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Discussion Papers in
Economics and Econometrics

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No. 1003

ISSN 0966-4246

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February, 2010

Abstract

Firms need to incur substantial sunk costs to break in foreign markets, yet many give up exporting shortly after their first experience, which typically involves very small sales. Conversely, other new exporters shoot up their foreign sales and expand to new destinations. We investigate a simple theoretical mechanism that can rationalize these patterns. A firm discovers its profitability as an exporter only after actually engaging in exporting. The profitability is positively correlated over time and across foreign destinations. Accordingly, once the firm learns how good it is as an exporter, it adjusts quantities and decides whether to exit and whether to serve new destinations. Thus, it is the possibility of profitable expansion at both the intensive and extensive margins what makes incurring the sunk costs to enter a single foreign market worthwhile despite the high failure rates. Using a census of Argentinean firm-level manufacturing exports from 2002 to 2007, we find empirical support for several implications of our proposed mechanism, indicating that the practice of "sequential exporting" is pervasive. Sequential exporting has broad but subtle implications for trade policy. For example, a reduction in trade barriers in a country has delayed entry effects in its own market, while also promoting entry in *other* markets. This trade externality poses challenges for the quantification of the effects of trade liberalization programs, while suggesting neglected but critical implications of international trade agreements.

JEL Codes: F10; D21; F13
Keywords: Export dynamics, trade liberalization, experimentation, uncertainty

*We thank Costas Arkolakis, Sami Berlinski, David Atkin, Jordi Blanes-i-Vidal, John Bluedorn, Holger Breinlich, Nic de Roos, Peter Egger, Robert Elliott, Daniel Ferreira, Rodrigo Fuentes, Martin Gervais, James Harrigan, Beata Javorcik, Marc-Andreas Muendler, Peter Neary, Brent Neiman, Dimitra Petropoulou, Horst Raff, Mark Roberts, Ina Simonovska, Thierry Verdier, Zhihong Yu, and seminar participants at various institutions and conferences for valuable comments and suggestions. We also thank the support of the Chair Jacquemin of the Université Catholique de Louvain for choosing this paper for its annual award at the 2009 European Trade Study Group Meeting. We gratefully acknowledge financial support from the British Academy and the ESRC. E-mails: f.albornoz@bham.ac.uk; calvo@soton.ac.uk; gregory.corcos@nhh.no; e.a.ornelas@lse.ac.uk.

1 Introduction

How do firms break in foreign markets? To understand patterns of international trade and the aggregate impact of trade liberalization, answering this question convincingly is of central importance. Recent trade theories (e.g. Melitz 2003) put great emphasis on the sunk costs firms have to incur to start exporting, and existing estimates indicate that those costs can indeed be very high.[1] The importance of sunk costs is however difficult to reconcile with the patterns of entry in foreign markets that recent empirical research has uncovered. For example, Eaton et al. (2008) show evidence suggesting that Colombian firms often start exporting small quantities to a single neighbor country, but almost half of them cease all exporting activities in less than a year. Those who survive, on the other hand, tend to increase shipments to their current destinations, and a sizeable fraction also expands to other markets. Similar patterns have been observed in other countries,[2] including in our data set of Argentine exporters.

On the face of significant sunk costs to export and high initial failure rates, how can we explain so much entry activity with so little initial sales? And what could explain the seemingly sequential entry pattern of the surviving exporters? A possibility is that firms are uncertain about their success as exporters. If a firm's export profit in a market is correlated over time, then firms could enter in a foreign market, even at a really small scale, to learn about their profit potential there today and in the future. Furthermore, since breaking in new markets entails unrecoverable costs, firms could enter a relatively "easy" market (e.g. a small neighbor) as a “testing ground” for future bolder steps, such as serving the American or the European markets. This “experimentation” can explain the sequential nature of entry across markets provided that the export profitability uncovered in a particular market provides information about the firm's profitability in other foreign markets. This correlation of profitabilities across markets could be due to demand similarities or to firms' characteristics that are associated with success in exporting, but which the firms themselves learn only after actually engaging in exporting.

In this paper, we develop the simplest model that can formalize these ideas. The driving assumption is that a firm's success in foreign markets is uncertain, but that the uncertainty is highly persistent over time and correlated across destinations. Despite its parsimony, our model rationalizes several of the recently uncovered empirical findings in 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 model also has a number of specific empirical implications.

First, if indeed firms learn about their export profitability only once they have exported, then

[1] Das et al. (2007) structurally estimate sunk entry costs for Colombian manufacturers of leather products, knitted fabrics, and basic chemicals to be at least \$344,000 in 1986 U.S. dollars.

[2] Buono et al. (2008) confirm the findings of Eaton et al. (2008) in a detailed study of the intensive and extensive margins of French exports. Lawless (2009a) carries out a similar exercise for a survey of Irish firms.

those that survive should experience on average 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 former have just learned their export potential while the latter will enter new markets only if market conditions change or if they experience positive productivity shocks. 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 Argentine 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 firm heterogeneity and for year-destination fixed effects. Our model also implies that the dynamic behavior of new exporters entering foreign destinations sequentially should be different from the behavior of exporters starting in multiple destinations, as well as from the behavior of firms that are returning to foreign markets. We find convincing evidence that those different types of firms do indeed behave differently over time. Finally, we carry out additional robustness checks to isolate other factors that could be driving some of our predictions; results remain qualitatively unchanged. Hence, while uncertainty correlated across time and markets is but one possible force shaping firms' export strategies, our evidence indicates that it plays an unequivocal role. For brevity, we refer to the implications of this uncertainty for exporting firms 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 attracts new exporting firms from Home. As these new exporters learn about their ability to serve foreign markets, some endure unsuccessful experiences while others realize that they are capable of serving foreign markets very profitably. The former group gives up exporting, whereas the latter expands to other foreign destinations. As a result, trade liberalization in the nearby country not only promotes entry in that market; it also induces entry in *third* markets, albeit with a lag. Similarly, the reduction of trade barriers in a distant country initially induces entry of some Home firms 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 from their experience in the neighbors' markets, they move on to the market of the liberalizing country.

Thus, our findings suggest the existence of a *trade externality*: lower trade barriers in a country induce entry of foreign firms in other markets. This could provide a motive for international coordination of trade policies that is very different from those often emphasized by trade economists.[3] In this sense, our proposed mechanism has the potential to offer the basis for a new rationale for

[3] See Bagwell and Staiger (2002) for a general discussion of the motivations for international trade policy coordination.

global trade institutions such as the World Trade Organization (WTO). If the trade externality were stronger at the regional level, it could also help to explain the pattern of regional trade agreements throughout the world.

If fact, our model suggests that the impact of trade agreements could be very distinct from what existing studies indicate. For example, a regional trade agreement would boost export experimentation by lowering the costs of accessing the markets of bloc partners. 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 should also stimulate *exports* to *non*-member countries. If the agreement were of the multilateral type, tracking down its effects becomes even trickier.

Third-country and lagged effects of trade liberalization can also be useful to explain 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, for example by exploring the rise of vertical specialization (Yi 2003), remain quantitatively unsatisfactory.[4] But if correlated export profitability explains observed sequential export entry, tariff reductions could have much larger impacts on global trade flows than existing models suggest. Third-country and delayed effects could also help to explain the difficulty in identifying significant trade effects of multilateral liberalization undertaken under the General Agreement on Tariffs and Trade and the WTO (Rose 2004), which contrasts with the entrenched beliefs that the GATT/WTO system has been crucial in promoting international trade. Similarly, those effects hint that the gains from trade may extend well beyond the static gains typically emphasized in the literature.

The growing documentation of the pattern of firms' foreign sales has been fostering increasing research interest on the dynamics of firms' exporting strategies.[5] The current work of Eaton et al. (2009) and Freund and Pierola (2009), who emphasize learning mechanisms, are closely related to ours. Eaton et al. develop a model where producers learn about the appeal of their products in a market by devoting resources to finding consumers and by observing the experiences of competitors. Freund and Pierola also consider a single export market, but with product-specific uncertainty, as 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

[4]For instance, Yi (2003) concludes that vertical specialization can resolve at most fifty percent of the excessive responsiveness of trade flows to trade barriers. Ornelas and Turner (2008) argue that offshoring under contract incompleteness is also likely to play a role in explaining this puzzle.

[5]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 opportunities can be gauged from the experience of export pioneers, who effectively provide a public good to the rest of the industry. Unlike those authors, who focus on learning from rivals, we are interested in individual self-discovery. Das et al. (2007) develop a structural model of firm heterogeneity and export dynamics to quantify the value of the sunk costs of exporting. Arkolakis (2009) proposes a model with increasing market 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.

patterns of trial and error based on the frequency of entry and exit from foreign markets. Unlike here, in those models uncertainty is destination-specific, and the focus is on the export dynamics within a market, without distinction between first and subsequent markets.

Our work is also related to other recent 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, in the sense that importing a product from a certain country is more likely if the origin country is supplying the same product to nearby markets. Besedes and Prusa (2006) find that the median duration of exporting a product to the United States is very short, with a hazard rate that decreases sharply over time. This is confirmed by Iacovone and Javorcik's (2010) study on the decision of Mexican firms to export to the U.S. after NAFTA's implementation. Alvarez et al. (2008) find evidence from Chilean firms that exporting a product to a country increases the likelihood of selling the same product to another foreign market. Bernard et al. (2009) study U.S. firms and show that the extensive margins of trade are key to explain variation in trade at long intervals, but that the intensive margin is responsible for most short-run (i.e. year-to-year) variation. These varying contributions of extensive and intensive margins at different intervals reflect the fact that new exporters start small but grow fast and also expand to other markets if they survive. Our model helps to rationalize some of these findings.

The remainder of the paper is organized as follows. Section 2 presents our model. In Section 3 we use Argentine customs data to test the distinguishing features of our theoretical mechanism. In Section 4 we develop the impact of trade liberalization under our mechanism and the resulting policy implications. Section 5 concludes.

2 Model

2.1 Basic structure

We consider the decision of a risk-neutral producer to serve two segmented foreign markets, 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 τ^A and τ^B, $\tau^A \leq \tau^B$. To sell in each foreign market, the firm needs to incur in a one-time fixed cost, $F \geq 0$. This corresponds to the costs of establishing distribution channels, of designing a marketing strategy, of learning about exporting procedures, of familiarization with the institutional and policy characteristics of the foreign country etc.

Variable costs comprise two elements: an unknown *export* unit cost, c^j, and a unit *production* cost that is known to the firm. For convenience, we normalize the latter to zero. In subsection 2.3 we show that allowing for differences in productivity has no qualitative consequences for our main mechanism. The producer faces the following demand in each market $j = A, B$:

$$q^j(p^j) = d^j - p^j, \tag{1}$$

where q^j denotes the output sold in destination j, p^j denotes the corresponding price, and d^j is an unknown parameter.

We therefore allow for uncertainty in both demand and supply parameters. Let

$$\mu^j \equiv d^j - c^j$$

be a random variable with a continuous cumulative distribution function $G(\cdot)$ on the support $[\underline{\mu}, \overline{\mu}]$. We refer to μ^j as the firm's "export profitability" in market j. $\overline{\mu}$ obtains when the highest possible demand intercept ($\overline{d}$) and the lowest possible export unit cost ($\underline{c}$) are realized; $\underline{\mu}$ obtains under the opposite extreme scenario ($d^j = \underline{d}$ and $c^j = \overline{c}$). The analysis becomes interesting when trade costs are such that, upon the resolution of uncertainty, it may become optimal to serve both, only one, or none of the markets. Accordingly, we assume $\underline{\mu} < \tau^A$—so that exporting may not be worthwhile even if $F = 0$—and $2F^{1/2} + \tau^B < \overline{\mu}$. This last condition implies that exporting may be profitable even in the distant market. To ensure that equilibrium prices are always strictly positive, we need that $E\mu < 2d^j$ for all d^j, so we assume throughout the paper that $\underline{d} > \frac{1}{2}E\mu$.[6]

Our central assumption is that export profitability is correlated over time and across markets. Correlation of export profitability over time reflects, first, the fact that the structure of demand a firm faces in a market, while likely unknown ex ante, tends to be persistent.[7] Furthermore, the same is true for the idiosyncratic component of some export costs, which a firm learns only after actually engaging in exports but that do not change much over time. For example, shipping and other port activities, maintenance of an international division within the firm, distribution of goods in foreign markets, compliance with requirements of financial services, as well as the handling and processing of the documents necessary for exporting—all these activities involve relatively stable idiosyncratic costs that are often unknown to the firm until it actually starts exporting.[8] Similarly, cross-country correlations in export profitability can come from similarities across countries either in demand or supply conditions. The patterns uncovered by gravity equations—which show that bilateral trade correlates strongly with indicators for language, religion, colonial origin etc.—suggest that demand similarities across countries can be significant.[9] Likewise, some of the initially unknown

[6] In an online addendum (http://www.economics.soton.ac.uk/staff/calvo/documents/Technical_Addendum_2.pdf) we show that adopting instead a demand function of the form $q^j(p^j) = \max\{d^j - p^j, 0\}$ leaves our results unaffected. We adopt the assumption $\underline{d} > \frac{1}{2}E\mu$ here for simplicity.

[7] Trade facilitation agencies do indeed place a heavy emphasis on the importance of uncovering foreign demand for would-be exporters, and their advices indicate that the key uncertainty is about persistent demand components (see for example the discussion of SITPRO, the British trade facilitation agency, at http://www.sitpro.org.uk).

[8] Even important but relatively straightforward tasks related to exporting are often performed very poorly—implying high costs—by some firms. For example, SITPRO points out that "well in excess of 50% of documents presented by exporters to banks for payment under letters of credit are rejected on first presentation" (http://www.sitpro.org.uk). This figure includes new as well as old exporters. And such mistakes can be quite costly, since "slight discrepancies or omissions may prevent merchandise from being exported, result in nonpayment, or even in the seizure of the exporter's goods by [...] customs" (U.S. International Trade Administration, "A Basic Guide to Exporting," http://www.unzco.com/basicguide). Arguably, firms learn how well they can perform such export-specific activities only after they actually engage in them.

[9] Buono et al. (2008) show evidence consistent with persistent market characteristics driving firms' choices of export destinations. Kee and Krishna (2008) argue that market-, but also firm-specific demand shocks can help reconcile the predictions of heterogeneous firms models with detailed micro evidence. Demidova et al. (2009) confirm this when studying how variations in American and European trade policies vis-à-vis Bangladeshi apparel products

idiosyncratic export costs mentioned above involve the general business of exporting, implying a correlation across markets.

To make the analysis as clear and simple as possible, we focus on the limiting case. First, as the definition of μ^j without time subscripts indicates, we consider that the μ^j's are constant over time. Second, we look at the case where the draws of μ^j are perfectly correlated across markets: $\mu^A = \mu^B = \mu$. Each of these assumptions can be relaxed. All of our qualitative results generalize to any strictly positive correlation of export profitabilities across markets and time. In Appendix B we show this for the case where μ^j's are positively but imperfectly correlated.

Since our main goal is to understand entry into foreign markets, we evaluate all profits from an *ex ante* perspective, i.e. at their $t = 0$ expected value. For simplicity we do not consider a discount factor, but this has no bearing on our qualitative results. 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. Output 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 arbitrarily small, it infers μ 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 the firm's export profitability parameter μ is not directly observed but inferred by the firm from its profits. To learn μ the firm must pay the fixed entry cost F and export a strictly positive quantity to one of the markets. This is reminiscent of Jovanovic's (1982) model, although a central difference is that we consider entry into several destinations.

Uncovering μ must be costly, or else all firms would, counterfactually, export at least a tiny quantity to gather their export potential. We rely on previous findings in the literature and model this cost as a sunk cost, but this is not necessary for our results. Alternatively, one could specify that a firm needs a minimum scale of experimentation to reliably uncover its true export profitability. We allow this minimum scale to be an arbitrarily small number (ε) because we require the firm to spend F to sell in a foreign market, but one could also assume the opposite (i.e. set $F = 0$ and require a larger minimum scale).[10]

affect firms' choices of export destinations.

[10] The specific type of experimentation chosen by the exporter is not the focus of this paper. For a more general analysis of experimentation, see for example the model of Aghion et al. (1991), where a Bayesian decision maker with an unknown objective function engages into costly experimentation, provided that it is informative enough.

In reality, entry may also be "passive," where a foreign buyer posts an order and the exporting firm simply delivers it. Trade in intermediate goods, for example, is indeed often importer-driven, rather than exporter-driven. Thus, in general firms may either deliberately choose to enter a market, as in our model, or simply wait until they are chosen by a foreign buyer. Importantly, both ways of exporting help to resolve uncertainty. Initially passive exporters may therefore become active, and pay entry costs, if upon delivery of their first foreign order they learn about their future export profitability. Since our predictions apply to export activity after a first experience, they would remain valid even when that first experience is "passive."

2.2 A Firm's Export Decision

Export profitability correlated across time and markets implies that exporting to country A reveals information about the firm's export performance in country B. As a result, there are three undominated entry strategies. The firm may enter both markets simultaneously at $t = 1$ ("simultaneous entry"); enter only market A at $t = 1$, deciding at $t = 2$ whether to enter market B ("sequential entry"); 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 $t = 1$, since by postponing entry the producer is faced with the same problem as in $t = 1$, but is left with a shorter horizon to recoup identical fixed entry costs.

We solve for the firm's decision variables $\{e_1^j, e_2^j, q_1^j, q_2^j\}$ using backward induction. We denote optimal quantities in period t under simultaneous entry by $\widehat{q}_t^j$, and under sequential entry by $\widetilde{q}_t^j$.

2.2.1 Period $t = 2$

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 μ and will choose its export volumes by solving

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

This yields

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

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

$$V(\tau^j) = \int_{\tau^j}^{\overline{\mu}} \left(\frac{\mu - \tau^j}{2} \right)^2 dG(\mu), \; j = A, B.$$

Function $V(\tau^j)$ represents the firm's option value of keeping exporting to market j after learning its profitability in foreign markets. If the firm cannot deliver positive profits in a market, it exits to avoid further losses. Otherwise, the firm tunes up its output choice to that market.

iii) *Sequential entry.* When the firm exports to country A in $t=1$, at $t=2$ it will have inferred its export profitability μ. Thus, q_2^A is again given by (2): $\widetilde{q}_2^A(\tau^A) = \widehat{q}_2^A(\tau^A) = \mathbf{1}_{\{\mu>\tau^A\}}\left(\frac{\mu-\tau^A}{2}\right)$, 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 sunk cost to enter that market. This will be the case when the firm realizes its export profitability is large relative to the sunk cost:

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

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

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

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 τ^B.

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

Expressed in $t=0$ expected terms, the firm's profit from (possibly) entering market B at $t=2$ corresponds to

$$\begin{aligned} W(\tau^B;F) &\equiv \int_{2F^{1/2}+\tau^B}^{\overline{\mu}} \left[\left(\frac{\mu-\tau^B}{2}\right)^2 - F\right] dG(\mu) \\ &= \left\{V(\tau^B) - \int_{\tau^B}^{2F^{1/2}+\tau^B} \left(\frac{\mu-\tau^B}{2}\right)^2 dG(\mu)\right\} - F\left[1-G(2F^{1/2}+\tau^B)\right]. \end{aligned}$$

Function $W(\tau^B;F)$ represents the firm's option value of exporting to market B after learning its profitability in foreign markets by entering market A first. The expression in curly brackets represents the (ex ante) expected operational profit from entering market B at $t=2$. 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 from directly "testing" that market. Naturally, this option has value because export profitabilities are correlated across destinations. If export profitabilities were independent, $W(\tau^B;F)=0$ and there would not be any gain from entering export markets sequentially. In Appendix B we show that if the correlation is positive but less than perfect, the value of the option falls but remains strictly positive.

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:

$$\Psi^{Sm}(q_1^A, q_1^B; \tau^A, \tau^B) \equiv \int_{\underline{\mu}}^{\overline{\mu}} (\mu - \tau^A - q_1^A) q_1^A dG(\mu) + \int_{\underline{\mu}}^{\overline{\mu}} (\mu - \tau^B - q_1^B) q_1^B dG(\mu) + \max\left\{\mathbf{1}_{\{q_1^A>0\}}, \mathbf{1}_{\{q_1^B>0\}}\right\}\left[V(\tau^A) + V(\tau^B)\right], \quad (5)$$

where superscript Sm stands for "simultaneous" entry. The first two terms correspond to the firm's period 1 per-destination operational profits. The third term 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 information on its export profitability in both markets, it is enough to have exported a positive amount in period 1 to either destination.

Maximization of (5) yields outputs

$$\widehat{q}_1^A(\tau^A) = \mathbf{1}_{\{E\mu>\tau^A\}}\left(\frac{E\mu - \tau^A}{2}\right) + \mathbf{1}_{\{E\mu\le\tau^A\}}\varepsilon, \quad (6)$$

$$\widehat{q}_1^B(\tau^B) = \mathbf{1}_{\{E\mu>\tau^B\}}\left(\frac{E\mu - \tau^B}{2}\right), \quad (7)$$

where $\varepsilon > 0$ is an arbitrarily small number. To understand these expressions, notice that there are three possibilities. If $E\mu > \tau^B$, $q_1^j = \frac{E\mu-\tau^j}{2}$ for $j = A, B$ is clearly optimal. If $\tau^B \ge E\mu > \tau^A$, $q_1^A = \frac{E\mu-\tau^A}{2}$ and $q_1^B = 0$ is the best choice. If $E\mu \le \tau^A$, setting $q_1^A = q_1^B = 0$ may appear optimal. However, inspection of (5) makes clear that a small but strictly positive $q_1^A = \varepsilon > 0$ dominates that option, since $\Psi^{Sm}(\varepsilon, 0; \tau^A, \tau^B) = \left(E\mu - \tau^A - \varepsilon\right)\varepsilon + V(\tau^A) + V(\tau^B) > 0$. Clearly, setting $q_1^A = q_1^B = 0$ forgoes the benefit from uncovering an informative signal of the firm's export profitability in B.

