Survival in Export Markets*

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Abstract

This paper explores the determinants of firm survival in export markets. We build an exporter dynamics model where firms need to pay market-specific sunk and fixed costs to operate abroad and where firm export profitability in each foreign market follows a geometric Brownian motion. Firms also differ ex ante by a constant market-specific profitability shifter. We derive the probability of export survival upon entry in a market and show that it increases with the ratio of sunk to fixed costs and is insensitive to the profitability shifters. Also, we show that the survival probability is unaffected by fixed costs if sunk costs are zero. We take the model to the data using firm-level Argentine export information. We find that survival rates decrease with distance, which the model rationalizes with sunk costs that increase with distance proportionally less than fixed costs. Estimated sunk costs are small. In fact, a counterfactual exercise shows that removing those costs increases aggregate exports by less than 1.5%. Finally, we also find that survival increases with a firm's export experience. Analogously to distance, the model's implication of this empirical result is that experience reduces sunk costs proportionally less than fixed costs.

JEL codes: F10, F12, F14.

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1 Introduction

A substantial fraction of aggregate exports is explained by new exporters (Eaton, Eslava, Kugler, and Tybout, 2008; Bernard, Jensen, Redding, and Schott, 2009; Lawless, 2009). Using our dataset of Argentine firms, we find that 42% of aggregate exports in 2006 are explained by either new exporters or old exporters entering new destinations after 1996. Similarly, Eaton, Eslava, Kugler, and Tybout (2008) find that new exporters explain about 50% of export growth in Colombia between 1996 and 2005. New exporters tend to start small and focus on a single, usually neighboring, country. Once they outlive their entry year, they tend to expand their sales abroad and reach a larger number of destinations (Albornoz, Calvo Pardo, Corcos, and Ornelas, 2012; Lawless, 2009; Buono, Fadinger, and Aeberhardt, 2014). The occurrence of this process, however, is not guaranteed. Both new exporters and exporters entering new markets exhibit high rates of failure in their exporting activity. Eaton, Eslava, Kugler, and Tybout (2008) show that about half of new exporters discontinue their exporting activity within the first year. For Argentine firms, we find a survival rate of 31% after two years for exporters - new or old - entering a new export destination. This body of evidence suggests the importance of understanding the determinants of export survival. This paper aims to contribute to this understanding.

A standard framework to analyze exporter dynamics consists of three key elements: (a) a firm-specific productivity process; (b) fixed export costs; and (c) sunk export costs. This framework is widely used in theoretical (e.g. Arkolakis (Forthcoming) and Impullitti, Irarrazabal, and Opromolla (2013)) and empirical (e.g. Das, Roberts, and Tybout (2007) and Morales, Sheu, and Zahler (2014)) studies. Confined to this standard framework, we derive theoretical implications for the probability of firm survival upon entry in a new market. We show that this probability increases with the ratio of sunk costs to fixed costs and is insensitive to firm- and market-specific profitability shifters. Also, we show that this probability is unaffected by fixed costs if sunk costs are zero. Based on these results, we use observed patterns of survival among Argentine exporters to estimate the relative magnitude of sunk to fixed costs and its relationship with distance (to the destination country) and firm's export experience. Observed survival rates decrease with distance and increase with export experience. Thus, combined with our theoretical results, these facts imply that fixed costs increase with distance and decrease with export experience proportionally more than sunk costs. They also imply that sunk costs are not negligible as they are key to explain observed variation in survival rates across destinations and types of export experience. Nevertheless, simulation results with the calibrated model indicate that sunk costs have a very small impact on aggregate exports.

We model firms whose export profitability in each foreign market follows an idiosyncratic and market-specific geometric Brownian motion (GBM) process. While the parameters that govern this process are common across firms and markets, variation in export profitability is also determined by a set of idiosyncratic and market-specific constant profitability shifters capturing, for instance, idiosyncratic demand components. Entering each market imposes paying sunk costs that are common to all firms. In addition, firms need to pay market-specific fixed costs - also common to all firms - while they operate in that market. Once a firm has entered a market by paying the sunk costs it can suspend operations and avoid fixed costs until it decides to operate again. Thus, there is no need to repay sunk costs to resume operations. In this environment, we derive the probability of survival upon entry in a foreign market and perform comparative statics with respect to sunk costs, fixed costs, and the idiosyncratic profitability parameter. A key finding is that a higher ex-ante ability to make profits in a specific market - governed by the constant profitability parameter - is compensated with a lower entry and exit threshold for the GBM profitability process. In other words, firms undo their static advantages in a given market by entering sooner. This finding is critical to obtain model predictions amenable for empirical estimation. It implies that the probability of survival is equal for all firms that enter a given market and depends only on the ratio of sunk to fixed costs. Specifically, the higher is this ratio the higher is also the probability of survival. However, if sunk costs are zero, the survival probability is insensitive to variation in fixed costs.

A direct test of the model's predictions would require exploiting variation across countries in sunk and fixed costs. Unfortunately, it is not easy to find independent proxies for both types of costs. The main reason is that sunk costs usually involve upfront activities that have to be repeated as a fixed cost every year after entering a new export market. For example, establishing distribution channels or adapting products to the idiosyncratic characteristics of local demand have a sunk cost component. Still, these costs are also fixed in the sense that distribution channels have to be maintained while adapting products to an evolving environment is a continuous process that requires sustained business services over time. Thus, observable variables that can proxy for one type of cost also proxy for the other. In particular, this is the case for distance (as other gravity variables) and export experience. As a result, the effect of these variables on survival probabilities can only inform us about the relative importance of both types of export costs.

Using Argentine firm-level customs data, we find that survival rates decrease with the distance to the destination country.[1] Through the lenses of the standard framework we use, this finding implies that the ratio of sunk to fixed costs also falls with distance. We parametrize this relationship and estimate it using the model. The main result of this exercise is that the magnitude of the ratio of sunk to fixed costs is strikingly small, ranging from 0.1 to 0 for short and long distance destinations, respectively. We also simulate the model to assess its quantitative implications. First, we quantify new exporters' contribution to exports in a given market. The model performs well at short horizons but overpredicts this contribution at long horizons. Second, by conducting counterfactual analysis, we find that while variation across countries in the relative magnitude of sunk to fixed costs is necessary to explain the observed cross-country variation in survival rates, the impact of sunk costs on aggregate exports is still small. In fact, similarly to Alessandria and Choi (2007), our counterfactual exercise indicates that completely removing those costs only has a negligible effect (at most 1.5%) on aggregate exports.

A firm's export experience can also proxy for sunk and fixed costs. Since an experienced firm should face lower sunk and fixed costs, the impact of experience on both types of costs, like the impact of distance, should

[1] In our empirical section, we find that survival rates also decrease when countries do not share a common language, which is another (non-geographical) measure of distance.

induce opposite effects on the survival probability. Nevertheless, the analysis in this case is complicated by the fact that once experience in one market is allowed to affect sunk and fixed costs in another, entry decisions across markets become interdependent. Therefore, to study the effect of experience we extend the baseline model to allow export decisions to be interdependent across markets. In particular, we allow sunk and fixed costs to be lower for an "experienced" firm, where the relevant experience can come from previous exports to any other country or, in the spirit of Morales, Sheu, and Zahler (2014)'s "extended gravity", from previous exports only to related countries (e.g. by geographical proximity or a common language). We derive and compare the probability of survival upon entry for experienced and inexperienced firms. If experience only lowers sunk costs, then the model predicts experience to reduce the survival probability upon entry. If, conversely, experience only reduces fixed cost, the result is ambiguous in general although under a "regular" case it predicts experience to raise the probability of survival. When we estimate the effect of export experience on firm survival, we find that different forms of experience, including those captured by the extended gravities, raise the probability of surviving in a new export market. Hence, this finding implies that the impact of experience on fixed costs dominates its impact on sunk costs. This finding contrasts with Morales, Sheu, and Zahler (2014), where export experience in extended gravity markets affects exclusively the magnitude of sunk costs. If that were the case, we should observe survival rates decreasing with a firm's export experience.

This paper is related to several strands of literature. First, it is related to a literature that attempts to obtain quantitative estimates of sunk and fixed exporting costs. Since the early work of Baldwin (1988); Krugman (1989); Baldwin and Krugman (1989) and Dixit (1989), the export dynamics literature has underscored the importance of sunk and fixed costs to explain entry and exit in export markets. The effect of these costs on firm's exporting activity was initially estimated by Roberts and Tybout (1997) and Bernard and Jensen (2004). More recently, quantifying these costs has become one of the most important challenges in this literature. For example, Das, Roberts, and Tybout (2007) find that sunk costs are substantial, about US$ 400,000 for Colombian firms in different industries, but fixed costs are negligible. More recently, Morales, Sheu, and Zahler (2014) emphasize that fixed and sunk costs vary across destinations. They also contend that a firm's previous exporting experience reduces the sunk costs of entering a new destination. Their estimates for Chilean chemical exporters indicate that sunk costs may be above US$ 100,000 but fixed costs are below US$ 11,000. Overall, this recent quantitative research suggests that sunk costs are substantially larger than fixed costs. Using a theoretical framework largely consistent with the framework used in that literature, we derive theoretical results on survival probabilities that, combined with observed survival rates, impose restrictions on how the relative magnitude of these costs vary with distance and experience. Interestingly, some of the estimates in the literature do not satisfy those restrictions and hence should be reconsidered in light of these new results. Furthermore, our estimates indicate the opposite: fixed costs are substantially larger than sunk costs. Since our implications are dependent on the standard framework we use to derive them, alternative explanations of the empirical findings could be obtained by extending the framework in various possible directions such as introducing uncertainty about market-specific demand (Albornoz, Calvo Pardo, Corcos, and Ornelas, 2012; Eaton, Eslava, Jinkins, Krizan, and Tybout, 2014; Fanelli and Hallak, 2015), network formation (Chaney, 2014), or reputation (Araujo, Mion, and Ornelas, 2014).

Our paper also contributes to an incipient literature on exporter dynamics primarily interested in explaining the size distribution of firms in an open economy. Impullitti, Irarrazabal, and Opromolla (2013) use a framework similar to the one developed in this paper to study the decision to enter and exit a foreign market in a two-country framework. They show that the survival probability (i.e. the band of inaction) increases with sunk costs and decreases with fixed costs. Arkolakis (Forthcoming) extends the standard framework with market penetration costs but assumes away sunk costs to develop a general equilibrium model of industry and exporter dynamics. Compared to these papers, our main contribution is to combine theoretical and empirical results on survival probabilities to infer how geography and export history affect the relative magnitude of sunk and fixed costs.

