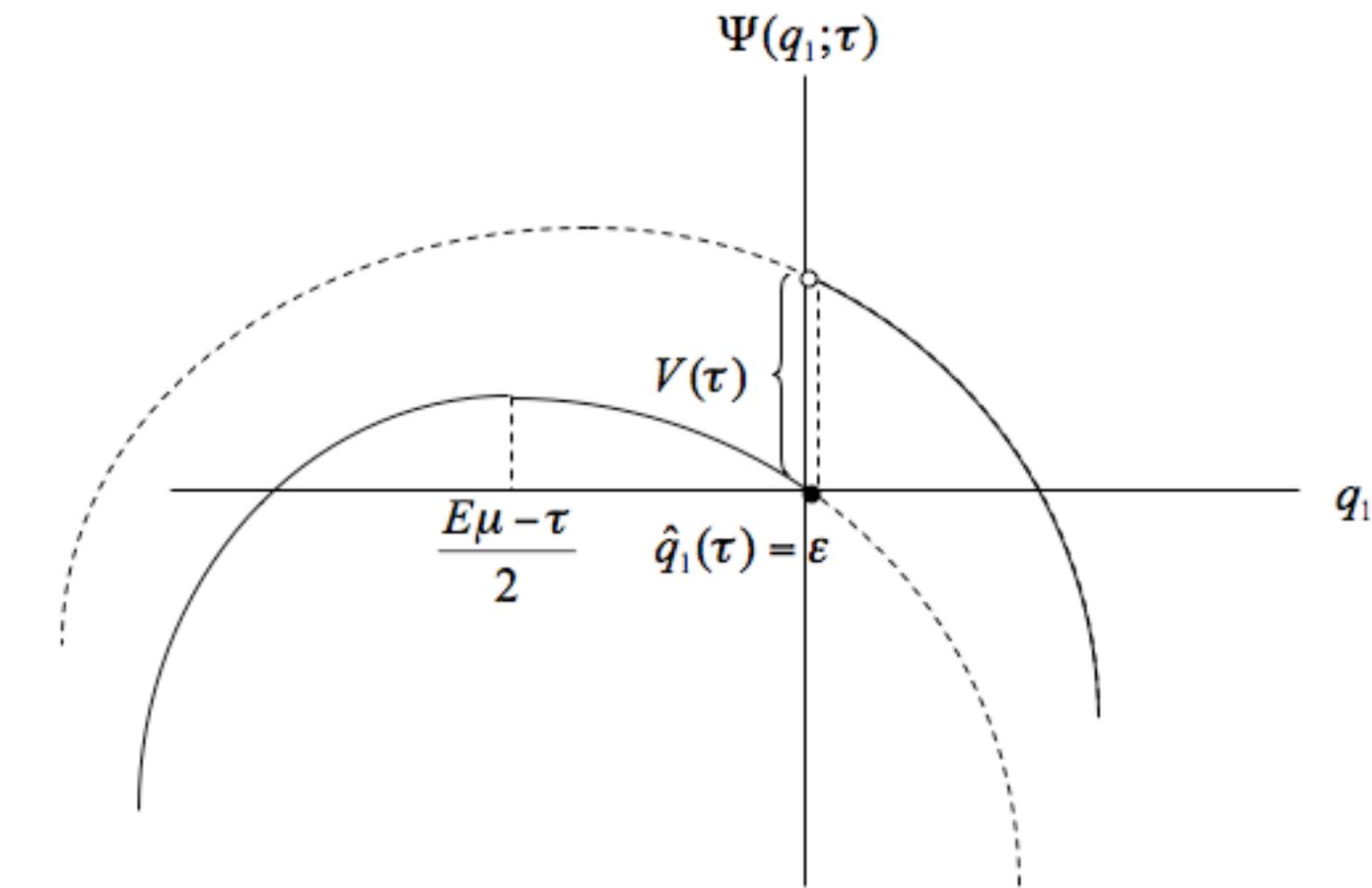


Figure 1: The profit function when  $E\mu < \tau$

at  $t = 2$  corresponds to

$$W(\tau^B; F) \equiv \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left[ \left( \frac{\mu - \tau^B}{2} \right)^2 - F \right] dG(\mu) \quad (5)$$

$$= \left\{ V(\tau^B) - \int_{\tau^B}^{2F^{1/2} + \tau^B} \left( \frac{\mu - \tau^B}{2} \right)^2 dG(\mu) \right\} - F \left[ 1 - G(2F^{1/2} + \tau^B) \right]. \quad (6)$$

Function  $W(\tau^B; F)$  represents the option value of learning one's export profitability in market  $B$  by entering market  $A$  first. The expression in curly brackets represents the (ex ante) expected operational profit from entering market  $B$  at  $t = 2$ . This is less than  $V(\tau^B)$  because entry is worthwhile only when (4)—a stricter condition than  $\mu \geq \tau^B$ —is satisfied. The other term represents the sunk cost from entering  $B$  times the probability that this happens. Thus, the return from first entering destination  $A$  includes the option value of subsequently becoming an exporter to destination  $B$  without incurring the costs due to the uncertainty about export profitability. As Figure 2 illustrates, export experimentation can be worthwhile even when  $E\mu < \tau^A$ , as long as the total value of information is sufficiently high (i.e.,  $V(\tau^A) + W(\tau^B; F) > F$ ):

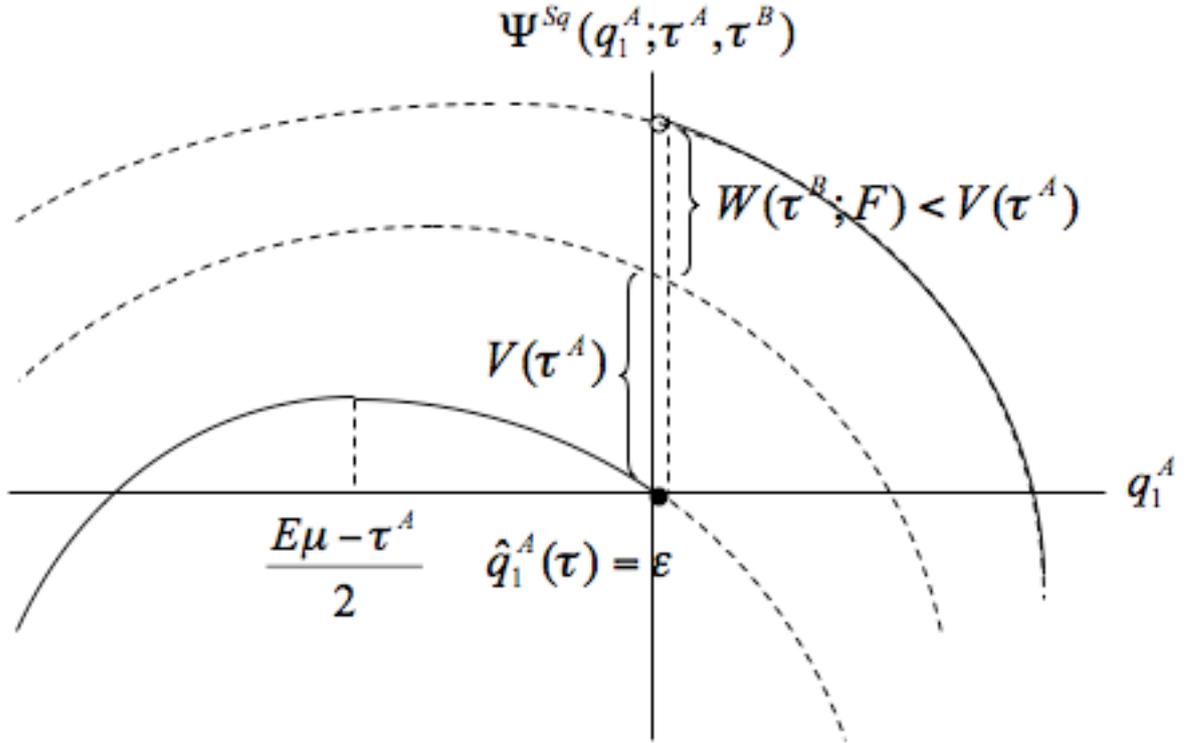


Figure 2: The profit function in  $A$ , when  $E\mu < \tau^A$  under Sequential exporting.

Finally notice that if profitability were instead uncorrelated across destinations, late entry in  $B$  would not reduce the firm's uncertainty about its export profitability there *even though*

it has previously entered  $A$ . In that case the option value would be zero, or  $W(\tau^B; F) = 0$ .<sup>9</sup> A corollary is that *if profitability is uncorrelated across destinations, exporters do not enter export markets sequentially.*

### 2.2.2 Period $t = 1$

i) *No entry.* The firm does not export, earning zero profit.

ii) *Simultaneous entry.* A firm exporting to both destinations at  $t = 1$  chooses  $q_1^A$  and  $q_1^B$  to maximize gross profits:

$$\begin{aligned} \Psi^{Sm}(q_1^A, q_1^B; \tau^A, \tau^B) &\equiv \int_{\underline{\mu}}^{\bar{\mu}} (\mu - \tau^A - q_1^A) q_1^A dG(\mu) + \int_{\underline{\mu}}^{\bar{\mu}} (\mu - \tau^B - q_1^B) q_1^B dG(\mu) \\ &\quad + \max \left\{ \mathbf{1}_{\{q_1^A > 0\}}, \mathbf{1}_{\{q_1^B > 0\}} \right\} [V(\tau^A) + V(\tau^B)], \end{aligned} \quad (7)$$

where superscript  $Sm$  stands for “simultaneous” entry. The first two terms correspond to the firm’s period 1 per-destination operational profits, whereas the third one denotes how much the firm expects to earn in period 2, depending on whether *either*  $q_1^A > 0$  or  $q_1^B > 0$ . Since exporting to one market provides the firm with information on its export profitability in both markets, it is enough to have exported a positive amount in period 1 to *either* destination. Hence the *max* operator.

The maximization of (7) yields outputs

$$\hat{q}_1^A(\tau^A) = \mathbf{1}_{\{E\mu > \tau^A\}} \frac{E\mu - \tau^A}{2} + \mathbf{1}_{\{E\mu \leq \tau^A\}} \varepsilon, \quad (8)$$

$$\hat{q}_1^B(\tau^B) = \mathbf{1}_{\{E\mu > \tau^B\}} \frac{E\mu - \tau^B}{2}. \quad (9)$$

where  $\varepsilon > 0$  is a small number, so that  $\hat{q}_1^A(\tau^A)$  is strictly positive. To understand this expression, set  $\hat{q}_1^B(\tau^B) = 0$  and consider each of the two possible cases: either (i)  $E\mu > \tau^A$ , in which case the first-order condition yields  $\hat{q}_1^A = \frac{E\mu - \tau^A}{2} > 0$ ; or (ii)  $E\mu \leq \tau^A$ , and period 1 operational profits are locally maximized when  $q_1^A = \frac{E\mu - \tau^A}{2} < 0$ . Therefore, inaction,  $\hat{q}_1^A = 0$ , would seem optimal. But notice from (7) that a small but strictly positive  $q_1^A = \varepsilon > 0$  dominates inaction – even if  $W(\tau^B; F) = 0$ :  $\Psi^{Sm}(\varepsilon, 0; \tau^A, \tau^B) = (E\mu - \tau^A - \varepsilon) \varepsilon + V(\tau^A) > 0$ . This case is illustrated in Figure 2 above. With a slight abuse of notation, we denote by  $\varepsilon$  that smallest strictly positive output level that is however large enough for the firm to *reliably* uncover its profitability.<sup>10</sup> The difference between (9) and (8) is that here the firm

<sup>9</sup>Recalling that profitability is identically distributed across destinations, condition (4) needs to be satisfied in expectation,

$$e_2^B(\tau^B) = 1 \Leftrightarrow E\mu \geq 2F^{1/2} + \tau^B$$

which is a stricter condition than  $E\mu \geq \tau^B$ , sufficient for early entry in  $B$ . Early entry therefore dominates late entry.

<sup>10</sup>For simplicity, we do not explicitly model the choice of  $\varepsilon$ , but technically speaking it cannot be arbitrarily small for then we would be maximizing over an open set. But more importantly, sending 1 sample to a trade fair would be informative enough for exporters to fully gather their export potential. We therefore impose that  $\varepsilon$  is large enough for it to be reliably informative, while emphasizing that for most of the firms it represents a smaller amount than their “natural” capacity.

does not need to "test" market  $B$  when  $E\mu \leq \tau^B$  just to learn  $\mu$ , because it will already know its export profitability from its engagement in country  $A$ . That experimentation takes place in  $A$ , and not in  $B$ , comes of course from the initial assumption that  $\tau^A \leq \tau^B$ .

Our model therefore suggests that firms "test" foreign markets before fully exploring them (or exiting them altogether), a feature consistent with the empirical findings of EEKT. Interestingly, experimentation can arise even when the trade cost is large enough to make expected operational profits at  $t = 1$  negative, and despite the existence of sunk costs to export. Intuitively, the firm can choose to incur the sunk cost and a small initial operational loss because it knows that it *may* be competitive in that foreign market; the outcome of the initial sale allows the firm to find out whether it actually is.

Clearly, this strategy does not exploit the possibility of learning across export markets, since the main benefit from such cross-market learning—the savings of fixed costs in foreign markets that prove not to be profitable—are not realized with this strategy. In fact, the firm's expected profit from simultaneous entry is the same as when profitability is uncorrelated across destinations:

$$\Psi^{Sm}(\tau^A, \tau^B) \equiv \lim_{\varepsilon \rightarrow 0} \Psi^{Sm}(\hat{q}_1^A(\tau^A), \hat{q}_1^B(\tau^B); \tau^A, \tau^B) = \Psi(\tau^A) + \Psi(\tau^B) \quad (10)$$

where  $\Psi(\tau^j) \equiv \lim_{\varepsilon \rightarrow 0} \Psi(\hat{q}_1^j; \tau^j) = \mathbf{1}_{\{E\mu > \tau^j\}} \left( \frac{E\mu - \tau^j}{2} \right)^2 + V(\tau^j)$  denotes the gross operational profit in country  $j$  conditional on entry when draws of  $\mu^j$  are i.i.d.

iii) *Sequential entry.* At  $t = 1$ , a firm that enters market  $A$  but not market  $B$  chooses  $q_1^A$  to maximize

$$\Psi^{Sq}(q_1^A; \tau^A, \tau^B) \equiv \Psi(q_1^A; \tau^A) + \mathbf{1}_{\{q_1^A > 0\}} W(\tau^B; F), \quad (11)$$

where  $Sq$  stands for sequential entry. Conditional on having entered market  $A$ , the firm learns its export profitability if  $q_1^A > 0$ . This allows the firm to make a more informed entry decision in market  $B$  at  $t = 2$ , according to (4). Clearly, the solution to this program is also  $\tilde{q}_1^A(\tau^A) = \hat{q}_1^A(\tau^A)$ , as in equation (8). If  $E\mu \leq \tau_A$ , the small loss expected from 'testing' the market is more than offset by the expected benefits from the information obtained, also valuable in deciding whether to enter  $B$ . This situation is illustrated in Figure 2 above.

Evaluating (11) at the optimal output choice  $\tilde{q}_1^A(\tau^A)$ , we obtain

$$\Psi^{Sq}(\tau^A, \tau^B) \equiv \lim_{\varepsilon \rightarrow 0^+} \Psi^{Sq}(\tilde{q}_1^A(\tau^A); \tau^A, \tau^B) = \Psi(\tau^A) + W(\tau^B; F) \quad (12)$$

as the firm's expected profit from sequential entry.