Define $\Psi(\tau^j) \equiv \mathbf{1}_{\{E\mu>\tau^j\}}\left(\frac{E\mu-\tau^j}{2}\right)^2 + V(\tau^j)$. Evaluating (5) at the optimal output choices (6), (7) and (2), we obtain the firm's expected gross profit from simultaneous entry:

$$\Psi^{Sm}(\tau^A, \tau^B) \equiv \lim_{\varepsilon\to 0} \Psi^{Sm}(\widehat{q}_1^A(\tau^A), \widehat{q}_1^B(\tau^B); \tau^A, \tau^B) = \Psi(\tau^A) + \Psi(\tau^B). \quad (8)$$

iii) *Sequential entry.* At $t = 1$, a firm that enters only market A chooses q_1^A to maximize

$$\Psi^{Sq}(q_1^A; \tau^A, \tau^B) \equiv \int_{\underline{\mu}}^{\overline{\mu}} (\mu - \tau^A - q_1^A) q_1^A dG(\mu) + \mathbf{1}_{\{q_1^A>0\}}\left[V(\tau^A) + W(\tau^B; F)\right], \quad (9)$$

where Sq stands for "sequential" entry. The firm learns its export profitability iff $q_1^A > 0$. A strictly positive quantity 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 $\widetilde{q}_1^A(\tau^A) = \widehat{q}_1^A(\tau^A)$, as in (6).

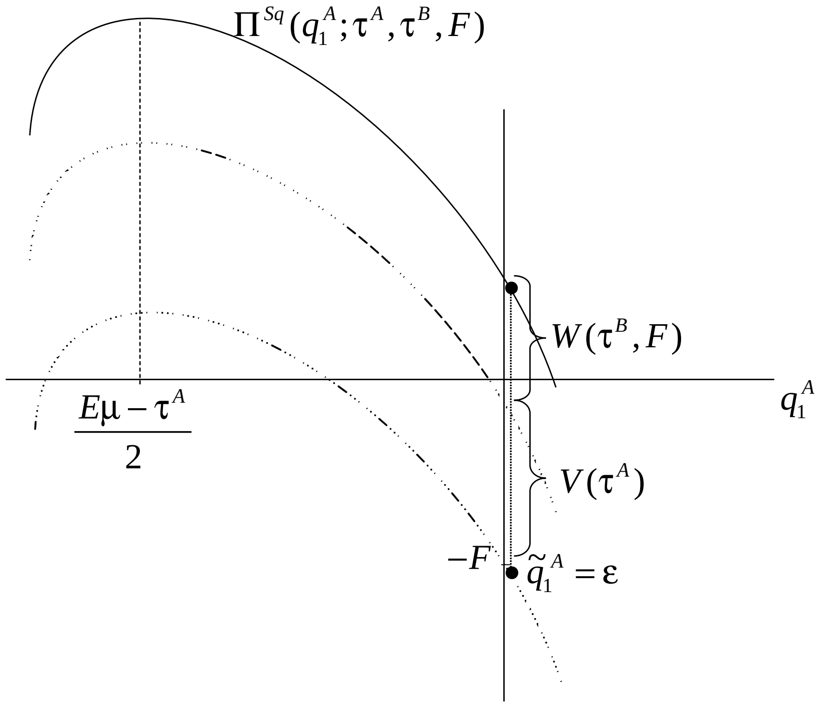

Figure 1: The Profit Function from Sequential Exporting when $E\mu < \tau^A$

Our model therefore suggests that some firms will "test" foreign markets before fully exploring them (or exiting them altogether), a feature consistent with the empirical findings discussed in the Introduction. Interestingly, experimentation can arise even when the variable 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 as well as in others; the return from the initial sale allows the firm to find out whether it actually is.

Figure 1 illustrates this point by showing a situation where export experimentation is worthwhile even though $E\mu < \tau^A$. The lowest curve represents the profit of entering market A when experimentation is useless. The middle curve adds the value of experimentation in the entry market; the highest curve includes also the value of experimentation across markets. In the figure, experimentation is worthwhile only because it has value in the other market; otherwise the value of information would not be high enough to compensate for the sunk costs [i.e., $V(\tau^A)+W(\tau^B;F) > F > V(\tau^A)$].

Evaluating (9) at the optimal output choice $\tilde{q}_1^A(\tau^A)$, we obtain the firm's expected profit from sequential entry:

$$\Psi^{Sq}(\tau^A,\tau^B) \equiv \lim_{\varepsilon\to 0^+} \Psi^{Sq}(\tilde{q}_1^A(\tau^A);\tau^A,\tau^B) = \Psi(\tau^A) + W(\tau^B;F). \tag{10}$$

2.2.3 Entry strategy

We can now fully characterize the firm's entry strategy. Using (8), the firm's net profit from simultaneous entry, Π^{Sm}, is

$$\Pi^{Sm} = \Psi(\tau^A) + \Psi(\tau^B) - 2F. \tag{11}$$

In turn, we have from (10) that the firm's net profit from sequential entry, Π^{Sq}, is

$$\Pi^{Sq} = \Psi(\tau^A) + W(\tau^B; F) - F. \tag{12}$$

Simultaneous entry is optimal if $\Pi^{Sm} > \Pi^{Sq}$ 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. Using (11) and (12), we can rewrite these conditions as follows. Simultaneous entry is optimal if

$$\begin{cases} F < \Psi(\tau^B) - W(\tau^B; F) \quad \text{and} \\ F \leq \left[\Psi(\tau^A) + \Psi(\tau^B)\right]/2. \end{cases}$$

Notice that the right-hand side of the second inequality above is strictly greater than the right-hand side of the first inequality, since $W(\tau^B; F) > 0$ and $\tau^A \leq \tau^B$. Intuitively, if F is small enough to make simultaneous entry preferred to sequential entry, it also makes simultaneous entry preferred to no entry at all. Thus, simultaneous entry is optimal if

$$F < \Psi(\tau^B) - W(\tau^B; F). \tag{13}$$

In turn, sequential entry is optimal if

$$\Psi(\tau^B) - W(\tau^B; F) \leq F \leq \Psi(\tau^A) + W(\tau^B; F). \tag{14}$$

Inequalities (13) and (14) define the firm's entry strategy at $t = 1$. The firm enters market A at $t = 1$ if either (13) or (14) are satisfied; it enters market B at $t = 1$ if (13) is satisfied but (14) is not:

$$e_1^A(\tau^A, \tau^B) = 1 \Leftrightarrow F \leq \Psi(\tau^A) + W(\tau^B; F), \tag{15}$$

$$e_1^B(\tau^B) = 1 \Leftrightarrow F < \Psi(\tau^B) - W(\tau^B; F). \tag{16}$$

Naturally, the condition for $e_1^B = 1$ is stricter than the condition for $e_1^A = 1$. Condition (16) implies that $e_1^B = 1$ (in which case simultaneous entry occurs) only if the sunk cost to export is sufficiently small. The following proposition shows this and other results that fully characterize the firm's export decision.

Proposition 1 *There are numbers F^{Sq} and F^{Sm}, with $F^{Sq} > F^{Sm} \geq 0$, such that at $t = 1$ the firm enters both markets A and B if $F < F^{Sm}$, enters only market A if $F \in [F^{Sm}, F^{Sq}]$, and enters neither market if $F > F^{Sq}$. Moreover, $F^{Sm} > 0$ iff $E\mu > \tau^B$. 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 (16) for $e_1^B = 1$ as

$$F + W(\tau^B; F) < \Psi(\tau^B). \tag{17}$$

The right-hand side of (17) is independent of F, whereas the left-hand side is strictly increasing in F. To see that, use Leibniz's rule to find that

$$\begin{aligned} \frac{\partial \left[F + W(\tau^B; F)\right]}{\partial F} &= 1 - \int_{2F^{1/2}+\tau^B}^{\overline{\mu}} dG(\mu) \\ &= G(2F^{1/2} + \tau^B) > 0. \end{aligned} \tag{18}$$

Defining F^{Sm} as the F that would turn (17) into an equality, $e_1^B = 1$ if $F < F^{Sm}$. However, $F^{Sm} = 0$ if $E\mu \leq \tau^B$, since in that case (17) becomes

$$F + \int_{2F^{1/2}+\tau^B}^{\overline{\mu}} \left[\left(\frac{\mu - \tau^B}{2}\right)^2 - F\right] dG(\mu) < \int_{\tau^B}^{\overline{\mu}} \left(\frac{\mu - \tau^B}{2}\right)^2 dG(\mu).$$

This expression becomes an equality when $F = 0$. Given (18), it follows that it does not hold for any $F > 0$.

Next rewrite condition (15) for $e_1^A = 1$ as

$$F - W(\tau^B; F) \leq \Psi(\tau^A). \tag{19}$$

The right-hand side of (19) is independent of F, whereas it is straightforward to see that the left-hand side is strictly increasing in F. Thus, defining F^{Sq} as the F that solves (19) with equality, $e_1^A = 1$ if $F \leq F^{Sq}$. Since F^{Sm} is the value of F that leaves the firm indifferent between a sequential and a simultaneous entry strategy [i.e. $\Pi^{Sq}(F^{Sm}) = \Pi^{Sm}(F^{Sm}) > 0$], while F^{Sq} is the value of F that leaves the firm indifferent between sequential entry and no entry [i.e. $\Pi^{Sq}(F^{Sq}) = 0$], because profits are decreasing in the value of the sunk entry cost, $\partial \Pi^{Sq}(F)/\partial F = G(2F^{1/2} + \tau^B) - 2 < 0$, it follows that $F^{Sq} > F^{Sm}$.

Finally, since the firm learns μ at $t = 1$ when $F \in [F^{Sm}, F^{Sq}]$, it enters market B at $t = 2$ according to (4). ∎

The intuition for these results is simple. By construction $\tau^A \leq \tau^B$, so if the firm ever enters any foreign market, it will enter market A. Since there are gains from resolving the uncertainty about export profitability, 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. Naturally, this can make sense only when the operational profit in B is expected to be positive ($E\mu > \tau^B$). 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.

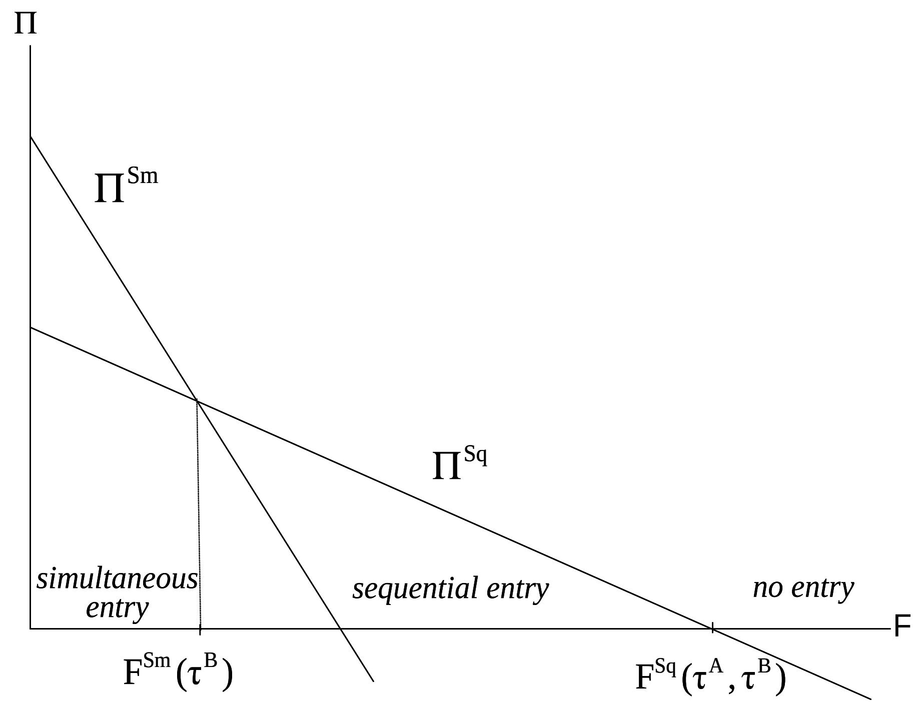

Figure 2: Optimal Entry Strategy ($E\mu > \tau^B$)

Hence, the higher the sunk cost to export, the more beneficial is waiting before sinking F in the less profitable market, B.

Figure 2 illustrates this result when $E\mu > \tau^B$, in which case simultaneous entry is optimal for small enough F. Notice that trade cost τ^B affects both thresholds, while trade cost τ^A only affects F^{Sq}. Thus, we can denote the thresholds as $F^{Sq}(\tau^A, \tau^B)$ and $F^{Sm}(\tau^B)$. We characterize how trade costs affect each of the thresholds in Section 4.

2.3 Differences in productivity

We have developed the analysis so far without mentioning how differences in productivity would affect our results. Yet the large and growing literature spurred by Melitz (2003) emphasizes that productivity differences are key to explain firms' export behavior. As we now show, they matter in our analysis too, but in a rather straightforward way.

To allow for differences in productivity, we denote a firm's unit costs as $\frac{1}{\varphi} + c$, where $\varphi \in [0, \infty)$ denotes the firm's (known) efficiency in production (i.e. its measure of productivity) and c again reflects its (unknown) unit export cost. It is easy to see, for example, that more productive firms will sell larger quantities (and expect higher profits) in the destinations they serve. More important for our purposes is how differences in productivity affect entry patterns in foreign markets. The following proposition shows that the more productive a firm is, the less stringent the start-up fixed entry thresholds F^{Sq} and F^{Sm} become.

Proposition 2 *F^{Sq} and F^{Sm} are increasing in productivity φ.*

Proof. Rewrite condition (16) for $e_1^B = 1$ as

$$F < \Psi(\tau^B + \frac{1}{\varphi}) - W(\tau^B + \frac{1}{\varphi}; F). \tag{20}$$

Analogously to Proposition 1, $F^{Sm} = 0$ if $E\mu \leq \tau^B + \frac{1}{\varphi}$, in which case $\frac{dF^{Sm}}{d\varphi} = 0$. Otherwise, the expression above rewritten as an equality defines F^{Sm} implicitly:

$$F^{Sm} = \left[\Psi(\tau^B + \frac{1}{\varphi}) - W(\tau^B + \frac{1}{\varphi}; F^{Sm})\right],$$

or equivalently,

$$\begin{aligned} F^{Sm} = \left(\frac{E\mu - \tau^B - \frac{1}{\varphi}}{2}\right)^2 + \int_{\tau^B + \frac{1}{\varphi}}^{\overline{\mu}} \left(\frac{\mu - \tau^B - \frac{1}{\varphi}}{2}\right)^2 dG(\mu) \\ - \int_{2(F^{Sm})^{1/2} + \tau^B + \frac{1}{\varphi}}^{\overline{\mu}} \left[\left(\frac{\mu - \tau^B - \frac{1}{\varphi}}{2}\right)^2 - F^{Sm}\right] dG(\mu). \end{aligned}$$

Totally differentiating this expression and manipulating it, we find

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

Next rewrite condition (15) for $e_1^A = 1$ as

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

This expression defines F^{Sq} implicitly when it holds with equality:

$$F^{Sq} = \Psi(\tau^A + \frac{1}{\varphi}) + W(\tau^B + \frac{1}{\varphi}; F^{Sq}),$$

or equivalently,

$$F^{Sq} = \mathbf{1}_{\{E\mu > \tau^A + \frac{1}{\varphi}\}} \left(\frac{E\mu - \tau^A - \frac{1}{\varphi}}{2} \right)^2 + \int_{\tau^A + \frac{1}{\varphi}}^{\overline{\mu}} \left(\frac{\mu - \tau^A - \frac{1}{\varphi}}{2} \right)^2 dG(\mu)$$
$$+ \int_{2(F^{Sq})^{1/2} + \tau^B + \frac{1}{\varphi}}^{\overline{\mu}} \left[\left(\frac{\mu - \tau^B - \frac{1}{\varphi}}{2} \right)^2 - F^{Sq} \right] dG(\mu).$$

Totally differentiating this expression and manipulating it, we find

$$\frac{dF^{Sq}}{d\varphi} = \frac{\partial \Psi(\tau^A + \frac{1}{\varphi})/\partial\varphi + \partial W(\tau^B + \frac{1}{\varphi}; F^{Sq})/\partial\varphi}{1 - \partial W(\tau^B + \frac{1}{\varphi}; F^{Sq})/\partial F}$$
$$= \frac{1}{2\varphi^2 \left[2 - G(2\left[F^{Sq}\right]^{1/2} + \tau^B + \frac{1}{\varphi}) \right]} \times \left[\mathbf{1}_{\{E\mu > \tau^A + \frac{1}{\varphi}\}} \left(E\mu - \tau^A - \frac{1}{\varphi} \right) + \right.$$
$$\left. + \int_{\tau^A + \frac{1}{\varphi}}^{\overline{\mu}} (\mu - \tau^A - \frac{1}{\varphi}) dG(\mu) + \int_{2[F^{Sq}]^{1/2} + \tau^B + \frac{1}{\varphi}}^{\overline{\mu}} (\mu - \tau^B - \frac{1}{\varphi}) dG(\mu) \right] > 0,$$

completing the proof. ■

Thus, varying productivity levels shift the thresholds defining sequential and simultaneous entry in foreign markets in an unambiguous way. Higher productivity increases the expected profits from entering foreign markets simultaneously, as well as the expected profits from exporting at all. The entry strategies can nevertheless still be characterized by the sunk cost thresholds. The only difference is that the more productive a firm is, the higher its sunk cost thresholds will be, implying that more productive firms are more likely to export, and to start exporting simultaneously to multiple destinations.

Figure 3 illustrates Proposition 2. Notice first that, if productivity is too low ($\varphi < \frac{1}{\overline{\mu} - \tau^A}$), there is no hope of making profits through exporting, and therefore the firm does not enter any foreign market even if $F = 0$. Similarly, the firm would never enter simultaneously if it did not expect to make positive operational profits in market B (i.e. if $\varphi < \frac{1}{E\mu - \tau^B}$). By contrast, observe that as the unit production cost falls to zero (i.e. $\varphi \to \infty$), the thresholds approach those defined in Proposition 1. Given this qualitative similarity, in the remaining of the paper we keep the specification where we normalize unit production costs to zero, while bearing in mind that they are affected by productivity levels.

2.4 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, so we can derive testable predictions for the intensive and the extensive (both entry and exit) margins of exporting. We assume throughout that F is 'moderate,'

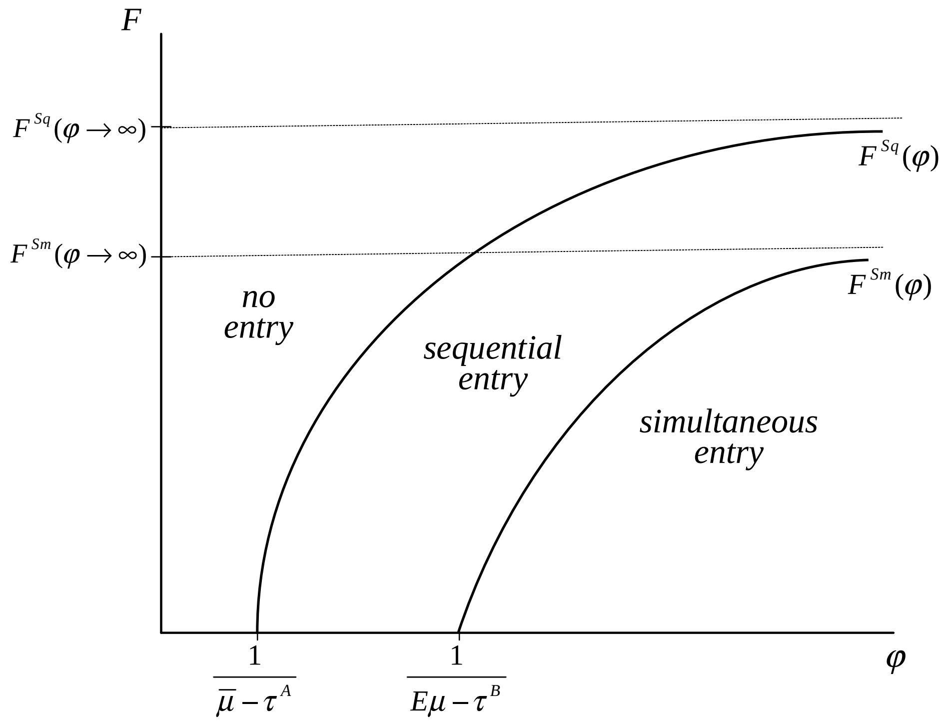

Figure 3: Optimal Entry Strategy with Varying Productivity

so that sequential exporting is optimal.[11] We maintain the convention that $\tau^A = \min\{\tau^j\}$, $j = A, ..., N$, so that market A is the first the firm enters at $t = 1$.

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. However, if it is not negligible, our main messages remain intact (Appendix B). The same is true about correlation of export profitabilities in a given market over time. Effectively, our running hypothesis is that the highest informational content is extracted from the first export experience. Our predictions should be interpreted accordingly.

Our model predicts, first, that conditional on survival we should expect faster intensive margin export growth when firms are learning their export profitabilities—i.e. right after they enter their first foreign market.