Variation in survival rates could potentially be explained as the result of different export entry technologies. Blum, Claro, and Horstmann (2013) distinguish between perennial and occasional exporters and argue that capacity constraints explain their different survival performance. Specifically, occasional exporters serve foreign markets sporadically as a way to use existing capacity in the face of negative demand shocks in the domestic market. Although they abstract from destinations and experience, their model could potentially match our facts provided that this type of occasional exporters is less prevalent among proximate markets and experienced firms. To the best of our knowledge, there is no evidence suggesting that this could be the case. More closely related to our paper, Békés and Muraközy (2012) also document survival rates decreasing in distance and build a three-period model to explain this fact. In their model, firms can pay a sunk cost to reduce variable trade costs, in which case the survival probability increases. A key assumption is that the decision to undertake this investment is made in period 1 (the beginning of times) when firms draw their productivity from an exogenous distribution. Conditional on this productivity, firms encounter more incentives to pay higher sunk costs in proximate markets because profits are higher due to lower variable trade costs. By contrast, in our model firms are not imposed an exogenous instant for assessing whether they wish to enter a new export market. As a result, at the time of entry profits need not be higher in proximate markets. In fact, one of our main results indicates that firms will enter sooner precisely in those markets, fully compensating the *ceteris paribus* higher market-specific profitability.

Other papers have previously documented the effect of experience on export survival. For example, Carrère and Strauss-Kahn (2014) provide evidence, albeit at the product level, that the export experience of non-OECD countries increases the survival of new exports to the OECD. Araujo, Mion, and Ornelas (2014) find that experience raises the probability of survival at the firm level, and offer an explanation based on reputation. In their model, contracts are not perfectly enforceable and exporters may be defaulted by their distributors. Experience in similar markets help exporters identify partners who will not default and therefore allow their export incursions to survive longer. While we explain the effect of experience within the limits of a model in which contracts are perfect, we see both explanations as complementary.

Finally, some empirical papers uncover additional determinants of exporter survival. For example, in a panel of Hungarian exporters Görg, Kneller, and Muraközy (2012) find that firm productivity is positively related to the duration of a new export experience. They also find that multi-product exporters are relatively more successful in exporting their core product. Cadot, Iacovone, and Rauch (2013), using customs data from Malawi, Mali, Senegal, and Tanzania, find that the survival rates upon entry in a new market increase with the number of competitors from the same country already serving that market. While these are valuable findings, we restrict ourselves to the simplest possible benchmark we can use to focus on the main determinants of exporter survival.

The rest of the paper proceeds as follows. In section 2, we set up the model in the case of independent markets and derive predictions about variation in survival probabilities across destination countries. In section 3, we estimate in a reduced form the effect of distance and other gravity variables on survival rates. In section 4, we structurally estimate the model and conduct counterfactual experiments. In section 5, we develop the case of interdependent markets and derive predictions on survival probabilities by export experience. In section 6, we estimate the effect of different forms of experience on survival rates. The last section presents concluding remarks.

2 Determinants of exporter survival (I): Independent markets

In this section, we develop a theoretical model to study exporter survival. We analyze the problem of a firm that has to decide whether and when to enter a foreign market. In section 2.1, we describe the setup of the model. In section 2.2, we find the optimal entry threshold θ_k^* in market k. In section 2.3, we derive the probability of survival upon entry and perform comparative statistics on parameters that vary across firms and markets. Here, we focus on the case in which the entry decision is independent across markets. Specific cases of interdependence are analyzed in section 4.

2.1 Setup

A firm is characterized by a time-varying profitability parameter θ_{kt} and a constant profitability shifter ψ_k for each of K foreign markets. These parameters determine the firm's operating profits conditional on exporting, $\pi_{kt} = \psi_k \theta_{kt}$. The firm-specific profitability shifters ψ_k capture ex-ante differences, such as the firms' ability to match idiosyncratic tastes or their overall productivity, while θ_{kt} reflects productivity or demand shocks. Following Luttmer (2007), Impullitti, Irarrazabal, and Opromolla (2013), and Arkolakis (Forthcoming), we assume that the profitability parameter θ_{kt} follows a geometric Brownian motion (GBM):

$$d\theta_{kt} = \alpha \theta_{kt} dt + \sigma \theta_{kt} dz_t;\ \theta_0 \text{ given}$$

where α and σ are, respectively, the drift and volatility parameters, and z_t is a standard Brownian motion. Firms are risk-neutral and have a constant discount factor υ. We assume $\upsilon > \alpha$ to ensure that expected discounted profits are bounded. We allow the $\{\theta_{kt}\}$ processes to be correlated across markets.[2] For example, $\{\theta_{kt}\}$ could be the combination of a productivity process $\{\varphi_t\}$ common to all markets and a demand process $\{\lambda_{kt}\}$ independent across markets.[3]

Each foreign market is characterized by the parameters S_k and F_k. To enter an export market, the firm must pay a sunk cost given by S_k. Also, exporting to market k entails paying fixed costs F_k on a continuous basis while the firm is exporting. Sunk costs are typically assumed by the literature to include activities such as setting up a distribution network, learning foreign regulations, and undertaking marketing efforts to establish a product or brand in the market. However, as we argue in section 3, those activities also require continuous maintenance. Analogously, most activities that involve fixed costs have an irreversible component which can be considered a sunk cost. Given the conceptual difficulty in distinguishing activities that are either sunk or fixed costs, we propose to interpret these costs as follows. Think of S_k as the investment a firm needs to make in a variety of activities when it first enters market k to achieve a certain stock that needs to be maintained. This stock depreciates at rate δ_k. Therefore, to maintain the initial stock and be able to keep its exporting status, the firm needs to pay $F_k = \delta_k S_k dt$ per unit of time. In this section, we assume that both S_k and F_k are independent across markets. Section 4 will consider cases of interdependence.

Finally, we assume that whenever $\pi_{kt} < F_k$, the firm can suspend its activity in market k without cost and resume it when conditions improve without having to repay the sunk cost S_k. Hence, after entering market k, the firm is forever entitled to the flow of net profits $\Pi_{kt} = \max\{\pi_{kt} - F_k, 0\}$.[4] This assumption is consistent with the pervasiveness of re-entry in export markets (see Fanelli and Hallak, 2015). Nevertheless, as we discuss later, our main results hold even if S_k needs to be repaid at the beginning of each export spell.

2.2 Solving for the entry threshold θ_k^*

Formally, the entry problem of the firm is a standard "optimal stopping" problem in a context of investment under uncertainty (Dixit and Pindyck, 1994). There are three possible states of the firm regarding its activity in market k. The firm is "inside" market k if it has paid the sunk cost S_k and it is "outside" market k otherwise. In turn, an inside firm can be "active" if it is currently operating in the market ($\pi_{kt} \geq F_k$) or "inactive" otherwise ($\pi_{kt} < F_k$). At every instant while the firm is outside market k, it must decide whether to continue in its current state or pay the sunk cost to enter this market. The solution to this entry problem is characterized by a unique threshold value θ_k^* such that the firm stays outside market k if $\theta_{kt} \in [0, \theta_k^*)$ and enters this market if $\theta_{kt} \in [\theta_k^*, \infty)$.

[2] The fact that θ_0 is common across markets and firms is wlog because of the presence of ψ_k. Equivalently, we could set $\psi_k \equiv 1$ and allow the initial value θ_{k0} to differ across firms and markets.

[3] Luttmer (2007) shows that θ_{kt} can be microfounded as a combination of demand and productivity shocks that follow a multivariate GBM in a stationary monopolistic-competition environment with CES preferences.

[4] Note that under our suggested interpretation of fixed and sunk costs there is no depreciation of the investment if the firm does not export.

Let $V_{0k}(\theta_{kt})$ denote the value of an outside firm and $V_{1k}(\theta_{kt})$ denote the value of an inside firm. Using standard results of GBMs, we obtain[5]

$$
\begin{aligned}
V_{0k}(\theta_{kt}) &= A_{0k}\theta_{kt}^{\beta_1} \\
V_{1k}(\theta_{kt}) &= \left\{ \begin{array}{c} A_{1k}(\psi_k\theta_{kt})^{\beta_2} + \frac{\psi_k\theta_{kt}}{\upsilon-\alpha} - \frac{F_k}{\upsilon} \text{ if } \theta_{kt} \geq \frac{F_k}{\psi_k} \\ B_{1k}(\psi_k\theta_{kt})^{\beta_1} \text{ if } \theta_{kt} < \frac{F_k}{\psi_k} \end{array} \right\}
\end{aligned}
$$

where

$$
\beta_{1,2} = \frac{1}{2} - \frac{\alpha}{\sigma^2} \pm \sqrt{\left(\frac{\alpha}{\sigma^2} - \frac{1}{2}\right)^2 + \frac{2\upsilon}{\sigma^2}},
$$

A_{1k} and B_{1k} are positive constants, and A_{0k} is an unknown constant.

Since θ_{kt} follows a diffusion, the solution must satisfy a value-matching and a smooth-pasting condition at the threshold θ_k^*,

$$
V_{0k}(\theta_k^*) = V_{1k}(\theta_k^*) - S_k
$$

$$
\frac{dV_{0k}(\theta_{kt})}{d\theta_{kt}}|_{\theta_k^*} = \frac{dV_{1k}(\theta_{kt})}{d\theta_{kt}}|_{\theta_k^*}.
$$

Define "normalized" profitability as $\tilde{\theta}_{kt} \equiv \frac{\psi_k\theta_{kt}}{F_k}$ and the "normalized" entry threshold as $\tilde{\theta}_k^* \equiv \frac{\psi_k\theta_k^*}{F_k}$. In our particular setting, these conditions lead to the following equation,

$$
\left(\frac{\beta_1}{\upsilon} - \frac{\beta_1 - 1}{\upsilon - \alpha}\right)\tilde{\theta}_k^{*\beta_2} + \frac{(\beta_1 - 1)}{\upsilon - \alpha}\tilde{\theta}_k^* - \beta_1\left(\frac{1}{\upsilon} + \frac{S_k}{F_k}\right) = 0. \tag{1}
$$

The only unknown in this equation is $\tilde{\theta}_k^*$. While we cannot solve for $\tilde{\theta}_k^*$ in closed form, the following lemma will help us characterize key features of the implicit solution.