### 2.2.3 Entry strategy

We can now fully characterize the firm's entry strategy. Simultaneous entry in both markets at time  $t = 1$  yields exactly the same profits as with uncorrelated export profitabilities. In that case, the firm forgoes the potential benefit of learning its export profitability in market  $B$  before incurring the costs to enter that market. Using (10), the firm's *net* profit from

simultaneous entry,  $\Pi^{Sm}$ , is therefore

$$\begin{aligned}\Pi^{Sm} &\equiv \Psi^{Sm}(\tau^A, \tau^B) - 2F \\ &= \Psi(\tau^A) + \Psi(\tau^B) - 2F.\end{aligned}\tag{13}$$

In turn, we have from (12) that the firm's *net* profit from the sequential entry strategy,  $\Pi^{Sq}$ , is

$$\begin{aligned}\Pi^{Sq} &\equiv \Psi^{Sq}(\tau^A, \tau^B) - F \\ &= \Psi(\tau^A) + W(\tau^B; F) - F.\end{aligned}\tag{14}$$

Simultaneous entry is optimal if  $\Pi^{Sm} \geq \Pi^{Sq}$  and  $\Pi^{Sm} \geq 0$ . Conversely, sequential entry is optimal if  $\Pi^{Sq} \geq \Pi^{Sm}$  and  $\Pi^{Sq} \geq 0$ . If neither set of conditions is satisfied, the firm does not enter any market.

First notice that since  $\tau^A \leq \tau^B$  by assumption, and  $\partial_{\tau^j} \Psi(\tau^j) \leq 0$  we have  $\Psi(\tau^A) \geq \Psi(\tau^B)$ , and we only need to consider whether to enter  $B$  sequentially or simultaneously.<sup>11</sup> Intuitively, because  $A$  is always more profitable than  $B$ , whenever the firm is willing to pay to enter in  $B$ , it will also enter  $A$ . Therefore,  $e_1^B(\tau^B) = 1$  implies  $e_1^A(\tau^A, \tau^B) = 1$ .<sup>12</sup>

Second, if the firm decides to enter  $B$  sequentially ( $e_1^B(\tau^B) = 0, e_2^B(\tau^B) = 1$ ), it must be because: (i) it was not profitable to enter both  $A$  and  $B$  in  $t = 1$ , i.e.  $\Pi^{Sq} \geq \Pi^{Sm}$ , and (ii) it has entered  $A$  in the previous period, and has learned that it is profitable to subsequently enter in  $B$ , i.e.  $\Pi^{Sq} \geq 0$ , both of which can be rewritten using (13) and (14) as:

$$\begin{aligned}\text{(i)} \quad &\Psi(\tau^B) - W(\tau^B; F) \leq F \\ \text{(ii)} \quad &\Psi(\tau^A) + W(\tau^B; F) \geq F\end{aligned}$$

or combined:

$$\Psi(\tau^B) - W(\tau^B; F) \leq F \leq \Psi(\tau^A) + W(\tau^B; F).\tag{15}$$

Third, and then, simultaneous entry is optimal ( $e_1^B(\tau^B) = 1$ ) whenever it is more profitable to enter both  $A$  and  $B$  in  $t = 1$ , i.e.  $\Pi^{Sm} \geq \Pi^{Sq}$ .<sup>13</sup> Using (13) and (14), we obtain:

$$F \leq \Psi(\tau^B) - W(\tau^B; F).\tag{16}$$

Notice that naturally (16) implies (15): if expected profitability is sufficiently high, foregone first period profits are larger than the option value of learning profitability in  $B$  by

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<sup>11</sup> $\partial_{\tau^j} \Psi(\tau^j) \leq 0$  follows from: (i)  $\Psi(\tau^j) = \mathbf{1}_{\{E\mu > \tau^j\}} \left( \frac{E\mu - \tau^j}{2} \right)^2 + V(\tau^j)$  and (ii) by Leibniz's rule,  $\frac{dV(\tau)}{d\tau} = - \int_{\tau}^{\bar{\mu}} \left( \frac{\mu - \tau}{2} \right) dG(\mu) < 0$ . Since both terms are monotonically decreasing in  $\tau^j$ ,  $\Psi(\tau^j)$  is also monotonically and continuously decreasing in  $\tau^j$  on  $(\mu, \bar{\mu})$ .

<sup>12</sup>Recall from 2.1 that because trade costs are lower,  $\tau^A \leq \tau^B$ , but the start-up entry cost  $F$  is the same across destinations, late entry in  $A$  is a dominated strategy ( $e_1^A = 0 \implies e_2^A = 0$ ), and therefore,  $e_t^A = 0 \implies e_t^B = 0, \forall t$ . Combining both, we have that  $e_1^A = 0 \implies e_2^B = 0$ , and only the strategies examined in the text remain.

<sup>13</sup>We do not need to consider the condition  $\Pi^{Sm} \geq 0$ , as it is implied by  $\Pi^{Sm} \geq \Pi^{Sq}$  and  $\Psi(\tau^A) \geq \Psi(\tau^B)$ . By (16), and since  $W(\tau^B; F) \geq 0$  we have  $\Psi(\tau^B) \geq \Psi(\tau^B) - W(\tau^B; F) \geq F$ . Then by  $\Psi(\tau^A) \geq \Psi(\tau^B)$ , we also have  $\Psi(\tau^A) \geq F$ . Adding both:  $\Psi(\tau^A) + \Psi(\tau^B) \geq 2F \Leftrightarrow \Pi^{Sm} \geq 0$ .

exporting first to  $A$ , and early entry in  $B$  dominates. Inequalities (16) and (15) define the firm's entry strategy at  $t = 1$ . The firm enters market  $A$  at  $t = 1$  if either (16) or (15) are satisfied; it enters market  $B$  at  $t = 1$  if (16) is satisfied but (15) is not:

$$e_1^A(\tau^A, \tau^B) = 1 \Leftrightarrow F \leq \Psi(\tau^A) + W(\tau^B; F). \quad (17)$$

and

$$e_1^B(\tau^B) = 1 \Leftrightarrow F \leq \Psi(\tau^B) - W(\tau^B; F). \quad (18)$$

Notice that while  $e_1^B$  depends on  $\tau^B$  only,  $e_1^A$  is a function of *both*  $\tau^A$  and  $\tau^B$ , even though markets are segmented in our economy. A lower  $\tau^A$  makes entry in market  $A$  more appealing, as expected, but so does a lower  $\tau^B$ , because it increases the profits from potentially entering market  $B$  at  $t = 2$ . By contrast, while  $\tau^B$  directly affects the decision to enter market  $B$  at  $t = 1$ ,  $\tau^A$  plays no direct role in that decision, since entry in country  $B$  presupposes entry in country  $A$ , and therefore early entry in country  $B$  produces no learning benefit.<sup>14</sup>

On the surface, condition (18) suggests that  $e_1^B = 1$  (in which case simultaneous entry occurs) only if the sunk cost to export is sufficiently small. Notice, however, that since  $W(\tau^B; F)$  decreases with  $F$ , so both right- and left-hand sides of (18) rise with  $F$ . Yet the surface is accurate in this case: simultaneous entry takes place only for 'small'  $F$ , as the following proposition shows.

**Proposition 1** *There are positive numbers  $F^{Sq}$  and  $F^{Sm}$ , with  $F^{Sm} < F^{Sq}$ , such that at  $t = 1$  the firm enters both markets  $A$  and  $B$  if  $F \leq F^{Sm}$ , enters only market  $A$  if  $F \in (F^{Sm}, F^{Sq}]$ , and enters neither market if  $F > F^{Sq}$ . When  $F \in (F^{Sm}, F^{Sq}]$ , at  $t = 2$  the firm enters market  $B$  if it learns that condition (4) is satisfied.*

**Proof.** Rewrite condition (18) for  $e_1^B = 1$  as

$$F + W(\tau^B; F) \leq \Psi(\tau^B). \quad (19)$$

The right-hand side of (19) is independent of  $F$ , whereas the left-hand side is strictly increasing in  $F$ . To see that, use Leibniz's rule to find that

$$\begin{aligned} \frac{d[F + W(\tau^B; F)]}{dF} &= 1 - \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} dG(\mu) \\ &= G(2F^{1/2} + \tau^B) > 0. \end{aligned}$$

Thus, defining  $F^{Sm}$  as the  $F$  that solves (19) with equality,  $e_1^B = 1$  if  $F \leq F^{Sm}$ .

Next rewrite condition (17) for  $e_1^A = 1$  as

$$F - W(\tau^B; F) \leq \Psi(\tau^A). \quad (20)$$

The right-hand side of (20) is independent of  $F$ , whereas the left-hand side is strictly increas-

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<sup>14</sup>The variable trade cost  $\tau^A$  does affect *future* (i.e. at  $t = 2$ ) entry decisions in market  $B$ : a small enough  $\tau^A$  induces entry in market  $A$  at  $t = 1$ , and as a result can lead to future entry also in market  $B$ .

ing in  $F$ . Thus, defining  $F^{Sq}$  as the  $F$  that solves (20) with equality,  $e_1^A = 1$  if  $F \leq F^{Sq}$ . Since  $F^{Sm} = \{F : \Pi^{Sm}(F^{Sm}) = \Pi^{Sq}(F^{Sm})\}$  is positive, while  $F^{Sq} = \{F : \Pi^{Sq}(F^{Sq}) = 0\}$ , by  $\partial_F \Pi^{Sq}(F) = G(2F^{1/2} + \tau^B) - 2 < 0$  we must have that  $F^{Sq} > F^{Sm}$ .

Finally, since the firm learns  $\mu$  at  $t = 1$  when  $F \in (F^{Sm}, F^{Sq}]$ , it enters market  $B$  at  $t = 2$  according to (4). The results are illustrated in Figure 3. ■

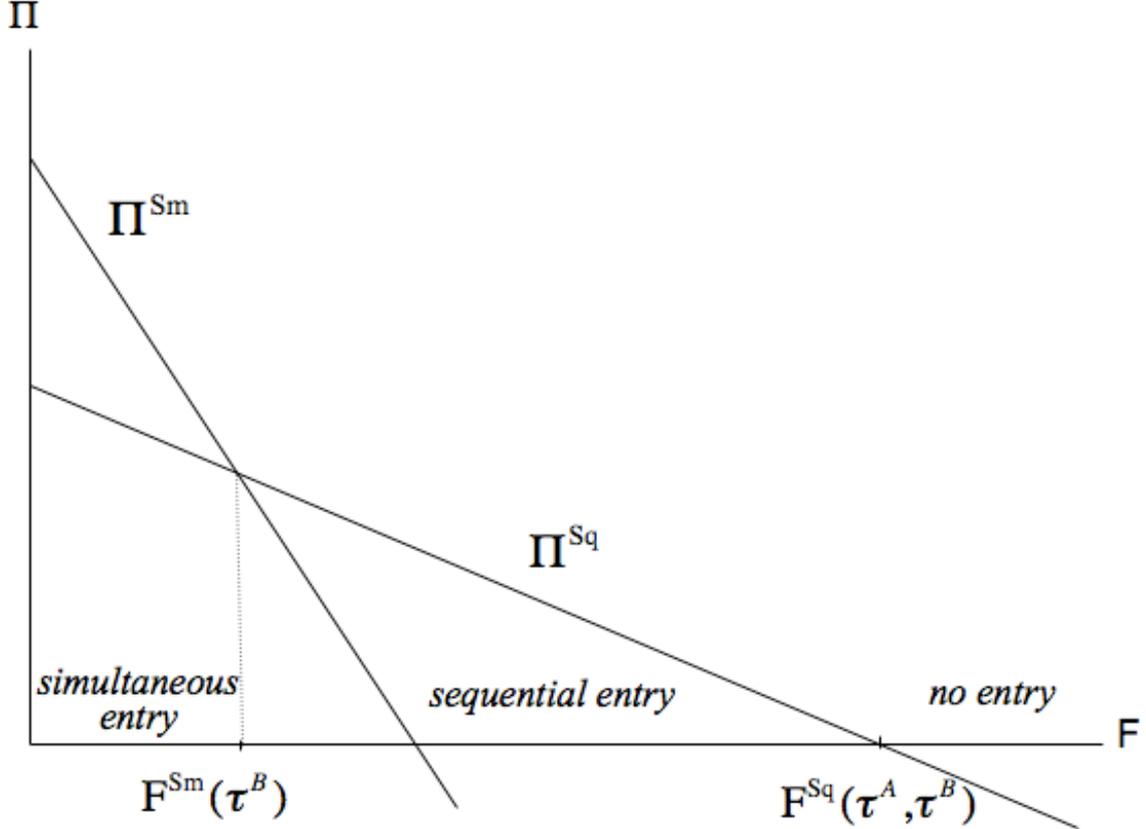


Figure 3: Optimal entry strategy and start-up costs.

The intuition for this result is simple. Since by construction  $\tau^A \leq \tau^B$ , if the firm ever enters any foreign market, it will enter market  $A$ . Since there are gains from learning, the entry in market  $A$ , if it happens, will take place in the first period. Provided that the firm enters country  $A$ , it can also enter country  $B$  in the first period or wait to learn its export profitability before going to market  $B$ . If the firm enters market  $B$  at  $t = 1$ , it earns the expected operational profit in that market in the first period. By postponing entry the firm forgoes that profit but saves the entry sunk cost if it realizes its export profitability is not sufficiently high. The size of the sunk cost has no bearing on the former, but increases the latter. Hence, the higher the sunk cost to export, the more beneficial is waiting before sinking  $F$  in the less profitable market,  $B$ .

Notice also that while trade cost  $\tau^B$  affects both thresholds, trade cost  $\tau^A$  only affects  $F^{Sq}$ . Thus, we can denote the thresholds as  $F^{Sq}(\tau^A, \tau^B)$  and  $F^{Sm}(\tau^B)$ . We fully characterize

the impact of trade costs on them in Section 4.