Prediction 1 (Intensive margin) *Conditional on survival, the growth of a firm's exports to a market is on average highest between the first and second periods in the first foreign market served by the firm.*

Proof. Consider the first market, A. Conditional on entry, export volume at $t = 1$ is given by (6). At $t = 2$, 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

[11] In practice, entry in foreign markets is indeed always "sequential" to some extent, as no firm in our sample enters all possible markets within a single year.

post quantities conditional on survival are distributed according to $G(\cdot|\mu > \tau^A)$. It follows that the average surviving firm will produce the ex ante expected quantity $E_0(q_2^A \big| \mu > \tau^A) = \frac{E_0(\mu|\mu>\tau^A)-\tau^A}{2}$. There are two cases. If $E\mu \leq \tau^A$, export growth from first to second year is $\sigma^A \equiv \frac{E_0(\mu|\mu>\tau^A)-\tau^A}{2} - \varepsilon > 0$. Otherwise, $\sigma^A = \frac{E_0(\mu|\mu>\tau^A)-\tau^A}{2} - \frac{E\mu-\tau^A}{2} = \frac{1}{2}[E_0(\mu|\, \mu > \tau^A) - E\mu]$. 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 in market A conditional on survival is nil, since $E_0(q_t^A \big| \mu > \tau^A) = \frac{E_0(\mu|\mu>\tau^A)-\tau^A}{2}$ for all $t > 1$.

Consider now foreign market j, $j \neq A$. Since the firm enters market j only if $\mu > 2F^{1/2} + \tau^j$, $E_0(q_{t+1}^j \Big| \mu > 2F^{1/2} + \tau^j) = E_0(q_t^j \Big| \mu > 2F^{1/2} + \tau^j) = \frac{E_0(\mu|\mu>2F^{1/2}+\tau^j)-\tau^j}{2}$ for all $t > 1$. Thus, export growth in market j is nil in all periods. Hence, export growth is on average highest in market A between the first and second years of exporting. ■

The intuition for this result is simple. Since export profitability is uncertain for a firm before it starts exporting, first-year exports are relatively low. If the firm anticipates positive variable profit in its first market, it produces according to this expectation. If the firm stays there in the second period, it must be because its uncovered export potential is relatively high ($\mu > \tau^A$). Therefore, conditional on survival, on average the firm expands sales in its first market, as the relevant distribution of μ is a truncation of the original one. If the firm had entered that market just to learn about its export potential (and to potentially benefit from expanding to other destinations in the future), the firm initially produces just the minimum necessary for effective learning and the same argument applies even more strongly. On the other hand, once the uncertainty about export profitability has been resolved, there is no reason for further changes in sales, and there should be no growth in export volumes in the years following this discovery period. Similarly, since the profitability of the firm in its first export destination conveys all information about export profitability in other destinations, there is no reason for export growth in markets other than the firm's first either.

Obviously, our basic model delivers these results too bluntly. It abstracts from a range of shocks that are likely to affect the firm's output choices and growth; we seek to control for those in our empirical analysis. There are also other reasons to expect export growth in new foreign markets, as we discuss later. Moreover, while in the basic model we assume that export profitability is perfectly correlated across markets and time, that assumption is clearly too strong. In particular, export profitability that is imperfectly correlated across markets implies strictly positive first-to-second year export growth in every market the firm expands to and survives. Our testing hypothesis is, instead, that firms learn *more* about their export profitabilities in their first markets, so the early expansion of surviving firms is greater in their initial markets than in their subsequent markets.

Our second prediction relates to entry patterns. Once a firm starts exporting, it will uncover its export profitability. If it turns out to be sufficiently high, the firm expands in the next period to other markets where the firm anticipates positive profits.

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

Proof. Denote the probability that a firm that has just started to export will enter a new foreign market j in the next period by $\Pr(e_2^j = 1 | e_1^A = 1 \ \& \ e_1^j = 0)$, and the probability that a firm that has been an exporter for a longer period will enter market j by $\Pr(e_t^j = 1 | \prod_{i=1}^{t-1} e_{t-i}^A = 1 \ \& \ e_{t-1}^j = 0)$, $t \geq 2$. The model implies that $\Pr(e_2^B = 1 | e_1^A = 1 \ \& \ e_1^j = 0) = 1 - G(2F^{1/2} + \tau^j) > 0 = \Pr(e_t^j = 1 | \prod_{i=1}^{t-1} e_{t-i}^A = 1 \ \& \ e_{t-1}^j = 0)$, concluding the proof. ■

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 learning now how profitable they can be as exporters, and some will realize it pays to expand to other destinations.

Again, the message from our basic model is extreme, as it abstracts from all other motives for expansion to different foreign markets—which we seek to control for in our empirical analysis. But it helps to highlight our central point, that (surviving) new exporters have an *extra* motivation for expansion.

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

Prediction 3 (Exit) *A firm is more likely to exit a foreign market if it is a new exporter.*

Proof. Let the probability of exiting a foreign market right after entering there be $\Pr(e_2^A = 0 | e_1^A = 1)$ 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. The latter is also equal to the probability of exiting a market after being there for more than one period. The model implies that

$$\Pr(e_2^A = 0 | e_1^A = 1) = G(\tau^A) > 0 = \Pr(e_{t+1}^j = 0 | e_t^j = 1 \ \& \ e_{t-1}^j = 1),$$

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. While many reasons can cause a firm to abandon a foreign destination, we argue that being a new exporter creates an additional motivation to do so, in expected terms.

3 Evidence

We can now test the main predictions of our model. We start by describing the data.

3.1 Data

Our data comes from the Argentine Customs Office. We observe the annual value (in US dollars) of the foreign sales of each Argentine manufacturing exporter between 2002 and 2007, distinguished by country of destination. Over our sample period, Argentine manufacturing exports involved 15,301 exporters and 130 foreign destinations.

Appendix C presents the trends of aggregate exports in Argentina during 2002-2007, as well as annual exports by sector and by destination. Figure 4 shows that Argentina experienced high export growth during this period, to a large extent a consequence of the steep depreciation of its currency in early 2002. As of 2007, Argentina's main export manufacturing sectors (Table 9) are petroleum (30%); food, tobacco and beverages (23%); and automotive and transport equipment (13%), while Argentina's main export destinations (Table 10) are its Mercosur partners Brazil, Paraguay and Uruguay (35%), followed by North America (13%) and by Argentina's other neighbors Chile and Bolivia (10%).

All new exporters in our data set are "sequential exporters," in the sense that none of them enter all 130 destinations at once. In fact, 79% of new exporters start in a single market, 15% enter initially in two or three destinations, and just 6% start with more than three destinations. On average, exporting firms serve three distinct foreign markets; around 40% of the exporting firms serve only one destination.

Table 1 reveals some interesting features of different types of exporters. First, new exporters—which correspond to the sum of "entrants" (firms that not do not export in $t-1$ but do so in both t and $t+1$) and "single-year" exporters (i.e. firms that export in t but not in either $t-1$ or $t+1$)—are common in our sample, representing on average 24% of all exporters in a year. Second, many new exporters are single-year (38% on average) and their share rises over time, reaching 47% of all new exporters in 2006. Third, "continuers" (those that export in $t-1$, t and $t+1$) account for the bulk of exports in Argentina, while entrants and "exiters" (firms that export in $t-1$ and in t but not in $t+1$) are much smaller, and single-year exporters even more so.[12]

New exporters that remain active, on the other hand, grow fast. This can be observed in Table 2, where we report the foreign sales of firms that break into a new market in 2003 and keep exporting there in the subsequent years of our data set.[13] We distinguish those exporting in 2003 for the first time ("First Market 2003") from those already in the exporting business ("New Market 2003"). To keep the comparison focused, we also look at the sales of the firms from the first group that expand to other markets in 2004 ("Second Market 2004"). The table displays each group's average export value by year. Observe that the average firm from all groups increases exports in every period but especially from its first to its second year in a market. Yet the feature of the table that really stands out is the markedly higher initial growth of the new exporters in their first market (190%), relative both to the initial growth of experienced exporters entering new markets (108%) and to the initial growth of the same firms but in the markets they enter later (104%).

These regularities are unlikely to be specific to Argentina. In fact, many of them echo those

[12] Single-year exporters sell on average less than 20% of what other new exporters sell abroad in their first year. In terms of our model, this suggests that the share of "pure experimenters" (i.e. those that start exporting even though $E\mu \leq \tau^A$) is higher among the single-year exporters than among the other entrants. Naturally, the pure experimenters are indeed the least likely to succeed as exporters.

[13] We focus on 2003 to obtain the longest possible time span after entry.

Table 1: Exports by Type of Exporter

Number of firms					
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				
Total Value of exports (US$ Millions)					
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				
Exports per firm (US$ Thousands)					
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 $t-1$, 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 $t+1$. "Single-Year" exporters are firms that exported in t but neither in $t-1$ nor in $t+1$.

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

Year	First Market 2003		Second Market 2004		New Market 2003	
	USD	Growth (%)	USD	Growth (%)	USD	Growth (%)
2003	35465				96541	
2004	102718	190	33831		200799	108
2005	139439	36	69100	104	304295	52
2006	163864	18	87036	26	340015	12
2007	216865	32	95835	10	449147	32

observed by other authors in different countries (e.g. Eaton et al. 2008 in Colombia, Buono et al. 2008 in France, Lawless 2009a in Ireland), although other authors do not distinguish between the behavior of exporters in their first and their subsequent foreign markets. These regularities provide a good illustration of our discussion in the Introduction. New exporters are small in foreign markets relative to old exporters, and almost 40% of them drop out of foreign markets in less than a year. Given the need to incur sunk costs to start exporting, those going through such short export spells ought to be realizing substantially negative profits from their export experience. Hence they must have expected very high profits in case of success abroad. Indeed, the new exporters that survive expand fast, often at both the intensive and the extensive margins.

Naturally, while these regularities are all consistent with export profitability being positively correlated over time and across destinations, other factors may also play a role in shaping these aggregate figures. We therefore turn now to investigating our predictions in more detail.

3.2 Empirical results

3.2.1 Intensive margin

Our model predicts that, conditional on survival, the growth of a firm's exports is on average highest between the first and second periods in the first foreign market served by the firm (Prediction 1). We test this prediction by estimating the following equation:

$$\Delta \log X_{ijt} = \alpha_1 \left(FY_{ij,t-1} \times FM_{ij} \right) + \alpha_2 FM_{ij} + \alpha_3 FY_{ij,t-1} + \{FE\} + u_{ijt},$$

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, $FY_{ij,t-1}$ is a dummy indicating whether firm i exported to destination j in $t-1$ for the first time, and FM_{ij} indicates whether j is the firm's first export market. Prediction 1 indicates that $\alpha_1 > 0$, but we also include FY and FM by themselves because there could be other reasons that make growth distinct in the first export market of a firm or in the firm's first periods of activity in a foreign market.

Of course, a number of other factors affect a firm's export growth in a market as well, such as the general characteristics of the destination country, the economic conditions in the year, and the firm's own distinguishing characteristics. To account for those factors, we take advantage of the richness of our data set and include a wide range of fixed effects, $\{FE\}$, including year, destination—or alternatively, year-destination—and firm fixed effects. Firm fixed effects control for all systematic differences across firms that do not change over time, including differences in the level of firms' productivities. Year-destination fixed effects control for all aggregate shocks that affect the general attractiveness of a market—aggregate demand growth, exchange rate variations, political changes etc. In these and all subsequent regressions, our standard errors allow for clusters in firms.

Importantly, the sample used in the intensive margin regressions consists of firms that exported for at least two consecutive years to a destination—i.e. firms that survive more than a year in a foreign market. Thus, selection is not an issue here. Notice also that, while the prediction is stated in terms of export quantities, the data report export values. Nonetheless, Prediction 1 can be equivalently stated in terms of sales values as long as demand (d) and supply shocks (c) are independently distributed (see Lemma 3 in Appendix A for the proof).

Table 3 displays the results. They show that growth is not in general higher in firms' first market, but it is so in their early periods of activity in a market. This could reflect market-specific uncertainty (as in Eaton et al. 2009 and Freund and Pierola 2009), or perhaps the dynamics of trust in business relationships.[14] It reflects also a simple accounting phenomenon: since firms enter markets over the year, initial exports appear artificially low in the first year whenever the data are on an annual basis, as here.

Table 3: Intensive Margin Growth (Dependent Variable: $\Delta \log X_{ijt}$)

OLS	1	2	3	4	5
$FY_{ij,t-1} \times FM_{ij}$	-.032	.141**	.098**	.095**	.308**
	(.028)	(.036)	(.036)	(.036)	(.029)
FM_{ij}	.025	-.013	-.009	-.008	-.043
	(.018)	(.038)	(.039)	(.038)	(.035)
$FY_{ij,t-1}$	.263**	.238**	.233**	.233**	-.137**
	(.014)	(.016)	(.016)	(.016)	(.014)
$\log X_{ij,t-1}$					-.427**
					(.007)
Firm FE		yes	yes	yes	yes
Year FE			yes		
Destination FE			yes		
Year-Destination FE				yes	yes
Number of obs	107390	107390	107390	107390	107390
R-squared	.01	.09	.10	.10	.30

**: significant at 1%; *: significant at 5%
Robust standard errors adjusted for clusters in firms.

The distinguishing feature of our proposed mechanism with respect to the intensive margin regards, however, the interaction term: firms' export growth should be higher in their early periods of activity in their first export market. That is, we compare firms' early growth in their first market relative to their early growth in subsequent markets. We find that, indeed, the coefficient associated with $FY_{ij,t-1} \times FM_{ij}$ is positive and significant in all specifications that include firm fixed effects. 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 initial growth 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.

The effect of being a new exporter on intensive-margin growth is economically sizeable, too. Unconditional intensive-margin growth in our sample is 20%. However, average growth is about 23 percentage points higher in a firm's initial period of activity in a market, and this effect jumps to

[14] 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.

33 percentage points if the market is the firm's first.

A common view in the literature is that firms start exporting after experiencing positive persistent idiosyncratic productivity shocks (e.g. Arkolakis 2009, Irrarazabal and Opromolla 2008). Due to serial correlation, growth in exports fades over time as shocks die out. This could explain why early export growth is highest in the first market. A way to partially control for this effect is to include the firm's lagged export level. Column 5 of Table 3 shows that, when doing so, the effect of $FY_{ij,t-1} \times FM_{ij}$ on export growth remains positive and significant. In fact, the coefficient is much higher in that case.[15]

3.2.2 Entry

Our model predicts also that new exporters are more likely to enter new foreign destinations (Prediction 2). To test this prediction, we create for every firm i exporting to some destination s other than r at period $t-1$, a binary variable $Entry_{irt}$ that takes the value of one if firm i *enters* destination r at time t, and zero otherwise. Therefore non-entry corresponds to the choice by an exporting firm i to *not enter* destination r at time t, although it might do so in the future. The sample consists of all firms that export for at least 2 years.

For computational reasons, we must place a limit on the number of destinations.[16] We define nine regions (r) grouping different countries: Mercosur, Chile-Bolivia (Argentina's neighbors that are not full Mercosur members), Other South America, Central America-Mexico, North America, Spain-Italy (Argentina's main historical migration sources), EU-27 except Spain-Italy, China, and Rest of the World. Each of these geographic areas is relatively homogenous and account for a sizeable share of Argentine exports (see Table 10 in Appendix C).[17] The region that is responsible for the smallest share is Spain-Italy, receiving 2% of Argentina's exports in 2007. However, it attracts 5% of all Argentine exporters, and 8% of all new exporters. Table 11 in Appendix C shows, for each of our nine regions, their 2003 and 2007 shares of Argentine exporters, in general and among new exporters. If the latter is larger than the former, it suggests the region is attractive as a "testing ground." The table shows that this is the case for Spain-Italy, Mercosur, North America, Chile-Bolivia and, recently, China. Notice that our grouping of countries in regions implies that when a firm enters a new country in a region r where it already exports, this is not coded as entry.[18]

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

$$\Pr[Entry_{irt} = 1] = \beta_1 FY_{i,t-1} + \{FE\} + v_{irt},$$

where $FY_{i,t-1}$ indicates whether the firm's export experience started at $t-1$ (i.e., whether t is firm

[15] Notice also that, once we include firms' lagged exports in the regression, the coefficient of $FY_{ij,t-1}$ turns to negative, indicating that an old exporter in a new market does not grow faster than an old exporter already in that market. Without the control the opposite appears to be true, but it reflects instead the facts that firms start small in new markets and that small exporters grow faster than large exporters.

[16] Notice that for this regression the observational unit is firm-year-destination without prior entry, and the average of this last dimension by exporting firm in our sample is 127 ($= 130 - 3$).

[17] We experienced with alternative groupings of destinations; they yield qualitatively similar results.

[18] Considering entry/non-entry within the region does not make an important difference to the results.

i's second year as an exporter). We include a wide range of fixed effects here as well. Prediction 2 indicates that $\beta_1 > 0$: fledgling exporters should be more likely to enter new destinations than experienced exporters.

Results are presented in columns 1-4 of Table 4. $FY_{i,t-1}$ has a positive and highly significant coefficient in all four specifications. The magnitudes may look small at first, but recall that they reflect entry in a given region in a given year, so the entry we consider is a rather specific event. We find that the probability of entering an "average" destination in an "average" year is around one percentage point higher if the firm is a new exporter. This compares with an overall average probability of 7% of entering a new foreign region.

Table 4: Probability of Exporting to a New Market

Dependent Variable:	$Entry_{irt}$	$Entry_{irt}$	$Entry_{irt}$	$Entry_{irt}$	$Entry_{irt}$	$D(ND)_{it}$	$D(ND)_{it}$
LPM	1	2	3	4	5	6	7
$FY_{i,t-1}$	.008**	.015**	.009**	.009**	.006**	.033**	.048**
	(.001)	(.002)	(.002)	(.002)	(.002)	(.002)	(.010)
$\Delta logX_{i,-r,t}$					.006**		.052**
					(.001)		(.003)
$\Delta logX_{i,-r,t} \times FY_{i,t-1}$					-.005**		-.043**
					(.002)		(.008)
Tests:							
$FY_{i,t-1} + (\Delta logX_{i,-r,t} \times FY_{i,t-1}) \times .10 = 0$					5.25		
					[.002]		
$FY_{i,t-1} + (\Delta logX_{i,-r,t} \times FY_{i,t-1}) \times .08 = 0$							19.80
							[.0001]
Firm FE		yes	yes	yes	yes	yes	yes
Destination FE			yes				
Year FE			yes			yes	yes
Year-Destination FE				yes	yes		
Number of obs	235693	235693	235693	235693	220335	32135	29760
R-squared	.0002	.08	.09	.09	.10	.32	.32

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

Robust standard errors adjusted for clusters in firms. P-values in square brackets.

While we control for time-invariant unobserved heterogeneity by using firm fixed effects, those regressions do not rule out the possibility that positive idiosyncratic productivity shocks are the factors actually leading firms to expand in their early years as exporters. But since such shocks would induce expansion at both intensive and extensive margins, we can control for them by introducing intensive margin export growth (in the current destinations) by itself and interacted with our indicator for new exporters, $FY_{i,t-1}$:

$$\Pr[Entry_{irt} = 1] = \beta_1 FY_{i,t-1} + \beta_2 \Delta logX_{i,-r,t} + \beta_3 \left[\Delta logX_{i,-r,t} \times FY_{i,t-1}\right] + \{FE\} + \eta_{irt}.$$

The results are displayed in column 5 of Table 4. The coefficient of $FY_{i,t-1}$ remains positive and significant. But we want to check whether being a new exporter matters also among the firms expanding at the intensive margin. The relevant comparison is between new and old exporters growing at the same rate g. A fledgling exporter growing at rate g is more likely to enter a new destination than an experienced exporter growing at same rate if $\beta_1 + \beta_3 g > 0$. At the point estimates, this condition is equivalent to $g < 1.2$. Close to 97% of the observations satisfy this condition. At the sample median, $g = .10$, this sum is positive and highly statistically significant, as the F-test shows.

In columns 6 and 7, we run a different regression, where we simply look at whether a surviving exporter increased its number of foreign destinations (in which case $D(ND)_{it} = 1$). This regression has the disadvantage of treating all destinations equally, so for example both entry in a very large market and entry in a very small market imply $D(ND)_{it} = 1$. On the other hand, it makes possible to consider entry in each of the 130 markets in the sample. We find that new exporters are 3.3 percentage points more likely to expand the number of markets they serve than experienced ones. This is slightly more than a seventh of the overall (unconstrained) probability that a surviving exporter will expand the number of destinations it serves, 22%. When we include intensive-margin growth in the regression (column 7), the point estimates indicate that a new exporter growing at rate g is more likely to add a new destination than an experienced exporter growing at the same rate if $g < 1.12$. At the sample median of $g = .08$, the F-test shows that this condition is clearly satisfied.

3.2.3 Exit

We turn now to the exit patterns of Argentina's exporting firms. Our model predicts that the probability that firm i will exit a particular export market j in period t ($Exit_{ijt} = 1$) is higher if the firm exported for the first time in $t-1$ (Prediction 3). To test this, we estimate the following equation:

$$\Pr[Exit_{ijt} = 1] = \gamma_1(FY_{ij,t-1} \times FM_{ij}) + \gamma_2 FM_{ij} + \gamma_3 FY_{ij,t-1} + \{FE\} + \zeta_{ijt}.$$

The sample consists of all exporting firms. Again, we introduce fixed effects to account for country and year specific factors that affect exit. Firm fixed effects, on the other hand, are *not* appropriate for the exit regressions, since Prediction 3 is about the behavior of single-year exporters. As most single-year exporters represent only one observation in our data set, 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 prior but not at $t-2$, and exited after exporting again at $t-1$) or simultaneous single-year exporters (those that broke simultaneously into more than one market in $t-1$ and exited in t). Since simultaneous exporters are relatively more confident about their export success at time of entry (recall that simultaneous entry requires $E\mu$ to be greater than τ^B and large relative to F), they are less likely to exit right after entry than pure sequential exporters. A related rationale applies for re-entrants.[19]

[19] In the next subsection we study more closely both simultaneous exporters and re-entrants.

Thus, we expect γ_1 to be positive in all specifications that do not include firm fixed effects. In that case, we include sector fixed effects to control, to the extent that is possible, for unobserved heterogeneity. When firm fixed effects are included, our model is silent about the sign of γ_1.