Lemma 1. Let $G_k(\tilde{\theta}_k)$ be the left-hand-side of equation (1). Then, there is a unique $\tilde{\theta}_k^* \in [1, \infty)$ such that $G_k(\tilde{\theta}_k^*) = 0$. Furthermore, $G_k'(\tilde{\theta}_k^*) \geq 0$, with strict inequality if $\tilde{\theta}_k^* > 1$. Finally, $\tilde{\theta}_k^* = 1$ iff $S_k = 0$.

Proof. See Appendix *A*.1.

Note that since $\frac{S_k}{F_k}$ is common across firms, so is $\tilde{\theta}_k^*$. Hence, the (un-normalized) entry threshold θ_k^* is firm-specific and directly proportional to the demand shifter, ψ_k, and to the inverse of fixed costs, F_k^{-1}. In other words, firms with higher ψ_k have a lower θ_k^* and, hence, will be more likely to enter market k. Note, however, that as long as the $\{\theta_{kt}\}$ processes are not perfectly correlated across markets, a firm's market entry sequence is not predetermined.

2.3 The probability of survival

We define the probability of survival $P_k(T)$ as the probability that a firm entering market k at time τ is still active in that market at time $\tau + T$. As an initial condition, we assume all firms are born with an initial

[5] We provide detailed derivations in Online Appendix 1, available from the authors' websites.

value θ_0 that is lower than θ_k^*.[6] Therefore, the continuity of the process for θ_{kt} ensures that all firms enter market k with $\theta_{kt} = \theta_k^*$. In turn, they exit (possibly temporarily) whenever operating profits π_{kt} fall below F_k, which occurs at $\theta_{kt} = \frac{F_k}{\psi_k}$.

The survival probability $P_k(T)$ can be written as:

$$P_k(T) = P\left(\theta_{k,\tau+T} > \frac{F_k}{\psi_k}\bigg|_{\theta_{k\tau}=\theta_k^*}\right).$$

Since θ_{kt} is a GBM with parameters α and σ, $\ln\theta_{kt}$ is a standard Brownian motion with drift $\mu = \alpha - \frac{1}{2}\sigma^2$ and volatility σ. Hence, the distribution of $\ln(\theta_{k,\tau+T})$ conditional on $\ln(\theta_{k\tau})$ is normally distributed with mean $\ln(\theta_k^*) + \mu T$ and variance $\sigma^2 T$. $P_k(T)$ can be computed as:

$$P_k(T) = 1 - \Phi\left(\frac{\ln(\frac{F_k}{\psi_k\theta_k^*}) - \mu T}{\sigma\sqrt{T}}\right). \tag{2}$$

Equation (2) displays a closed form solution for the survival probability in market k as a function of model parameters and the endogenous entry threshold θ_k^*. All model parameters except for the market-specific shifter ψ_k are common across firms. Those parameters include the sunk cost (S_k), the fixed cost (F_k), and the parameters of the general profitability process (α and σ). Therefore, only differences in ψ_k, and those they induce on θ_k^*, could potentially generate variation across firms in survival probabilities. However, as we show next, $P_k(T)$ does not depend on ψ_k. As a result, this probability is the same for all firms upon entry into market k.

Proposition 1. $P_k(T)$ is independent of ψ_k.

Proof.

Using our definition of $\tilde{\theta}_{kt}$, we can rewrite (2) as:

$$P_k(T) = \Phi\left(\frac{\ln\tilde{\theta}_k^* + \mu T}{\sigma\sqrt{T}}\right). \tag{3}$$

Lemma 1 established that $\tilde{\theta}_k^*$ is common to all firms. Therefore, (3) establishes that the probability of survival in market k is also common to all firms. *QED*

Proposition 1 provides a "neutrality" result. This result is critical for our empirical analysis. It implies that the probability of survival does not depend on the unobserved value of the heterogeneous parameter ψ_k and hence is common to all firms entering market k. This probability will vary across markets solely as a function of S_k and F_k. An implication of this result is that the model does not need to impose any restriction on the distribution of ψ_k across firms or markets.

[6] Assuming $\frac{\psi_d\theta_0}{F_d} > 1$ and $S_d = 0$ firms serve their domestic market first (d = domestic).

The probability of survival is unaffected by ψ_k because this parameter induces inversely proportional changes in the entry and exit thresholds, compensating each other's effect on this probability. The intuition is simple. Suppose that market k is ex-ante more appealing *ceteris paribus* for firm 1 than for firm 2 ($\psi_{k1} > \psi_{k2}$). Then, firm 1's entry threshold will be lower and the firm will be more likely to enter that market sooner. However, it will also exit with a proportionally lower threshold. Since entry and exit thresholds decrease proportionally with ψ_k, the probability of survival does not change. Note that this result implies that profitability differences across markets that are general to all firms will not have any effect on survival rates either. For example, market k may be more profitable than market k' for all firms because it is larger or geographically more proximate. Nevertheless, since entry and exit thresholds will be (proportionally) lower, this fact will not generate different survival probabilities in the two markets.

The second proposition relates the probability of survival to the relative size of sunk and fixed costs:

Proposition 2. $P_k(T)$ is increasing in the ratio of sunk to fixed costs $\frac{S_k}{F_k}$. If $S_k = 0$, then $P_k(T)$ is invariant to the size of fixed costs.

Proof.

From the definition of G, it is immediate that $\frac{\partial G_k(\tilde{\theta}_k)}{\partial(S_k/F_k)} < 0$. If $S_k > 0$, by Lemma 1 we also know that $\frac{\partial G_k(\tilde{\theta}_k)}{\partial\tilde{\theta}} > 0$. Hence, applying the implicit function theorem, we obtain $\frac{\partial\tilde{\theta}_k^*}{\partial(S_k/F_k)} > 0$. Since P_k is increasing in $\tilde{\theta}_k^*$ (equation 2), we obtain that $\frac{\partial P(\tilde{\theta}_k^*(S_k/F_k))}{\partial(S_k/F_k)} > 0$.

If $S_k = 0$, then $\tilde{\theta}_k^* = 1$ regardless of the level of F_k. Since $\tilde{\theta}_k^*$ is a sufficient statistic for $P_k(T)$, this probability will also be invariant to F_k. *QED*

Proposition 2 establishes that the probability of survival will be higher in markets where sunk costs are larger relative to fixed costs. To understand this result further, note that the normalized entry threshold ($\tilde{\theta}_k^* \equiv \frac{\psi_k \theta_k^*}{F_k}$) is a measure of entry profits relative to fixed costs. Hence, in markets with higher $\frac{S_k}{F_k}$ firms will require higher expected profitability relative to fixed costs to enter. Thus, they will enter those markets with a higher value of $\tilde{\theta}_k$ and as a result will survive longer. A trivial corollary of this result is that $P_k(T)$ increases with S_k conditional on F_k while it decreases with F_k conditional on S_k.

In case S_k and F_k change proportionally, the (unnormalized) entry threshold changes in the same proportion, leaving $P_k(T)$ unaltered. Given that θ_{kt} is a GBM, expected profits at the new threshold will increase in the same proportion as S_k, maintaining the balance between the costs and benefits of entry. Finally, if $S_k = 0$, the level of fixed costs does not matter. In that case, since there is no value of waiting, the entry threshold is equal to the exit threshold. Therefore, the probability of survival is just determined by the probability that a GBM that passes a given point at time τ remains above that point at time $T + \tau$. That probability does not depend on the particular entry/exit point.

The fact that firms can costlessly exit and re-enter markets is not essential for the results. In the Online Appendix 2, we solve the model under the alternative assumption that sunk costs must be paid at the beginning of each export spell as in Das, Roberts, and Tybout (2007). On the contrary, the fact that the profitability process following a GBM and that the market-specific profitability shifters are multiplicative are necessary for the sharp results of propositions 1 and 2. However, these assumptions are useful to generate a clean benchmark for understanding how survival probabilities are determined. While more general stochastic processes or demand structures might induce deviations from this benchmark, the direction in which alternate assumptions might affect these results is not obvious. In any event, the result that the probability of survival increases with sunk costs holds with minimal assumptions on the stochastic process for profitability.[7]

3 Empirical analysis (I): Independent markets

To empirically assess the predictions of the model, we exploit firm-level customs data on the universe of Argentine export transactions during the period 1994-2006. We start by describing the data (section 3.1) and establishing some basic facts about export survival of Argentine firms (section 3.2). The econometric analysis of the predictions obtained under the case of independent markets are discussed in section 3.3.

3.1 Data

The primary source of information of our dataset is Argentine customs data (ACD). Our dataset covers firm-level exports of all Argentine firms (including agriculture). Each record corresponds to a firm's unique 10-digit tax code (national identification tax number, CUIT); the exported good identified at the 12-digit level NCM (Nomenclador Común del Mercosur); the destination country; and the value exported in a given year. The dataset spans from 1994 to 2006. Data on geographical distance and other gravity variables come from the CEPII Gravity Dataset. This dataset includes measures of bilateral distances (in kilometers), GDP, population, and whether a country pair shares a border or an official language.

Before turning to the descriptive statistics, we introduce the following terminology. First, we denote an "incursion" as a firm's first entry in a given destination market (i.e. re-entering a market previously served is not considered an incursion). Second, "export survival" indicates whether the firm exports two years after the incursion.[8]

3.2 Facts about Argentine exports and export survival

During the period of our study, Argentine exports experienced steady growth from 1994 to 1998, and became anemic from 1999 to the economic collapse of 2001. Following the dramatic currency devaluation of early 2002 (more than 140% in the first quarter of 2002), Argentine exports boomed, increasing more than 80% between 2002 and 2006. Figure 1 displays this evolution. We also note a similar trend for manufacturing goods (Harmonized System two-digit categories greater than 27) and differentiated goods (defined according

[7] The required assumption is that the process satisfies first-order-stochastic dominance, i.e. if $\theta_t' > \theta_t$ then $\Pr(\theta_{t+dt} \geq x|\theta_t') > \Pr(\theta_{t+dt} \geq x|\theta_t)$.

[8] Note that we do not impose consecutive exports in our definition of export survival. Alternative measures of survival will be used to check the robustness of our results.

to Rauch (1999)).