### 2.3 Differences in productivity

Before providing evidence for our mechanism in Section 3, we briefly consider the implications for exporters who differ in their productivities,  $\varphi_i$ . For simplicity we assume that there is a continuum of producers, each of which knows their own productivity and operates as a monopolist. Productivities are draws from a known distribution  $\Phi(\bullet)$  defined over a support  $[0, +\infty)$ , which effectively renders unit production costs equal to

$$c_i^j = \frac{1}{\varphi_i} + c^j$$

Since markets remain segmented, we drop subscript  $i$  at this stage. Allowing for cross-sectional productivity differences reveals that, *ceteris paribus*, more productive exporters: (i) are more likely to enter any given foreign destination  $j = A, B$ , i.e.  $\partial_\varphi \Psi(\tau^j + \frac{1}{\varphi}) \geq 0$ , because they (ii) make larger first period profits, i.e.  $\mathbf{1}_{\{E\mu > \tau^j + \frac{1}{\varphi}\}} \left( \frac{E\mu - \tau^j - \frac{1}{\varphi}}{2} \right)^2$  increases with  $\varphi$  and (iii) have a larger option value of exporting in period two without incurring in start-up entry costs, i.e.  $\partial_\varphi V(\tau^j + \frac{1}{\varphi}) \geq 0$ ; (iv) are more likely to sell larger volumes abroad, i.e.  $\partial_\varphi \tilde{q}_t^j(\tau^j + \frac{1}{\varphi}) \geq 0, \forall t$ , and therefore less likely to experiment; and (v) are more likely to enter simultaneously than sequentially, as the following proposition shows:

**Proposition 2** *There are positive numbers  $\varphi^{Sq}$  and  $\varphi^{Sm}$ , with  $\varphi^{Sm} > \varphi^{Sq}$ , such that at  $t = 1$  the firm enters both markets  $A$  and  $B$  if  $\varphi \geq \varphi^{Sm}$ , enters only market  $A$  if  $\varphi \in [\varphi^{Sq}, \varphi^{Sm})$ , and enters neither market if  $\varphi < \varphi^{Sq}$ . When  $\varphi \in [\varphi^{Sq}, \varphi^{Sm})$ , at  $t = 2$  the firm enters market  $B$  if it learns that condition (4) written in terms of  $\varphi$  is satisfied.*

**Proof.** Rewrite condition (18) for  $e_1^B = 1$  as

$$F \leq \Psi(\tau^B + \frac{1}{\varphi}) - W(\tau^B + \frac{1}{\varphi}; F). \quad (21)$$

The left-hand side of (21) is independent of  $\varphi$ , whereas the right-hand side is strictly increasing in  $\varphi$ . To see that, use Leibniz's rule to find that

$$\frac{d \left[ \Psi(\tau^B + \frac{1}{\varphi}) - W(\tau^B + \frac{1}{\varphi}; F) \right]}{d\varphi} = \frac{1}{\varphi^2} \left[ (E\mu - \tau^B - \frac{1}{\varphi}) + \int_{\tau^B + \frac{1}{\varphi}}^{2F^{1/2} + \tau^B + \frac{1}{\varphi}} (\mu - \tau^B - \frac{1}{\varphi}) dG(\mu) \right] > 0$$

Thus, defining  $\varphi^{Sm}$  as the  $\varphi$  that solves (21) with equality,  $e_1^B = 1$  if  $\varphi \geq \varphi^{Sm}$ .

Next rewrite condition (17) for  $e_1^A = 1$  as

$$F \leq \Psi(\tau^A + \frac{1}{\varphi}) + W(\tau^B + \frac{1}{\varphi}; F). \quad (22)$$

By a similar reasoning, while the left-hand side of (22) is independent of  $\varphi$ , the right-hand

side is strictly increasing in  $\varphi$ . Thus, defining  $\varphi^{Sq}$  as the  $\varphi$  that solves (22) with equality,  $e_1^A = 1$  if  $\varphi \geq \varphi^{Sq}$ . Since  $\varphi^{Sm}:\Pi^{Sm}(\varphi^{Sm}) = \Pi^{Sq}(\varphi^{Sm}) \geq 0$  while  $\varphi^{Sq}:\Pi^{Sq}(\varphi^{Sq}) = 0$ , by  $\partial_\varphi \Pi^{Sq}(\varphi) = \partial_\varphi \Psi(\tau^A + \frac{1}{\varphi}) + \partial_\varphi W(\tau^B + \frac{1}{\varphi}; F) > 0$  we must have that  $\varphi^{Sm} > \varphi^{Sq}$ .

Finally, since the firm learns  $\mu$  at  $t = 1$  when  $\varphi \in [\varphi^{Sq}, \varphi^{Sm})$ , it enters market  $B$  at  $t = 2$  according to (4) rewritten in terms of  $\varphi$  :

$$e_2^B(\tau^B) = 1 \Leftrightarrow \mu \geq 2F^{1/2} + \tau^B + \frac{1}{\varphi}. \quad (23)$$

■

Figure 4 below illustrates the results of both propositions (1) and (2), on the vertical and horizontal axes, respectively.

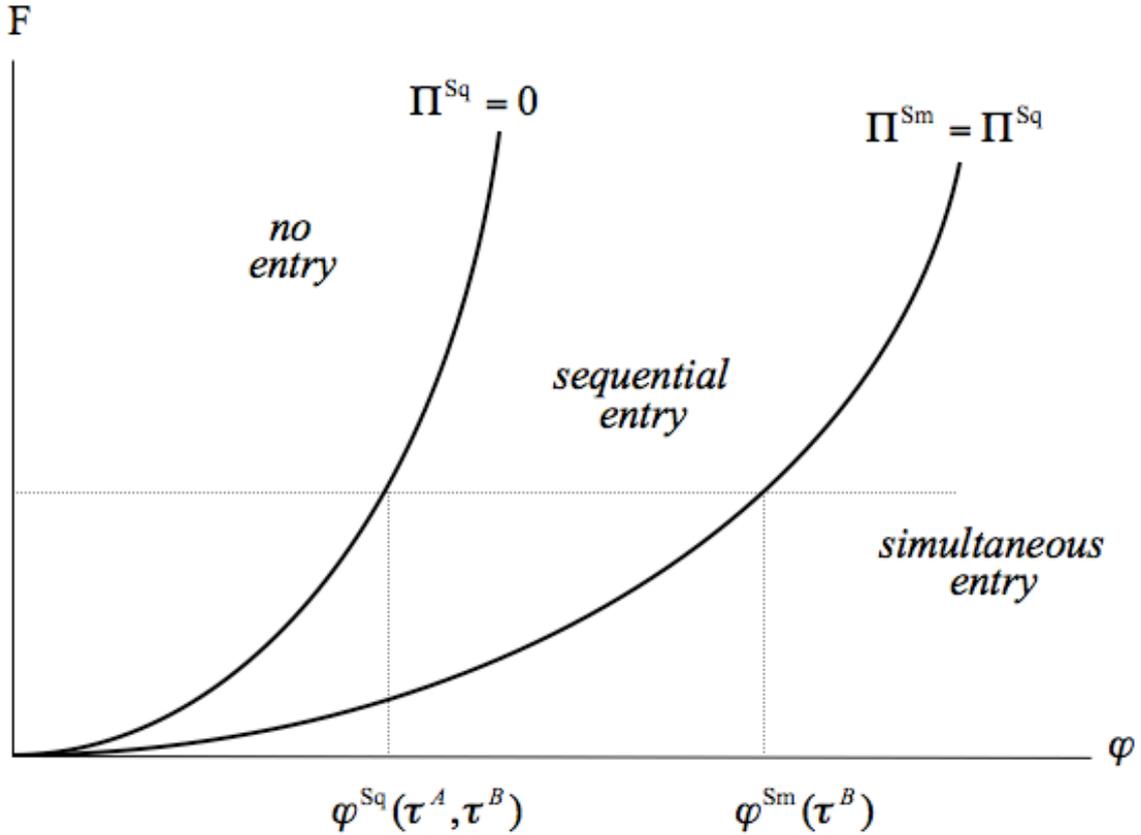


Figure 4: Optimal entry strategies as a function of firm productivity and start-up costs.

As it was the case in proposition (1), from conditions (22) and (21) we can see that trade cost  $\tau^B$  affects both productivity cutoffs, while trade cost  $\tau^A$  only affects  $\varphi^{Sq}$ . Hence  $\varphi^{Sq}(\tau^A, \tau^B)$  and  $\varphi^{Sm}(\tau^B)$  in Figure 4.

We now turn to provide empirical evidence on our basic mechanism.

### 3 Sequential Exporting: Evidence

How important, if at all, is sequential exporting? In the basic formulation of our model, firms learn fully about their profitability in exporting to market  $j$  by selling at market  $i$ ,  $i \neq j$ . In truth, the correlation of export profitabilities across markets is surely less than perfect, but if it is not negligible, our main messages remain intact (Appendix B). We now derive explicit testable implications of our model and take them to the data.<sup>15</sup>

#### 3.1 Testable implications

Our model is parsimonious in many dimensions. But it is straightforward to extend it to  $T > 2$  periods and  $N > 2$  foreign countries. We can derive testable predictions from this model for the intensive margin of exporting, for the extensive margin of exporting (entry and exit), and for the relationship between the two margins. We assume throughout that  $F$  is ‘moderate,’ so sequential exporting is optimal. We also maintain the convention that  $\tau^A = \min\{\tau^j\}$ ,  $j = A, \dots, N$ , so that market  $A$  is the first the firm enters at  $t = 1$ .

First, our model predicts that, conditional on survival, we should expect faster export growth when firms are learning their export profitabilities—right after they enter their first foreign market, that is when they are experimenting with exports.

**Prediction 1 (Intensive margin)** *Conditional on survival, the growth of a firm’s exports between the first and second periods in a given foreign market:*

- 1a. *is higher than in other periods, on average;*
- 1b. *is highest if that market is the first ever served by the firm, on average.*

**Proof.** Consider initially the first market,  $A$ . Conditional on entry, export volume at  $t = 1$  is given by (8). The firm decides to stay active there if  $\mu > \tau^A$ , and in that case produces  $q_2^A = \frac{\mu - \tau^A}{2}$ . Ex post quantities conditional on survival are distributed with  $G(\cdot | \mu > \tau^A)$ . It follows that the average surviving firm will produce the ex ante expected quantity  $E_0(q_2^A | \mu > \tau^A) = \frac{E_0(\mu | \mu > \tau^A) - \tau^A}{2}$ . We must distinguish between two cases. If  $E\mu \leq \tau^A$ , second-year export growth  $\sigma_2^A$  is given by  $\sigma_2^A \equiv \frac{E_0(\mu | \mu > \tau^A) - \tau^A}{2} - \varepsilon > 0$ . Otherwise,  $\sigma_2^A = \frac{E_0(\mu | \mu > \tau^A) - \tau^A}{2} - \frac{E\mu - \tau^A}{2} = \frac{1}{2}[E_0(\mu | \mu > \tau^A) - E\mu]$ . Lemma 2 in Appendix A shows that this inequality is strictly positive. Hence, conditional on survival, the firm expects to increase its export volume to market  $A$  in the second period.

In all subsequent periods expected growth conditional on survival is nil according to our model, since  $E_0(q_{t+1}^A | \mu > \tau^A) = \frac{E_0(\mu | \mu > \tau^A) - \tau^A}{2}$  for all  $t \geq 1$ . Thus, export growth in market  $A$  is greatest in the second year of exporting.

Consider now foreign market  $j$ ,  $j \neq A$ . Since the firm enters market  $j$  only if  $\mu^j > 2F^{1/2} + \tau^j$ ,  $E_0(q_{t+1}^j | \mu > 2F^{1/2} + \tau^j) = E_0(q_t^j | \mu > 2F^{1/2} + \tau^j) = \frac{E_0(\mu | \mu > 2F^{1/2} + \tau^j) - \tau^j}{2}$  for all

<sup>15</sup>Although the model predictions are stated in terms of export quantities while the data is in terms of export sales, the testable implications can be equivalently stated in terms of sales as long as demand (a) and supply shocks (c) are independently distributed. See Lemma 3 in appendix A for a proof.

$t \geq 1$ . Thus, export growth in market  $j$  is  $\sigma_t^j = 0$  for all  $t$ , hence never higher than in the second period the firm exports to that market. This proves part 1a. Furthermore,  $\sigma_2^A > \sigma_2^j$ , completing the proof. ■

The intuition for this result is simple. Because export profitability is uncertain for a firm before it starts exporting, first-year exports are likely to be relatively low. If the firm anticipates a positive variable profit in its first market, it produces according to this expectation. Otherwise, if the firm is entering there just to learn about its export potential (and the potential benefits from expanding to other destinations in the future), the firm produces just the minimum necessary for effective learning. If the firm stays in the market, it must be because its uncovered export potential is above a certain threshold. Therefore, conditional on survival, the firm expands its sales in its first market. On the other hand, once the uncertainty about export profitability has been resolved, there is no reason for further changes in sales, and export volume growth should accordingly be lower in the years following this discovery period, i.e. zero, in our simplified setting. Similarly, since the profitability of the firm in its first export destination conveys information about export profitability in other destinations, there is no reason for export growth in markets other than the firm's first.

Obviously, our basic model delivers these results too bluntly. First, we abstract from a range of shocks that are likely to affect the firm's output choices. Second, there are in general other reasons to expect export growth in a certain market over several years (e.g. incomplete information coupled with weak institutions, as in Araujo and Ornelas 2007, see the discussion at the end of this Section). Third, we assume in the main text that export profitability is perfectly correlated across markets. Yet imperfectly correlated export profitability across markets alone implies strictly positive second-year export growth in every market the firm expands to and survives (our Prediction 1a). However, if the highest informational content is extracted from the first export experience, second-year export growth should be greater than in other periods in each foreign destination. In particular it should be greater in the firm's first export market than in subsequent destinations (Prediction 1b). We will therefore consider Prediction (1b) as the main testable implication and will control for idiosyncratic shocks to demand and cost.

Our second prediction relates to entry patterns. Assuming 'moderate' sunk costs of exporting, a firm will first test its closest market. If its export profitability turns out to be sufficiently high, the firm expands in the next period to those markets close enough to make entry worthwhile. We can state the following prediction:

**Prediction 2 (Extensive margin)** *Conditional on survival, new exporters are more likely to enter other foreign markets than experienced ones.*

**Proof.** The assumption of moderate fixed entry costs is maintained. A firm that has just started exporting enters a second foreign market  $B$  with probability  $pr(e_2^B = 1 | e_1^A = 1 \ \& \ e_1^B = 0)$ . A firm that has been an exporter for a longer period enters market  $j$  with

probability  $pr(e_t^j = 1 | \prod_{i=1}^{t-1} e_{t-i}^A = 1 \ \& \ e_{t-1}^j = 0)$ ,  $t \geq 2$ . We have that

$$pr(e_2^B = 1 | e_1^A = 1 \ \& \ e_1^B = 0) = 1 - G(2F^{1/2} + \tau^B) > 0 = pr(e_t^j = 1 | \prod_{i=1}^{t-1} e_{t-i}^A = 1 \ \& \ e_{t-1}^j = 0),$$

completing the proof. ■

The intuition for this prediction is simple. Experienced exporters have already learnt enough about their export profitability, and therefore have already made their entry decisions in the past. In contrast, new exporters are still learning, and some will realize it pays for them to expand activities to other destinations.

Our last prediction refers to the exit patterns of exporting firms.

**Prediction 3** *A firm is more likely to exit a foreign market immediately if the firm is a new exporter.*

**Proof.** The probability of exiting a foreign market right after entering there is  $pr(e_{t+1}^A = 0 | e_t^A = 1 \ \& \ e_{t-1}^A = 0)$  if the foreign market is the firm's first, and  $pr(e_{t+1}^j = 0 | e_t^j = 1 \ \& \ e_{t-1}^j = 1)$ ,  $t \geq 2$ ,  $j \neq A$ , otherwise. We have that

$$pr(e_{t+1}^A = 0 | e_t^A = 1 \ \& \ e_{t-1}^A = 0) = G(\tau^A) > 0 = pr(e_{t+1}^j = 0 | e_t^j = 1 \ \& \ e_{t-1}^j = 1),$$

completing the proof. ■

An experienced exporter is better informed about export profitability in a new foreign destination than it would have been, were that foreign market the firm's first. Accordingly, finding out that it is not worthwhile to keep serving that market is more likely in the latter than in the former case.