Table 5 shows the results. Observe first that, in all estimations without firm fixed effects (columns 1-4 and 7), the coefficients associated with $FY_{ij,t-1}$ and FM_{ij} are positive and significant, indicating that in general exit from a market is more likely in a firm's first market and in its early periods of operation in a market. More importantly, the coefficient of the interaction $FY_{ij,t-1} \times FM_{ij}$ is also positive and significant in those regressions, confirming that exit rates from a market are highest for fledgling exporters. Magnitudes are also economically significant. Being a fledgling exporter increases the probability of exiting a market by almost 29 percentage points relative to an exporter with experience in a market other than its first, by 15 percentage points relative to an experienced exporter operating in its first foreign market, and by over 26 percentage points relative to an experienced exporter that has just entered an additional market. These figures compare with an overall average probability of 7% of exiting a market in a certain year.

Table 5: Probability of Exit after Exporting to a New Market (Dependent Variable: $Exit_{ijt}$)

LPM	1	2	3	4	5	6	7
$FY_{ij,t-1} \times FM_{ij}$	.122**	.121**	.123**	.125**	-.199**	-.197**	.133**
	(.004)	(.006)	(.006)	(.006)	(.003)	(.003)	(.006)
FM_{ij}	.154**	.149**	.139**	.138**	-.015**	-.017**	.129**
	(.003)	(.004)	(.004)	(.004)	(.003)	(.003)	(.004)
$FY_{ij,t-1}$	.017**	.015**	.026**	.025**	-.011**	-.013**	.009**
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
$\log X_{ij,t-1}$							-.009**
							(.0003)
Firm FE					yes	yes	
Sector FE		yes	yes	yes			yes
Destination FE			yes				
Year FE			yes				
Year-Destination FE				yes		yes	yes
Number of obs	119610	119610	119610	119610	119610	119610	119610
R-squared	.13	.14	.15	.15	.69	.70	.16

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

Robust standard errors adjusted for clusters in firms.

Now, once firm fixed effects are introduced (columns 5 and 6), the sign of the interaction (and of $FY_{ij,t-1}$) shifts to negative. This shows that the exit patterns of firms that re-start to export or start exporting in more than one market simultaneously are indeed very different from those of the firms that start with a single market. Specifically, new simultaneous exporters and re-entrants are, jointly, less likely to exit than continuing exporters.

Finally, in column 7 we control for firms' lagged export levels (in addition to sector and year-destination fixed effects), since low sales in a year may suggest a low expectation of survival. This is indeed what we find. There is however little change in the coefficient of $FY_{ij,t-1} \times FM_{ij}$.

3.3 Robustness

The key predictions from our model are strongly supported by the Argentine data, but they may be driven by alternative explanations that are correlated with ours. We have discussed the possibility that our regressions may be simply picking up behavior driven by idiosyncratic firm productivity shocks. Our controls in the intensive margin and entry regressions suggest that this is not the case. In particular, there is no reason for a productivity shock to cause additional growth in the first export market on the first year. Moreover, the productivity shocks rationale is at odds with our results on exit. As pointed out by Ruhl and Willis (2009), if productivity shocks alone drove the behavior of exporting firms, the hazard rate out of exporting would have to increase with export tenure as shocks die out over time. Our results on exit indicate that the opposite is true,[20] further confirming that there is more to the dynamics of new exporters than productivity shocks.[21] Similarly, a "learning-by-exporting" process by which an exporter's productivity improves with exposure to foreign competition would be consistent with high early intensive-margin growth, provided that most learning takes place in the initial period of foreign activities. A learning-by-exporting process is, however, difficult to reconcile with our findings about high early exit. Furthermore, the evidence on learning from exporting indicates that, if it exists, it is likely to be specific to the destination market.[22] Thus, such a mechanism would also be unable to rationalize our findings that fledgling exporters are more likely to enter new markets than experienced exporters.

There are however other mechanisms that could be advanced and may be consistent with our main results. Thus, we now run further tests to better distinguish our mechanism from others. We start by looking at firms that re-enter foreign markets and of simultaneous exporters, which our model suggests should behave differently from new sequential exporters.

3.3.1 Re-entrants

First, we focus on *re-entrant* exporters. These are the firms that did not export at $t-1$ but did so before $t-1$ and export again at t. Of the 15,301 exporting firms in our sample, we can identify 17% as re-entrants. Observations associated with the activities of these re-entrants correspond to 6%, 3% and 2% of the observations in the samples used in the intensive margin, entry and exit regressions, respectively. Since we cannot spot all re-entrants (i.e. some firms that we identify as "true" new exporters may have exported before 2002, the fist year of our sample), in the main regressions we treat all firms that export at t but not at $t-1$ as new exporters. However, according

[20] In line with the findings of previous studies focusing on the hazard rates out of exporting, such as Besedes and Prusa (2006).

[21] Binding capacity constraints may as well be consistent with early intensive- and extensive-margin growth, but not with early exit. If a firm faced binding capacity constraints as it entered foreign markets, but capacity could be expanded disproportionately within a year, intensive-margin growth and the probability of expansion to other markets would be disproportionately high in the second year. However, exit would be unaffected as the survival cutoff does not depend on (sunk) capacity-building costs. The idea of capacity constraints forcing firms to enter foreign markets "small" also conflicts with studies that show that firms often undertake significant investment *before* entering foreign markets, as a preparation for exporting (e.g. Iacovone and Javorcik 2009).

[22] See the survey by Wagner (2007).

to our model (barring problems with "short memory"), if firm i had exported prior to $t-1$, when re-starting to export in period t the firm should already have a reliable (in the strictest version of the model, a perfect) signal of its export profitability, so the change in the value of its shipment to a market between t and $t+1$ should not be as large as it would be for a first-time exporter. By the same token, re-entrants in t should be less likely to exit and to expand to new destinations at $t+1$ than first-time exporters. Thus, if our model is right, the inclusion of re-entrants as new exporters should only weaken our results.

But we can also test explicitly for differential effects between "regular" new exporters and re-entrants, which no alternative theories that we are aware of would predict. To do so, we re-run our three main regressions (intensive margin, entry and exit) with our key variables by themselves and interacted with an indicator of whether the firm is a re-entrant (RE_i), plus the indicator by itself. We add year-destination fixed effects in all regressions, sector fixed effects in the exit regression, and firm fixed effects in the intensive margin and entry regressions. We run the intensive margin and exit regressions with and without lagged export levels.

Table 6 displays the results. They lend broad support to our theory. Notice first that our main coefficients in each regression remain positive and statistically significant, and in fact are generally higher than the estimates that do not distinguish re-entrants. Moreover, their interactions with RE_i yield estimates that are either statistically indistinguishable from zero or, as in most cases, negative and significant.

More specifically, consider the firms that are in their first market ($FM_{ij} = 1$). We can ask whether the extra effect from being in their first year of activity there (in the current spell) is different for re-entrants. The differential effect is given by the sum of the coefficients on $FY \times FM \times RE$ and $FY \times RE$. As the F-tests show, this sum is negative and statistically significant for both exit specifications and for the intensive margin specification that does not include lagged exports (when lagged exports are included, the sum is statistically indistinguishable from zero). These results indicate that, for firms in their first market, the extra effect from being a new exporter on intensive-margin growth and on the likelihood of exit is lower if the firm is a re-entrant. The F-tests on the sum of the coefficients on $(FY \times FM \times RE) + (FY \times FM) + (FY + RE) + FY$ indicate that the overall extra effect from being a new exporter for re-entrants in their first market is still positive for intensive-margin growth; however, it is actually negative for the probability of exit.

Similarly, consider the firms that are starting to export to a market ($FY_{ij,t-1} = 1$). We can test whether the extra effect due to being in their first market is different for re-entrants. The results indicate that the impact of the first market on intensive-margin growth and on the probability of exit is generally weaker for re-entrants. Indeed, the results are very similar to the results on the impact of the first year discussed above, as shown by the F-tests on the sum of the coefficients on $(FY \times FM \times RE) + (FM \times RE)$ and on $(FY \times FM \times RE) + (FM \times RE) + FM + (FM \times RE)$.

Finally, we can ask whether the pattern of entry in different regions is the same for first-time exporters and for those re-entering export activities. The results indicate that the latter are indeed

Table 6: Differential Effects: Re-entrant Exporters (RE)

	$\Delta \log X_{ijt}$	$\Delta \log X_{ijt}$	$Entry_{irt}$	$Exit_{ijt}$	$Exit_{ijt}$
$FY_{ij,t-1} \times FM_{ij}$	.161**	.294**		.158**	.164**
	(.040)	(.033)		(.006)	(.006)
FM_{ij}	-.049	-.047		.093**	.086**
	(.039)	(.037)		(.004)	(.004)
$FY_{ij,t-1}$	.257**	-.119**		.012**	-.002
	(.018)	(.016)		(.001)	(.001)
$FY_{ij,t-1} \times FM_{ij} \times RE_{it}$	-.178*	.079		-.364**	-.363**
	(.081)	(.064)		(.014)	(.014)
$FM_{ij} \times RE_{it}$	-.089	-.109		-.049**	-.047**
	(.131)	(.112)		(.013)	(.013)
$FY_{ij,t-1} \times RE_{it}$	-.098**	-.072**		.087**	.089**
	(.032)	(.028)		(.014)	(.014)
RE_{it}	.546*	.331†		.320**	.314**
	(.241)	(.204)		(.014)	(.014)
$\log X_{ij,t-1}$		-.428**			-.008**
		(.007)			(.0003)
$FY_{i,t-1}$			.009**		
			(.002)		
$FY_{i,t-1} \times RE_{it}$			-.005		
			(.011)		
RE_{it}			.023		
			(.020)		
Tests:					
$(FY_{ij,t-1} \times FM_{ij} \times RE_{it}) + (FY_{ij,t-1} \times RE_{it}) = 0$	3.91	0.01		352.08	345.88
	[.048]	[.917]		[.0001]	[.0001]
$(FY_{ij,t-1} \times FM_{ij} \times RE_{it}) + (FM_{ij} \times RE_{it}) = 0$	11.69	0.07			
	[.001]	[.793]			
$(FY_{ij,t-1} \times FM_{ij}) + (FY_{ij,t-1} \times FM_{ij} \times RE_{it}) +$ $FY_{ij,t-1} + (FY_{ij,t-1} \times RE_{it}) = 0$	3.88	4.49		60.01	64.53
	[.049]	[.034]		[.0001]	[.0001]
$(FY_{ij,t-1} \times FM_{ij}) + (FY_{ij,t-1} \times FM_{ij} \times RE_{it}) +$ $FM_{ij} + (FM_{ij} \times RE_{it}) = 0$	1.63	10.65		157.24	153.77
	[.202]	[.001]		[.0001]	[.0001]
$FY_{i,t-1} + (FY_{i,t-1} \times RE_{it}) + RE_{it}$			2.65		
			[.103]		
Firm FE	yes	yes	yes		
Sector FE				yes	yes
Year-Destination FE	yes	yes	yes	yes	yes
Number of obs	107390	107390	235693	119610	119610
R-squared	.10	.30	.09	.23	.24

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

Robust standard errors adjusted for clusters in firms. P-values in square brackets.

less likely to expand to new regions. In fact, the sum of the coefficients on $FY + (FY \times RE) + RE$ indicates that the entry pattern of those returning to foreign markets is hardly different from the pattern of continuing exporters.

Overall, then, we find that re-entrants are less likely to grow in their first market and to exit right after re-entering their first market than ordinary entrants. Moreover, they are less likely to expand to different regions after re-starting foreign sales than first-time exporters.[23] One interpretation is that re-entrants are firms that respond to customers' orders but do not establish permanent export presence in foreign markets, perhaps because of the type of product they produce or industry they operate in, perhaps because their uncovered μ is not large enough to justify paying the sunk costs necessary to have a permanent foreign presence. What is most important for us, however, is that the behavior of the re-entrants is not nearly as affected by their initial experience abroad after re-entry as the 'regular' new exporters are.

3.3.2 Simultaneous exporters

Second, we investigate whether the behavior of *simultaneous exporters*—i.e., the firms that start exporting to more than one destination (which we code as $SIM_i = 1$)—is distinct from the behavior of the pure sequential exporters. Our model indicates that simultaneous exporters are willing to pay the sunk costs to enter multiple markets because they are optimistic about their export profitability (i.e. because $E\mu$ is high relative to τ^B and large relative to F). This implies different behavior relative to the firms that break in a single foreign destination, suggesting less volatility in all dimensions for these firms. To test for such differences, we re-run our three main regressions adding interactions between our key variables and the indicator SIM_i.[24] As before, we add year-destination fixed effects in all regressions, sector fixed effects in the exit regression, and firm fixed effects in the intensive margin and entry regressions. We also run the intensive margin and exit regressions with and without lagged export levels.

Table 7 shows the results. In all specifications, our main coefficients remain positive and statistically significant, and are generally higher than in the baseline regressions. Furthermore, their interactions with SIM_i generate estimates that are either statistically indistinguishable from zero or, as in most cases, negative and significant.

Considering in particular the firms that are in their first market ($FM_{ij} = 1$), we can ask whether the extra effect from being in their first year of activity there is different for the simultaneous entrants. The differential effect is given by the sum of the coefficients on $FY \times FM \times SIM$ and $FY \times SIM$. As the F-tests show, this sum is indistinguishable from zero in the intensive margin regressions. However, it is clearly negative in the exit regressions, indicating that simultaneous exporters are indeed less likely to exit one of their first markets than pure sequential exporters. We can similarly test, for firms starting to export to a market ($FY_{ij,t-1} = 1$), whether the extra effect

[23] If we re-run the regressions in Table 6 restricting the sample to 2005 onwards (so we minimize the possibility of coding a re-entrant as a new exporter while still allowing for firm fixed effects), results remain qualitatively unaltered.

[24] Notice that, whenever we use firm fixed effects, the variable SIM_i is dropped from the regression.

Table 7: Differential Effects: Simultaneous Exporters (SIM)

	$\Delta \log X_{ijt}$	$\Delta \log X_{ijt}$	$Entry_{irt}$	$Exit_{ijt}$	$Exit_{ijt}$
$FY_{ij,t-1} \times FM_{ij}$	.105*	.305**		.243**	.250**
	(.046)	(.036)		(.007)	(.007)
FM_{ij}	.009	-.060		.140**	.132**
	(.051)	(.048)		(.005)	(.005)
$FY_{ij,t-1}$	.235**	-.145**		.023**	.007**
	(.016)	(.015)		(.001)	(.001)
$FY_{ij,t-1} \times FM_{ij} \times SIM_i$	.004	-.159*		-.063**	-.050*
	(.095)	(.077)		(.015)	(.023)
$FM_{ij} \times SIM_i$	-.043	.114		-.291**	-.301**
	(.083)	(.075)		(.020)	(.027)
$FY_{ij,t-1} \times SIM_i$	-.023	.188**		-.196**	-.205*
	(.073)	(.059)		(.017)	(.024)
SIM_i				.285**	.292**
				(.024)	(.029)
$\log X_{ij,t-1}$		-.428**			-.009**
		(.007)			(.0003)
$FY_{i,t-1}$			.011**		
			(.002)		
$FY_{i,t-1} \times SIM_i$			-.007†		
			(.004)		
Tests:					
$(FY_{ij,t-1} \times FM_{ij} \times SIM_i) + (FY_{ij,t-1} \times SIM_i) = 0$	0.09	0.32			
	[.768]	[.570]			
$(FY_{ij,t-1} \times FM_{ij} \times SIM_i) + (FM_{ij} \times SIM_i) = 0$	0.21	0.35			
	[.650]	[.555]			
$(FY_{ij,t-1} \times FM_{ij}) + (FY_{ij,t-1} \times FM_{ij} \times SIM_i) +$ $FY_{ij,t-1} + (FY_{ij,t-1} \times SIM_i) = 0$	43.57	23.48		2.98	3.42
	[.0001]	[.0001]		[.084]	[0.06]
$(FY_{ij,t-1} \times FM_{ij}) + (FY_{ij,t-1} \times FM_{ij} \times SIM_i) +$ $FM_{ij} + (FM_{ij} \times SIM_i) = 0$	1.28	12.36		0.25	0.01
	[.259]	[.0004]		[.620]	[.903]
$FY_{i,t-1} + (FY_{i,t-1} \times SIM_i) + SIM_i$			0.62		
			[.430]		
Firm FE	yes	yes	yes		
Sector FE				yes	yes
Year-Destination FE	yes	yes	yes	yes	yes
Number of obs	107390	107390	235693	119610	119610
R-squared	.10	.30	.09	.18	.19

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

Robust standard errors adjusted for clusters in firms. P-values in square brackets.

due to being in their first market is different for simultaneous exporters. Again, with respect to intensive-margin growth, we cannot distinguish the extra effect from being in one's first market for simultaneous versus pure sequential exporters. On the other hand, there is a very clear differential effect for the probability of exit. In fact, new simultaneous exporters are as likely to exit one of their first markets as old exporters are to exit their subsequent markets upon entry there, as the F-tests on the sum of the coefficients on $(FY \times FM \times SIM) + (FM \times SIM) + FM + (FM \times SIM)$ indicate.

Finally, the entry regression shows that new simultaneous exporters are less likely to expand to new regions than new (pure) sequential exporters. Indeed, the F-test on $FY + (FY \times SIM)$ shows that they are no more likely to expand to new regions than old exporters.

We therefore conclude that, upon entry, simultaneous exporters do behave similarly to pure sequential exporters in terms of their intensive-margin growth, conditional on survival. On the other hand, new simultaneous exporters are much less likely to exit and to expand to other destinations than other new exporters (in fact behaving very similarly to old exporters in those dimensions), in line with the predictions of our model.

3.3.3 Other robustness checks

Third, our findings on entry are consistent with *within-industry learning*, as in Hausmann and Rodrik (2003), Alvarez et al. (2007), Krautheim (2008) and Segura-Cayuela and Vilarrubia (2008). That is, firms may use the entry of domestic rivals in foreign markets as a signal of their own odds of success as exporters.[25] To consider this possibility, we estimate the following expanded specification (with firm and year-destination fixed effects) of our entry regression:

$$\Pr[Entry_{ijt} = 1] = \beta_1 FY_{i,t-1} + \beta_2 NArgExp_{kr,t-1} + \beta_3 \Delta logX(ArgExp_{krt}) + \xi_{ijt},$$

where $NArgExp_{kr,t-1}$ is the number of Argentine exporters (measured in thousands) in industry k selling to region r at $t-1$ and $\Delta logX(ArgExp_{krt})$ is the export growth to r of these same competitors between t and $t-1$. These variables control, respectively, for static and dynamic characteristics of export profitability that a firm may infer from observing its rivals.

The first two columns of Table 8 display the results controlling for within-industry learning. Consistently with within-industry learning effects, the number and the growth rates of domestic competitors in a given destination help to explain entry there. Nevertheless, a new exporter remains significantly more likely to enter a new destination than an experienced exporter. Thus, our finding of the role of experimentation in fostering entry in new destinations is not a mere artifact of domestic rivals' informational externality.

Some of our results may also be driven by the presence of *credit constraints*. For example, if firms face liquidity constraints at entry, then the inability of either financing sunk entry costs

[25] The idea of learning from the experience of others in foreign markets extends also to the product extensive margin (Iacovone and Javorcik 2010), as well as to decisions beyond exporting, such as foreign direct investments (Lin and Saggi 1999).

Table 8: Controlling for Within-Industry Learning and Credit Constraints

	$Entry_{irt}$	$Entry_{irt}$	$\Delta \log X_{ijt}$	$Entry_{irt}$	$Exit_{ijt}$
Controlling for Within-Industry Learning					
$FY_{i,t-1}$	.009**	.009**			
	(.002)	(.002)			
$NArgExp_{kr,t-1}$	.092**	.095**			
	(.009)	(.009)			
$\Delta logXArgExp_{krt}$		.004**			
		(.001)			
Excluding Credit-Constrained Sectors					
$FY_{ij,t-1} \times FM_{ij}$			.165**		.123**
			(.057)		(.008)
FM_{ij}			-.034		.133**
			(.06)		(.006)
$FY_{ij,t-1}$			.242**		.021**
			(.025)		(.002)
$FY_{i,t-1}$				.009**	
				(.004)	
Firm FE	yes	yes	yes	yes	
Sector FE					yes
Year-Destination FE	yes	yes	yes	yes	yes
Number of obs	235693	227769	43258	87892	71349
R-squared	.09	.10	.10	.09	.15

**: significant at 1%; *: significant at 5%
Robust standard errors adjusted for clusters in firms.

internally or of obtaining the necessary external credit could force some firms to enter foreign markets sequentially when they would prefer to enter them simultaneously. Similarly, as more experienced exporters become less constrained due to retained earnings, credit constraints may also help to explain the high intensive-margin growth of surviving new exporters. Employing a panel of bilateral exports at the industry level, Manova (2008) finds that credit constraints are indeed important determinants of export participation and of export volumes. Muuls (2009) finds that credit constraints make Belgian exporters less likely to expand to other foreign destinations. Since credit constraints may be correlated with being a new exporter, we need to check whether they may be driving our results.

To account for the role of credit constraints in shaping exporting behavior, we would ideally use credit constraint information at the firm level. Since that information is unavailable to us, 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. 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 hold for the subsample of credit unconstrained firms (we include firm fixed effects in the intensive margin and entry regressions, sector fixed effects in the exit regressions, and year-destination fixed effects in all of them). The last three columns of Table 8 show the results. They are very similar to our previous results, indicating that the effects from experimentation that we uncover are not driven by firms being in sectors that are more likely to be liquidity constrained.