Figure 1: Argentine Exports (1994 - 2006)

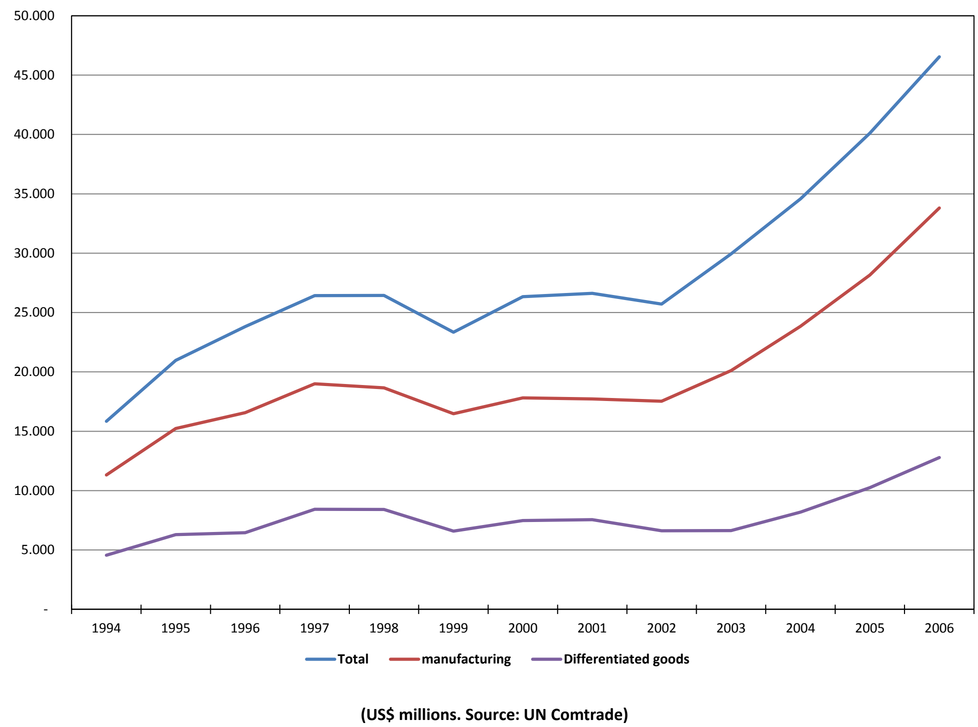


Table 1 provides basic information about exports from Argentina. The value of exports almost tripled during the period, whereas the number of firms selling abroad increased by about 50%; from 9559 exporting firms in 1994 to 14960 in 2006. The number of incursions per year followed a u-shaped trajectory. First, we observe a peak of 13955 incursions in 1995. Then, we see a steady fall in incursions until reaching a minimum in 2001 (9022). After the 2002 currency devaluation, the number of incursions resumed growth to reach 13684 incursions in 2004. Incursions involved average sales of about US$ 12000, exhibiting a decreasing trend over time (the geometric mean of sales per incursion rages from US$ 22136 in 1995 to US$ 7899 in 2003). Finally, the last column reports the survival rate, that is the fraction of surviving incursions. This fraction is generally low (around 31%) and it is slightly higher during 1995, 1996, and the years after the 2002 currency devaluation. We note that both the number of incursions and the survival rates might be overestimated in 1995 and 1996 by our inability to exclude re-entrants with export activity previous to 1994 and the fact that re-entrants tend to survive more.[9]

[9] We deal with this issue later with a robustness exercise where we focus on incursions to destinations for which we are certain that the firm did not export for at least the previous 4 years.

Table 1: Argentine Exports, 1994-2006

Year	Export Value (millions US$)	# Firms	# Incursions	Sales per incursion (geometric mean)	Rate of survival upon entry
1994	15800	9559			
1995	20900	11025	13955	22136	0.34
1996	23800	11376	11816	19045	0.31
1997	26200	12107	11772	16281	0.28
1998	26200	12583	11931	8506	0.27
1999	23400	11818	10254	9833	0.28
2000	26400	11433	9239	9373	0.29
2001	27000	11217	9022	10818	0.30
2002	25500	12753	13219	8400	0.31
2003	29300	13602	13962	7899	0.33
2004	34200	13992	13684	9321	0.33
2005	39400	14668			
2006	46000	14960			
	Total:	Average:	Total:	Average:	Average:
	364100	12392	118854	12161	0.31

3.3 Empirical analysis

Proposition 2 states that the probability of survival increases with the ratio $\frac{S_k}{F_k}$. Ideally, we would like to have good measures of S_k and F_k to test whether survival rates upon entry are higher in markets with higher $\frac{S_k}{F_k}$. However, neither S_k nor F_k are observable. Furthermore, we cannot find a set of proxies that we can distinctively associate with each of these two variables because both types of costs are incurred on similar activities. To see this, consider the activities typically thought of as sunk costs by the literature. They involve, for example, establishing distribution channels, designing marketing strategies, complying with local regulations, learning about exporting procedures, and adapting to the institutional and cultural characteristics of destination countries. While these activities have an upfront component and hence are justifiably associated with sunk costs, they also need to be conducted repeatedly after the initial investment. Thus, they are also a fixed cost. For example, distribution networks have to be maintained over time, learning and adapting to an evolving environment is usually done on a continuous basis, and knowledge about regulations has to be regularly updated.

Since we cannot find variables that convincingly proxy for $\frac{S_k}{F_k}$, we cannot perform a test of Proposition 2. However, by exploiting the observed variation in survival rates across markets at different distances, we can use this proposition to infer how $\frac{S_k}{F_k}$ varies.[10] While this ratio will be the focus of our empirical analysis, as a preliminary step to help interpret the results, we present some evidence suggesting that the absolute magnitudes of these exporing costs increase with distance. In the model, exit thresholds, which are in terms of profits, are proportional to fixed costs. Under CES preferences, this translates into an observable

[10]We note that since we are only using exports from one country, we cannot rule out that omitted factors that are correlated with Argentina's bilateral distances also affect the results.

implication: sales of exiting firms have to be larger the higher are the fixed costs. Specifically, we run the following regression:

$$\ln x_{kt}^{exit} = \alpha_1 \ln d_k + \gamma_t + \mu_{kt},$$

where $\ln x_{kt}^{exit}$ is the average (log) exit sales from market k at time t, d_k is the distance from Argentina to the destination market, and exit sales refer to exports the year before a firm stops exporting for at least one year. We also include γ_t to capture year fixed effects. Table 2 reports the results. The results show that exit sales increase with distance, which implies that fixed costs are larger in more distant destinations.[11] To the extent that sunk and fixed costs involve similar activities, this evidence suggests that sunk costs increase with distance as well.

Table 2: Exit Sales and Distance

	(1)	(2)
$\ln d_k$	0.571***	0.616***
	(0.129)	(0.110)
Constant	0.054	-0.358
	(1.179)	(1.005)
Year FE :	no	yes
Observations	2193	2193
R-squared	0.008	0.281

Standard errors in parentheses
*** p<0.01, ** p<0.05

Table 3 displays survival rates for different country groupings. Panel A groups countries according to geographical regions. The most salient feature in this panel is that the survival probability is highest for Argentine firms entering other Latin American countries. Panel B groups countries according to different distance ranges from Argentina (Short distance, Medium distance and Long distance) and compute the probability of export survival for each range. The probability is highest in the closest group of countries and is lowest in the farthest group. Additional evidence reported in Panel B suggests that sharing borders and language raises the probability of survival by about 10%. Finally, we group countries according to whether their income level is Low and Middle or High, following the definition of the World Bank. The probability of survival is about 20% lower for incursions of Argentine firms in High-income countries (Panel C).

One of the clearest messages of Table 3 is that distance affects the probability of export survival. We can estimate this relationship by running a linear probability model at the incursion level:

$$P_{ikt} = \alpha_1 \ln d_k + \gamma_t + \mu_{ikt},$$

where P_{ikt} is the probability of being active T years ($T = 2$) after the export incursion of firm i in market

[11] This result also holds if we include firm fixed effects.

Table 3: Rate of Survival by Year and Region

	# Incursions	Sales (gmean)	Rate of survival upon entry
Panel A: Regions			
Latin America	61918	10091	0.34
North America	10772	8101	0.29
EU	14923	12713	0.30
Spain and Italy	9190	8510	0.27
China	1162	26469	0.25
Rest of the World	20889	20031	0.27
Panel B: Gravities			
Short-distance	27109	9487	0.35
Medium-distance	21066	11883	0.33
Long-distance	70679	12162	0.28
Contiguous country	42674	10925	0.34
Same Language	68210	9918	0.33
Panel C: Income			
Low and Middle Income Country	73644	12184	0.33
High Income Country	45210	10336	0.27
Total	118854	12161	0.31

k in period t, and d_k stands again for the distance between country k and Argentina. Note that, based on the results of Proposition 1, this probability is the same across all firms that enter market k regardless of the firm-specific appeal of this market. We also include γ_t to control for year fixed effects.[12] Since the main regressor varies at a more aggregate level (k) than the unit of observation (i), we allow the error term (μ_{ikt}) to be clustered at the destination level. In addition, we allow for multi-way clustering at the firm and destination levels following the procedure developed by Cameron, Gelbach, and Miller (2011).[13]

In Table 4, we report the baseline results of this section. As shown in column 1, the coefficient associated with distance is negative and significant at the 1% level. This result is almost unaffected by the inclusion of year fixed effects (column 2). Other country-specific characteristics may also capture differences in fixed and sunk costs across countries. We consider *Common Language*$_k$ (whether country k shares the same language with Argentina) and *Contiguity*$_k$ (whether country k and Argentina share a border). These variables can arguably be associated with lower sunk and fixed costs. A common language, for example, may facilitate the establishment and maintenance of distributions networks, as well as ease understanding of country-specific legal and cultural idiosyncrasies. Contiguity, in turn, is a proxy for geographical distance and cultural similarities. Column 3 shows that having a common language has a significantly positive effect on the

[12] Although the theory does not point to yearly changes that should be controlled for with time fixed effects, we include them to control for the potential effect of movements in the exchange rate. In particular, a devaluation as the one that occurred in Argentina in 2002 may induce discrete jumps in θ_{kt}. Those jumps may either increase the survival probability of firms that have already entered a foreign market or they may increase it for firms that might enter this market with a value of θ_{kt} above the entry threshold.

[13] We cannot apply this procedure to cluster at the firm and destination levels when we control for firm or firm-year fixed effects (as we do later in Tables 7 and A.1) because the estimated variance-covariance matrix is not positive semi-definite. This procedure cannot be used either when we estimate using a Probit model as a robustness check (Table A.1).