## 3.2 Data

Our dataset includes the universe of Argentinean export transactions, as collected by the Argentinean Customs Office, between 2002 and 2007. For each export transaction, the Argentinean Customs Office records information on the value (in US dollars), the exporter's tax firms, the product code, the number of physical units and unit values, and the country of destination. We restrict our analysis to manufacturing firms. Over our sample period, Argentinean manufacturing exports involved 15,301 exporters and 130 export destinations.

Appendix C presents the trends of aggregate exports in Argentina during 2002-2007. This is a particularly fruitful context to study export experimentation, as Argentina experienced an export boom during those years, after a steep depreciation of its currency in early 2002. As of 2007, Argentina's main export manufacturing sectors are petroleum (30%); food, tobacco and beverages (23%); and automotive and transport equipment (13%). The largest share of Argentina's manufacturing foreign sales takes place in the other Mercosur countries (40%), followed by other Latin America countries (18%) and the United States (12%).

We first present aggregate export patterns at the firm level. To facilitate comparison with the study of Colombian firms by EEKT, we use their export status categories. Specifically, "Entrants" in year  $t$  are firms that not did not export in  $t - 1$ , exported in  $t$ , *and will export* in  $t + 1$ . "Exiters" exported in  $t - 1$  and in  $t$  but stopped exporting in  $t + 1$ . "Continuers" exported in  $t - 1$ ,  $t$  and in  $t + 1$ . Finally, "Single Year" are firms that exported at  $t$  but not in either  $t - 1$  or  $t + 1$ .

Table 1 reveals some interesting features of different types of exporters. First, single-year exporters are common (comprising close to 38% of all new exporters), although not as much as in Colombia (where they represent around half of the new exporters). Their absolute and relative participation clearly increases overtime, however, reaching 47% of all new exporters in 2006. Second, continuers respond for the bulk of exports in Argentina, at both the intensive and the extensive margin. Entrants and exiters are considerably smaller, and single-year firms even more so. Third, continuers experience export growth at all margins in every year of the sample, but there is volatility among entrants, exiters and single-year exporters. These regularities echo those observed in Colombian firms by EEKT.<sup>16</sup>

Table 1: Exports by Type of Exporter

<b>Number of firms</b>					
Year	Total	Entrant	Exiter	Continuer	Single Year
2002	7205				
2003	8251	1484	499	5520	748
2004	9055	1569	487	6517	482
2005	10884	1568	1053	7033	1230
2006	10944	1244	1230	7371	1099
2007	10062				
<b>Total Value of exports (US\$ Millions)</b>					
Year	Total	Entrant	Exiter	Continuer	Single Year
2002	17890				
2003	18554	80	299	18183	26
2004	23544	133	34	23369	16
2005	29060	204	161	28603	102
2006	30872	362	127	30405	41
2007	41395				
<b>Exports per firm (US\$ Thousands)</b>					
Year	Total	Entrant	Exiter	Continuer	Single Year
2002	2483				
2003	2249	54	598	3294	34
2004	2600	85	70	3586	32
2005	2670	130	153	4067	83
2006	2821	291	103	4125	37
2007	4114				

Note: "Entrants" in year  $t$  are firms that not did not export in  $t-1$  and exported in  $t$ , *and will export* in  $t + 1$  as well. "Exiters" exported in  $t-1$  and in  $t$  but are not exporters in  $t + 1$ . "Continuers" export in  $t-1$ ,  $t$  and in  $t + 1$ . "Single Year" exporters are firms that exported in  $t$  but neither in  $t-1$ , nor in  $t + 1$ .

<sup>16</sup>A broadly similar picture arises in the study of Freund and Pierola (2008), who look at exports by Peruvian non-traditional agricultural exporters.

Finally, we can distinguish firms according to their entry strategy and note that 79% of new exporters adopt a sequential strategy, 15% enter simultaneously to two or three destinations and that 6% enter simultaneously to more than three destinations. Among, these exporters a scant minority (less than 1 %) appear in our data set as "re-entrant exporters" (a firm exporting in year  $t$ , not in  $t - 1$  but yes in  $t - d$  with  $d > 1$ ).

### 3.3 Empirical results

Table 2 provides some preliminary evidence of learning across export markets. We identify firms that break into a new market in 2003 and keep exporting there in the subsequent years of our data set, and distinguish those exporting in 2003 for the first time ("First Market 2003") from those already in the exporting business ("New Market 2003").<sup>17</sup> The table displays each group's average exports value by year of experience. Observe that both types of firms increase their exports by more than 100% during the first year, provided that they keep exporting in 2004, but that export growth is considerably lower in subsequent years. This is consistent with firms learning their profitability in a particular market after serving it for some time. Furthermore, consistent with correlated export profit uncertainty, (i) export growth is significantly higher in first markets than in subsequent destinations in all years in the sample, and (ii) average values shipped by experienced exporters ("new market 2003") are larger than those shipped by fledging ones ("first market 2003").

Table 2: Firm-level export growth, First Market versus New Market

Year	First Market 2003		New Market 2003	
	USD	Growth (%)	USD	Growth (%)
2003	34023		96541	
2004	88262	159	200799	108
2005	149602	69	304295	52
2006	197447	32	340015	12
2007	303041	53	449147	32

To investigate more precisely whether second-year exports are greater in a firm's first market than in subsequent markets, we estimate the following equation:

$$\Delta \log X_{ijt} = \alpha_1 FY_{ijt-1} + \alpha_2 (FY_{ijt-1} \times FM_{ij}) + u_{ijt} ,$$

where  $\Delta \log X_{ijt}$  is the growth rate of the value of exports between  $t$  and  $t - 1$  by firm  $i$  in market  $j$ .  $FY_{ijt-1}$  is a dummy indicating whether firm  $i$  exported to destination  $j$  in  $t - 1$  for the first time.  $FM_{ij}$  indicates whether  $j$  was the firm's first export market.

Now, of course a number of other factors affect a firm's export growth in a market as well: the general characteristics of the destination, the economic conditions in the year, and perhaps even more the firm's own distinguishing characteristics. To account for these other

<sup>17</sup>We focus on 2003 to obtain the largest possible time span where we can observe entry.

factors, we take advantage of the richness of our dataset and include a wide range of fixed effects, including firm, year, destination, year-destination, and even firm-year fixed effects (exploiting the variation of a firm’s exports in a single year across destinations).

Table 3 displays the results. Second-year growth is significantly higher in the firm’s *first* export market, as Prediction 1 indicates. The coefficient associated with  $FY_{ijt-1} \times FM_{ij}$  is significantly positive in all specifications that include firm fixed effects, including when we look only at variations within firms in each year (i.e. across firms’ destinations) and when we control for firm’s initial exports. The insignificant coefficient in the regression without firm fixed effects simply reveals the degree of firm heterogeneity in our sample. It indicates that firms that have high second-year growth in general tend to enter more markets, washing out the differential first-market effect in the sample when the firms’ average export growth is not accounted for. Since it is a well-known fact from the IO literature that small firms tend to grow faster, we also control for lagged exports in column 6.<sup>18</sup> When doing so, the effect of  $FY_{ijt-1} \times FM_{ij}$  on export growth remains positive and significant; in fact, the coefficient is much higher in that case.

Table 3: Dependent Variable: Log-difference of exports of recurring exporters

OLS	1	2	3	4	5	6	7
$\log X_{i,j,t-1}$						-.428** (.007)	-.427** (.007)
$FY_{ijt-1}$	.260** (.013)	.239** (.015)	.234** (.015)	.234** (.016)	.234** (.015)	-.123** (.014)	-.122** (.014)
$FY_{ijt-1} \times FM_{ij}$	-.007 (.023)	.159** (.035)	.109** (.036)	.076* (.033)	.104** (.036)	.270** (.029)	.260** (.029)
Constant	.129** (.005)	.126** (.003)	.198** (.018)	.093** (.039)	.151** (.011)	4.64** (.073)	4.63** (.071)
Firm FE		yes	yes		yes	yes	yes
Firm-Year FE				yes			
Year FE			yes	yes		yes	
Destination FE			yes	yes		yes	
Year-Destination FE					yes		yes
Number of obs	107390	107390	107390	107390	107390	107390	107390
R-squared	0.005	0.092	0.092	0.271	0.100	0.304	0.301

$FY_{i,j,t-1} = 1$  if in year  $t$  firm  $i$  is exporting to  $j$  for the *second* year.

$FM_{ij} = 1$  if  $j$  is the first market firm  $i$  has ever exported to.

\*\* : significant at 1%; \* : significant at 5%.

Robust Standard Errors adjusted for clusters in firms.

We now proceed to test Prediction 2. For every firm-year pair with at least one export transaction, we create a binary variable  $Entry_{ijt}$  that takes one if firm  $i$  enters destination  $j$  at time  $t$ , and zero otherwise. We exclude post-entry exports from the dataset. Therefore non-entry corresponds to the choice by an exporting firm  $i$  *not to enter* destination  $j$  at time  $t$ , although it might do so in the future. For computational reasons we must place a

<sup>18</sup>Unreported regressions with the same fixed effects but no lagged exports yield identical results for our variables of interest. The discussion of our results in the next subsection will make clear why we choose to present this specification.

limit on the number of destinations. We choose nine regions ( $j$ ) grouping different countries: Mercosur, Other Neighbors (Chile and Bolivia), Other South America, Other Latin America, North America, Spain, Other EU, China, Rest of the World. These geographic areas account for most of Argentine exports and are relatively homogenous.<sup>19</sup> Notice that when a firm enters a new country in a region  $j$  where it exports already, this does not appear in our data by construction. In so doing our results are likely to underestimate the extent of experimentation.

We then run the following basic regression on the probability of starting to export to a new market:

$$Prob[Entry_{ijt} = 1] = \beta_1 FY_{i,t-1} + v_{ijt} ,$$

where  $FY_{i,t-1}$  indicates whether the firm's export experience started at  $t - 1$  (i.e., whether  $t$  is firm  $i$ 's second year of exports). We include a wide range of fixed effects here as well. We expect a positive coefficient  $\beta_1$ : fledgling exporters are more likely to enter new destinations than experienced exporters.

Results are presented in columns 1-4 in Table 4.  $FY_{i,t-1}$  has a positive and highly significant coefficient in all four specifications. Comparing the intercept (which gives the probability of entry in destination  $j$  of a firm that started exporting before  $t - 1$ ) with the coefficient of  $FY_{i,t-1}$ , we find that a new exporter is at least 10 percent more likely to enter an "average" destination in an "average" year than a more experienced one.

While we control for time-invariant unobserved heterogeneity with our broad range of fixed effects, we cannot rule out that positive idiosyncratic productivity shocks lead firms to expand at both margins in their early years. To account for them (albeit imperfectly), we introduce pre-entry export growth (in those destinations served prior to entry) by itself and interacted with our indicator for new exporters,  $FY_{i,t-1}$ , in two different specifications. Each specification separately identifies the effect on entry of the sign of prior export growth (column 5:  $D(\Delta \log X_{i,-j,t})$ ) from its magnitude (column 6:  $\Delta \log X_{i,-j,t}$ ):

$$\begin{aligned} Prob[Entry_{ijt} = 1] &= \beta_1 FY_{i,t-1} + \beta_2 D(\Delta \log X_{i,-j,t}) + \beta_3 [D(\Delta \log X_{i,-j,t})_{i,-j,t} \times FY_{i,t-1}] + \omega_{ijt}, \\ Prob[Entry_{ijt} = 1] &= \beta_1 FY_{i,t-1} + \beta_2 \Delta \log X_{i,-j,t} + \beta_3 [\Delta \log X_{i,-j,t} \times FY_{i,t-1}] + \eta_{ijt}, \end{aligned}$$

where  $D(\Delta \log X_{i,-j,t})$  is a dummy indicating whether firm  $i$  has increased exports to the markets it serves both at  $t - 1$  and  $t$ .

The results are displayed below columns 5 and 6 of Table 4. The central message is that  $FY_{i,t-1}$  still has a positive and significant coefficient. In addition, the overall effect of  $FY_{i,t-1}$  is positive for most observations of our sample. In column 5 the interaction term has no explanatory power: if a fledgling exporter and an experienced exporter both have positive growth rates, the fledgling exporter is more likely to enter new markets. In column 6 we find that this effect applies for most values of the growth rate. A fledgling exporter is more likely to enter than an experienced exporter growing at the same rate  $g$  if  $\beta_1 + \beta_3 g \geq 0$ . Given

<sup>19</sup>Alternative sets of destinations yield similar results, but are not so meaningful because they bundle very different destinations (available upon request).

Table 4: Probability of Exporting to a New Market (Dependent Variable:  $Entry_{ijt}$ )

LPM	1	2	3	4	5	6	7
$FY_{i,t-1}$	.008** (.001)	.015** (.002)	.009** (.002)	.009** (.002)	.009** (.002)	.005* (.003)	
$FY_{i,t-1}$ *MERCOSUR							.016** (.006)
$FY_{i,t-1}$ *Other-Neighbours							.013** (.006)
$FY_{i,t-1}$ *North-America							-.001 (.006)
$FY_{i,t-1}$ *China							.006 (.005)
$FY_{i,t-1}$ *Other-EU							.012** (.005)
$FY_{i,t-1}$ *Other-Latin-America							.011* (.005)
$FY_{i,t-1}$ *Spain							.010† (.006)
$FY_{i,t-1}$ *Other-South-America							.003 (.006)
$FY_{i,t-1}$ *RofW							.003 (.006)
$D(\Delta \log X_{i,-j,t})$					.009** (.001)		
$D(\Delta \log X_{i,-j,t}) \times FY_{i,t-1}$					-.006 (.005)		
$\Delta \log X_{i,-j,t}$						.006** (.0001)	
$\Delta \log X_{i,-j,t} \times FY_{i,t-1}$						-.004* (.002)	
Constant	.063** (.001)	.062** (.001)	.098** (.002)	.089** (.004)	.063** (.004)	.068** (.004)	.089** (.003)
Firm FE		yes	yes	yes	yes	yes	yes
Destination FE			yes				
Year FE			yes				
Year-Destination FE				yes	yes	yes	yes
Number of obs	234223	234223	234223	234223	219047	234223	234223
R2	.0003	.08	.09	.08	.09	.09	.09

\*\* : significant at 1%; \* : significant at 5%; † : significant at 10% .

Robust Standard Errors adjusted for clusters in firms.

our estimates, this amounts to  $g \leq \frac{.005}{.004} = 1.25$ . This condition is met at the sample mean ( $g = .075$ ) and for 89.4% of the observations used in the estimation reported in column 6.

Finally, we turn to Prediction 3 on the exit patterns of Argentine's exporting firms. We expect that the probability of exiting a particular export market  $j$  by a firm  $i$  in period  $t$ , ( $Exit_{i,j,t} = 1$ ) is higher if the firm exported there for the first time in  $t - 1$ . This effect should be stronger if  $j$  is the first destination market, where subindex  $j$  accounts now for individual countries rather than regions. To test this, we estimate the following specification:

$$Prob[Exit_{i,j,t} = 1] = \gamma_1 FY_{i,j,t-1} + \gamma_2 (FY_{i,j,t-1} \times FM_{ij}) + \zeta_{ijt}$$

As defined above,  $FY_{i,j,t-1}$  indicates whether  $t - 1$  is the first time  $i$  exported to  $j$ . Similarly  $FM_{i,j}$  is a dummy that takes value one if  $j$  was  $i$ 's first export market (if the firm entered several destinations simultaneously, the dummy variable takes value one for each of them).