We have also carried out additional robustness checks, which are unreported to save space but are available upon request. These are as follows. (i) We exclude exports of "samples," defined as yearly transactions of less than \$1000, to see whether our results are driven by very small exporters.[26] (ii) We consider the possibility of "slow learning," where FY is defined over two years, to allow for a longer period of uncertainty resolution about one's type. (iii) We employ different adjustments of robust standard errors, like clustering in destinations. None of the results from those alternative specifications change our main messages in an important way.

4 Trade Liberalization and Policy Implications

Our empirical analysis strongly suggests that correlation of firms' export profitabilities over time and across destinations is an important ingredient of firms' export decisions. Does that matter? Should we care? We argue that we should. In addition to providing a new insight to help us understand better how firms behave in foreign markets, the mechanism we propose renders the impact of trade liberalization on trade flows subtler, more complex, and potentially much larger than standard trade theories suggest. This opens new perspectives for trade policy, in particular the coordination of trade policies across countries, as in regional and multilateral trade agreements. To show this, we examine trade liberalization in a simple extension of the basic model that includes many firms/sectors.

Consider a continuum of total mass one of firms with heterogeneous sunk costs of exporting, F. Let F follow a continuous c.d.f. $H(F)$ on the support $[0, \infty)$. As before, for each firm ex ante profitability follows $G(\mu)$. Let $h(\cdot)$ and $g(\cdot)$ denote the p.d.f.s of $H(\cdot)$ and $G(\cdot)$, respectively. We assume that F and μ are independently distributed. Assuming independence is analytically very convenient. It also clarifies that the third-country effects of trade liberalization identified below do not depend on assuming (perhaps more realistically) that more profitable firms (or sectors) have higher fixed entry costs. The independence assumption implies an equivalence between having a single firm (as in the basic model) and a continuum of monopolists.

The number of potential firms in Home is exogenous and normalized to one. The total number of exporters to market $j = A, B$ in period $t = 1, 2$, M_t^j, follows from Proposition 1:

- $M_1^A = H\left[F^{Sq}(\tau^A, \tau^B)\right]$ firms export to market A at $t = 1$;
- $M_1^B = H\left[F^{Sm}(\tau^B)\right]$ of firms export to market B at $t = 1$;
- $M_2^A = H\left[F^{Sq}(\tau^A, \tau^B)\right]\left[1 - G(\tau^A)\right]$ of firms export to market A at $t = 2$, all of which already exported to A at $t = 1$;
- $M_2^B = H\left[F^{Sm}(\tau^B)\right]\left[1 - G(\tau^B)\right] + \int_{F^{Sm}}^{F^{Sq}}\left[1 - G(2F^{\frac{1}{2}} + \tau^B)\right] dH(F)$ firms export to market B at $t = 2$. The first term corresponds to existing exporters, the second to new entrants;

[26] We also try \$2000 and \$3000 as alternative thresholds.

- $1 - H\left[F^{Sq}(\tau^A, \tau^B)\right]$ firms do not export.

Quantities sold in markets $j = A, B$ at $t = 1$ follow $\widehat{q}_1^j$, as defined in expressions (6) and (7). Quantities sold at $t = 2$ by new and old firms follow the expressions developed in subsection 2.2.1. From an ex-ante perspective, the expected value of these quantities are given in Prediction 1.

Let us then start to look at the effects of a $t = 1$ permanent decrease in trade cost τ^j on export levels. Consider first the intensive margin. Clearly, a fall in τ^A increases sales of current exporters to A at $t = 1$ without affecting sales to B, while a fall in τ^B has symmetric immediate effects. At $t = 2$, export levels rise for surviving exporters. This is counterbalanced by a negative composition effect: the new entrants benefiting from lower trade costs operate at a lower-than-average scale. The overall intensive margin effect is therefore generally ambiguous.[27]

The most interesting and novel features of the model regard however the extensive margin effects of trade liberalization. As a first step, we determine how variable trade costs affect the entry thresholds $F^{Sm}(\tau^B)$ and $F^{Sq}(\tau^A, \tau^B)$.

Lemma 1 *Variable trade costs in markets A and B affect the sunk cost thresholds as follows:*

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

Proof. Condition (16) for $e_1^B = 1$ defines F^{Sm} implicitly when it holds with equality: $F^{Sm} = \mathbf{1}_{\{E\mu>\tau^B\}}\left[\Psi(\tau^B) - W(\tau^B; F^{Sm})\right]$. It is straightforward to see that $\frac{dF^{Sm}}{d\tau^A} = 0$. From Proposition 1, we know that $F^{Sm} = 0$ if $E\mu \leq \tau^B$, so in that case $\frac{dF^{Sm}}{d\tau^B} = 0$ too. If instead $E\mu > \tau^B$, then $F^{Sm} > 0$ and we can find $dF^{Sm}/d\tau^B$ by applying the implicit function theorem:

$$\begin{aligned}\frac{dF^{Sm}}{d\tau^B} &= \mathbf{1}_{\{E\mu>\tau^B\}}\left[\frac{\partial\Psi(\tau^B)/\partial\tau^B - \partial W(\tau^B; F^{Sm})/\partial\tau^B}{1 + \partial W(\tau^B; F^{Sm})/\partial F}\right] \\ &= -\mathbf{1}_{\{E\mu>\tau^B\}}\left[\frac{\left(\frac{E\mu-\tau^B}{2}\right) + \int_{\tau^B}^{2\left[F^{Sm}\right]^{1/2}+\tau^B}\left(\frac{\mu-\tau^B}{2}\right)dG(\mu)}{G(2\left[F^{Sm}\right]^{1/2} + \tau^B)}\right] \leq 0.\end{aligned}$$

[27] Lawless (2009b) shows that both effects exactly offset each other in a heterogeneous firms' model *a la* Melitz (2003) whenever export sales follow a Pareto distribution. However, she finds ambiguous intensive margin effects of trade cost reductions in empirical work on U.S. firms' exports.

Condition (15) for $e_1^A = 1$ defines F^{Sq} implicitly when it holds with equality: $F^{Sq} = \Psi(\tau^A) + W(\tau^B; F^{Sq})$. Applying the implicit function theorem to this identity, we obtain

$$\frac{dF^{Sq}}{d\tau^A} = \frac{\partial\Psi(\tau^A)/\partial\tau^A}{1 - \partial W(\tau^B; F^{Sq})/\partial F} = -\frac{\left[\mathbf{1}_{\{E\mu > \tau^A\}}\left(\frac{E\mu - \tau^A}{2}\right) + \int_{\tau^A}^{\overline{\mu}}\left(\frac{\mu - \tau^A}{2}\right) dG(\mu)\right]}{2 - G\left(2\left[F^{Sq}\right]^{1/2} + \tau^B\right)} < 0, \text{ and}$$

$$\frac{dF^{Sq}}{d\tau^B} = \frac{\partial W(\tau^B; F)/\partial\tau^B}{1 - \partial W(\tau^B; F^{Sq})/\partial F} = -\frac{\left[\int_{2[F^{Sq}]^{1/2}+\tau^B}^{\overline{\mu}}\left(\frac{\mu - \tau^B}{2}\right) dG(\mu)\right]}{2 - G\left(2\left[F^{Sq}\right]^{1/2} + \tau^B\right)} < 0,$$

completing the proof. ∎

We can now establish the extensive margin effects of trade liberalization in countries A and B in both the short and the long runs.[28]

Proposition 3 *Trade liberalization in a country has qualitatively different effects on entry in the short and long runs, and encourages entry in other countries. Specifically:*

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

1. *increases the number of Home exporters to A at $t = 1$ and at $t = 2$;*
2. *has no effect on Home exports to B at $t = 1$, but increases the number of Home exporters to B at $t = 2$.*

b) A decrease in τ^B at $t = 1$, holding τ^A fixed and such that τ^B remains larger than τ^A:

1. *increases the number of Home exporters to A at $t = 1$ and $t = 2$;*
2. *increases the number of Home exporters to B at $t = 1$ and $t = 2$.*

Proof. The proof follows from the definition of M_t^j, Lemma 1, and the facts that $H(\cdot)$ is a non-decreasing function and that both $1 - G(\tau_B + 2F^{\frac{1}{2}})$ and $1 - G(\tau_B)$ are decreasing in τ_B. Differentiating the M_t^j's with respect to both variable trade costs, we obtain:

- $\frac{dM_1^A}{d\tau^j} = h(F^{Sq})\frac{dF^{Sq}}{d\tau^j} < 0$, $j = A, B$;
- $\frac{dM_1^B}{d\tau^A} = h(F^{Sm})\frac{dF^{Sm}}{d\tau^A} = 0$;
- $\frac{dM_2^A}{d\tau^A} = h(F^{Sq})\frac{dF^{Sq}}{d\tau^A}\left[1 - G(\tau^A)\right] - H(F^{Sq})g(\tau^A) < 0$;
- $\frac{dM_2^B}{d\tau^A} = h(F^{Sq})\frac{dF^{Sq}}{d\tau^A}\left[1 - G(2\left[F^{Sq}\right]^{1/2} + \tau^B)\right] < 0$;

[28] In an online addendum available online (http://www.economics.soton.ac.uk/staff/calvo/documents/Technical_Addendum_1.pdf), we show that reductions in trade costs have qualitatively similar effects on aggregate trade flows in both the short and long runs, despite the ambiguous intensive margin effect in the long run.

- $\frac{dM_1^B}{d\tau^B} = h(F^{Sq})\frac{dF^{Sm}}{d\tau^B} < 0;$
- $\frac{dM_2^A}{d\tau^B} = h(F^{Sq})\frac{dF^{Sq}}{d\tau^B}\left[1 - G(\tau^A)\right] < 0.$

To find $\frac{dM_2^B}{d\tau^B}$, notice that

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

which is negative since each of its terms are negative. ■

Proposition 3 has three startling elements. First, it shows that trade liberalization has immediate as well as delayed effects on trade flows. This distinction is especially important given economists' typical focus on the static gains from trade; our analysis indicates that we should not disregard lagged responses of trade flows to trade barriers. Second, the Proposition shows that trade liberalization in a country affects entry into other countries. Third, it shows that this induced entry in other markets is always present in the long run, but not necessarily in the short run.

To understand the effects of trade liberalization more fully, consider first the short run. A lower τ^A makes early entry in market A more appealing, as expected, but so does a lower τ^B, because it increases the profits from potentially entering market B at $t = 2$. By contrast, while τ^B directly affects the decision to enter market B at $t = 1$, τ^A plays no direct role in that decision. The reason is that the choice between entering markets sequentially or simultaneously is unaffected by τ^A. Conversely, in the long run there is no asymmetry and cross-market effects are always present. As variable trade costs fall, firms' potential future gains from learning their export profitabilities increase. As a result, more firms choose to engage in exporting. Among those new exporters, a fraction will find it profitable to enter other destinations in the future.

Hence, Proposition 3 implies that trade liberalization in a country creates *trade externalities* to other countries. From the perspective of Argentine firms, for example, this means that events such as the opening of the Chinese market since the late 1990s may have induced some firms to start exporting to Argentina's *neighbors*: even though trade policy in those countries have hardly changed in the last ten years, the better prospect of serving the Chinese market increases the attractiveness of experimenting as exporters, and nearby markets could serve that role. Similarly, the formation of Mercosur in 1991 may have been responsible for the subsequent entry of some

Argentine firms in North American or European markets, as they realized their export potential by serving the Mercosur partners.

Taking into account the implications of our mechanism, the Mercosur example also highlights the fact that the consequences of trade agreements could be very different from what existing studies suggest. Specifically, an RTA will tend to spawn an *extensive margin trade creation effect*—and one that involves *third countries*. That is, even from a purely partial equilibrium perspective, regional integration can create trade with non-partner countries for reasons that are entirely different from those emphasized in the existing literature, and involving not greater imports, but enhanced *exports* to non-members. Naturally, empirical research focused on this effect is necessary to gather its practical relevance.[29]

5 Conclusion

Firms typically start exporting small volumes to a single country. Despite the high entry sunk costs these firms often have to incur, many drop out of the export business very shortly. By contrast, the successful ones grow at both the intensive and the extensive margins. Most existing trade models, including 'new new trade theory' ones based on selection due to heterogeneity in productivity and export sunk costs, are not well equipped to address these dynamic patterns. In this paper, we argue that firms' uncertainty about their success in foreign markets is central to understanding their export patterns, provided that this uncertainty is correlated over time and across markets.

We develop the minimal model to address the implications of this mechanism. A firm discovers its profitability as an exporter only after exporting takes place. After learning it, the firm can condition the decision to serve other destinations on this information. Since breaking into new markets entails significant and unrecoverable costs, the correlation of export profitability across markets gives the firm an incentive to enter foreign destinations sequentially. For example, neighboring markets could serve as natural "testing grounds" for future expansions to larger or distant markets. We derive specific predictions from our model and test them using Argentine firm-level data. We cannot reject any of the predictions. We are equally unable to come up with alternative mechanisms that would lead to a similar set of predictions. This leads us to conclude that uncertainty correlated over time and across markets is a central determinant of firms' export strategies.

This mechanism has potentially broad implications. First, it implies a *trade externality*: exports to a country could increase because *other* countries have liberalized trade, thereby making

[29] Our data set does not permit such an evaluation because Argentina has not formed any RTA after Mercosur. However, the single empirical study of how an RTA affects members' exports to non-members that we are aware of, by Borchert (2009), suggests that RTAs might indeed be very conducive of sequential exporting. Borchert finds that the growth of Mexican exports *to Latin America* from 1993—right before NAFTA entered into force—to 1997 is higher, the greater the reduction in the preferential U.S. tariff under NAFTA for that product. Moreover, and critically, this effect comes entirely from changes in the *extensive* margin. While most existing trade models would find it difficult to explain this finding, it corresponds to a direct implication of our model. In the same spirit, the literature on the euro's trade effect finds a positive effect of the euro on the eurozone's external trade, and in particular a one-sided effect on eurozone exports, not imports (see for example Micco et al. 2003 and Flam and Nordström 2007). Our theory offers one possible rationalization of this external and one-sided effect of the euro.

experimentation in foreign markets more profitable. Thus, our findings indicate that 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 studies seeking to evaluate the effectiveness of the GATT/WTO system in promoting trade (e.g. Rose 2004). Similar implications apply to the 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 choose to break into extra-regional markets as well. This lagged trade-creation effect toward non-members corresponds to an implication of regional trade agreements that the literature has so far entirely neglected.

Our model is not designed for welfare analysis, and therefore we are not in a position to discuss optimal trade policy. However, it seems clear that the trade externality we uncover can provide a strong reason for broader coordination of trade policies across countries. That is, the sequentiality of firms' export strategies due to their profitabilities as exporters being uncertain, but correlated across markets, could provide the basis for a new rationale for multilateral trade institutions such as the WTO. Such a rationale would be independent of terms of trade effects (Bagwell and Staiger 1999), strategic uncertainty (Calvo-Pardo 2009), commitment motives (Maggi and Rodriguez-Clare 2007), production relocation externalities (Ossa 2009), and profit-shifting motives (Mrazova 2009)—the existing explanations for multilateral trade cooperation.

The resulting trade externality need not, however, warrant export promotion policies. One may be led to think that, because entry in one foreign market can lead to future entry in other destinations, governments may play a positive role in this process by enacting policies that induce domestic firms to start exporting. This need not be the case, and could actually be misleading, because individual firms take all the benefits related to their future export performance into account when deciding whether to become an exporter. Naturally, if the government had access to a better technology to acquire and disseminate information than those available to the private sector, then there would be a role for export promotion policies. Similarly, if there were market inefficiencies—e.g. credit constraints that prevent willing domestic firms from entering foreign markets—then their interaction with our proposed mechanism could provide a role for public intervention. But since such market inefficiencies alone may justify active trade policies at the national level even in the absence of sequential exporting, it is not clear that the mechanism we develop here generates new reasons for national export promotion policies. A thorough assessment of such issues would nevertheless require a fully specified general equilibrium model. This is beyond the scope of this paper, but future research building on our analysis could deliver important insights for the design of national trade policy.

Sequential exporting strategies could also help to rationalize some empirical findings from the trade literature, such as the apparent excess sensitivity of trade flows to changes in trade barriers (Yi 2003), and the greater sensitivity of trade flows to trade costs at the extensive relative to the intensive margin (Bernard et al. 2007, Mayer and Ottaviano 2007). However, for a thorough evaluation of the implications of sequential exporting for these issues, a more general theoretical structure would be necessary.

A distinct but equally promising avenue for future research is in exploring the mechanism we lay out in this paper at a disaggregated level, seeking to identify the types of products, or the sectors, as well as the characteristics of foreign markets, for which correlation of export profitabilities is likely to be stronger. Here our purpose is to identify only whether there is such a mechanism or not, and to do so we take the simplistic view that the correlation of export profitabilities across destinations is the same for all sectors and for all pairs of countries. This is, undeniably, a very crude approximation. In reality, we should observe instead a matrix of correlations across countries for each sector. Exploring the structure of those matrices is well beyond the scope of this paper, but it could prove very useful, making it possible to fine tune the analysis of firms' export strategies and the analysis of the impact of trade policies.[30] 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

$$\begin{aligned} E_0(\mu) &= \overline{\mu} - \int_{\underline{\mu}}^{\tau} G(\mu)d\mu - \int_{\tau}^{\overline{\mu}} G(\mu)d\mu, \\ E_0(\mu|\,\mu &> \tau) = \overline{\mu} - \int_{\tau}^{\overline{\mu}} G(\mu|\,\mu > \tau)d\mu. \end{aligned}$$

Thus,

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

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

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

[30] Elliott and Tian (2009) provide a first step in this direction. Using our data set and empirical methodology, they evaluate the patterns of sequential exporting of Argentine firms in Asia. They find that China serves as the main stepping stone for entry in the ten members of the ASEAN free trade bloc. Japan also plays such a role, but the effect is smaller. Entry in Europe and in the U.S., on the other hand, does not seem to help subsequent entry in ASEAN.

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

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

under the condition that demand and supply shocks are independently distributed. Similarly, we can express the exporter's unrestricted expected optimal sales as

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

Now, by Lemma 2 we have that

$$E_0(d|\,d > \tau + c) \geq E_0(d),$$

since the left-hand side is an expectation truncated at the left of the distribution (given that assumption $\underline{\mu} < \tau$ implies $\underline{d} < \tau + \bar{c}$). Proceeding analogously, we also have that

$$E_0(c|\,c < d - \tau) \leq E_0(c).$$

Therefore,

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

completing the proof. ■

Appendix B: Imperfect correlation in export profitability

We show here that our results generalize to the case of positive but imperfect statistical dependence between random variables μ^A and μ^B. In particular, we emphasize that the third-country result of Proposition 3 (parts a.2 and b.1) holds in the general case.[31]

We assume identical distributions $G(\mu^A)$ and $G(\mu^B)$, although this is not essential. Upper-bar variables denote the counterparts to the variables in the main text under perfect correlation. For brevity, we denote $E\left[\mu^B\middle|\,\mu^A = u^A\right]$ by $E\left(\mu^B\middle|\,\mu^A\right)$, where u^A denotes a particular realization of the random variable μ^A.

Output choice Output decisions in A at all times and in B at $t = 1$ are made in the same way as in the main text. Output choice in B at $t = 2$ takes into account the realization of μ^A. From the convexity of the max function and Jensen's inequality,

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

where $dG(\mu^B) = \int_{\underline{\mu}^A}^{\overline{\mu}^A} dG(\mu^B|\,\mu^A)dG(\mu^A)$. 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 $\overline{q}_2^B(\tau^B) = \frac{E\left(\mu^B|\mu^A\right)-\tau^B}{2}$.

Value of the sequential exporting strategy The conditional expectation of random variable μ^B can be expressed as

$$E\left[\mu^B\middle|\,\mu^A\right] = E\mu^B + (u^A - E\mu^A)\underbrace{\int_{\underline{\mu}}^{\overline{\mu}}\left[-\frac{d}{du}G\left(w|\,\mu^A = u^A\right)\right]\Bigg|_{u=u_0} dw}_{\equiv\varpi}, \tag{22}$$

where ϖ captures the statistical dependence between μ^A and μ^B.[32]

At $t = 2$ the firm enters market B if

$$\left(\frac{E\left[\mu^B\middle|\,\mu^A = u^A\right] - \tau^B}{2}\right)^2 \geq F \Leftrightarrow E\left(\mu^B\middle|\,\mu^A\right) \geq 2F^{1/2} + \tau^B. \tag{23}$$

Define $\overline{F}_2^B(u^A;\tau^B)$ as the F that solves (23) with equality. The firm enters market B at $t = 2$ if

[31] Some auxiliary results and the complete proofs for all results in this Appendix are available at http://www.economics.soton.ac.uk/staff/calvo/documents/Technical_Addendum_1.pdf.

[32] The proof of this claim rests on a stochastic order based on the notion of *regression dependence* introduced by Lehman (1966), and is available upon request. A particular case is when μ^A and μ^B follow a bivariate normal distribution with parameters $(E\mu^A, E\mu^B, \sigma_A, \sigma_B, \rho)$. In that case, $\varpi = \rho\frac{\sigma_B}{\sigma_A}$ and $E\left[\mu^B\middle|\,\mu^A\right] = E\mu^B + \rho\frac{\sigma_B}{\sigma_A}\left(u^A - E\mu^A\right)$.

$F \leq \overline{F}_2^B(u^A; \tau^B)$. Plugging (22) in (23) yields

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

which is strictly decreasing in τ^B. Comparing $\overline{F}_2^B(u^A; \tau^B)$ with its analog under perfect correlation $F_2^B(\tau^B)$, defined on page 8, we have that $E\mu^A = E\mu^B$ implies $\lim_{\varpi \to 1} \overline{F}_2^B(u^A; \tau^B) = F_2^B(\tau^B)$.

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

$$\overline{W}(\tau^B; F) \equiv \int_{\mu^{*A}(\varpi)}^{\overline{\mu}} \left[\left(\frac{E\left(\mu^B \middle| \mu^A\right) - \tau^B}{2} \right)^2 - F \right] dG(\mu^A), \tag{24}$$

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 above which a sequential exporter enters in B at $t = 2$.