Table 4: Survival and Gravities

	(1)	(2)	(3)	(4)
$\ln d_k$	-0.027***	-0.028***	-0.024***	-0.037***
	(0.003)	(0.003)	(0.007)	(0.008)
	[0.003]	[0.003]	[0.006]	[0.008]
$Common\ Language_k$			0.025**	0.041**
			(0.013)	(0.017)
			[0.012]	[0.018]
$Contiguity_k$			-0.011	-0.017
			(0.013)	(0.015)
			[0.012]	[0.016]
$\ln X_{ikt}$				0.031***
				(0.001)
				[0.001]
ln $NINCUR_{it}$				0.014***
				(0.001)
				[0.001]
Constant	0.533***	0.542***	0.497***	0.264***
	(0.022)	(0.021)	(0.064)	(0.001)
	[0.023]	[0.026]	[0.059]	[0.001]
Year FE :	no	yes	yes	yes
Observations	118,776	118,776	118,776	118,776
R-squared	0.004	0.007	0.007	0.044

Robust standard errors in parentheses clustered at the destination level
Robust standard errors in brackets clustered (two-way) by firm and destination
*** p<0.01, ** p<0.05, * p<0.1

probability of survival. By contrast, the effect of contiguity is not significant. In any event, the effect of distance is robust to the inclusion of these two controls.

There is a mismatch between our theoretical results and their empirical implementation. In our model, since time is continuous firms make an incursion into a new destination as soon as export profitability hits the entry threshold. Hence, we calculate the survival probability after T periods since that precise instant in time. In the data, time is discretized in yearly periods. Thus, reported export sales in the year of entry aggregate through time the implication for sales of a continuum of profitability shocks. Even if firms enter with equal (instantaneous) sales, the yearly figure we observe incorporates a specific trajectory of θ_{kt} once it has passed the entry threshold. In addition, as we do not know the exact moment at which the incursion takes place within the reported year, the time span over which sales are aggregated may vary across incursions. To control for this mismatch, we include export sales at the year of the incursion (X_{ikt}) and the number of simultaneous incursions by firm i in year t ($NINCUR_{it}$). Both variables capture the combined effect of the profitability trajectory – since entry until the end of the reported period – and the time of entry within the period. For example, a firm that has entered market k at the beginning of the reported period and since then has received positive shocks to profitability will exhibit both higher reported sales in market k during the period and entry into additional export markets. In both cases, these are proxies for a high θ_{kt}, which will raise the probability of survival. As expected, column 4 shows that both variables are positively associated with export survival. Nonetheless, the estimated effect of distance becomes stronger.

To interpret the magnitude of the effect of distance, consider the difference in survival probabilities between entering a short-distance and a long-distance destination. According to Table 3, the probability of survival upon entering a short-distance country is 0.07 percentage points higher. Consider now the difference in the average (log) distance from Argentina to each of these two groups of countries. This difference is 2.473 (not shown). As the coefficient associated with d_k is -0.024 (column 3), the difference in distance between these two country groups implies a predicted variation in export survival of 0.06 percentage points. Thus, variation in distance explains 85% of the observed difference in survival probabilities between short-distance and long-distance destinations.

We have also run additional regressions to check the robustness of our results. These are as follows: (i) we control for firm-invariant characteristics by including firm fixed effects; (ii) we estimate the effect of distance with a probit instead of a linear probability model; (iii) we use a definition of survival that imposes consecutive export spells (at least three years) and treats re-entries as new export incursions; (iv) we re-define "export survival" more strictly by imposing that a new export incursion has to be active three years later instead of two. We have also considered different samples of our data. As we do not observe whether a firm exported to a particular market before 1994, we might have treated a re-entry as a new incursion. To mitigate this potential bias, we restrict the analysis to incursions after 1997. This ensures that the firm did not export in the last 4 years before the incursion took place in the new market. We also address the potential effects of the currency devaluation of 2002 by excluding incursions in years 2000, 2001 and 2002 from our sample. This ensures that survival rates are not artificially high as a result of the unexpected devaluation. Finally, we restrict the sample to manufacturing goods (Harmonized System 2-digit categories greater than 27). The results of these alternative specifications are reported in Appendix Table A.1. None of these results changes the main message in a relevant way: the probability of survival is lower in more distant destinations and is usually higher in countries related by other gravity variables.

4 Model fit and quantitative implications

The fact that the survival rate decreases with distance and increases with other gravities implies that $\frac{S_k}{F_k}$ decreases with distance and increases with other gravities as well. In this section, we parametrize the relationship between $\frac{S_k}{F_k}$ and distance and estimate it using the model developed in section 2. Then, we study the model's implications for re-entry patterns and the contribution of new exporters to aggregate exports. Finally, we conduct counterfactuals alternatively removing sunk costs, and decreasing fixed costs and foreign tariffs.

4.1 Quantifying the sunk-to-fixed cost ratio

The probability of survival in market k depends on a subset of model parameters $\left\{\mu, \sigma, \upsilon, \frac{S_k}{F_k}\right\}$, as can be inferred from equations (1) and (3). To simulate the model, we need to assign them specific values. First, given a ratio $\frac{\mu}{\sigma}$ the model cannot rationalize a probability of survival at time T below the lower bound $\Phi\left(\frac{\mu}{\sigma}\sqrt{T}\right)$, which arises when $S_k = 0$. This is an important restriction. For example, to rationalize the predicted survival probability of 0.268 delivered by our OLS estimates for the most distant market in the data, the model requires a ratio $\frac{\mu}{\sigma} \leq -0.44$. This bound coincides with the ratio calibrated by Impullitti, Irarrazabal, and Opromolla (2013), who to the best of our knowledge obtain the most negative value of $\frac{\mu}{\sigma}$ in the literature. We set $\frac{\mu}{\sigma} = -0.44$ to maximize predictive power while maintaining $\frac{\mu}{\sigma}$ within the range of available estimates. For ratios closer to zero, the model gradually loses its ability to explain the variability of survival with distance, eventually predicting $S_k = 0$ for all markets.[14]

Having set $\frac{\mu}{\sigma}$, we need to set these parameters' absolute values. In section 4.2, we show that the upper tail of the exporter profitability distribution is Pareto with shape parameter $r_2 = \frac{1}{\sigma}\left(-\frac{\mu}{\sigma} + \sqrt{\left(\frac{\mu}{\sigma}\right)^2 + 2g_B}\right)$, where g_B is the growth rate in the mass of new firms. In this section, we assume a constant mark-up arising from CES preferences and monopolistic competition. Thus, r_2 also describes the upper tail of the sales distribution. Using our customs data for the top five destinations, we find that the upper tail of the exporter size distribution is well approximated by a Pareto distribution with a shape parameter of 1.44.[15] Using this parameter value in the above formula and setting $g_B = 0.038$ to match the average annual growth rate in the number of exporters in our database, we obtain $\mu = -0.29$ and $\sigma = 0.66$.[16] Last, we set $\upsilon = 0.1$ to match the average annual real lending rate in Argentina between 1995 and 2006.[17]

Finally, we posit a log-linear relationship $\frac{S_k}{F_k} = \varsigma_0 + \varsigma_1 \ln d_k$. Since we are interested in the relationship between survival and distance we estimate ς_0 and ς_1 by the Generalized Method of Moments (GMM) to match the sample analogs of $E\left[P_{ikt}\right]$ and $E\left[P_{ikt} \ln d_k\right]$.[18] We restrict the parameter space so that $\frac{S_k}{F_k} \geq 0$ for all distances in our database. We perform this estimation for our baseline case, where we set $\frac{\mu}{\sigma} = -0.44$, and for an alternative case, where we set $\frac{\mu}{\sigma} = -0.66$.

Panel A of Table 5 displays the estimation results. In the baseline estimation, the model fits the moments very well, implying that the nonnegativity constraint on $\frac{S_k}{F_k}$ does not play a major role.[19] As expected, the ratio of sunk to fixed costs decreases with distance. Nevertheless, the magnitude of this ratio and its estimated

[14] We find that when $\frac{\mu}{\sigma} = -0.35$ the predicted probability of survival barely varies with distance. This implication applies, in particular, to the less negative $\frac{\mu}{\sigma}$ used in Luttmer (2007) and in Arkolakis (Forthcoming).

[15] More specifically, for each year and destination we restrict the sample to the 1% largest firms and regress $\log(sales_{ikt})$ against the fraction of firms that export at least $sales_{ikt}$. If the distribution is Pareto with shape parameter r_2, then the slope coefficient is $-\frac{1}{r_2}$. Then, we take the simple average across destinations and years. We use the top five destinations measured by the average number of firms in the sample (in order: Uruguay, Brazil, Chile, the United States and Paraguay) to have a reasonable number of firms. Doing the same computation for French exporters, Eaton, Kortum, and Kramarz (2011) find an average number of 1.49.

[16] In the steady state, all aggregate variables grow at rate g_B.

[17] We deflate the annual nominal lending rate by the consumer price index, using data from the International Financial Statistics (IFS) database.

[18] See details in Appendix A.2.

[19] This restriction still binds in our baseline estimation. As $\frac{\mu}{\sigma}$ becomes closer to 0, the restriction turns more important and the model decreases its ability to fit the moments. Conversely, the model's fit improves with more negative $\frac{\mu}{\sigma}$.

range of variation are both strikingly small. In our baseline specification, the ratio varies from a maximum value of 0.09 for the shortest distance to 0 for the longest distance.[20] These figures are sensitive to the choice of $\frac{\mu}{\sigma}$. To illustrate this point, we re-estimated the model with a 50% more negative $\frac{\mu}{\sigma}$. The estimates in this alternative case imply a maximum $\frac{S_k}{F_k}$ that is one order of magnitude larger (the maximum ratio is 0.54).

Under both specifications, the importance of sunk costs vis-a-vis fixed costs is at odds with existing estimates in the literature. For example, working with a similar model to ours, Impullitti, Irarrazabal, and Opromolla (2013) find that sunk costs are 65 times larger than fixed costs. Similarly, Das, Roberts, and Tybout (2007) and Morales, Sheu, and Zahler (2014) find that sunk costs are substantial but fixed costs are negligible or substantially lower. Impullitti, Irarrazabal, and Opromolla (2013) obtain such a high $\frac{S_k}{F_k}$ estimate because they do not use survival rates upon entry to discipline their estimation procedure. At odds with the data, their model implies a survival probability of 0.95 two years after entry.[21] We cannot compute implied survival probabilities upon entry for the other two papers so we cannot check goodness of fit in this dimension. Nevertheless, we think our different results stem from the fact that they impose assumptions about the correlation between domestic and foreign profitability to infer the magnitude of sunk costs. In particular, they infer that sunk costs are high when profitable firms in the domestic market do not enter the foreign market. In our case, failure to enter a foreign market does not convey information about sunk costs as this behavior can always be rationalized with a low value of ψ for firms that do not enter.