We introduce a wide range of fixed effects to account for directly unobserved determinants of exit. We expect  $\gamma_2$  to be significantly positive in all specifications that do not include firm fixed effects. The explanation is simple. The first part of Prediction 3 is based on firms that drop an export market after one period of exporting there for the first time. This is why  $\gamma_1$  is expected to be significantly positive. Learning across markets would strengthen this effect for first destination markets. This implies a significantly positive  $\gamma_2$ . Notice however that this part of the proposition concerns single-year exporters. Most single-year exporters represent only one observation in our data set and therefore they are excluded when we focus on within firm variation. The only cases of single-year exporters that remain after controlling for firm fixed effects are re-entrant single year exporters (firms that exported to  $j$  at some point in the past but not in  $t - 1$ , and exited after exporting in  $t$ ) or simultaneous single year exporters (those that broke simultaneously into more than one market in  $t - 1$  and exited in  $t$ ). Insomuch as re-entrants and simultaneous exporters are relatively less uncertain about their export profitability at time of entry, we predict that they are actually less likely to exit right after entry. This implies that  $\gamma_2$  should switch signs from positive to negative when including firm fixed effects.

Table 5 provides support to our predictions on exit. Observe first, that the coefficient associated with  $FY_{i,j,t-1}$  is positive and significant in all estimations without firm fixed effects. More importantly, observe that the coefficient of  $FY_{i,j,t-1} \times FM_{ij}$  is positive and significant for all the estimations that include no firm fixed effects (four first columns) and the sign of the coefficient switches to negative once firm fixed effects are considered.

### 3.4 Robustness

We run a battery of further tests in order to rule out some potential alternative explanations for our results.

First, we focus on re-entrant exporters, defined as entrants with prior exporting experience (10 % of all entrants in our sample). Arguably, re-entrants possess more information about their profitability abroad than ordinary entrants. Therefore, we do *not* expect our

Table 5: Probability of Exit after Exporting to a New Market (Dependent variable:  $Exit_{i,j,t}$ )

LPM.	1	2	3	4	5	6	7
$FY_{i,j,t-1}$	.011** (.002)	.017** (.001)	.019** (.001)	.019** (.002)	-.021** (.001)	-.013** (.001)	-.013** (.007)
$FY_{i,j,t-1} \times FM_{ij}$	.163** (.002)	.161** (.002)	.157** (.002)	.158** (.002)	-.026** (.002)	-.036** (.002)	-.036** (.003)
Constant	yes	yes	yes	yes	yes	yes	yes
Firm FE					yes	yes	yes
Destination FE		yes	yes				yes
Year FE			yes				yes
Year-Destination FE				yes		yes	
Number of obs	135932	135932	135932	135932	135932	135932	135932
R2	0.06	0.07	0.08	.008	0.651	0.656	0.655

\*\* : significant at 1%; \* : significant at 5%.

$FY_{i,j,t-1} = 1$  if  $t - 1$  is the first time  $i$  exported to  $j$ .  $FM_{i,j} = 1$  if  $j$  is the first market firm  $i$  has ever exported to.

Robust Standard Errors adjusted for clusters in firms.

predictions to hold: if firm  $i$  had exported to  $j$  at some point in the past ( $t - \delta$  for  $\delta > 1$ ), when re-entering  $j$  in  $t$ , the firm has already a reliable signal of its profitability there so that the value of its shipment in  $t$  is not going to be very different from the value in  $t + 1$  (unlike our prediction 1). By the same token, re-entrants in  $t$  are less likely to: (i) subsequently jump to new destinations right after their first year of re-entry (against our prediction 2), and (ii) less likely to exit  $j$  in  $t + 1$  (against our prediction 3).

To test these predictions we run our three regressions (growth, entry and exit) where the key variables are interacted with an indicator of whether the firm is a re-entrant. We display results in table 6.<sup>20</sup>

The results lend broad support to our theory. Growth regressions show that, unlike ordinary entrants, re-entrants: (i) are significantly (at 10%) less likely to grow in their first market, and (ii) are less likely to exit right after their first year of re-entering their first market. Finally, although our results do not support a significant difference in the entry pattern for re-entrants, this is not necessarily inconsistent with our theory, if some of them re-enter in a different destination restoring an interrupted sequential entry pattern.

Second, some of our findings might be consistent with within-industry learning, as in Hausmann and Rodrik (2003), Krautheim (2008) or Segura-Cayuela and Vilarrubia (2008): firms may use as an informative signal of own's odds of success as an exporter, the successful entry in foreign markets of domestic rivals. To consider this possibility, we estimate the following expanded specification (with firm and year-destination fixed effects):

<sup>20</sup>We choose to run these regressions with F YD fixed effects. This specification has the advantage of controlling for unobserved firm heterogeneity and macroeconomic fluctuations as well as movements in exchange rates.

Table 6: Predictions and Re-entrant Exporters

	$\Delta \log X_{ijt}$	$Entry_{ijt}$	$Exit_{i,j,t}$
$FY_{ijt-1}$	.254** (.016)		
$FY_{ijt-1} \times \text{Re-entrant}_{i,t-1}$	-.071** (.016)		
$FY_{ijt-1} \times FM_{ij}$	.099** (.037)		
$FY_{ijt-1} \times FM_{ij} \times \text{Re-entrant}_{i,t-1}$	-.188† (.073)		
$FY_{i,t-1}$		.008** (.002)	
$FY_{i,t-1} \times \text{Re-entrant}_{i,t-1}$		.003 (.005)	
$FY_{i,j,t-1}$			.017** (.002)
$FY_{i,j,t-1} \times \text{Re-entrant}_{i,t-1}$			-.078** (.013)
$FY_{i,j,t-1} \times FM_{ij}$			.028** (.002)
$FY_{i,j,t-1} \times FM_{ij} \times \text{Re-entrant}_{i,t-1}$			-.179** (.013)
Constant	.165** (.012)	.089** (.003)	-.298 (.232)
Firm FE	yes	yes	
Year-Destination FE	yes	yes	yes
Number of obs	107390	234223	135932
R2	0.10	0.09	0.116

\*\* : significant at 1%; \* : significant at 5%; † : significant at 10% .  
Robust Standard Errors adjusted for clusters in firms.

$$Prob[Entry_{ijt} = 1] = \beta_1 FY_{i,t-1} + \beta_2 NCompetitors_{k,j,t-1} + \beta_3 \Delta \log XCompetitors_{k,j,t} + \xi_{ijt} ,$$

where  $NCompetitors_{k,j,t-1}$  is the number of domestic competitors in industry  $k$  exporting to country  $j$  at  $t - 1$ , and  $\Delta \log XCompetitors_{k,j,t}$  is the export growth of these same competitors between  $t$  and  $t - 1$ . Both control for static and dynamic characteristics of export profitability that a firm may infer from observing its rivals.

Finally, our results might also be consistent with the presence of credit constraints: Some firms might prefer to enter simultaneously into different destinations, but be forced to enter sequentially because of the large sunk entry costs and the impossibility of either financing them internally or of obtaining the necessary external credit. To account for that possibility, we borrow Manova's (2008) measure of 'asset tangibility' to identify the industries that are least credit constrained, i.e. those that have the highest proportion of collateralizable assets (at the industry level). We then define an industry to be relatively credit unconstrained if the value of asset tangibility for the industry is above the median for the whole manufacturing sector (i.e. 30%), and examine whether our predictions (growth, entry and exit) hold for the subsample of credit unconstrained firms in the presence of firm and year-destination fixed effects:

Table 7 displays the results for both within-industry learning and credit constraints. Below the first two columns, and consistently with within-industry learning effects, the number and the growth rates of domestic competitors in a given destination explain entry. Still, a new exporter is significantly more likely to enter a new destination than an experienced exporter, providing support for the importance of experimentation in entering new destinations even in the presence of rivals' informational externality. Regarding credit constraints, we find below the last three columns that our predictions hold for firms in the relatively unconstrained industries, indicating that the choice of entering export markets sequentially is not a consequence of firms being liquidity constrained.

### 3.5 Discussion

We now discuss alternative explanations for our empirical findings. We consider several alternative mechanisms and argue that none of them can single-handedly account for all of our findings.

First, consider that recent models of trade with heterogeneous firms (e.g. Bernard *et al.* 2003; Chaney 2008; Melitz 2003; Melitz and Ottaviano 2007) focus on the steady state. They are therefore not conceived to shed light on the dynamics of exporting.

Heterogeneous firms models with destination-specific uncertainty can only generate our Predictions 1a and 3, to some extent. Segura-Cayuela and Vilarrubia (2008) consider a Melitz model with uncertain per-period fixed costs of serving a foreign market. These costs are country-pair-specific and uncorrelated across markets. In Freund and Pierola (2008) small first-year exports reveal information on export profitability, but only in a given market. Both

Table 7: Controlling for Within-Industry Learning and Credit Constraints

	$Entry_{ijt}$	$Entry_{ijt}$	$\Delta \log X_{ijt}$	$Entry_{ijt}$	$Exit_{i,j,t}$
<i>Controlling for Within-Industry Learning</i>					
$FY_{i,t-1}$	.009** (.002)	.009** (.002)			
$NCompetitors_{k,j,t-1}$	.0001** (.000001)	.0001** (.000001)			
$\Delta \log X Competitors_{k,j,t}$		.004** (.001)			
<i>Excluding Credit-Constrained Sectors</i>					
$FY_{ijt-1}$			.243** (.023)		
$FY_{ijt-1} \times FM_{ij}$			.180** (.057)		
$FY_{i,t-1}$				.004** (.001)	
$FY_{i,j,t-1}$					.014** (.002)
$FY_{i,j,t-1} \times FM_{ij}$					.153** (.003)
Constant	.072** (.004)	.010** (.002)	.137** (.021)	.034** (.003)	.049 (2467)
Firm FE yes	yes	yes	yes	yes	
Year-Destination FE yes	yes	yes	yes	yes	yes
Number of obs	234223	234223	43258	202434	54139
R2	0.09	0.09	0.10	0.12	0.08

\*\* : significant at 1%.

Robust Standard Errors adjusted for clusters in firms.

models can generate Prediction 1a, but not 1b: export growth is higher in the second year, but to the same extent in all markets. Similarly in both models prior export experience is uninformative on future entry prospects, which explains why they both fail to generate our Prediction 2. Both models can generate Prediction 3 (on exit), but only to the extent that exit after the first year represents exit from all export markets altogether (after negative information has been revealed). That our results on exit hold with firm fixed effects, i.e. across a firm’s export markets, is a problem for these alternative explanations.

Second, we examine explanations involving firms’ technology. Firms that experience positive persistent idiosyncratic TFP shocks will self-select into exporting to increasingly distant destinations (Das *et al.*, 2007; Arkolakis, 2008; Irrarazabal and Opromolla, 2008). Firms start exporting when they experience positive shocks. Due to serial correlation entrants are more likely to enter further markets, while growth in exports fades over time as shocks die out. This may explain why prior export experience matters more in the second market than in subsequent ones (Prediction 2). It can also explain why second-year export growth is highest in the first market (Prediction 1b).<sup>21</sup> But they cannot explain Prediction 3 (on exit). The reason is that the hazard rate increases with export tenure since shocks die out over time (as pointed out by Ruhl and Willis, 2009). In contrast, we predict that the likelihood of exit decreases with export tenure.

We therefore examine their relevance by including firm and firm-year fixed effects in all regressions as well as the level of lagged exports in growth regressions. In Table 3 our results are robust to these empirical specifications. In Table 4 we cannot use firm-year fixed effects but control for prior export growth (which captures some of these shocks) and find that our results are robust. While balance sheet data would be desirable to assess the exact role of stochastic technological processes, we conclude that they cannot fully explain our results.

A third possible explanation is that firms learn by exporting. Under this explanation a firm’s productivity increases deterministically through contact with foreign customers or competitors, leading to higher second-year export sales. As long as that learning is exhausted after a year, second-year export growth should be higher (Prediction 1a). To explain why learning is greater in the first export market (Prediction 1b), or why export experience matters more for entry in early than late years, the firm’s new knowledge should be applicable to all markets. In contrast, a general result message from empirical studies is that the existence of learning by exporting depends strongly on the country setting.<sup>22</sup>

A fourth possible explanation relates to liquidity constrained exporters (Chaney, 2005; Manova, 2008). If exporters face liquidity constraints at time of financing entry costs, then those who obtain credit will immediately produce the optimal quantity. Therefore there is no reason to expect higher export growth in the second year than in later years (contrary

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<sup>21</sup>An interesting variant of this approach is to consider decreasing returns to scale in production or marketing, as in Arkolakis (2008). Then firms will experience higher growth in the second year of exporting, particularly in the first export market which corresponds to its first production run. While it is impossible to consider our findings in the one-country model in Arkolakis (2008), we conjecture that an extension of his model to several countries with returns to marketing decreasing across destinations (not just within each destination) would generate our predictions.

<sup>22</sup>See Wagner (2007) for a survey.

to Prediction 1). In addition, these models cannot predict that inexperienced exporters are more likely to exit than experienced ones. This is because there are no exit costs and liquidity constraints do not matter for exit. Admittedly, to the extent that more experienced exporters are not constrained any more (perhaps thanks to retained earnings), then their chances of entry are less dependent on previous export status than inexperienced exporters (our Prediction 2).

A fifth and final alternative is that the dynamics of exports follow the dynamics of trust in interpersonal relationships. Rauch and Watson (2003) argue that exporters “start small” and are only able to expand once their foreign partners are convinced of their reliability. Araujo and Ornelas (2007) point out that evolving trust levels within partnerships substitute for weak cross-border contract enforcement, implying that trade volumes increase over time, conditional on survival. Again, these explanations apply to all export markets, unless distributors or other trade intermediaries are global, which does not seem very plausible. Therefore these mechanisms cannot generate our predictions.

## 4 Trade Liberalization, Entry, and Trade Flows

Under sequential entry, trade liberalization has subtler and potentially much larger impacts on trade flows than standard trade theories suggest. To highlight the distinct impact of trade liberalization on entry and trade flows when sequential entry is possible, we consider now a multi-sector version of the basic model.

There is a continuum of independent sectors, each of them being characterized by a different  $F$ , with  $F$  following a continuous cumulative distribution function  $H(F)$  on the support  $[0, \infty)$ .

First, we compute the mass of firms following each possible entry strategy. Let  $M_t^j$  represent the mass of firms exporting to market  $j$  in period  $t$ . The distribution of firms according to their export strategies follows from Proposition 1.

**Corollary 1** *Firms are heterogeneous with respect to their export strategies:*

- a mass  $M_1^A = H(F^{Sq}(\tau^A, \tau^B))$  of firms export to market A at  $t = 1$ ;
- a mass  $M_1^B = H(F^{Sm}(\tau^B))$  of firms export to market B at  $t = 1$ ;
- a mass  $M_2^A = H(F^{Sq}(\tau^A, \tau^B)) [1 - G(\tau^A)]$  of firms export to market A at  $t = 2$ , all of which already exported to A at  $t = 1$ ;
- a mass  $M_2^B = H(F^{Sm}(\tau^B)) [1 - G(\tau^B)] + [H(F^{Sq}(\tau^A, \tau^B)) - H(F^{Sm}(\tau^B))] [1 - G(2F^{1/2} + \tau^B)]$  of firms export to market B at  $t = 2$ , the first term corresponding to existing exporters, the second corresponding to new entrants;
- a remaining mass  $1 - H(F^{Sq}(\tau^A, \tau^B))$  of firms do not export.