For expositional clarity, notice that if μ^A and μ^B follow a bivariate normal distribution with parameters $(E\mu, E\mu, \sigma, \sigma, \rho)$, the cutoff varies with $\varpi = \rho$ as follows:

$$\frac{d\mu^{*A}(\rho)}{d\rho} = \frac{E\mu^B - (2F^{1/2} + \tau^B)}{\rho^2}.$$

Thus, when $E\mu^B > 2F^{1/2} + \tau^B$ the cutoff rises as ρ increases, implying a lower value from experimentation. This simply reflects the fact that, if $E\mu^B > 2F^{1/2} + \tau^B$, it is optimal to enter market B already at $t = 1$. Conversely, when $E\mu^B < 2F^{1/2} + \tau^B$ the cutoff falls as ρ rises, implying a higher value from experimentation. This indicates that experimentation becomes more worthwhile as the statistical dependence between μ^A and μ^B increases. Experimentation is most valuable in the case of perfect correlation assumed in the main text, when it is worth $W(\tau^B; F)$. Experimentation is least valuable when μ^A and μ^B are independent, when it has no value.[33]

Choice of export strategy (extension of Proposition 1) As in the main text, $\overline{F}^{Sq}$ is the fixed cost that makes a firm indifferent between exporting sequentially and not exporting, whereas $\overline{F}^{Sm}$ makes a firm indifferent between simultaneous and sequential exporting strategies:

$$\overline{F}^{Sq} : \Psi(\tau^A) + \overline{W}(\tau^B; \overline{F}^{Sq}) = \overline{F}^{Sq}, \tag{25}$$

$$\overline{F}^{Sm} : \Psi(\tau^B) - \overline{W}(\tau^B; \overline{F}^{Sm}) = \overline{F}^{Sm}. \tag{26}$$

[33] Under independence between μ^A and μ^B, entry in A conveys no information about profitability in B. Thus, if it is not worthwhile to enter market B at $t = 2$, it is not worthwhile entering at $t = 1$ either. Conversely, if it pays to enter market B at $t = 2$, it must pay to enter also at $t = 1$, to avoid forgoing profits in the first period. Thus, under independence waiting to enter B at $t = 2$ is never optimal.

Since $\Psi(\tau^j)$ is monotonically decreasing in τ^j and $\tau^A \leq \tau^B$, and since $\overline{W}(\tau^B; F)$ 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 $\overline{W}(\tau^B; F)$, we find

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

where the term in brackets is zero by construction of $\mu^{*A}(\varpi)$. Using this result and totally differentiating (25) and (26), we have that

$$\frac{d\overline{F}^{Sm}}{d\tau^A} = 0;$$

$$\frac{d\overline{F}^{Sm}}{d\tau^B} = -\mathbf{1}_{\{E\mu > \tau^B\}} \left\{ \frac{\left[\left(\frac{E\mu - \tau^B}{2}\right) + \int_{\tau^B}^{\overline{\mu}} \left(\frac{\mu - \tau^B}{2}\right) dG(\mu) - \int_{\mu^{*A}(\varpi)}^{\overline{\mu}} \left(\frac{E\left(\mu^B | \mu^A\right) - \tau^B}{2} \right) dG(\mu^A) \right]}{G(\mu^{*A}(\varpi))} \right\} \leq 0;$$

$$\frac{d\overline{F}^{Sq}}{d\tau^A} = -\frac{\left[\mathbf{1}_{\{E\mu > \tau^A\}} \left(\frac{E\mu - \tau^A}{2}\right) + \int_{\tau^A}^{\overline{\mu}} \left(\frac{\mu - \tau^A}{2}\right) dG(\mu) \right]}{2 - G(\mu^{*A}(\varpi))} < 0;$$

$$\frac{d\overline{F}^{Sq}}{d\tau^B} = -\frac{\int_{\mu^{*A}(\varpi)}^{\overline{\mu}} \left[\left(\frac{E\left(\mu^B | \mu^A\right) - \tau^B}{2} \right) \right] dG(\mu^A)}{2 - G(\mu^{*A}(\varpi))} < 0.$$

The sign of all derivatives are as in Lemma 1.[34] The rest of the proof of parts a.2 and b.1. of Proposition 3 proceeds analogously. The probability of sequential entry is equivalent except for the new entry cutoff $\mu^{*A}(\varpi)$. Exports vary at the intensive margin as in the main text. Where intensive margin effects are ambiguous, they are also dominated by extensive margin ones, driven by the above effects of variable trade costs on fixed cost entry thresholds. Thus, trade liberalization has positive third-country effects also in the general case of positive statistical dependence between export profitability in A and B.

[34] The sign of $\frac{d\overline{F}^{Sm}}{d\tau^B}$ when $E\mu > \tau^B$ depends on the sign of the numerator. The numerator is negative under perfect correlation ($\varpi = 1$), as shown in the main text. It is also negative under independence ($\varpi = 0$). To see that, notice that $\int_{\mu^{*A}(\varpi)}^{\overline{\mu}} \left[\left(\frac{E\left(\mu^B | \mu^A\right) - \tau^B}{2} \right) \right] dG(\mu^A) \Big|_{\varpi=0} = \mathbf{1}_{\{E\mu > 2F^{1/2} + \tau^B\}} \left(\frac{E\mu - \tau^B}{2} \right)$. Thus, the expression in square brackets is minimized when $E\mu > 2F^{1/2} + \tau^B$, but even in that case it remains positive. Invoking a stochastic monotonicity argument in ϖ, by which $\left| \frac{\partial W(\tau^B;F)}{\partial \tau^B} \right| \geq \left| \frac{\partial \overline{W}(\tau^B;F)}{\partial \tau^B} \right|, \forall \varpi \geq 0$, the numerator keeps its negative sign for any other degree of non-negative statistical dependence. Therefore, $\frac{d\overline{F}^{Sm}}{d\tau^B} \leq 0$.

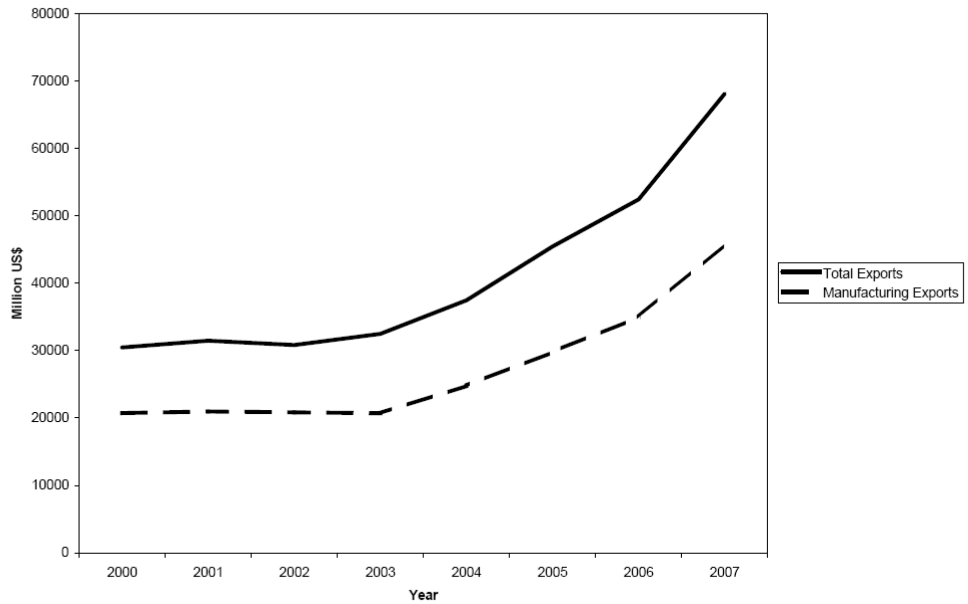

Figure 4: Growth of Argentina's Total and Manufacturing Exports, 2000-2007

Appendix C: Descriptive Statistics

There is substantial export growth over our sample period. Figure 4 plots Argentine total and manufacturing exports since 2000. A dramatic exchange rate devaluation in early 2002 led to a sharp increase in Argentine aggregate exports (223% from 2002 to 2007). Manufacturing exports, which account for about 68% of total exports, followed a similar growth trend (220%).

As Table 9 reveals, export growth was similar in most industries. The only relevant change in the export structure was an increase in Petroleum's relative share (from 23% in 2002 to 30% in 2007) at the expense of the Automotive and Transport industry's (17% to 13%).

On the other hand, the distribution of export destinations has changed more significantly during the sample period. Table 10 shows a growing importance of Mercosur after 2003, accounting for 35% of Argentine exports in 2007, while the participation of Chile and Bolivia has dropped by almost half in the period, to 10% in 2007. Starting from a low level, the importance of China has also increased significantly, having more than doubled its share of Argentine exports during our sample period, to 7%. Meanwhile the United States, non-Mercosur Latin American markets and the European Union have become relatively less important as destinations for Argentine exports.

Finally, Table 11 displays the share of Argentine exporters that each region accounts for (columns DS) and the share of new Argentine exporters that each region receives (columns FMS). The ratio FMS/DS is a proxy for the relative importance of the region as a "testing ground" for Argentine exporters. Between 2003 and 2007, the most significant change in this ratio happened for China, which plays a small but increasing role as first destination.

Table 9: Argentinean Manufacturing Exports by Industry

Industry	**Exports*** 2002	**Exports*** 2007	**Growth** (%)	**Share** 2002	**Share** 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 10: Argentinean Manufacturing Exports by Region (%)

Region	2002	2003	2004	2005	2006	2007
Mercosur	32	25	27	28	32	35
Chile-Bolivia	17	18	16	15	13	10
Rest of the World	16	15	17	17	20	20
North America	15	19	17	18	13	13
EU-27 except Spain-Italy	6	6	5	5	5	5
Central America-Mexico	6	6	7	6	7	6
China	3	6	6	5	5	7
Other South America	3	3	3	3	3	3
Spain-Italy	3	3	3	3	2	2

Table 11: Argentinean Manufacturing First Markets by Region (%)

Region	2003			2007		
	FMS	DS	FMS/DS	FMS	DS	FMS/DS
Mercosur	29	24	123	36	25	144
Chile-Bolivia	20	16	126	17	14	120
North America	12	9	139	9	7	132
Spain-Italy	11	7	171	8	5	145
Rest of the World	8	17	46	12	20	61
Central America-Mexico	7	11	67	4	10	43
Other South America	7	9	72	7	10	69
EU-27 except Spain-Italy	5	7	74	6	8	71
China	0	1	50	2	1	152

FMS: share of region j as first export destination by number of firms.
DS: share of region j as export destination by number of firms.

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Technical Addendum 1: Appendix B (complete)

February 26, 2010

Abstract

This appendix is a complete version of the abridged appendix B in the main text. It provides all the technical proofs for the results as well as some details omitted there.

Here we show that our results generalize to the case of positive but imperfect statistical dependence between random variables μ^A and μ^B. In particular, we emphasize that the third-country result of Proposition 3 (parts a.2 and b.1) holds in the general case.

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 brevity, we denote $E\left[\mu^B \middle| \mu^A = u^A\right]$ by $E\left(\mu^B \middle| \mu^A\right)$, where u^A denotes a particular realization of the random variable μ^A.

Output choice: Output decisions in A at all times and in B at $t = 1$ are taken in the same way as in the main text. Output choice in B at $t = 2$ takes into account the realization of μ^A. From the convexity of the max function and Jensen's inequality,

$$\int_{\underline{\mu}^A}^{\overline{\mu}^A} \left[\max_{q^B \geq 0} \int_{\underline{\mu}^B}^{\overline{\mu}^B} (\mu^B - \tau^B - q^B) q^B dG(\mu^B \middle| \mu^A) \right] dG(\mu^A) \geq \max_{q^B \geq 0} \int_{\underline{\mu}^B}^{\overline{\mu}^B} (\mu^B - \tau^B - q^B) q^B dG(\mu^B),$$

where $dG(\mu^B) = \int_{\underline{\mu}^A}^{\overline{\mu}^A} dG(\mu^B \middle| \mu^A) dG(\mu^A)$. 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 $\overline{q}_2^B(\tau^B) = \mathbf{1}_{\{E[\mu^B|\mu^A] > \tau^B\}} \left[\frac{E\left(\mu^B|\mu^A\right) - \tau^B}{2} \right]$.

Value of the sequential exporting strategy: The conditional expectation of random variable μ^B can be expressed as

$$E\left[\mu^B \middle| \mu^A\right] = E\mu^B + (u^A - E\mu^A)\underbrace{\int_{\underline{\mu}}^{\overline{\mu}} \left[-\frac{d}{du}G\left(w \middle| \mu^A = u\right)\right]\Bigg|_{u=u_0} dw}_{\equiv\varpi}, \quad (1)$$

where ϖ captures the statistical dependence between μ^A and μ^B.[1]

At $t = 2$ a firm enters market B if

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

Define $\overline{F}_2^B(u^A;\tau^B)$ as the F that solves (2) with equality. The firm enters market B at $t = 2$ if $F \leq \overline{F}_2^B(u^A;\tau^B)$. Plugging (1) in (2) yields

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

which is strictly decreasing in τ^B. Comparing $\overline{F}_2^B(u^A;\tau^B)$ with its analog under perfect correlation $F_2^B(\tau^B)$, defined on page 8, we have that $E\mu^A = E\mu^B$ implies $\lim_{\varpi\to 1}\overline{F}_2^B(u^A;\tau^B) = F_2^B(\tau^B)$.

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

$$\begin{aligned}
\overline{W}(\tau^B;F) &\equiv E_{\mu^A}\left[\max\left\{\max_{q^B\geq 0}\left[(E\left[\mu^B \middle| \mu^A\right] - \tau^B - q^B)q^B\right] - F, 0\right\}\right] \\
&= E_{\mu^A}\left\{\mathbf{1}_{\{\mu^A > \mu^{*A}(\varpi)\}}\left[\mathbf{1}_{\{E[\mu^B|\mu^A] > \tau^B\}}\left(\frac{E\left[\mu^B \middle| \mu^A\right] - \tau^B}{2}\right)^2 - F\right]\right\} \\
&= \int_{\mu^{*A}(\varpi)}^{\overline{\mu}}\left[\left(\frac{E\left(\mu^B \middle| \mu^A\right) - \tau^B}{2}\right)^2 - F\right] dG(\mu^A), \quad (3)
\end{aligned}$$

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 above which a sequential exporter enters in B at $t = 2$.

[1] The proof of (1) can be found at the end of this appendix.

For expositional clarity, notice that if μ^A and μ^B follow a bivariate normal distribution with parameters $(E\mu, E\mu, \sigma, \sigma, \rho)$, the cutoff varies with $\varpi = \rho$ as follows:

$$\frac{d\mu^{*A}(\rho)}{d\rho} = \frac{E\mu^B - (2F^{1/2} + \tau^B)}{\rho^2}.$$

Thus, when $E\mu^B > (2F^{1/2} + \tau^B)$ the cutoff rises as ρ increases, implying a lower value from experimentation. This simply reflects the fact that, if $E\mu^B > (2F^{1/2} + \tau^B)$, it is optimal to enter market B already at $t = 1$. Conversely, when $E\mu^B < (2F^{1/2} + \tau^B)$ the cutoff falls as ρ rises, implying a higher value from experimentation. This indicates that experimentation becomes more worthwhile as the statistical dependence between μ^A and μ^B increases. Experimentation is most valuable in the case of perfect correlation assumed in the main text, when it is worth $W(\tau^B; F)$. Experimentation is least valuable when μ^A and μ^B are independent, when it has no value.[2]

Choice of export strategy (extension of Proposition 1): As in the main text, $\overline{F}^{Sq}$ is the fixed cost that makes a firm indifferent between exporting sequentially and not exporting, whereas $\overline{F}^{Sm}$ makes a firm indifferent between simultaneous and sequential exporting strategies:

$$\overline{F}^{Sq} : \Psi(\tau^A) + \overline{W}(\tau^B; \overline{F}^{Sq}) = \overline{F}^{Sq}, \tag{4}$$

$$\overline{F}^{Sm} : \Psi(\tau^B) - \overline{W}(\tau^B; \overline{F}^{Sm}) = \overline{F}^{Sm}. \tag{5}$$

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

[2] Under independence between μ^A and μ^B, entry in A conveys no information about profitability in B. Thus, if it is not worthwhile to enter market B at $t = 2$, it is not worthwhile entering at $t = 1$ either. Conversely, if it pays to enter market B at $t = 2$, it must pay to enter also at $t = 1$, to avoid forgoing profits in the first period. Thus, under independence waiting to enter B at $t = 2$ is never optimal. For a formal proof of this statement, see F.N. 4 below.

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

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

where the second term is zero –by construction of $\mu^{*A}(\varpi)$. Using this result and totally differentiating (4) and (5), we have that

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

The sign of all derivatives is non-positive, as in Lemma 1.[3] Therefore, the rest of the proof of parts a.2 and b.1. of Proposition 3 is straightforward, and proceeds analogously. The probability of sequential entry is qualitatively similar (considering the new entry cutoff $\mu^{*A}(\varpi)$). Exports vary at the intensive margin just as in the main text. Thus, trade liberalization has positive third-country effects also in the general case of positive statistical dependence between export profitability in A and B.

Comparing the general case with the polar cases: Here we show that when profitabilities are non-negatively regression dependent, the option value of learning one's export profitability in market B by entering in market

[3] The sign of $\frac{d\overline{F}^{Sm}}{d\tau^B}$ when $E\mu > \tau^B$ depends on the sign of the numerator, which is negative whenever $\varpi = 1$ (perfect correlation), as shown in the main text. Property (3) at the end of this appendix proves that $\left|\frac{\partial W(\tau^B;F)}{\partial\tau^B}\right| \geq \left|\frac{\partial\overline{W}(\tau^B;F)}{\partial\tau^B}\right|, \forall\varpi \geq 0$. Consequently, the numerator will even more so remain negative for any other degree of non-negative statistical dependence. Therefore $\frac{d\overline{F}^{Sm}}{d\tau^B} < 0$.

A first, $\overline{W}(\tau^B; F)$, is bounded by the option values in the two polar cases of i.i.d. distributions (below) and perfect positive correlation (above).

We start with the lower bound. With i.i.d. marginal distributions of μ^A and μ^B we have $E\left(\mu^B \middle| \mu^A\right) = E\mu^B = E\mu$ and therefore $\varpi = 0$. Accordingly, the entry condition (2) becomes $E\mu \geq 2F^{1/2} + \tau^B$ so that

$$\lim_{\varpi \to 0} \overline{W}(\tau^B; F) = \mathbf{1}_{\{E\mu > 2F^{1/2} + \tau^B\}} \left[\mathbf{1}_{\{E\mu > \tau^B\}} \left(\frac{E\mu - \tau^B}{2} \right)^2 - F \right].$$

But then entering market B sequentially is dominated by a simultaneous entry strategy at $t = 1$: $\lim_{\varpi \to 0} \overline{W}(\tau^B; F) < \Psi(\tau^B) - F$. The reason is that by entering at $t = 2$ the firm only sacrifices positive expected profits, $V(\tau^B)$, because under independence, export experience in A is useless in B..Hence $\lim_{\varpi \to 0} \overline{W}(\tau^B; F) = 0$, and the firm will never adopt a sequential entry strategy. Figure 1 illustrates this case.[4]

Consider now the upper bound. Under perfect positive correlation between μ^A and μ^B, the term that captures the degree of statistical dependence

[4] Analytically, we only need to examine whether there are values of F such that $\Pi^{Sm} \leq \overline{\Pi}^{Sq}$ when $\varpi = 0$:

$$\Psi(\tau^A) + \Psi(\tau^B) - 2F \leq \Psi(\tau^A) + \lim_{\varpi \to 0} \overline{W}(\tau^B; F) - F$$

Cancelling terms and substituting the expression for $\lim_{\varpi \to 0} \overline{W}(\tau^B; F)$,

$$\Psi(\tau^B) - F \leq \mathbf{1}_{\{E\mu > 2F^{1/2} + \tau^B\}} \left[\mathbf{1}_{\{E\mu > \tau^B\}} \left(\frac{E\mu - \tau^B}{2} \right)^2 - F \right]$$

According to the first indicator function, we must distinguish two cases: (i) if $E\mu > 2F^{1/2} + \tau^B$, the inequality reduces to $V(\tau^B) \leq 0$, which is false. Hence, there is no value of F that satisfies it. (ii) If $E\mu \leq 2F^{1/2} + \tau^B$, the inequality reduces to $\Psi(\tau^B) - F \leq 0$, meaning that the only values of F that satisfy the inequality are those for which early entry in B is not worth ($e_1^B = 0$). Since late entry in B is worth only when $\Psi(\tau^B) - V(\tau^B) \geq F$, $V(\tau^B) > 0$ and the above inequality imply that:

$$F \geq \Psi(\tau^B) > \Psi(\tau^B) - V(\tau^B) \geq F,$$

a contradiction. Therefore, there is no value of F either that satisfies the inequality. Consequently, the sequential entry strategy is never adopted.