The small magnitude of the sunk-to-fixed cost ratio implies there should be a significant amount of re-entry in export markets, especially in more distant ones. To test this implication, we computed the share of entrants that survive at $T = 2$ having exited at $T = 1$. We call these firms "re-entrants". Furthermore, we run a simple OLS regression of the probability of being a re-entrant on (log) distance to compute a predicted range of variation for this share across destinations.[22] Panel B in Table 5 displays the results. The model is successful at explaining these moments, which were not targeted in the estimation.[23] In the baseline parametrization, the model matches the average share of re-entrants (23%) very well.[24] Furthermore, the model is qualitatively consistent with the fact that this share increases with distance, although it quantitatively underpredicts its range of variation.

In sum, our focus on survival probabilities suggests that within the confines of a standard framework that includes (only) sunk costs, fixed costs, and a highly persistent profitability process, sunk costs are necessary to explain the observed variation of survival rates across countries. Still, their overall size is much smaller

[20] To interpret this ratio, note that a firm pays exactly F if it exports the entire year without interruption. However, *effective* fixed costs accumulated during a year are often lower in the model as firms can costlessly suspend operations.

[21] To compute this probability as in their model, we add costly re-entry (as described in the Online Appendix) and a death rate δ. We use their calibrated parameter values for $\frac{S}{F}$, the interest rate r, the death rate δ, and the parameters of the profitability process μ and σ. This parameter configuration yields a similar survival probability assuming instead costless re-entry.

[22] More specifically, we run $y_{ik} = \beta_0 + \beta_1 x_k$, where x_k is (log) distance to market k and y_{ik} is one if incursion i to market k (in year T) survived at $T+2$ but not at $T+1$ and 0 if it survived both at $T+1$ and $T+2$. We obtained $\hat{\beta}_0 = 0.12$ and $\hat{\beta}_1 = 0.014$. Including year fixed effects does not change the results.

[23] Specifically, in the model we compute $\frac{P(\tilde{\theta}_{k2}>1,\tilde{\theta}_{k1}<1)}{P(\tilde{\theta}_{k2}>1)}$, i.e. the probability that a firm that is outside at $T = 1$ exports at $T = 2$, normalized by the mass of survivors at $T = 2$.

[24] The alternative parametrization yields a worse fit. Since the drift is more negative, conditional on surviving at $T = 2$, having survived at $T = 1$ becomes more likely. We interpret this as evidence favoring our baseline calibration of $\frac{\mu}{\sigma}$.

Table 5: Estimation Results

	Baseline estimation $\frac{\mu}{\sigma}$ = -0.44	Alternative estimation $\frac{\mu}{\sigma}$ = -0.66	
Panel A: $\frac{S}{F}$			Data
Coefficient estimates			
ς_0	0.244	1.274	
	(0.000)	(0.000)	
ς_1	-0.025	-0.117	
	(0.000)	(0.000)	
Implied range of $\frac{S}{F}$			
min $\frac{S}{F}$	0.000	0.124	
max $\frac{S}{F}$	0.089	0.542	
Moments			
$E(P_{ikt})$	0.322	0.308	0.308
$E\left(P_{ikt} * \ln(d_k)\right)$	2.669	2.546	2.546
Panel B: Re-entry share			Data (Average) and OLS prediction (max and min)
Average	23.46%	16.73%	22.92%
min distance	23.29%	16.60%	20.19%
max distance	23.60%	16.84%	25.09%
Panel C: θ_0			Data
Coefficient estimates			
η_0	6.045	6.975	
	[0.056]	[0.056]	
η_1	-0.972	-1.009	
	[0.007]	[0.007]	
Implied range of θ_0			
min θ_0	0.029	0.051	
max θ_0	0.950	1.906	
Moments			
$E(\frac{Mkt}{Mt})$	0.016	0.016	0.016
$E\left(\frac{Mkt}{Mt} * \ln(d_k)\right)$	0.002	0.002	0.002

Robust standard errors in parenthesis clustered at the firm level
Robust standard errors in brackets

than previous estimates. Furthermore, the results underscore the important role played by fixed costs in explaining the observed patterns of geographical variation in survival rates. Based on the idea laid out in section 2 that sunk costs are a stock of export-associated activities that depreciates over time and fixed costs are the activities that restore the depreciated stock, a potential interpretation of our empirical results is that the stock of export activities depreciates more rapidly in distant countries. This would be the case if, for example, distribution networks were more difficult to maintain in distant countries or if distant markets required a higher proportion of business services to adapt to changing market conditions. This interpretation would also be consistent with marketing activities that become more preponderant in distant markets.

4.2 Contribution of new exporters to aggregate exports

The relative size of sunk and fixed costs has important potential implications for the contribution of new exporters to aggregate exports. To evaluate those implications, we first need to determine the distribution of exporter profitability. In particular, a key component of this distribution is the relative density of firms near the entry threshold. This density directly affects the strength of adjustment along the extensive margin and thus shapes the dynamics of aggregate exports as well as its response to policies and shocks.

Under the assumption that the mass of new firms grow at rate g_B, Appendix A.3 shows that the cross-sectional distribution of (normalized) profitability $\tilde{\theta}_{kt}$ is a double Pareto distribution with a kink at $\tilde{\theta}_{k0}$:

$$f\left(\tilde{\theta}_k\right) = \left\{ \begin{array}{l} \frac{r_1 r_2}{r_1+r_2}\tilde{\theta}_k^{r_1-1}\tilde{\theta}_{k0}^{-r_1} \text{ if } \tilde{\theta}_k < \tilde{\theta}_{k0} \\ \frac{r_1 r_2}{r_1+r_2}\tilde{\theta}_k^{-r_2-1}\tilde{\theta}_{k0}^{r_2} \text{ if } \tilde{\theta}_k \geq \tilde{\theta}_{k0} \end{array} \right\} \tag{4}$$

where $r_1 = \frac{1}{\sigma}\left(\frac{\mu}{\sigma} + \sqrt{\left(\frac{\mu}{\sigma}\right)^2 + 2g_B}\right)$ and $r_2 = \frac{1}{\sigma}\left(-\frac{\mu}{\sigma} + \sqrt{\left(\frac{\mu}{\sigma}\right)^2 + 2g_B}\right)$. Similarly, the cross-sectional distribution of (normalized) profitability $\tilde{\theta}_{kt}$ of inside firms (i.e. those that have already paid the sunk cost) is also a double Pareto distribution with the same shape parameters but with a kink at $\tilde{\theta}_k^*$ instead of at $\tilde{\theta}_{k0}$.

A key element of the size distribution is the profitability at birth, $\tilde{\theta}_{k0}$. While survival probabilities are independent of this parameter (as long as $\tilde{\theta}_{k0} < \tilde{\theta}_k^*$), the size distribution is not. Thus, we need to estimate it for each k. Define the entry rate as the number of firms exporting to k over the total number of firms $(\frac{M_{kt}}{M_t})$. Appendix A.3 shows that this rate can be expressed as:

$$\frac{M_{kt}}{M_t} = \left\{1 - \frac{r_2}{r_1+r_2}\tilde{\theta}_k^{*-r_1}\right\}\left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2}. \tag{5}$$

This result intuitively establishes that the entry rate is increasing in $\tilde{\theta}_{k0}$ (given $\tilde{\theta}_k^*$). We construct the empirical analog of $\frac{M_{kt}}{M_t}$ by obtaining M_t from the number of manufacturing firms reported in Argentina's 2003 Economic Census and M_{kt} from the number of manufacturing firms in our database exporting to k in that same year.[25] We posit a linear relationship $\ln\tilde{\theta}_{k0} = \eta_0 + \eta_1 \ln d_k$. Given $\{\eta_0, \eta_1\}$, this equation yields a

[25]We calculate this ratio using manufacturing firms because the Economic Census does not include agricultural activities.

prediction for $\tilde{\theta}_{k0}$ and hence for the entry rate in market k. We estimate η_0 and η_1 by GMM to match the sample analogs of $E\left[\frac{M_k}{M}\right]$ and $E\left[\frac{M_k}{M}\ln d_k\right]$.[26]

Panel C of Table 5 displays the results. The coefficient estimates imply that $\tilde{\theta}_{k0}$, and hence entry rates, are lower in farther away destinations. Since $\frac{S_k}{F_k}$ needs to be lower in more distant countries to explain their lower survival rates, the model rationalizes a lower entry rate in those countries by lowering normalized initial profitability $\tilde{\theta}_{k0}$. This implies a lower ψ_k, which would follow naturally in a microfounded model due to higher variable transport costs or a weaker match with idiosyncratic demand.

Equipped with all required parameters, we analyze the model implications for the contribution of new exporters to aggregate exports. At any arbitrary time t with the economy at the steady state, we classify firms in two groups: old exporters ("inside" firms) and new exporters (either "outside" firms or firms unborn at t). Then, we simulate the evolution of each group's aggregate exports at dates $t' > t$ and compute the share explained by new exporters (see details in Online Appendix 3). We perform this simulation for a fictitious "short-distance" market 1 located at the 25 distance percentile and for another "long-distance" market 2 located at the 75 distance percentile.[27] Finally, we compare these model predictions with the data. In the data, we identify a firm as a "new exporter" in market k if it exported to that destination in 1997 or later without having exported in 1994, 1995 and 1996. We aggregate exports across markets into two groups, "short" and "long" distance, depending on whether they are below or above the median distance.