Denoting by  $X_t^j$  the aggregate volume of exports to country  $j$  at period  $t$ , we can use Corollary 1 to express aggregate exports as

$$X_1^A = H(F^{Sq}(\tau^A, \tau^B)) \left[ \mathbf{1}_{\{E\mu > \tau^A\}} \frac{E\mu - \tau^A}{2} + \mathbf{1}_{\{E\mu \leq \tau^A\}} \varepsilon \right]; \quad (24)$$

$$X_1^B = H(F^{Sm}(\tau^B)) \mathbf{1}_{\{E\mu > \tau^B\}} \left( \frac{E\mu - \tau^B}{2} \right); \quad (25)$$

$$X_2^A = H(F^{Sq}(\tau^A, \tau^B)) \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu); \quad (26)$$

$$X_2^B = H(F^{Sq}(\tau^A, \tau^B)) \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) + H(F^{Sm}(\tau^B)) \int_{\tau^B}^{2F^{1/2} + \tau^B} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu). \quad (27)$$

Next we consider the distinct impacts of variable trade costs on the thresholds for entry,  $F^{Sm}(\tau^B)$  and  $F^{Sq}(\tau^A, \tau^B)$ .

**Lemma 1** *In each sector, trade costs in markets A and B affect the fixed cost thresholds as follows:*

- $\frac{dF^{Sm}}{d\tau^A} = 0$ ;
- $\frac{dF^{Sm}}{d\tau^B} = - \frac{\left[ \left( \frac{E\mu - \tau^B}{2} \right) + \int_{\tau^B}^{2F^{1/2} + \tau^B} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right]}{G(2F^{1/2} + \tau^B)} < 0$ ;
- $\frac{dF^{Sq}}{d\tau^A} = - \mathbf{1}_{\{E\mu > \tau^A\}} \left( \frac{E\mu - \tau^A}{2} \right) - \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu) < 0$ ;
- $\frac{dF^{Sq}}{d\tau^B} = - \frac{\left[ \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right]}{2 - G(2F^{1/2} + \tau^B)} < 0$ .

**Proof.** It is straightforward to see that  $\frac{dF^{Sm}}{d\tau^A} = 0$ . Note also that

$$\frac{dF^{Sq}}{d\tau^A} = \frac{d\Psi(\tau^A)}{d\tau^A} = - \mathbf{1}_{\{E\mu > \tau^A\}} \left( \frac{E\mu - \tau^A}{2} \right) - \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu).$$

To find  $dF^{Sq}/d\tau^B$ , apply the implicit function theorem to the identity that defines  $F^{Sq}$ ,  $F - W(\tau^B; F) - \Psi(\tau^A) \equiv 0$ :

$$\frac{dF^{Sq}}{d\tau^B} = \frac{\frac{dW(\tau^B; F)}{d\tau^B}}{1 - \frac{dW(\tau^B; F)}{dF}} = - \frac{\left[ \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right]}{2 - G(2F^{1/2} + \tau^B)}.$$

To find  $dF^{Sm}/d\tau^B$ , apply the implicit function theorem to the identity that defines  $F^{Sm}$ ,  $F + W(\tau^B) - \Psi(\tau^B) \equiv 0$ :

$$\frac{dF^{Sm}}{d\tau^B} = \frac{\frac{d\Psi(\tau^B)}{d\tau^B} - \frac{dW(\tau^B; F)}{d\tau^B}}{1 + \frac{dW(\tau^B; F)}{dF}}.$$

It is easy to see that  $e_1^B = 1$  implies  $E\mu > \tau^B$ , so  $q_1^B = \frac{E\mu - \tau^B}{2}$ . Therefore, the expression above can be rewritten as

$$\begin{aligned} \frac{dF^{Sm}}{d\tau^B} &= \frac{-\left(\frac{E\mu - \tau^B}{2}\right) - \int_{\tau^B}^{\bar{\mu}} \left(\frac{\mu - \tau^B}{2}\right) dG(\mu) + \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left(\frac{\mu - \tau^B}{2}\right) dG(\mu)}{1 - \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} dG(\mu)} \\ &= -\frac{\left[\left(\frac{E\mu - \tau^B}{2}\right) + \int_{\tau^B}^{2F^{1/2} + \tau^B} \left(\frac{\mu - \tau^B}{2}\right) dG(\mu)\right]}{G(2F^{1/2} + \tau^B)}, \end{aligned}$$

completing the proof. ■

We can now establish the impact of trade liberalization in countries  $A$  and  $B$  in both the short and the long runs.

**Proposition 3** *Trade liberalization has qualitatively different effects in the short and long runs, and affects entry in third countries. Specifically:*

a) *A decrease in  $\tau^A$  at  $t = 1$ , holding  $\tau^B$  fixed:*

1. *increases exports to  $A$  at  $t = 1$  and at  $t = 2$  at both the intensive and extensive margins;*
2. *has no effect on exports to  $B$  at  $t = 1$ , but increases them at  $t = 2$  at the extensive margin.*

b) *A decrease in  $\tau^B$  at  $t = 1$ , holding  $\tau^A$  fixed:*

1. *increases exports to  $A$  at  $t = 1$  and  $t = 2$  at the extensive margin;*
2. *increases exports to  $B$  at  $t = 1$  and  $t = 2$  at both the intensive and extensive margins.*

**Proof.** The claims on the extensive margin follow directly from Corollary 1, Lemma 1, the fact that  $H(\cdot)$  is an increasing function and the fact that both  $1 - G(\tau_B + 2F^{1/2})$  and  $1 - G(\tau_B)$  are decreasing in  $\tau_B$ . The extensive margin effects are as follows:

- $\frac{dM_1^A}{d\tau^A} = H' \frac{dF^{Sq}}{d\tau^A} < 0;$
- $\frac{dM_1^B}{d\tau^A} = H' \frac{dF^{Sm}}{d\tau^A} = 0;$
- $\frac{dM_2^A}{d\tau^A} = H' \frac{dF^{Sq}}{d\tau^A} [1 - G(\tau^A)] - H(F^{Sq})G'(\tau^A) < 0;$
- $\frac{dM_2^B}{d\tau^A} = H' \frac{dF^{Sq}}{d\tau^A} [1 - G(2F^{1/2} + \tau^B)] < 0;$
- $\frac{dM_1^A}{d\tau^B} = H' \frac{dF^{Sq}}{d\tau^B} < 0;$
- $\frac{dM_1^B}{d\tau^B} = H' \frac{dF^{Sm}}{d\tau^B} < 0;$
- $\frac{dM_2^A}{d\tau^B} = H' \frac{dF^{Sq}}{d\tau^B} [1 - G(\tau^A)] < 0.$

To find  $dM_2^B/d\tau^B$ , notice that

$$\begin{aligned}\frac{dM_2^B}{d\tau^B} &= H' \frac{dF^{Sq}}{d\tau^B} \left[ 1 - G(2F^{1/2} + \tau^B) \right] - H(F^{Sq})G'(2F^{1/2} + \tau^B) \\ &\quad + H' \frac{dF^{Sm}}{d\tau^B} \left[ G(2F^{1/2} + \tau^B) - G(\tau^B) \right] + H(F^{Sm}) \left[ G'(2F^{1/2} + \tau^B) - G'(\tau^B) \right] \\ &= H' \frac{dF^{Sq}}{d\tau^B} \left[ 1 - G(2F^{1/2} + \tau^B) \right] + H' \frac{dF^{Sm}}{d\tau^B} \left[ G(2F^{1/2} + \tau^B) - G(\tau^B) \right] \\ &\quad - G'(2F^{1/2} + \tau^B) \left[ H(F^{Sq}) - H(F^{Sm}) \right] - G'(\tau^B)H(F^{Sm}),\end{aligned}$$

which is negative since each of its terms are negative.

Differentiating aggregate trade flows with respect to  $\tau^A$  and  $\tau^B$  yields:

- $\frac{dX_1^A}{d\tau^A} = -\frac{1}{2}H(F^{Sq})\mathbf{1}_{\{E\mu > \tau^A\}} + H' \frac{dF^{Sq}}{d\tau^A} \left[ \mathbf{1}_{\{E\mu > \tau^A\}} \frac{E\mu - \tau^A}{2} + \mathbf{1}_{\{E\mu \leq \tau^A\}}\varepsilon \right] < 0$  ;
- $\frac{dX_1^B}{d\tau^A} = H' \frac{dF^{Sm}}{d\tau^A} \mathbf{1}_{\{E\mu > \tau^B\}} \left( \frac{E\mu - \tau^B}{2} \right) = 0$ ;
- $\frac{dX_2^A}{d\tau^A} = -\frac{1}{2} \left[ 1 - G(\tau^A) \right] H(F^{Sq}) + H' \frac{dF^{Sq}}{d\tau^A} \left( \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu) \right) < 0$ ;
- $\frac{dX_2^B}{d\tau^A} = H' \frac{dF^{Sq}}{d\tau^A} \left[ \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right] < 0$ ;
- $\frac{dX_1^A}{d\tau^B} = H' \frac{dF^{Sq}}{d\tau^B} \left[ \mathbf{1}_{\{E\mu > \tau^A\}} \frac{E\mu - \tau^A}{2} + \mathbf{1}_{\{E\mu \leq \tau^A\}}\varepsilon \right] < 0$ ;
- $\frac{dX_1^B}{d\tau^B} = -\frac{1}{2}H(F^{Sm})\mathbf{1}_{\{E\mu > \tau^B\}} + H' \frac{dF^{Sm}}{d\tau^B} \mathbf{1}_{\{E\mu > \tau^B\}} \left( \frac{E\mu - \tau^B}{2} \right) < 0$ ;
- $\frac{dX_2^A}{d\tau^B} = H' \frac{dF^{Sq}}{d\tau^B} \left[ \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu) \right] < 0$ .

To find  $\frac{dX_2^B}{d\tau^B}$ , notice that

$$\begin{aligned}\frac{dX_2^B}{d\tau^B} &= \left( -\frac{1 - G(2F^{1/2} + \tau^B)}{2} - F^{1/2} \right) H(F^{Sq}) + H' \frac{dF^{Sq}}{d\tau^B} \left[ \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right] \\ &\quad + \left( F^{1/2} - \frac{G(2F^{1/2} + \tau^B) - G(\tau^B)}{2} \right) H(F^{Sm}) + H' \frac{dF^{Sm}}{d\tau^B} \left[ \int_{\tau^B}^{2F^{1/2} + \tau^B} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right] \\ &= -\frac{1 - G(2F^{1/2} + \tau^B)}{2} H(F^{Sq}) + H' \frac{dF^{Sq}}{d\tau^B} \left[ \int_{2F^{1/2} + \tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right] \\ &\quad - \frac{G(2F^{1/2} + \tau^B) - G(\tau^B)}{2} H(F^{Sm}) + H' \frac{dF^{Sm}}{d\tau^B} \left[ \int_{\tau^B}^{2F^{1/2} + \tau^B} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) \right] \\ &\quad + F^{1/2} \left( H(F^{Sm}) - H(F^{Sq}) \right),\end{aligned}$$

which is negative since each of its terms are negative.

The third-market effects  $\frac{dX_2^B}{d\tau^A}$ ,  $\frac{dX_1^A}{d\tau^B}$  and  $\frac{dX_2^A}{d\tau^B}$  all play only at the extensive margin since output does not depend on third-market trade costs. ■

Hence, we find that trade liberalization has third-country effects. First, a reduction in trade barriers always has a cross-market trade-creation effect in the long-run. As variable

trade costs fall, potential future gains from learning across markets are greater; as a result, a greater number of firms chooses to engage in exporting, and do so sequentially. Among those new exporters, a fraction will find it profitable to keep exporting in the long run.

Second, trade liberalization with  $A$  does not affect exports to  $B$  in the short-run: the firms entering both markets simultaneously are not affected, while those entering markets sequentially have not started to export to  $B$ . In contrast, trade liberalization with  $B$  does increase short-run exports to  $A$ , through changes in the extensive margin: more firms enter  $A$  due to the greater expected gains from learning across markets.

The rationale behind Proposition 3 implies, furthermore, that preferential liberalization will have much broader effects than existing studies suggest, as the next corollary indicates.

**Corollary 2** *Bilateral trade liberalization with distant countries increases exports to close countries in the short run; bilateral trade liberalization with close countries increases exports to distant countries with a lag.*

Hence, preferential liberalization involves a new form of trade creation: *export creation with third countries*. That is, even from a purely partial equilibrium perspective, regional integration can create trade with non-partner countries for entirely different reasons than those emphasized in the existing literature (e.g. the endogenous reductions of external tariffs, as studied by Ornelas 2005), and involving not greater imports, but enhanced *exports* to non-members.

## 5 Conclusion

Firms typically start exporting small volumes to a single neighbor country. Many drop out of the export market in the following year, while most of the successful ones grow at both the intensive and the extensive margins. According to Eaton et al. (2008), such firms account for more than half of Colombia's export growth over the ten years up to 2005.

Existing trade models, including 'new new trade theory' ones based on selection due to heterogeneity in productivity and export sunk costs (as Melitz 2003 and its many extensions), are not well-equipped to address these dynamic patterns. In this paper, we argue that uncertainty correlated across markets is central to understanding them. We develop the minimal model to address the implications of this correlated uncertainty. A firm discovers its profitability as an exporter only after exporting takes place. Once the firm has learned it, the firm can condition the decision to serve other destinations on this information. Since breaking into new markets entails significant and unrecoverable costs, if export profitability is correlated across markets the firm will have an incentive to enter foreign destinations sequentially. When doing so, neighboring markets serve as natural "testing grounds" for future expansions to larger or farther away markets. We derive specific predictions from our model and expose them to intense empirical scrutiny using Argentinean firm-level data. We cannot reject any of them. We are equally unable to come up with alternative mechanisms that would lead to similar predictions. This leads us to conclude that uncertainty correlated across markets is a central determinant of firms' export strategies.

This mechanism has subtle but broad policy implications. For example, existing studies of major proposals for multilateral liberalization, like those discussed under the current Doha Round of negotiations in the World Trade Organization, could greatly understate their impact on trade flows, since those studies do not account for the lagged and third-country effects on firms' export decisions that we uncover.

The same is true for more limited—but much more widespread—arrangements of liberalization at the regional level. Regional liberalization raises the number of firms willing to experiment with intra-regional exports. Eventually, some of those firms will choose to break into extra-regional markets as well. This lagged trade-creation effect toward *non-partners* corresponds to an entirely novel implication of regional trade agreements, which the literature has so far entirely neglected. Clearly, empirical research focused on this effect is necessary to gather its practical relevance. Yet Borchert (2007), who develops the single related study we are aware of, suggests it is meaningful: the share of Mexican products exported exclusively to the United States fell from 12 percent in 1993—right before NAFTA entered into force—to 8 percent in 1997, a pattern that would be difficult to rationalize without sequential exporting. Furthermore, he finds that the growth of Mexican exports to *Latin America* in that period is higher, the greater the reduction in the preferential U.S. tariff under NAFTA for that product, in line with the predictions of our model.