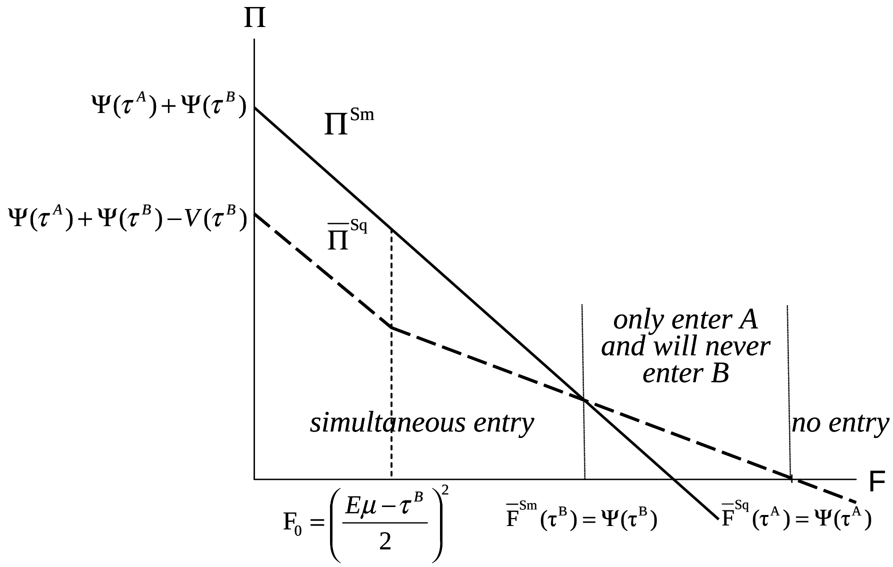

Figure 1: With independent export profitabilities ($\varpi = 0$), a firm will never enter sequentially.

ϖ in expression (1) becomes [5]:

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

Plugging this condition into expression (3), and since $E\mu^B = E\mu^A = E\mu$,

[5]Under perfect positive correlation between μ^A and μ^B,

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

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 $\delta(w-s) = \begin{cases} +\infty & \text{if } w = s \\ 0 & \text{otherwise} \end{cases}$ such that $\int_{\underline{\mu}}^{\overline{\mu}} \delta(w-s)dw = 1$, $\forall s \left[\underline{\mu}, \overline{\mu}\right]$. Since $\frac{d}{du}T(w-u) = -\delta(w-u)$ we have:

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

$E\left(\mu^B \middle| \mu^A\right) = \mu^A$, we obtain that as $\varpi \to 1$:

$$\lim_{\varpi \to 1} \overline{W}(\tau^B; F) = W(\tau^B; F)$$

Finally, notice that:

$$\begin{aligned}
W(\tau^B; F) &= E_{\mu^B}\left[\max\left\{\max_{q^B \geq 0}(\mu^B - \tau^B - q^B)q^B - F, 0\right\}\right] \\
&= E_{\mu^A}\left[E_{\mu^B|\mu^A}\left(\max\left\{\max_{q^B \geq 0}(\mu^B - \tau^B - q^B)q^B - F, 0\right\}\middle| \mu^A\right)\right] \\
&\geq E_{\mu^A}\left[\max\left\{\max_{q^B \geq 0} E_{\mu^B|\mu^A}\left[(\mu^B - \tau^B - q^B)q^B \middle| \mu^A\right] - F, 0\right\}\right] \\
&= E_{\mu^A}\left[\max\left\{\max_{q^B \geq 0}\left[(E\left[\mu^B \middle| \mu^A\right] - \tau^B - q^B)q^B\right] - F, 0\right\}\right] \\
&= \overline{W}(\tau^B; F), \forall \varpi \geq 0
\end{aligned}$$

where the inequality obtains from applying twice Jensen's inequality and the convexity of the max $\{.\}$ operator, while the third equality above follows from the law of iterated expectations, i.e. $E_{\mu^B}\left[f(\mu^B)\right] = E_{\mu^A}\left[E_{\mu^B|\mu^A}\left(f(\mu^B) \middle| \mu^A\right)\right]$. Therefore:

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

As in the main text, those bounds on the option values correspond to sunk entry cost thresholds above which the exporter prefers to enter sequentially (F^{Sm}), as illustrated in Figure 2. [6]Hence, the region defined by Proposition 1 where it is optimal to adopt a sequential entry strategy

[6]Notice that in figure (in accordance with notation in the main text) $\Pi^{Sq} \equiv \left.\overline{\Pi}^{Sq}\right|_{\varpi=1}$ whereas, $\underline{\Pi}^{Sq} \equiv \left.\overline{\Pi}^{Sq}\right|_{\varpi=0}$. Also notice from the figure that $\Pi^{Sq}(F) > \overline{\Pi}^{Sq}(F), \forall F \leq \left.\overline{F}^{Sq}\right|_{\varpi=1}$. The only non-trivial point is to prove that $\Pi^{Sq}(0) = V(\tau^B) \geq \overline{\Pi}^{Sq}(0) = \Psi(\tau^B) - V(\tau^B)$ which follows from the application of Jensen's inequality and the convexity of the max $\{.\}$ operator:

$$\begin{aligned}
V(\tau^B) &= E\left[\max_{q \geq 0}(\widetilde{\mu} - \tau^B - q)q\right] = E\left[\mathbf{1}_{\{\mu > \tau^B\}}\left(\frac{\mu - \tau^B}{2}\right)^2\right] \\
&\geq \max_{q \geq 0} E\left[(\widetilde{\mu} - \tau^B - q)q\right] = \mathbf{1}_{\{E\mu > \tau^B\}}\left(\frac{E\mu - \tau^B}{2}\right)^2 \equiv \Psi(\tau^B) - V(\tau^B)
\end{aligned}$$

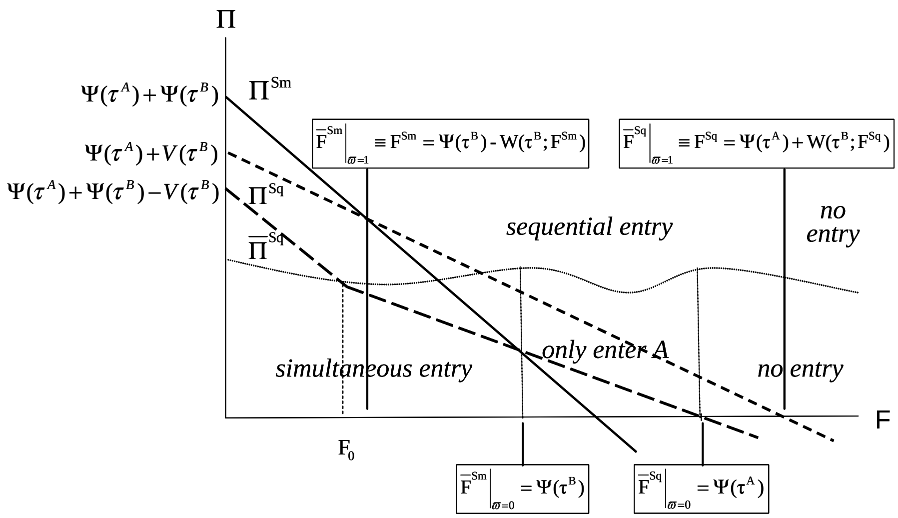

Figure 2: Bounds on sunk entry thresholds, F^{Sm} and F^{Sq}, as a function of the statistical dependence (ϖ) between export profitabilites.

shrinks as the statistical dependence of export profitabilities across the two destinations is reduced from perfect to no correlation:

$$\begin{aligned}
F^{Sq} - F^{Sm} &\equiv \Psi(\tau^A) + W(\tau^B; F^{Sq}) - \left[\Psi(\tau^B) - W(\tau^B; F^{Sm})\right] \\
&= \Psi(\tau^A) - \Psi(\tau^B) + W(\tau^B; F^{Sq}) + W(\tau^B; F^{Sm}) \\
&\geq \Psi(\tau^A) - \Psi(\tau^B) + \overline{W}(\tau^B; \overline{F}^{Sq}) + \overline{W}(\tau^B; \overline{F}^{Sm}) \\
&\equiv \left. \overline{F}^{Sq} - \overline{F}^{Sm} \right|_{1>\varpi>0} \\
&\geq \Psi(\tau^A) - \Psi(\tau^B) \\
&\equiv \left. \overline{F}^{Sq} - \overline{F}^{Sm} \right|_{\varpi=0}
\end{aligned}$$

Derivation of (1)**:** Here we show how the conditional expectation can be expressed as a function of the unconditional expectation, as in (1). Integrating by parts both expectations and taking the difference we obtain:

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

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

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

Now assuming that $G\left(w \middle| .\right) \in C^1\left[\underline{\mu}, \overline{\mu}\right]$, by the mean-value theorem,

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

we obtain:

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

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

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

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

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

Our assumption of statistical dependence between μ^A and μ^B implies regression dependence. Thus we can sign the integrand in the last equality above. Finally by rearranging the last equality, we obtain (1): if μ^B and μ^A are positively associated, $\left[\frac{d}{du}G\left(w|\,\mu^A=u\right)\right]\Big|_{u=u_0}\leq 0$ and $\left(-\left[\frac{d}{du}G\left(w|\,\mu^A=u\right)\right]\Big|_{u=u_0}\right)\geq 0, \forall w$ so that $\int_{\underline{\mu}}^{\overline{\mu}}\left(-\left[\frac{d}{du}G\left(w|\,\mu^A=u\right)\right]\Big|_{u=u_0}\right)dw\geq 0$. Now if export profitability in A was better than expected ($u^A\geq E\left[\mu^A\right]$), expected export profitability to B increases ($E\left[\mu^B\big|\,\mu^A=u^A\right]\geq E\left[\mu^B\right]$).

Example: normal distribution. Consider a joint normal distribution of μ^A and μ^B. It is enough to compute[7]:

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

where

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

is the conditional distribution of μ^B, such that $\left(\mu^B\big|\,\mu^A=u\right)\sim N(E\mu^B+\rho\frac{\sigma_B}{\sigma_A}(u-E\mu^A),\sigma_B^2(1-\rho^2))$. We note that[8]: (i) $dG\left(s|\,\mu^A=u\right)$ is a continuous function of $(s,u)\in\mathbb{R}^2$, (ii) $\frac{d}{du}[dG\left(s|\,\mu^A=u\right)]$ exists and is continuous, and (iii) $\int_{-\infty}^{w}dG\left(s|\,\mu^A=u\right)ds$ is continuous. Therefore we can differentiate inside the integral:

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

[7] Although expression (1) 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 $|\mu|^{\psi-1}\left[1-G(\mu)+G(-\mu)\right]$ is integrable over $(-\infty,+\infty)$, (see Lemma 2 in Feller (1966, p.149).

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

which substituted above yields:

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

This yields the well-known relationship:

$$E\left[\mu^B\middle|\,\mu^A\right]=E\left[\mu^B\right]+\rho\frac{\sigma_B}{\sigma_A}\left[\mu^A-E\left[\mu^A\right]\right] \tag{6}$$

which is a particular case of (1) where $\varpi\equiv\rho\frac{\sigma_B}{\sigma_A}$.

The impact of a reduction in trade costs on aggregate trade flows: In the main text we examined the impact of a reduction in trade costs on the extensive margin. The intensive margin effects at $t=1$ are straightforward, following from the fact that all firms ship optimal quantities that are non-increasing functions of trade costs. Intensive margin effects at $t=2$ are only slightly more complicated to examine, since output depends on the distribution of μ *conditional* on survival. Denote by $\widehat{IM}_2^j\equiv\int_{\tau^j}^{\overline{\mu}}\left(\frac{\mu-\tau^j}{2}\right)dG(\mu|\,\mu>\tau^j)$ the average quantity sold in country j by a *surviving* simultaneous exporter,[9] and by $\widetilde{IM}_2^B\equiv\int_{F^{Sm}}^{F^{Sq}}\int_{2F^{1/2}+\tau^B}^{\overline{\mu}}\frac{\left(\frac{\mu-\tau^B}{2}\right)}{\int_{F^{Sm}}^{F^{Sq}}\left[1-G(2F^{1/2}+\tau^B)\right]dH(F)}dG(\mu)dH(F)$ the average quantity sold in B by an *entrant* sequential exporter. Differen-

[9] Notice that by definition, $\widehat{IM}(\tau^A)\equiv\int_0^{F^{Sq}}\int_{\tau^A}^{\overline{\mu}}\frac{\left(\frac{\mu-\tau^A}{2}\right)}{\left[1-G(\tau^A)\right]H\left[F^{Sq}(\tau^A,\tau^B)\right]}dG(\mu)dH(F)=\int_0^{F^{Sq}}\int_{\tau^A}^{\overline{\mu}}\left(\frac{\mu-\tau^A}{2}\right)\frac{dG(\mu)}{\left[1-G(\tau^A)\right]}\frac{dH(F)}{H\left[F^{Sq}(\tau^A,\tau^B)\right]}=\int_{\tau^A}^{\overline{\mu}}\left(\frac{\mu-\tau^A}{2}\right)dG(\mu|\,\mu>\tau^A)$.

tiating both expressions using Leibniz' rule yields:

$$\frac{d\widetilde{IM}_2^j}{d\tau^j} = \int_{\tau^j}^{\overline{\mu}} \left(-\frac{1}{2}\right) dG(\mu|\,\mu > \tau^j) + \frac{g(\tau^j)}{1-G(\tau^j)} \int_{\tau^j}^{\overline{\mu}} \left(\frac{\mu-\tau^j}{2}\right) dG(\mu|\,\mu > \tau^j), \forall j$$

$$\frac{d\widetilde{IM}_2^j}{d\tau^k} = 0, \forall j \neq k$$

$$\frac{d\widetilde{IM}_2^B}{d\tau^A} = \left\{ \begin{array}{c} -\frac{\widetilde{IM}_2^B}{M_2^B} h(F^{Sq}) \left[1 - G(2\left[F^{Sq}\right]^{1/2} + \tau^B)\right] \frac{dF^{Sq}}{d\tau^A} + \\ +h(F^{Sq}) \frac{dF^{Sq}}{d\tau^A} \int_{2[F^{Sq}]^{1/2}+\tau^B}^{\overline{\mu}} \frac{\left(\frac{\mu-\tau^B}{2}\right)}{M_2^B} dG(\mu) \end{array} \right\},$$

$$\frac{d\widetilde{IM}_2^B}{d\tau^B} = \left\{ \begin{array}{c} -\frac{1}{2} + \int_{F^{Sm}}^{F^{Sq}} \frac{\left(\widetilde{IM}_2^B - F^{1/2}\right) dG(2F^{1/2}+\tau^B)}{M_2^B} dH(F) \\ +\widetilde{IM}_2^B \left\{ -\frac{h(F^{Sq})\left[1-G(2\left[F^{Sq}\right]^{1/2}+\tau^B)\right] \frac{dF^{Sq}}{d\tau^B}}{M_2^B} + \frac{h(F^{Sm})\left[1-G(2\left[F^{Sm}\right]^{1/2}+\tau^B)\right] \frac{dF^{Sm}}{d\tau^B}}{M_2^B} \right\} \\ +h(F^{Sq}) \frac{dF^{Sq}}{d\tau^B} \int_{2[F^{Sq}]^{1/2}+\tau^B}^{\overline{\mu}} \frac{\left(\frac{\mu-\tau^B}{2}\right)}{M_2^B} dG(\mu) \\ -h(F^{Sm}) \frac{dF^{Sm}}{d\tau^B} \int_{2[F^{Sm}]^{1/2}+\tau^B}^{\overline{\mu}} \frac{\left(\frac{\mu-\tau^B}{2}\right)}{M_2^B} dG(\mu). \end{array} \right\}$$

Therefore a lower τ^A has an ambiguous effect on exports per firm in country B, while a lower τ^B leaves exports per firm to country A unaffected. But, while exports per firm to destination j unambiguously increase in $t = 1$ following a reduction in τ^j, in $t = 2$, the positive effect on exports per firm is counterbalanced by the negative effect of more firms surviving, each of which operates at a much lower optimal scale than the average surviving exporter (e.g. the term multiplied by the selection factor $\frac{g(\cdot)}{1-G(\cdot)}$ above). Therefore, lower variable costs have an ambiguous intensive margin effect in $t = 2$.[10] Despite of this ambiguity, at $t = 2$ aggregate exports unambiguously

[10] Lawless (2009b) shows that both effects in $\frac{d\widetilde{IM}_2^j}{d\tau^j}$ exactly compensate each other when specifying a Pareto distribution for the productivity parameter in a heterogeneous firms' model *a la* Melitz (2003). Importantly, the ambiguous effect of variable trade costs on the intensive margin is consistent with the empirical work conducted by her, for the US.

increase in destination j following a reduction in τ^k :

$$\frac{dX_2^A}{d\tau^A} = -\frac{1}{2}H\left(F^{Sq}\right)\left[1-G(\tau^A)\right] + h\left(F^{Sq}\right)\frac{dF^{Sq}}{d\tau^A}\int_{\tau^A}^{\overline{\mu}}\left(\frac{\mu-\tau^A}{2}\right)dG(\mu) < 0$$

$$\frac{dX_2^A}{d\tau^B} = h\left(F^{Sq}\right)\frac{dF^{Sq}}{d\tau^B}\int_{\tau^A}^{\overline{\mu}}\left(\frac{\mu-\tau^A}{2}\right)dG(\mu) < 0$$

$$\frac{dX_2^B}{d\tau^A} = h\left(F^{Sq}\right)\frac{dF^{Sq}}{d\tau^A}\int_{2[F^{Sq}]^{1/2}+\tau^B}^{\overline{\mu}}\left(\frac{\mu-\tau^B}{2}\right)dG(\mu) < 0$$

$$\frac{dX_2^B}{d\tau^B} = \left\{\begin{array}{c} -\frac{1}{2}\left\{H\left(F^{Sm}\right)\left[1-G(\tau^B)\right] + \int_{F^{Sm}}^{F^{Sq}}\left[1-G(2F^{1/2}+\tau^B)\right]dH(F)\right\} + \\ -\int_{F^{Sm}}^{F^{Sq}} F^{1/2}dG(2F^{1/2}+\tau^B)dH(F) + \\ +h\left(F^{Sq}\right)\frac{dF^{Sq}}{d\tau^B}\int_{2[F^{Sq}]^{1/2}+\tau^B}^{\overline{\mu}}\left(\frac{\mu-\tau^B}{2}\right)dG(\mu) + \\ +h\left(F^{Sm}\right)\frac{dF^{Sm}}{d\tau^B}\int_{\tau^B}^{2\left[F^{Sm}\right]^{1/2}+\tau^B}\left(\frac{\mu-\tau^B}{2}\right)dG(\mu) \end{array}\right\} < 0$$

Hence, extensive margin effects dominate there where intensive margin ones are ambiguous.

Formal definition and some properties of the option value functions: The formal definition of the option value functions are: ([11])

$$\begin{aligned}
V(\tau^j) &= E\left[\max_{q^j\geq 0}(\mu^j-\tau^j-q^j)q^j\right] = E\left[\mathbf{1}_{\{\mu^j>\tau^j\}}\left(\frac{\mu^j-\tau^j}{2}\right)^2\right] \\
&= \Pr(\mu^j>\tau^j)E\left[\left(\frac{\mu^j-\tau^j}{2}\right)^2\middle|\mu^j>\tau^j\right] \\
&= \int_{\tau^j}^{\overline{\mu}}\left(\frac{\mu^j-\tau^j}{2}\right)^2 dG(\mu); \\
W(\tau^B;F) &= E\left[\max\left\{\max_{q^B\geq 0}(\mu-\tau^B-q^B)q^B-F,0\right\}\right] \\
&= E\left\{\mathbf{1}_{\left\{\mu>\tau^B+2F^{\frac{1}{2}}\right\}}\left[\mathbf{1}_{\{\mu>\tau^B\}}\left(\frac{\mu-\tau^B}{2}\right)^2-F\right]\right\} \\
&= \Pr(\mu>\tau^B+2F^{\frac{1}{2}})E\left[\left(\frac{\mu-\tau^B}{2}\right)^2-F\middle|\mu>\tau^B+2F^{\frac{1}{2}}\right] \\
&= \int_{\tau^B+2F^{\frac{1}{2}}}^{\overline{\mu}}\left[\left(\frac{\mu-\tau^B}{2}\right)^2-F\right]dG(\mu)
\end{aligned}$$

Some properties:

(1) *Expected profits are larger when optimal decisions are taken on the basis of more information.*

From these expressions, by the convexity of the max $\{.\}$ operator and

[11] Although in the main text we have adopted the simplest analytic expressions, sometimes doing so obscures the implicit timing behind them. As an example, the value of early entry in B can be expressed as:

$$\begin{aligned}
\max\left\{\Psi(\tau^B)-F,0\right\} &= \max\left\{\begin{array}{c}\mathbf{1}_{\left\{E\mu^B>\tau^B\right\}}\left(\frac{E\mu^B-\tau^B}{2}\right)^2+\mathbf{1}_{\left\{E\mu^B\leq\tau^B\right\}}\left(E\mu^B-\tau^B-\varepsilon\right)\varepsilon+ \\ +\mathbf{1}_{\left\{\widehat{q}_1^B>0\right\}}E\left[\mathbf{1}_{\left\{\mu^B>\tau^B\right\}}\left(\frac{\mu^B-\tau^B}{2}\right)^2\right]-F,0\end{array}\right\} \\
&= \mathbf{1}_{\left\{e_1^B=1\right\}}\left(\begin{array}{c}\mathbf{1}_{\left\{E\mu^B>\tau^B\right\}}\left(\frac{E\mu^B-\tau^B}{2}\right)^2+\mathbf{1}_{\left\{E\mu^B\leq\tau^B\right\}}\left(E\mu^B-\tau^B-\varepsilon\right)\varepsilon+ \\ +\mathbf{1}_{\left\{\widehat{q}_1^B>0\right\}}E\left[\mathbf{1}_{\left\{\mu^B>\tau^B\right\}}\left(\frac{\mu^B-\tau^B}{2}\right)^2\right]-F\end{array}\right)
\end{aligned}$$

Jensen's inequality we obtain:

$$\begin{aligned} V(\tau^j) &\equiv E\left[\max_{q^j\geq 0}(\mu^j - \tau^j - q^j)q^j\right] = E\left[\left(\widehat{q}_2^j\right)^2\right] \\ &\geq \max_{q^j\geq 0} E\left[(\mu^j - \tau^j - q^j)q^j\right] = \left(\widehat{q}_1^j\right)^2 \equiv \Psi(\tau^j) - V(\tau^j) \\ W(\tau^B; F) &\geq \overline{W}(\tau^B; F), \forall \varpi \geq 0 \end{aligned}$$

where the second inequality has already been established above.