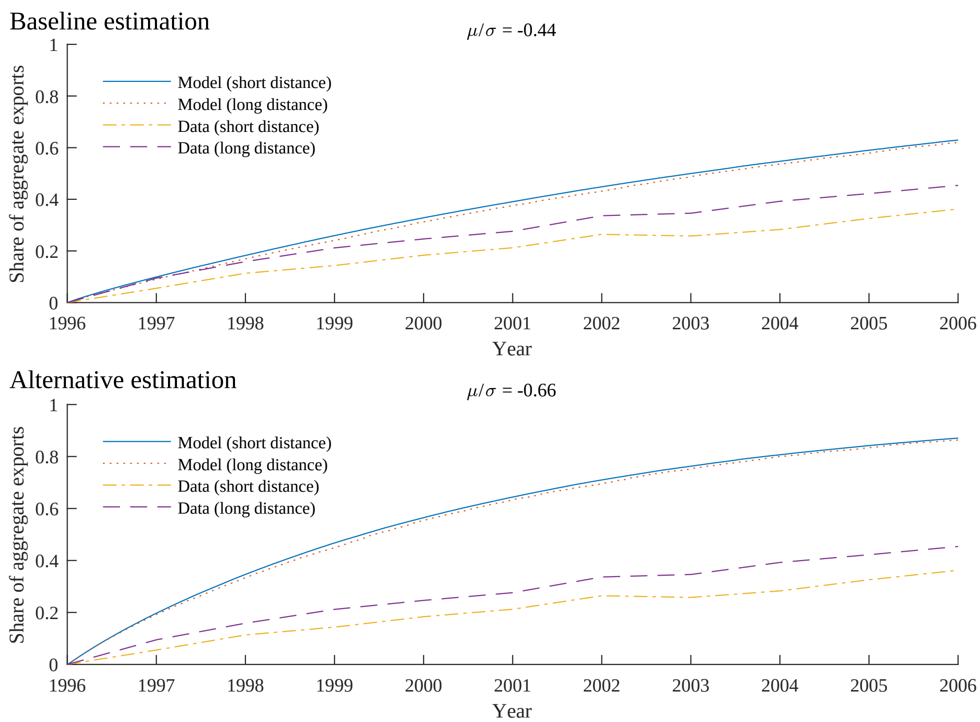
Figure 2 compares model predictions with data for our baseline and alternative estimations. While very stylized, the model does a reasonable job of explaining the contribution of new exporters to aggregate exports in the baseline estimation. Nevertheless, it systematically overpredicts this contribution, especially at long distances. In the case of the alternative estimation (with $\frac{\mu}{\sigma} = -0.66$), the fit is considerably worse. In this case, new exporters counterfactually explain most of aggregate exports in a very short time. The reason is that with a more negative $\frac{\mu}{\sigma}$, positive innovations are more likely to be reversed tomorrow. Hence, future success is mostly determined by luck rather than current profitability, which implies that new firms are less at a disadvantage at birth. Importantly, this evidence strongly favors calibrations of $\frac{\mu}{\sigma}$ that deliver smaller $\frac{S_k}{F_k}$ such as in our baseline case.[28]

[26] See details in Appendix $A.2$.

[27] More specifically, 25% of the export observations go to markets closer (more distant) than market 1 (2).

[28] In essence, in the region of our baseline $\frac{\mu}{\sigma}$ there is a trade-off between fitting the survival moments and fitting the contribution of new exporters to aggregate exports.

Figure 2: Contribution of new exporters to aggregate exports



Finally, note that the model does not predict any quantitatively significant variability with distance: The paths for the short- and long-distance destinations are almost indistinguishable. In contrast, the data suggests that new exporters explain a larger share of aggregate exports in more distant destinations.

4.3 Counterfactual analysis

Our estimation results point to a small ratio $\frac{S_k}{F_k}$. However, this does not imply that sunk costs are unimportant. For example, we already know that, albeit small, they are capable of explaining the variability of survival rates with distance. In this section, we study the importance of sunk costs using another metric: their impact on aggregate exports and the response to trade shocks.

Consider markets 1 (short distance) and 2 (long distance) as in the previous section and imagine that at some point in time T_{shock} sunk costs in market k are unexpectedly lowered to 0.[29] Note that once sunk costs are lowered to 0, there is no hysteresis: exporting becomes a static decision. This implies that all the adjustment occurs instantaneously without transitional dynamics. In fact, at T_{shock} only outside firms in

[29]In keeping our partial equilibrium analysis we assume that (i) the impact of the shock on firm's overall home labor demand is negligible; and (ii) firm's decisions do not affect the destination's price index. Assumption (i) is reasonable for analyzing a shock to a single market as long as the implied labor changes are small relative to the overall size of the home labor market. Assumption (ii) is reasonable for a small open economy such as Argentina.

Table 6: Counterfactual Results

	Baseline estimation $\frac{\mu}{\sigma}$ = -0.44	Alternative estimation $\frac{\mu}{\sigma}$ = -0.66
Change in aggregate exports (%)		
Short distance	1.40	11.95
Long distance	0.31	5.85
Change in τ_F		
Short distance	0.0321	0.2794
Long distance	0.0070	0.1358
Change in τ_u		
Short distance	0.0048	0.0385
Long distance	0.0011	0.0196

the *hysteresis* region change their behavior by entering the market. Using (4) and the analogue for inside firms (11), it is straightforward to compute the ratio of outside firms in this region to the total number of exporters in the original stationary distribution. Our estimates imply that the region is not quantitatively important: in our baseline estimation, new entrants represent only 4.4% and 1% of the original exporters in the short-distance and long-distance destinations, respectively. Thus, as shown in Table 6, the impact of removing sunk costs on aggregate exports is very low: 1.4% and 0.3% for the two distances, respectively. The low entry response is due to the fact that, in our baseline case, estimated sunk costs are low. For comparison, Table 6 also shows the predictions for the case with $\frac{\mu}{\sigma} = -0.66$. Since sunk costs are much higher in this case, outside firms in the hysteresis region represent 38.6% and 18.4% of the original exporters. As a result, the aggregate export response is more than an order of magnitude larger.

Next, we compare the effect of eliminating sunk costs with a different set of shocks. First, we assume that at time T_{shock} fixed costs in market k are unexpectedly reduced to $(1 - \tau_F) F_k$ forever. Second, we assume that at time T_{shock} tariffs τ_k charged to Argentine firms in market k are unexpectedly reduced to $(1 - \tau_U) \tau_k$ forever. In a CES monopolistic competition framework, this reduction increases potential sales to $(1 - \tau_U)^{-\varepsilon} \tilde{\theta}_{kt}$, where ε is the elasticity of substitution across varieties, which we set equal to 2. We compute the size of τ_F and τ_U that generate the same aggregate export response in the steady state as eliminating sunk costs (details in Appendix A.4). Unsurprisingly, Table 6 shows that τ_F is very small while τ_U is even smaller.[30] The response to these two shocks has transitional dynamics in this case. The fact that fixed costs or tariffs are lower implies firms are more likely to become insiders. This "extra kick" from the shock only affects outside firms after T_{shock}. Thus, as long as $S_k > 0$, the long-run export elasticity will be larger than the short-run elasticity. While this statement is qualitatively true, in our simulations we find that aggregate exports converge to their new long-run level within a year in all cases.[31] Beyond this particular calibration of the trade shocks, this exercise shows that the $\frac{S_k}{F_k}$ ratio that rationalizes the facts in this paper does not

[30] τ^U decreases with ε (not shown) so given our choice of ε the current number can be interpreted as an upper bound.

[31] This is true also for the case with larger sunk costs, although in that case the result is driven by the negative $\frac{\mu}{\sigma}$, which induces a fast convergence.

generate interesting transitional dynamics.[32]

5 Determinants of export survival (II): Interdependent markets

The framework developed in section 2 ruled out possible interdependencies across markets. However, entry decisions might be connected across markets in various forms. For example, Morales, Sheu, and Zahler (2014) find that sunk export costs can be substantially reduced if a firm has previously entered a market with the same language. In this section, we allow entry and exit decisions into different markets to be connected by having common sunk- and fixed-cost components that vary with previous export experience. In other words, we study how exporting history matters for understanding export survival. We first develop analytically the case of interdependent sunk costs. In this case, we find that previous export experience lowers the probability of survival by reducing the effective sunk cost. Second, we treat the case of interdependent fixed costs. The result in this case is ambiguous.

5.1 Interdependent sunk costs

We assume that the sunk cost required to enter the first market, k, within a "group" of countries g has two components. The first is a common sunk cost $S_g > 0$ paid only once to enter group g. The second is a country-specific sunk cost $\tilde{S}_k$. Thus:

$$S_k = S_g + \tilde{S}_k.$$

Fixed costs are assumed to be independent across markets. Country group g could be defined according to language, regional location, or income level. For example, the common component S_g could capture sunk costs associated with the translation of instruction manuals and packaging materials, which need not be repaid once paid in another country that speaks the same language. Similarly, sunk costs associated with quality upgrading to enter high income countries could be paid only once to serve all markets with a similar income level. Country group g could also be defined to be the entire world. For example, a firm might need to pay a sunk cost to learn the customs regulations in its own country only the first time it exports. While the theoretical treatment of group g in this section is general, the empirical analysis in section 6 explores the contours of country groups where interdependence matters.

We will distinguish two types of firms: (a) the *experienced* firm has already entered another market in group g; (b) the *inexperienced* firm has not yet entered any market in that group. Equation (1) determines the unique entry threshold $\theta_k^*(S_k)$ in the case of independent markets as a function of the sunk cost. In contrast, with interdependent sunk costs the thresholds of experienced and inexperienced firms are different. Denote by θ_{Ek}^* the entry threshold for experienced firms and $\theta_{Ik}^*(\boldsymbol{\theta}_{-k})$ the entry threshold for inexperienced firms. Once a firm becomes experienced, the exporting decision becomes independent across markets. In

[32] This would also be true for real exchange rate shocks, which in a microfounded model can be understood as a combination of our τ^U and τ^F shocks.

contrast, when a firm is inexperienced the decision to enter is linked across markets: A firm will be more likely to enter market k if it is also considering entering some other market k'. In other words, despite having a higher sunk cost, inexperienced firms now find that entering the first market may have "strategic value" and therefore decide to enter earlier. Notwithstanding this possibility, Proposition 3 shows that the probability of survival is always higher for the inexperienced firm.

Proposition 3. $\theta^*_{Ek} \leq \inf_{\boldsymbol{\theta}_{-k}} \theta^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right)$. Hence, $P(\theta^*_{Ek}) \leq \inf_{\boldsymbol{\theta}_{-k}} \left\{P\left(\theta^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right)\right)\right\}$.

Proof. Following the notation in section 2, let V^E_{0k} denote the value function of an experienced firm that is "outside" market k and V^E_{1k} denote the value function of an experienced firm that is "inside" market k. Note these value functions can be obtained using the same steps as in section 2. Furthermore, let V^I denote the value function of an inexperienced firm. Note there is no subindex k on V^I since the value function is not separable across markets when the firm is inexperienced.