Sequential exporting strategies can also help to rationalize other empirical findings from the trade literature, such as the apparent excess sensitivity of trade flows to changes in trade barriers (Yi 2003), the seeming ineffectiveness of the GATT/WTO system in promoting trade (Rose 2004), or the greater sensitivity of trade flows to trade costs at the extensive rather than at the intensive margin (Bernard et al. 2007, Mayer and Ottaviano 2008). However, the theoretical structure we develop in this paper is too simple to permit a thorough evaluation of the implications of sequential exporting for the impact of changes in trade costs on aggregate trade flows. This would require a general equilibrium trade model that takes into account economies' resource constraints and endogenizes entry (of potential exporting firms). A distinct but equally promising avenue for further exploring the mechanism we lay out here is to identify the types of products, as well as the characteristics of foreign markets, for which correlation of export profitabilities is likely to be stronger. This would make it possible to fine tune the analysis of firms' export strategies and of the impact of policies. We look forward to advances in those areas.

## 6 Appendices

### Appendix A: Proofs

**Lemma 2**  $E_0(\mu | \mu > \tau) \geq E_0(\mu)$ .

**Proof.** Integrating both expressions by parts, we find

$$E_0(\mu) = \bar{\mu} - \int_{\underline{\mu}}^{\tau} G(\mu) d\mu - \int_{\tau}^{\bar{\mu}} G(\mu) d\mu,$$

$$E_0(\mu | \mu > \tau) = \bar{\mu} - \int_{\tau}^{\bar{\mu}} G(\mu | \mu > \tau) d\mu.$$

Thus,

$$\begin{aligned} E_0(\mu | \mu > \tau) - E_0(\mu) &= \int_{\underline{\mu}}^{\tau} G(\mu) d\mu + \int_{\tau}^{\bar{\mu}} [G(\mu) - G(\mu | \mu > \tau)] d\mu \\ &= \int_{\underline{\mu}}^{\tau} G(\mu) d\mu + \frac{G(\tau)}{1 - G(\tau)} \int_{\tau}^{\bar{\mu}} [1 - G(\mu)] d\mu \\ &\geq 0, \end{aligned}$$

where the second equality follows from  $G(u | \mu > \tau) = \int_{\tau}^u \frac{dG(s)}{1 - G(\tau)} = \frac{1}{1 - G(\tau)} \left[ \int_{\underline{\mu}}^u dG(s) - \int_{\underline{\mu}}^{\tau} dG(s) \right] = \frac{1}{1 - G(\tau)} [G(u) - G(\tau)]$ . Since  $\tau \in (\underline{\mu}, \bar{\mu})$  implies  $G(\tau) \geq 0$ , the inequality follows. ■

**Lemma 3**  $E_0(pq | \mu > \tau) \geq E_0(pq)$

**Proof.** The left hand side of the inequality describes the exporter's expected optimal sales conditional on survival. Recalling that  $\mu \equiv a - c$ , we can rewrite it in terms of demand ( $a$ ) and supply ( $c$ ) shocks as:

$$\begin{aligned} E_0(pq | \mu > \tau) &= E_0((a - q)q | \mu > \tau) \\ &= E_0 \left[ \left( a - \frac{E_0(\mu | \mu > \tau) - \tau}{2} \right) \left( \frac{E_0(\mu | \mu > \tau) - \tau}{2} \right) \middle| \mu > \tau \right] \\ &= E_0 \left[ \left( a - \frac{E_0(a - c | a - c > \tau) - \tau}{2} \right) \left( \frac{E_0(a - c | a - c > \tau) - \tau}{2} \right) \middle| a - c > \tau \right] \\ &= \frac{[E_0(a | a > \tau + c)]^2 - [E_0(c | c < a - \tau) + \tau]^2}{4} \end{aligned}$$

under the condition that demand and supply shocks are independently distributed, i.e. their joint p.d.f. is given by  $dV(a, c) = \begin{cases} dK(a)dF(c), a \in [\underline{a}, \bar{a}], c \in [\underline{c}, \bar{c}] \\ 0 & \text{otherwise} \end{cases}$ .

Similarly, we can express the exporter's expected optimal sales in the right hand side of the above inequality as:

$$\begin{aligned} E_0(pq) &= E_0[(a - q)q] \\ &= E_0 \left[ \left( a - \frac{E_0(\mu) - \tau}{2} \right) \left( \frac{E_0(\mu) - \tau}{2} \right) \right] \\ &= E_0 \left[ \left( a - \frac{E_0(a - c) - \tau}{2} \right) \left( \frac{E_0(a - c) - \tau}{2} \right) \right] \\ &= \frac{[E_0(a)]^2 - [E_0(c) + \tau]^2}{4} \end{aligned}$$

Since  $\tau + c > \underline{a}, \forall c$ , it must also be true in the worst case, i.e.  $\tau + \bar{c} > \underline{a}$ . The latter is true by

the assumption in Lemma 1:  $\tau > \underline{\mu} \equiv \underline{a} - \bar{c}$ . Therefore by Lemma 1 we immediately have:

$$E_0(a|a > \tau + c) \geq E_0(a)$$

Proceeding similarly we obtain:<sup>23</sup>

$$E_0(c|c < a - \tau) \leq E_0(c)$$

Therefore:

$$\begin{aligned} E_0(pq) &= \frac{[E_0(a)]^2 - [E_0(c) + \tau]^2}{4} \\ &\leq \frac{[E_0(a|a > \tau + c)]^2 - [E_0(c) + \tau]^2}{4} \\ &\leq \frac{[E_0(a|a > \tau + c)]^2 - [E_0(c|c < a - \tau) + \tau]^2}{4} \\ &= E_0(pq|\mu > \tau) \end{aligned}$$

■

## Appendix B: Imperfect correlation in export profitability

We show here that the third-country result of Proposition 3 (parts a.2 and b.1) holds in the general case of positive statistical dependence between the random variables  $\mu^A$  and  $\mu^B$ . To keep the model symmetric, we assume distributions  $G(\mu^A)$  and  $G(\mu^B)$  are identical, although this is not essential. Upper-bar variables denote the counterparts to the variables in the main text under perfect correlation. For the sake of brevity, we denote  $E[\mu^B|\mu^A = u^A]$  by  $E(\mu^B|\mu^A)$ .

**Output choice** Output decisions in  $A$  at all times and in  $B$  at  $t = 1$  (if the simultaneous entry strategy is chosen) are taken in the same way as in the main text.

Output choice in  $B$  at  $t = 2$  takes into account the realization of  $\mu^A$ . From the convexity

<sup>23</sup>This is the converse of Lemma 2, where the distribution is rather truncated on the right of the support. Proceeding identically, we obtain:

$$\begin{aligned} E_0(c) &= \bar{c} - \int_{\underline{c}}^{a-\tau} F(c)dc - \int_{a-\tau}^{\bar{c}} F(c)dc \\ E_0(c|c < a - \tau) &= a - \tau - \int_{\underline{c}}^{a-\tau} F(c|c < a - \tau)dc \\ E_0(c) - E_0(c|c < a - \tau) &< a - \tau = \bar{c} - (a - \tau) - \int_{a-\tau}^{\bar{c}} F(c)dc + \int_{\underline{c}}^{a-\tau} [F(c|c < a - \tau) - F(c)]dc \\ &= \int_{a-\tau}^{\bar{c}} [1 - F(c)]dc + \int_{\underline{c}}^{a-\tau} [F(c|c < a - \tau) - F(c)]dc \\ &\geq 0 \end{aligned}$$

since  $\underline{c} < a - \tau, \forall a$ , it must also be true in the worst case, i.e.  $\bar{a} - \tau > \underline{c}$ . The latter is true by the assumption in Lemma 2:  $\tau < \bar{\mu} \equiv \bar{a} - \underline{c}$ .

of the max function and Jensen's inequality,

$$\int_{\underline{\mu}^A}^{\bar{\mu}^A} \left[ \max_{q^B} \int_{\underline{\mu}^B}^{\bar{\mu}^B} (\mu^B - \tau^B - q^B) q^B dG(\mu^B | \mu^A) \right] dG(\mu^A) \geq \max_{q^B} \int_{\underline{\mu}^B}^{\bar{\mu}^B} (\mu^B - \tau^B - q^B) q^B dG(\mu^B), \quad (28)$$

where  $dG(\mu^B) = \int_{\underline{\mu}^A}^{\bar{\mu}^A} dG(\mu^B | \mu^A) dG(\mu^A)$ . Expected profits are larger when an optimal production decision in  $B$  is made taking into account the experience acquired in  $A$ . By linearity of the expectation operator, optimal output is  $\bar{q}_2^B(\tau^B) = \frac{E(\mu^B | \mu^A) - \tau^B}{2}$ .

**Value of the sequential exporting strategy** In the last section of this Appendix we show that the conditional expectation of random variable  $\mu^B$  can be expressed as

$$E[\mu^B | \mu^A] = E\mu^B + (u^A - E\mu^A) \underbrace{\int_{\underline{\mu}}^{\bar{\mu}} \left[ -\frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} dw}_{\equiv \varpi}, \quad (29)$$

where  $\varpi$  captures the statistical dependence between  $\mu^A$  and  $\mu^B$ .

At  $t = 2$  a firm chooses to start exporting to  $B$  if

$$\left( \frac{E[\mu^B | \mu^A = u^A] - \tau^B}{2} \right)^2 \geq F \Leftrightarrow E(\mu^B | \mu^A) \geq 2F^{1/2} + \tau^B. \quad (30)$$

Define  $\bar{F}_2^B(u^A; \tau^B)$  as the  $F$  that solves (30) with equality. The firm enters market  $B$  at  $t = 2$  if  $F \leq \bar{F}_2^B(u^A; \tau^B)$ . Plugging (29) in (30) yields

$$\bar{F}_2^B(u^A; \tau^B) = \left( \frac{E\mu^B + \varpi(u^A - E\mu^A) - \tau^B}{2} \right)^2,$$

which is strictly decreasing in  $\tau^B$ . Comparing  $\bar{F}_2^B(u^A; \tau^B)$  with its analog under perfect correlation  $F_2^B(\tau^B)$ , defined on page 7, we have that  $E\mu^A = E\mu^B = E\mu$  implies  $\lim_{\varpi \rightarrow 1} \bar{F}_2^B(u^A; \tau^B) = F_2^B(\tau^B)$ .

Expressed in  $t = 0$  expected terms, entering market  $B$  at  $t = 2$  yields profits

$$\bar{W}(\tau^B; F) \equiv \int_{\mu^{*A}(\varpi)}^{\bar{\mu}} \left[ \left( \frac{E(\mu^B | \mu^A) - \tau^B}{2} \right)^2 - F \right] dG(\mu^A), \quad (31)$$

where

$$\mu^{*A}(\varpi) \equiv \left( \frac{1}{\varpi} \right) (2F^{1/2} + \tau^B) - \left( \frac{1 - \varpi}{\varpi} \right) E\mu^B$$

is the cutoff realization of export profitability in  $A$ ,  $\mu^A$ , above which a sequential exporter enters in  $B$  at  $t = 2$ .

**Choice of export strategy (extension of Proposition 1)** As in the main text,  $\bar{F}^{Sq}$  is the fixed cost that makes a firm indifferent between exporting sequentially and not export-

ing, whereas  $\bar{F}^{Sm}$  makes a firm indifferent between simultaneous and sequential exporting strategies:

$$\bar{F}^{Sq} : \Psi(\tau^A) + \bar{W}(\tau^B; \bar{F}^{Sq}) = \bar{F}^{Sq}, \quad (32)$$

$$\bar{F}^{Sm} : \Psi(\tau^B) - \bar{W}(\tau^B; \bar{F}^{Sm}) = \bar{F}^{Sm}. \quad (33)$$

Since  $\Psi(\tau^j)$  is monotonically decreasing in  $\tau^j$  and  $\tau^A \leq \tau^B$ , and since  $\bar{W}(\tau^B; F)$  is non-negative, there is a non-degenerate interval of fixed costs where firms choose the sequential export strategy.

**Effects of trade liberalization (extension of Proposition 3)** Differentiating  $\bar{W}(\tau^B; F)$ , we find

$$\frac{d\bar{W}(\tau^B; F)}{d\tau^B} = - \int_{\mu^{*A}(\varpi)}^{\bar{\mu}} \left( \frac{E(\mu^B | \mu^A) - \tau^B}{2} \right) dG(\mu^A) - \underbrace{\frac{1}{\varpi} \left[ \left( \frac{E(\mu^B | \mu^{*A}(\varpi)) - \tau^B}{2} \right)^2 - F \right]}_{=0} < 0,$$

where the second term is zero by construction of  $\mu^{*A}(\varpi)$ . Using this result and differentiating (32) and (33), we have that

$$\begin{aligned} \frac{d\bar{F}^{Sm}}{d\tau^A} &= 0; \\ \frac{d\bar{F}^{Sm}}{d\tau^B} &= -\mathbf{1}_{\{E\mu > \tau^B\}} \left( \frac{E\mu - \tau^B}{2} \right) - \int_{\tau^B}^{\bar{\mu}} \left( \frac{\mu - \tau^B}{2} \right) dG(\mu) + \int_{\mu^{*A}(a)}^{\bar{\mu}} \left[ \left( \frac{E(\mu^B | \mu^A) - \tau^B}{2} \right) \right] dG(\mu^A); \\ \frac{d\bar{F}^{Sq}}{d\tau^A} &= -\mathbf{1}_{\{E\mu > \tau^A\}} \left( \frac{E\mu - \tau^A}{2} \right) - \int_{\tau^A}^{\bar{\mu}} \left( \frac{\mu - \tau^A}{2} \right) dG(\mu) < 0; \\ \frac{d\bar{F}^{Sq}}{d\tau^B} &= - \int_{\mu^{*A}(\varpi)}^{\bar{\mu}} \left[ \left( \frac{E(\mu^B | \mu^A) - \tau^B}{2} \right) \right] dG(\mu^A) < 0. \end{aligned}$$

The sign of the second derivative is in general indeterminate. This is because second-period output in  $B$  in the general case can be higher or lower than in the perfect correlation case. All other derivatives are negative, as in Lemma 1.

The rest of the proof of parts 1.b and 2.a. of Proposition 3 is straightforward. The probability of sequential entry is qualitatively similar (considering the new entry cutoff  $\mu^{*A}(\varpi)$ ). Exports vary at the intensive margin in the exact same way as in the main text.

Thus, in the general case of positive statistical dependence between export profitability in  $A$  and  $B$ , trade liberalization has positive third-country effects, although own-country effects cannot be signed in general.

**Comparing the general case with the polar cases of independence and perfect positive correlation** We now show that  $\bar{W}(\tau^B; F)$  is bounded above and below by the corresponding values in the two polar cases of i.i.d.  $\mu$ 's and perfectly positively correlated  $\mu$ 's (across destinations).

We start with the lower bound. With i.i.d. marginal distributions of  $\mu^A$  and  $\mu^B$  we have  $E(\mu^B | \mu^A) = E\mu^B$  and therefore  $\varpi = 0$ , so that

$$\lim_{\varpi \rightarrow 0} \overline{W}(\tau^B; F) = \Psi(\tau^B) - V(\tau^B) - F$$

But notice that then entering market  $B$  sequentially is strictly dominated by a simultaneous entry strategy at  $t = 1$ :  $\Psi(\tau^B) - V(\tau^B) - F < \Psi(\tau^B) - F$ . Under independence export experience in  $A$  is useless in  $B$ . By entering late (at  $t = 2$ ) the firm sacrifices positive export profits, since it will never learn in market  $B$ . Hence:  $W(\tau^B; F) = 0$ .