(2) *The smaller the degree of spatial correlation across destinations, the less would firms find optimal a sequential entry strategy.*

From the main text, we also know that:

$$V(\tau^B) \geq W(\tau^B; F)$$

and therefore:

$$V(\tau^B) \geq W(\tau^B; F) \geq \overline{W}(\tau^B; F), \forall \varpi \geq 0$$

meaning that the option value of early entry is larger than the option value of late entry (only because sunk export costs have already been incurred by early entrants, but not by late ones), and the more so, the less informative entering A is about export success in B.

(3) *The impact of a reduction in trade barriers on the option value of a sequential entry strategy, increases with the degree of spatial correlation across destinations.*

$$\left|\frac{\partial W(\tau^B; F)}{\partial \tau^B}\right| \geq \left|\frac{\partial \overline{W}(\tau^B; F)}{\partial \tau^B}\right|, \forall \varpi \geq 0$$

Computing:

$$\begin{aligned}
\frac{\partial W(\tau^B;F)}{\partial \tau^B} &= \frac{\partial}{\partial \tau^B}\left(E_{\mu^B}\left[\max\left\{\max_{q^B\geq 0}(\mu^B-\tau^B-q^B)q^B-F,0\right\}\right]\right) \\
&= -E_{\mu^B}\left[\mathbf{1}_{\left\{\mu^B>\tau^B+2F^{\frac{1}{2}}\right\}}\left(\frac{\mu^B-\tau^B}{2}\right)\right] \\
&= -E_{\mu^B}\left[\max\left\{\left[\max_{q^B\geq 0}(\mu^B-\tau^B-q^B)q^B\right]^{\frac{1}{2}}-F^{\frac{1}{2}},0\right\}\right] \\
&= -E_{\mu^A}\left[E_{\mu^B|\mu^A}\left(\max\left\{\left[\max_{q^B\geq 0}(\mu^B-\tau^B-q^B)q^B\right]^{\frac{1}{2}}-F^{\frac{1}{2}},0\right\}\middle|\,\mu^A\right)\right] \\
&\leq -E_{\mu^A}\left[\max\left\{E_{\mu^B|\mu^A}\left(\left[\max_{q^B\geq 0}(\mu^B-\tau^B-q^B)q^B\right]^{\frac{1}{2}}\middle|\,\mu^A\right)-F^{\frac{1}{2}},0\right\}\right] \\
&\leq -E_{\mu^A}\left[\max\left\{\left[\max_{q^B\geq 0}\left[(E\left[\mu^B\middle|\,\mu^A\right]-\tau^B-q^B)q^B\right]\right]^{\frac{1}{2}}-F^{\frac{1}{2}},0\right\}\right] \\
&= -E_{\mu^A}\left[\mathbf{1}_{\left\{E[\mu^B|\mu^A]>\tau^B+2F^{\frac{1}{2}}\right\}}\left(\frac{E\left[\mu^B\middle|\,\mu^A\right]-\tau^B}{2}\right)\right] \\
&= -E_{\mu^A}\left[\mathbf{1}_{\{\mu^A>\mu^{*A}(\varpi)\}}\left(\frac{E\left[\mu^B\middle|\,\mu^A\right]-\tau^B}{2}\right)\right] \\
&= \frac{\partial}{\partial \tau^B}\left(E_{\mu^A}\left[\max\left\{\max_{q^B\geq 0}\left[(E\left[\mu^B\middle|\,\mu^A\right]-\tau^B-q^B)q^B\right]-F,0\right\}\right]\right) \\
&\equiv \frac{\partial \overline{W}(\tau^B;F)}{\partial \tau^B}
\end{aligned}$$

Since taking absolute values, reverses the inequalities, the proof is complete. The fourth equality applies the law of iterated expectations, while the first inequality follows from the convexity of the $\max\{.\}$ operator and Jensen's inequality, and the negative sign. The second follows from noting that:

$$\begin{aligned}
E_{\mu^B|\mu^A}\left(\left[\max_{q^B\geq 0}(\mu^B-\tau^B-q^B)q^B\right]^{\frac{1}{2}}\middle|\,\mu^A\right) &= E_{\mu^B|\mu^A}\left(\mathbf{1}_{\{\mu^B>\tau^B\}}\left[\frac{\mu^B-\tau^B}{2}\right]\middle|\,\mu^A\right) \\
&\geq E_{\mu^B|\mu^A}\left(\frac{\mu^B-\tau^B}{2}\middle|\,\mu^A\right) \\
&= \left[\max_{q^B\geq 0}\left[(E\left[\mu^B\middle|\,\mu^A\right]-\tau^B-q^B)q^B\right]\right]^{\frac{1}{2}}
\end{aligned}$$

Then, subtract $-F^{\frac{1}{2}}$ and apply the $\max\{.,0\}$ operator on both sides of the inequality, take expectations wrt. μ^A and switch signs to reverse the direction of the inequality.

References

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Technical Addendum 2: The Consequences of Imposing a Non-negative Price Restriction

February 8, 2010

Abstract

In this appendix we show that adopting a demand function of the form $p(q) = \max\{d - q, 0\}$ to avoid negative prices leaves our main results and empirical predictions unaffected. The reason is that this change does not affect the expected value of information either across periods or destinations. This implies that the technical restriction (12) adopted in the main text, $\underline{d} > \frac{1}{2}E\mu$, simplifies the analysis but is largely inconsequential.

If we impose a restriction to avoid negative prices, the demand function takes the form $p(q) = \max\{d - q, 0\}$. In this appendix we show that adopting this natural restriction leaves our main results and empirical predictions unaffected. The main reason being that avoiding negative prices has no effect on the expected value of information either across periods or destinations. Intuitively, such a demand function "convexifies" the revenue function, providing implicit insurance to the risk neutral producer against the event of negative prices. Consequently, the producer is induced to take more risk, producing larger volumes conditional on entry, and becoming more propense to enter. [1]

To summarize, here we show as a result of forcing prices to be non-negative, optimal export quantities in $t = 1$ increase, while volumes in $t = 2$ remain unaffected. Since expected export profits also increase, there is also more entry. Because the surviving threshold in $t = 2$ remains unchanged ($\mu > \tau$), there is also more exit. Therefore our empirical predictions 2 and 3 are if anything, strengthened. Since optimal export quantities in $t = 1$ increase, while volumes in $t = 2$ remain unaffected, *predicted* average second year growth is lower, but still positive as long as minimum marginal costs lie above expected willigness to pay. Hence, also our empirical prediction 1 survives.

More entry and larger volumes in $t = 1$ translate into higher expected first period operational profits, inducing more experimentation. And because expected first period operational profits are larger, some firms that would have entered sequentially, now enter simultaneously, as well as some non-entrants now will rather enter (sequentially) than not. Therefore our propositions 1 and 2 obtain, and so do their implications for trade policy (proposition 3). This

[1] Technically, it just introduces a first order stochastically dominant (FSD) shift in first period profitability, irrespective of destinations.

is why in the main text we impose the (minor) technical restriction $\underline{d} > \frac{1}{2}E\mu$, instead of exposing the reader to the cumbersome technicalities displayed here.

Proposition 1 *First period export volumes are larger under a non-negative price restriction*

Proof. We want to show that:

$$q_1^{j*} \geq \widehat{q}_1^j$$

where:

$$\begin{aligned} q_1^{j*} &\in \arg\max_{q_1 \geq 0} E\left[\max\left\{\widetilde{d} - q_1, 0\right\} q_1 - (\widetilde{c} + \tau^j) q_1\right] \\ \widehat{q}_1^j &\in \arg\max_{q_1 \geq 0} E\left[\left(\widetilde{d} - q_1\right) q_1 - (\widetilde{c} + \tau^j) q_1\right] \end{aligned}$$

The corresponding necessary and sufficient FOCs are, under the assumption of independence between demand $(\widetilde{d})$ and supply $(\widetilde{c})$ shocks:

$$\begin{aligned} \underbrace{E\left\{-\mathbf{1}_{\left\{d > q_1^{j*}\right\}} q_1^{j*}\right\} + E\max\left\{\widetilde{d} - q_1^{j*}, 0\right\}}_{MR|p\geq 0} &= \underbrace{E\widetilde{c} + \tau^j}_{MC} \\ \underbrace{-\widehat{q}_1^j + \left(E\widetilde{d} - \widehat{q}_1^j\right)}_{MR} &= \underbrace{E\widetilde{c} + \tau^j}_{MC} \end{aligned}$$

Observing that $E\left\{-\mathbf{1}_{\{d>q\}} q\right\} = qE\left\{-\mathbf{1}_{\{d>q\}}\right\} = -q\left[1 - K(q)\right] \geq -q, \forall q \in \left[\underline{d}, \overline{d}\right]$, and that $E\max\left\{\widetilde{d} - q_1, 0\right\} \geq \max\left\{E\widetilde{d} - q_1, 0\right\} = \mathbf{1}_{\{Ed>q_1\}}\left(E\widetilde{d} - q_1\right) \geq \left(E\widetilde{d} - q_1\right)$, it follows that the marginal revenue is larger under the non-negative price restriction, while the marginal cost remains the same (MC) :

$$\left(MR|\, p \geq 0\right)(q_1) \geq MR(q_1), \forall q_1 \in \left[\underline{d}, \overline{d}\right]$$

Since the marginal revenue is a non-increasing function of the quantity[2], $q_1^{j*} \geq \widehat{q}_1^j$. ∎

To be able to say if there is more or less (sequential) entry, we would need to know how do expected profits compare under the non-negative price restriction relative to its absence. First, notice that:

Proposition 2 *Conditional on entry, expected first period operational profits are larger when imposing a non-negative price restriction.*

[2] From Leibniz's rule, we have that $\frac{\partial(MR|p\geq 0)(q_1)}{\partial q_1} = -2(1 - K(q_1)) \geq -2 = \frac{\partial MR(q_1)}{\partial q_1}, \forall q_1$

Proof. Expected first period operational profits under a non-negative price restriction are:

$$\begin{aligned}
\Psi(q_1^{j*};\tau^j) - V(\tau^j) &= \left\{\max_{q_1\geq 0} E\left[\max\left\{\widetilde{d}-q_1,0\right\}q_1 - (\widetilde{c}+\tau^j)q_1\right]\right\} \\
&\geq \left\{\max_{q_1\geq 0}\left[\max\left\{E\widetilde{d}-q_1,0\right\}q_1 - (E\widetilde{c}+\tau^j)q_1\right]\right\} \\
&\geq \left\{\max_{q_1\geq 0}\left[\left(E\widetilde{d}-q_1\right)q_1 - (E\widetilde{c}+\tau^j)q_1\right]\right\} = \Psi(\widehat{q}_1^j;\tau^j) - V(\tau^j)
\end{aligned}$$

Where the second inequality follows from the convexity of the max operator and Jensen's inequality, and the third from noting that $\max\left\{E\widetilde{d}-q_1,0\right\} = \mathbf{1}_{\{Ed>q_1\}}\left(E\widetilde{d}-q_1\right) \geq \left(E\widetilde{d}-q_1\right), \forall q_1$.[3] ■

Second, it is also true that:

Corollary 3 *Operational profits under a non-negative price restriction are larger* ([4])

Proof. Notice that the definitions of $V(\tau^j)$ and of $W(\tau^B;F)$ in the main text remain unchanged by the imposition of a non-negative price-restriction. The reason being that they constitute the ex-ante evaluation of ex-post optimal entry decisions, which rule out negative prices, i.e. $\mu \geq \tau \Longrightarrow p^* \geq 0$:

$$\begin{aligned}
V(\tau^j) &= \int_{\tau^j}^{\overline{\mu}} \left(\frac{\mu^j-\tau^j}{2}\right)^2 dG(\mu) = E\left[\mathbf{1}_{\{\mu^j>\tau^j\}}\left(\frac{\mu^j-\tau^j}{2}\right)^2\right] \\
&= \Pr(\mu^j>\tau^j)E\left[\left(\frac{\mu^j-\tau^j}{2}\right)^2 \middle| \mu^j>\tau^j\right]; \\
W(\tau^B;F) &= \int_{\tau^B+2F^{\frac{1}{2}}}^{\overline{\mu}} \left[\left(\frac{\mu-\tau^B}{2}\right)^2 - F\right] dG(\mu) \\
&= \Pr(\mu>\tau^B+2F^{\frac{1}{2}})E\left[\left(\frac{\mu-\tau^B}{2}\right)^2 - F \middle| \mu>\tau^B+2F^{\frac{1}{2}}\right].
\end{aligned}$$

Therefore, the previous corollary implies that:

$$\Psi(q_1^{j*};\tau^j) \geq \Psi(\widehat{q}_1^j;\tau^j), \forall j$$

[3] After some tedious algebra, it can be shown that expected first period operational profits are equal to $\Psi(q_1^{j*};\tau^j) = \mathbb{P}(d>q_1^{j*})\left(q_1^{j*}\right)^2 + V(\tau^j)$.

[4] In the case of imperfect correlation across destinations, second period optimal output of sequential entrants is based on the conditional expectation of prices. As a result, prices can also be negative and the non-negative price restriction also constraints second period optimal outputs to be larger than they would absent the restriction. But because profits are larger, the new entry cutoff would also allow for more entry, and a similar reasoning applies.

■

As a result:

Corollary 4 *Both sequential and simultaneous entry strategies display higher profits under a non-negative price restriction. Therefore, the fixed cost entry thresholds under a non-negative price restriction, F_*^{Sq} and F_*^{Sm}, are less binding.*

Proof. Defining $\Psi(q_1^{j*};\tau^j) \equiv \Psi^*(\tau^j)$, $\Pi_*^{Sq} \equiv \Psi^*(\tau^A) + W(\tau^B;F) - F$, $\Pi_*^{Sm} \equiv \Psi^*(\tau^A) + \Psi^*(\tau^B) - 2F$, the previous corollary implies:

$$\Pi_*^{Sq} \geq \Pi^{Sq} \text{ and } \Pi_*^{Sm} \geq \Pi^{Sm}$$

Since the profit function is decreasing in the sunk entry cost F, we immediately have:

$$F_*^{Sq} \geq F^{Sq}$$

The definition of F_*^{Sm} and the previous corollary imply that:

$$F_*^{Sm} + W(\tau^B; F_*^{Sm}) = \Psi^*(\tau^B) \geq \Psi(\tau^B) = F^{Sm} + W(\tau^B; F^{Sm})$$

Since $\frac{d(F+W(\tau^B;F))}{dF} = G(\tau^B + 2F^{\frac{1}{2}}) \geq 0$, we immediately have that $F_*^{Sm} \geq F^{Sm}$.

■

Firms that in the absence of a non-negative price restriction did not enter, now adopt a sequential entry strategy, and some of the previous sequential entrants, now would rather enter simultaneously. Therefore:

Corollary 5 $F_*^{Sq} > F_*^{Sm}$, *i.e. Proposition 1 survives a non-negative price restriction*

Proof.

$$F_*^{Sq} = \Psi^*(\tau^A) + W(\tau^B; F_*^{Sq}) > \Psi^*(\tau^A) \geq \Psi^*(\tau^B) > \Psi^*(\tau^B) - W(\tau^B; F_*^{Sm}) = F_*^{Sm}$$

where the weak inequality follows from the assumption that $\tau^A \leq \tau^B$, and the strict inequalities obtain because under perfect positive correlation, the option value of entering B sequentially is strictly positive, $W(\tau^B; F) > 0, \forall F$. ■

Consequently, our empirical predictions 2 (entry) and 3 (exit) prevail, and are even reinforced by the adoption of a non-negative price restriction. The next proposition shows that under an economically reasonable condition, also prediction 1 holds despite of being weakened:

Proposition 6 *Empirical prediction 1 holds if $\underline{c} \geq Ed$.*

Proof. From the FOC we obtain the following expression for q_1^{j*} :

$$q_1^{j*} = \mathbf{1}_{\{E\mu > \tau^j + \lambda\}} \frac{E\mu - (\tau^j + \lambda)}{2\mathbb{P}(d > q_1^{j*})}$$

where $\mathbb{P}(d > q_1^{j*}) \equiv \left[1 - K(q_1^{j*})\right] \leq 1$, and $\lambda \equiv \mathbb{P}(d \leq q_1^{j*})E\left[d|\, d \leq q_1^{j*}\right] \geq 0, \forall q_1^{j*} \in \left[\underline{d}, \overline{d}\right]$. We need to show that:

$$\underline{c} \geq Ed \Longrightarrow Eq_2^{j*} - q_1^{j*} \geq 0$$

Noting that $Eq_2^{j*} = E\widehat{q}_2^j = \frac{E\left[\mu|\mu > \tau^j\right] - \tau^j}{2}$, omitting the non-negativity restriction on quantities in the profit maximization problem, the above implication is equivalent to:

$$\underline{c} \geq Ed \Longrightarrow \frac{E\left[\mu|\, \mu > \tau^j\right] - \tau^j}{2} \geq \frac{E\mu - (\tau^j + \lambda)}{2\mathbb{P}(d > q_1^{j*})}$$

The proof proceeds in 3 steps.

Step 1: Simplifying the RHS of the above implication.

After cancelling common terms and rearranging, we can express the RHS as :

$$\mathbb{P}(d > q_1^{j*})E\left[\mu|\, \mu > \tau^j\right] \geq E\mu - \mathbb{P}(d \leq q_1^{j*})\left(E\left[d|\, d \leq q_1^{j*}\right] + \tau^j\right)$$

by definition of λ. Since $E\mu = \mathbb{P}(d > q_1^{j*})E\left[\mu|\, d > q_1^{j*}\right] + \mathbb{P}(d \leq q_1^{j*})E\left[\mu|\, d \leq q_1^{j*}\right]$, plugging this expression into the above inequality and rearranging yields:

$$\mathbb{P}(d > q_1^{j*})\left\{E\left[\mu|\, \mu > \tau^j\right] - E\left[\mu|\, d > q_1^{j*}\right]\right\} \geq \mathbb{P}(d \leq q_1^{j*})\left\{E\left[\mu|\, d \leq q_1^{j*}\right] - E\left[d|\, d \leq q_1^{j*}\right] - \tau^j\right\}$$

Sustituting in the definition of $\widetilde{\mu} = \widetilde{d} - \widetilde{c}$, and taking advantage of the assumption of independence between demand and supply shocks, we get:

$$\mathbb{P}(d > q_1^{j*})\left\{E\left[d|\, d > c + \tau^j\right] - E\left[d|\, d > q_1^{j*}\right] + Ec - E\left[c|\, c < d - \tau^j\right]\right\} \geq \mathbb{P}(d \leq q_1^{j*})\left\{-Ec - \tau^j\right\}$$

Noting that by the converse of Lemma 2 in the main text, $\mathbb{P}(d > q_1^{j*})\left\{Ec - E\left[c|\, c < d - \tau^j\right]\right\} \geq 0$. We can therefore move this term to the RHS of the inequality to obtain, after some simplifications:

$$\begin{aligned} \mathbb{P}(d &> q_1^{j*})\left\{E\left[d|\, d > c + \tau^j\right] - E\left[d|\, d > q_1^{j*}\right]\right\} \geq \\ &\geq -\left\{Ec - E\left[c|\, c < d - \tau^j\right]\right\} - \mathbb{P}(d \leq q_1^{j*})\left\{E\left[c|\, c < d - \tau^j\right] + \tau^j\right\} \end{aligned}$$

Therefore the RHS of the inequality is negative.

Step 2: The LHS of the inequality is positive if $c + \tau^j > q_1^{j*}, \forall c$.

It follows from an extension of Lemma 2 in the main text: [5]

$$\tau' \geq \tau \Longrightarrow E\left[\mu|\, \mu > \tau'\right] \geq E\left[\mu|\, \mu > \tau\right], \forall\left(\tau', \tau\right) \in \left(\underline{\mu}, \overline{\mu}\right)$$

Step 3: $\underline{c} > Ed \Longrightarrow c + \tau^j > q_1^{j*}, \forall c.$
Notice that

$$c + \tau^j \geq \frac{c + \tau^j}{2\mathbb{P}(d > q_1^{j*})} \geq \frac{c + \tau^j - Ec - 2\tau^j}{2\mathbb{P}(d > q_1^{j*})} = \frac{c - Ec - \tau^j}{2\mathbb{P}(d > q_1^{j*})}$$

and also that

$$\frac{Ed - Ec - \tau^j}{2\mathbb{P}(d > q_1^{j*})} = \frac{E\mu - \tau^j}{2\mathbb{P}(d > q_1^{j*})} \geq \frac{E\mu - (\tau^j + \lambda)}{2\mathbb{P}(d > q_1^{j*})} = q_1^{j*}$$

Since the inequality must be true for all realizations of c, if $\underline{c} > Ed$ it must be true that $\frac{c-Ec-\tau^j}{2\mathbb{P}(d>q_1^{j*})} > \frac{Ed-Ec-\tau^j}{2\mathbb{P}(d>q_1^{j*})}$ and therefore that $\forall c, c + \tau^j > q_1^{j*}$, completing the proof. ■

[5] The proof proceeds as in lemma 2 in the main text: integrate by parts both expressions and subtract them to obtain

$$E\left[\mu|\, \mu > \tau'\right] - E\left[\mu|\, \mu > \tau\right] = \int_{\tau}^{\tau'} G(\mu|\, \mu > \tau) d\mu + \frac{G(\tau') - G(\tau)}{\left[1 - G(\tau')\right]\left[1 - G(\tau)\right]} \int_{\tau'}^{\overline{\mu}} \left[1 - G(\mu)\right] d\mu \geq 0$$

because $G(.)$ is a non-decreasing function.