Consider now the upper bound. Under perfect positive correlation between  $\mu^A$  and  $\mu^B$ . Then

$$G(w | \mu^A = u) = \begin{cases} 1 & \text{if } w \geq u \\ 0 & \text{if } w < u \end{cases}$$

which is a Heavyside step function (or unit step function)  $T(w - u) = \int_{\underline{\mu}}^u \delta(w - s) ds$  where  $\delta(w - s)$  denotes a Dirac delta function  $\delta(w - s) = \begin{cases} +\infty & \text{if } w = s \\ 0 & \text{otherwise} \end{cases}$  with  $\int_{\underline{\mu}}^{\overline{\mu}} \delta(w - s) dw = 1, \forall s \in [\underline{\mu}, \overline{\mu}]$ .

Since  $\frac{d}{du} T(w - u) = -\delta(w - u)$  we have:

$$\int_{\underline{\mu}}^{\overline{\mu}} \left[ -\frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} dw = \int_{\underline{\mu}}^{\overline{\mu}} \delta(w - u_0) dw = 1$$

and since  $E\mu^B = E\mu^A = E\mu$ ,  $E(\mu^B | \mu^A) = \mu^A$  and  $\lim_{\varpi \rightarrow 1} \overline{W}(\tau^B; F) = W(\tau^B; F)$ , so that:

$$0 \leq \overline{W}(\tau^B; F) \leq W(\tau^B; F)$$

and correspondingly:

$$F^{\max} \geq \overline{F}_2^B(u^A; \tau^B) \geq F_2^B(\tau^B)$$

where  $F^{\max} : \Psi(\tau^B) - V(\tau^B) - F^{\max} = 0$ . In words, it would be the maximum willingness to pay to enter destination  $B$  in  $t = 2$  if the firm had decided not to enter in  $t = 1$  and profitability was uncorrelated across destinations. Therefore:

$$\overline{F}^{Sq} - \overline{F}^{Sm} \leq F^{Sq} - F^{Sm}$$

The region defined by proposition 1 in the main text, inside which it is optimal for the exporter to adopt a sequential destination export penetration strategy ( $F^{Sq} - F^{Sm}$ ), shrinks as the statistical dependence across the two destinations is reduced from perfect correlation to independent export profitabilities.

**Conditional and unconditional expectations (derivation of (29))** Here we show how the conditional expectation can be expressed as a function of the unconditional expectation,

as in (29). Integrating by parts both expectations and taking the difference we obtain:

$$\begin{aligned} E [\mu^B | \mu^A = u^A] - E [\mu^B] &= \int_{\underline{\mu}}^{\bar{\mu}} [G_B(w) - G(w | \mu^A = u^A)] dw \\ &= \int_{\underline{\mu}}^{\bar{\mu}} [G(w | \mu^A \leq \bar{\mu}) - G(w | \mu^A = u^A)] dw \end{aligned}$$

Since  $G_B(w) \equiv G(\mu^B \leq w, \mu^A \leq \bar{\mu}) = G(\mu^B \leq w | \mu^A \leq \bar{\mu}) G_A(\mu^A \leq \bar{\mu}) = G(\mu^B \leq w | \mu^A \leq \bar{\mu})$ ,  $\forall w \in [\underline{\mu}, \bar{\mu}]$ , because  $G_A(\mu^A \leq \bar{\mu}) = 1$ . By definition,  $G(w | \mu^A \leq \bar{\mu}) = \int_{\underline{\mu}}^{\bar{\mu}} G(w | \mu^A = u) dG_A(u)$ , which inserted above yields:

$$\begin{aligned} E [\mu^B | \mu^A = u^A] - E [\mu^B] &= \int_{\underline{\mu}}^{\bar{\mu}} \left[ \int_{\underline{\mu}}^{\bar{\mu}} G(w | \mu^A = u) dG_A(u) - G(w | \mu^A = u^A) \right] dw \\ &= \int_{\underline{\mu}}^{\bar{\mu}} \left[ \int_{\underline{\mu}}^{\bar{\mu}} G(w | \mu^A = u) dG_A(u) - G(w | \mu^A = u^A) \underbrace{\int_{\underline{\mu}}^{\bar{\mu}} dG_A(u)}_{=1} \right] dw \\ &= \int_{\underline{\mu}}^{\bar{\mu}} \int_{\underline{\mu}}^{\bar{\mu}} [G(w | \mu^A = u) - G(w | \mu^A = u^A)] dG_A(u) dw. \end{aligned}$$

Now assuming that  $G(w | \cdot) \in C^1[\underline{\mu}, \bar{\mu}]$ , by the mean-value theorem,

$$\exists u_0 \in [\underline{\mu}, \bar{\mu}] : G(w | \mu^A = u) - G(w | \mu^A = u^A) = (u - u^A) \left( \left[ \frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} \right)$$

we obtain:

$$E [\mu^B | \mu^A = u^A] - E [\mu^B] = \int_{\underline{\mu}}^{\bar{\mu}} \int_{\underline{\mu}}^{\bar{\mu}} \left[ (u - u^A) \left( \left[ \frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} \right) \right] dG_A(u) dw$$

Since the term  $\left[ \frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0}$  is a constant, it follows that:

$$\begin{aligned} E [\mu^B | \mu^A = u^A] - E [\mu^B] &= (E [\mu^A] - u^A) \int_{\underline{\mu}}^{\bar{\mu}} \left[ \left[ \frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} \right] dw \\ &= (u^A - E [\mu^A]) \int_{\underline{\mu}}^{\bar{\mu}} \left( - \left[ \frac{d}{du} G(w | \mu^A = u) \right] \Big|_{u=u_0} \right) dw \end{aligned}$$

We use Lehmann's (1966, p.1143-4) definition of *regression dependence*, which is in our context:

**Definition 1**  $\mu^B$  is positively (negatively) regression dependent on  $\mu^A$  if  $G(\mu^B \leq w | \mu^A = u)$  is non-increasing (non-decreasing) in  $u$ .

Our assumption of statistical dependence between  $\mu^A$  and  $\mu^B$  implies regression dependence. Thus we can sign the integrand in the last equality above. Finally by rearranging the

last equality, we obtain (29): if  $\mu^B$  and  $\mu^A$  are positively associated,  $[\frac{d}{du}G(w|\mu^A = u)]|_{u=u_0} \leq 0$  and  $(-[\frac{d}{du}G(w|\mu^A = u)]|_{u=u_0}) \geq 0, \forall w$  so that  $\int_{\underline{\mu}}^{\bar{\mu}} (-[\frac{d}{du}G(w|\mu^A = u)]|_{u=u_0}) dw \geq 0$ . Now if export profitability in A was better than expected ( $u^A \geq E[\mu^A]$ ), expected export profitability to B increases ( $E[\mu^B|\mu^A = u^A] \geq E[\mu^B]$ ).

**Example: normal distribution.** Consider a joint normal distribution of  $\mu^A$  and  $\mu^B$ . It is enough to compute<sup>24</sup>:

$$\int_{-\infty}^{+\infty} \left[ -\frac{d}{du}G(w|\mu^A = u) \right] \Big|_{u=u_0} dw$$

where

$$G(w|\mu^A = u) = \int_{-\infty}^w \frac{1}{\sigma_B \sqrt{2\pi} \sqrt{1-\rho^2}} \exp \left\{ -\frac{1}{2(1-\rho^2)} \left[ \frac{s - (E\mu^B + \rho \frac{\sigma_B}{\sigma_A}(u - E\mu^A))}{\sigma_B} \right]^2 \right\} ds$$

is the conditional distribution of  $\mu^B$ , such that  $(\mu^B|\mu^A = u) \sim N(E\mu^B + \rho \frac{\sigma_B}{\sigma_A}(u - E\mu^A), \sigma_B^2(1-\rho^2))$ . We note that<sup>25</sup>: (i)  $dG(s|\mu^A = u)$  is a continuous function of  $(s, u) \in \mathbb{R}^2$ , (ii)  $\frac{d}{du}[dG(s|\mu^A = u)]$  exists and is continuous, and (iii)  $\int_{-\infty}^w dG(s|\mu^A = u) ds$  is continuous. Therefore we can differentiate inside the integral:

$$\begin{aligned} \frac{d}{du}G(w|\mu^A = u) &= \int_{-\infty}^w \frac{d}{du} [dG(s|\mu^A = u)] ds \\ &= \int_{-\infty}^w \left( \frac{1}{\sigma_B \sqrt{2\pi} \sqrt{1-\rho^2}} \left[ \frac{\rho \frac{\sigma_B}{\sigma_A}}{\sigma_B(1-\rho^2)} \left[ \frac{s - (E\mu^B + \rho \frac{\sigma_B}{\sigma_A}(u - E\mu^A))}{\sigma_B} \right] \right] \right) \times \\ &\quad \times \exp \left\{ -\frac{1}{2(1-\rho^2)} \left[ \frac{s - (E\mu^B + \rho \frac{\sigma_B}{\sigma_A}(u - E\mu^A))}{\sigma_B} \right]^2 \right\} ds \\ &= -\rho \frac{\sigma_B}{\sigma_A} G(w|\mu^A = u), \end{aligned}$$

which substituted above yields:

$$\int_{-\infty}^{+\infty} \left[ -\frac{d}{du}G(w|\mu^A = u) \right] \Big|_{u=u_0} dw = \int_{-\infty}^{+\infty} \rho \frac{\sigma_B}{\sigma_A} G(w|\mu^A = u_0) dw = \rho \frac{\sigma_B}{\sigma_A}$$

This yields the well-known relationship:

$$E[\mu^B|\mu^A] = E[\mu^B] + \rho \frac{\sigma_B}{\sigma_A} [\mu^A - E[\mu^A]] \quad (34)$$

which is a particular case of (29) where  $\varpi \equiv \rho \frac{\sigma_B}{\sigma_A}$ .

<sup>24</sup>Although expression (29) is defined for random variables on bounded supports, we conjecture that it can be extended to random variables over unbounded supports as long as their c.d.f., say  $G(\bullet)$ , possess an absolute moment of order  $\psi > 0$ , i.e if and only if  $|\mu|^{\psi-1} [1 - G(\mu) + G(-\mu)]$  is integrable over  $(-\infty, +\infty)$ , (see Lemma 2 in Feller (1966, p.149).

<sup>25</sup>Facts (i) - (iii) are stated without proof, but since  $\exp(-\frac{x^2}{2})$  is continuous, positive and bounded above by an integrable function ( $\int_{\mathbb{R}} \exp(-|x|+1) dx = 2e$ ), on  $\mathbb{R}$ , the proofs are left to the interested reader.

## Appendix C: Descriptive Statistics

Our data reveal substantial export growth over the sample period. In Figure 5 we plot Argentinean total and manufacturing exports since 2000. A dramatic exchange rate devaluation in early 2002 led to a sharp increase in Argentinean aggregate exports (223% from 2002 to 2007). Manufacturing exports, which account for about 68% of total exports, followed a similar growth trend (220%).

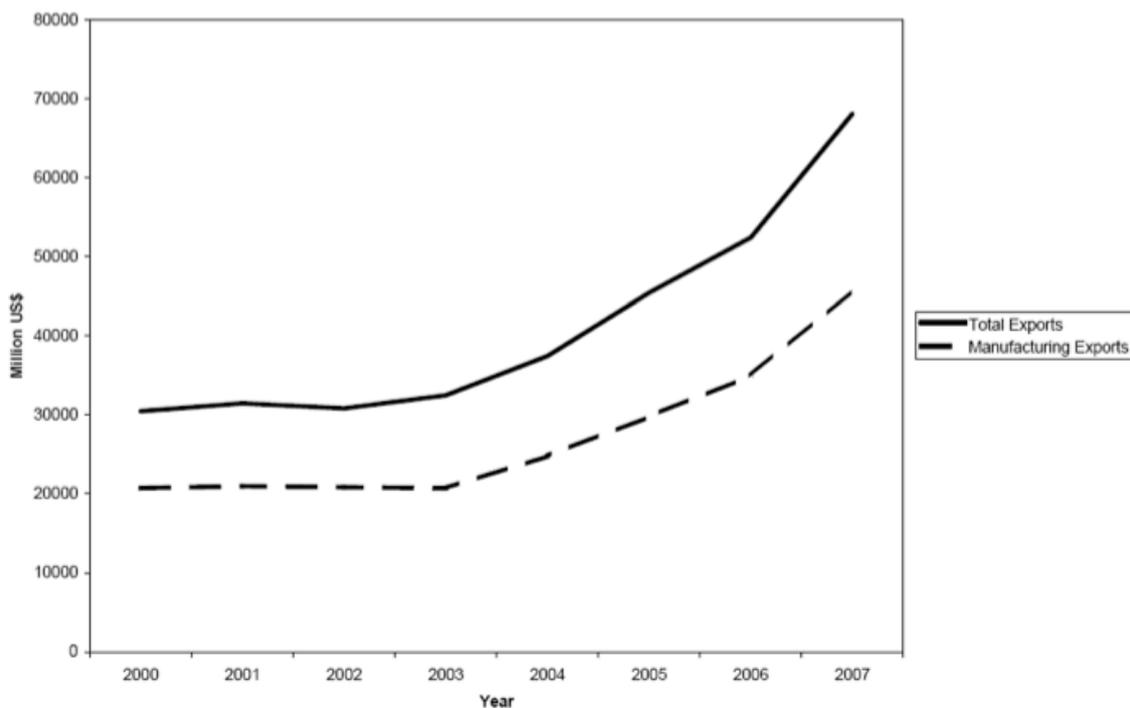


Figure 5: Growth of Argentine total and manufacturing exports,

Another remarkable feature, revealed by Table 8, is that export growth was similar in most industries. The only relevant change in the export structure was that Petroleum increased its relative share (from 23% in 2002 to 30% in 2007) at the expense of the Automotive and Transport industry (17% to 13%). On the other hand, the distribution of export destinations has changed during the sample period. Table 9 shows a growing importance of Mercosur after 2003, accounting for 40% of Argentinean exports in 2007. While starting from a low level, the importance of China has also increased significantly, having doubled its share of Argentinean exports during our sample period (from 3% to 6%). Lastly, the United States, non-Mercosur Latin American markets, and the European Union have become relatively less important as destinations for Argentinean exports.

Table 8: Summary Information by Industry

Industry	Exports*	Exports*	Growth (%)	Share	Share
	2002	2007		2002	2007
Food, Tobacco and Beverages	4979	10884	219	23	23
Petroleum	4967	13863	279	23	30
Chemicals	1514	3466	229	7	7
Rubber and Plastics	928	1845	199	4	4
Leather and Footwear	829	1144	138	4	2
Wood Products, Pulp and Paper Products	506	998	197	2	2
Textiles and Clothing	533	775	145	2	2
Metal Products, except Machinery	2102	4092	195	10	9
Machinery and Equipment	1127	3137	278	5	7
Automotive and Transport Equipment	3492	5894	169	16	13
Electrical Machinery	385	426	111	2	1
Total Manufacturing	20837	45773	220	100	100

\* Million USD

Table 9: Argentinean Manufacturing Exports by Destination (%)

Region	2002	2003	2004	2005	2006	2007
MERCOSUR	34	27	29	31	34	40
Other Latin America	25	25	25	24	23	18
USA	14	18	16	16	12	12
EU	10	10	9	9	8	8
China	3	5	6	5	5	6
Rest of the World	14	13	14	15	18	16

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