Suppose $\inf_{\boldsymbol{\theta}_{-k}} \theta^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right) < \theta^*_{Ek}$. Then, we can pick some $\underline{\boldsymbol{\theta}}_{-k}$ such that for $\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right)$ the inequality is satisfied strictly. Since the inexperienced firm is indifferent between exporting to (at least) k and not exporting at $\underline{\theta}^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right)$,

$$V^I\left(\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right), \boldsymbol{\theta}_{-k}\right) = V^E_{1k}\left(\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right)\right) - \tilde{S}_k - S_g + \sum_{-k} \max\left\{V^E_{0k'}\left(\theta_{k'}\right), V^E_{1k'}\left(\theta_{k'}\right) - \tilde{S}_{k'}\right\}. \tag{6}$$

Next, note that the firm could always follow this strategy: enter market k at $\tilde{\theta}^*_{Ek}$ and just pay S_g in the market the firm reaches θ^*_{Ek} first. The outcome of this strategy - J - satisfies

$$J\left(\boldsymbol{\theta}_k\right) \geq \sum_k \max\left\{V^E_{0k}\left(\theta_k\right), V^E_{1k}\left(\theta_k\right) - \tilde{S}_k\right\} - S_g.$$

Since J is feasible,

$$V^I\left(\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right), \boldsymbol{\theta}_{-k}\right) \geq \sum_k \max\left\{V^E_{0k}\left(\theta_k\right), V^E_{1k}\left(\theta_k\right) - \tilde{S}_k\right\} - S_g \tag{7}$$

Replacing (6) in (7) and noting that $\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right) < \theta^*_{Ek}$,

$$V^E_{1k}\left(\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right)\right) - \tilde{S}_k \geq V^E_{0k}\left(\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right)\right).$$

This is a contradiction since inaction is strictly optimal for experienced firms in market k when $\theta^*_{Ik}\left(\underline{\boldsymbol{\theta}}_{-k}\right) < \theta^*_{Ek}$. Thus, $\inf_{\boldsymbol{\theta}_{-k}} \theta^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right) \geq \theta^*_{Ek}$. Since exit thresholds are equal in both cases, this result immediately implies that $P(\theta^*_{Ek}) \leq \inf_{\boldsymbol{\theta}_{-k}} \left\{P\left(\theta^*_{Ik}\left(\boldsymbol{\theta}_{-k}\right)\right)\right\}$. *QED*

Proposition 3 states that the probability of survival in market k is always lower for firms with previous history when previous export activities reduce sunk costs of entry in new markets. In a regression framework that controls for destination fixed effects, this result implies that the different forms of export experience should have a negative effect on the survival probability. We will assess the empirical relevance of this prediction in the next section.

5.2 Interdependent fixed costs

In contrast to the case of interdependent sunk costs, there are not sharp results in the case of interdependent fixed costs. Based on the results of Proposition 2, we would expect that if fixed costs are interdependent then experienced firms will survive more than their inexperienced counterparts because they only need to pay a fraction of the fixed cost. Unfortunately, although this is a possible case, the reverse outcome is also possible. Thus, the case of interdependent fixed costs yields ambiguous results.

Analogously to our treatment of sunk costs, we assume that fixed costs in market k have two components:

$$F_k = F_g + \tilde{F}_k$$

where F_g is a common component of fixed costs paid only once in group g and $\tilde{F}_k$ is an idiosyncratic market-k component. When an experienced firm enters market k, on the margin it only needs to pay $\tilde{F}_k$ (S_k is assumed here to be unaffected by experience). Hence, in this case not only entry but also exit decisions are interconnected across markets. Since the order in which firms exit these markets matters, a general treatment of the case of interdependent fixed costs is substantially more complicated than the case of interdependent sunk costs. Nevertheless, a case with only two countries and θ_{kt} processes that are perfectly correlated across markets is sufficient to show how the counter-intuitive prediction for survival probabilities can arise.

Consider an arbitrary firm i and define $\psi_i \equiv \frac{\psi_{iA}}{\psi_{iB}}$. We know that there is a ψ_{iA} sufficiently high (relative to ψ_{iB}) that firm i will want to enter market A first. Hence, denote by $\bar{\psi}^{entry}$ the threshold such that firm i enters this market first if $\psi_i > \bar{\psi}^{entry}_A$. There is also a threshold $\bar{\psi}^{entry}_B$ ($\bar{\psi}^{entry}_A > \bar{\psi}^{entry}_B$) such that firm i will want to enter market B first if $\psi_i < \bar{\psi}^{entry}_B$.[33] Similarly, we can find $\bar{\psi}^{exit}_A$ and $\bar{\psi}^{exit}_B$ such that firm i will exit market A last if $\psi_i > \bar{\psi}^{exit}_A$, will exit B last if $\psi_i < \bar{\psi}^{exit}_B$, and will exit both markets simultaneously if ψ_i is between these two thresholds. The entry and exit thresholds in general will not coincide so many different cases arise. We will focus on a case in which $\bar{\psi}^{entry}_B > \bar{\psi}^{exit}_A$ to show the possibility of contradictory predictions on survival probabilities for experienced and inexperienced firms. Given this assumption, $\bar{\psi}^{entry}_A > \bar{\psi}^{entry}_B$ also implies that $\bar{\psi}^{entry}_A > \bar{\psi}^{exit}_A$.

Consider a firm (firm 1) with a sufficiently high relative profitability in market A such that $\psi_1 > \bar{\psi}^{entry}_A > \bar{\psi}^{exit}_A$. This firm will enter market A first and will leave it last. We will call this a "regular" firm. Since firm 1 enters market A first, it is inexperienced when it enters A and it is experienced when it enters B. In the case of a regular firm, the analysis is greatly simplified. Since the firm enters market A first and exits it last, it can impute the common component of the fixed cost (F_g) to A, which bears the burden of the full

[33]In between these two thresholds, the firm will enter the two markets simultaneously.

cost (F_A), while imputing only the idiosyncratic component of the fixed cost ($\tilde{F}_B$) to B. Formally, it can be shown that in the regular case the entry threshold (θ_A^*) is the same as in the independent case (see Online Appendix 4). Therefore, the problem becomes equivalent to the problem with independent fixed and sunk costs, where fixed costs are F_A in market A and $\tilde{F}_B$ in market B.

Now consider another regular firm (firm 2) in the opposite situation. That is, suppose that its relative profitability is sufficiently high in market B such that $\psi_2 < \bar{\psi}_B^{entry}$ and $\psi_2 < \bar{\psi}_B^{exit}$. This firm enters market B first (as an inexperienced firm) and leaves it last. Hence, it imputes the full burden of the common fixed cost (F_B) to B. In market A instead it enters as an experienced firm and imputes only the idiosyncratic component $\tilde{F}_A$. Comparing the survival probabilities of firms 1 and 2 in market A, it is easy to notice that since the inexperienced firm (firm 1) imputes a higher fixed cost in this market (F_A) than the fixed cost ($\tilde{F}_A$) imputed by the experienced firm (firm 2), the probability of survival for the latter firm will be higher. Analogously, the probability of survival will also be higher in B for the firm that enters as experienced in this market (firm 1). Thus, the results when both firms are regular accord with the intuition derived from Proposition 2: experienced firms survive more because they have a lower fixed cost. The formal derivation of this result is provided in Online Appendix 4.

Next, consider an alternative firm (firm 2) with $\psi_2 < \bar{\psi}_B^{entry}$ but $\psi_2 > \bar{\psi}_A^{exit}$. This firm will enter market B first but will also exit first this market. We will call this a "reversal" firm. Let us consider the probability of survival of this firm in market A. Since the firm is already paying the common fixed cost in B, it will enter A with a lower normalized profitability $\tilde{\theta}$ than the entry profitability of firm 1, which is regular and inexperienced. However, both firms exit market A with the same normalized profitability since they both exit it last. It follows that the experienced, reversal firm survives less than the inexperienced, regular firm in market A. This is the opposite prediction to the one derived above.

In sum, the comparison of survival probabilities for experienced and inexperienced firms cannot be signed unambiguously when fixed costs are interdependent. Nonetheless, in the regular case experience lowers imputed fixed costs and hence increases the survival probability. This is the opposite outcome to the case of interdependent sunk costs. In section 6, the predictions of the regular case will be those with the ability to explain the estimated effect of experience on observed survival rates.

6 Empirical analysis (II): Interdependent markets

The theoretical results obtained in section 4 state that export experience matters. In a context of market interdependency, gaining export experience may reduce country specific fixed and sunk costs in new destinations. Thus, variations in experience can explain survival differences across firms in a given market according to the stage of their exporting history at the time of entry. Our previous analysis established that experience can affect the probability of survival through two channels. First, experience can reduce sunk costs, in which case it should lower the probability of survival (Proposition 3). Second, experience can reduce fixed costs, in which case it can either further reduce this probability (in the reversal case) or, conversely, increase the chances of survival (in the regular case). Next we explore which effect dominates in the data.

We distinguish two broad forms of experience. First, we explore the effect of "general" exporting experience, acquired over the life of the firm as an exporter regardless of the specific destinations it has previously served. Then, in subsection 6.2, we confine the effect of experience to that acquired by having previously exported to a group of related countries. We denote the latter "specific" experience.

6.1 General exporting experience

There are different ways to capture general exporting experience. Unfortunately, since our dataset starts in 1994 we do not know the whole history of a firm as an exporter. However, we can construct a number of indicators that capture essential aspects of this experience. We begin by constructing *Exporting Age* as the number of years a firm appears in our dataset before an incursion. Panel A of Table 7 shows basic descriptive statistics broken down by ranges for this variable. The last column exhibits the survival rate. We can see that this rate is substantially higher for firms with five or more years of export experience. We also proxy general experience by the value of past total exports upon entry in a new destination. To do this, we define $Exposure_{it} = \sum_{s=1994}^{t-1} X_{is}$ for a firm i entering a new destination in t. In panel B, we distinguish incursions by firms with low (below the median) and high (above the median) values of *Exposure*. We see that incursions with high exposure display a higher survival rate. As firms may enter a new destination with a different history of past incursions, we also consider the number of previous incursions as an alternative way to proxy for general exporting experience. Panel C shows that incursions by firms with a high record of past incursions tend to survive with a higher probability. Finally, since our dataset starts in 1994, the three variables explored thus far suffer from truncation. To address this concern, we construct one further variable. Panel D displays survival rates according to the number of destinations served by the firm the year before the incursion. A larger number of destinations arguably reflects more experience in the export market. Since this variable refers only to the previous year of the incursion, we do not need export data before 1994. As we can see in the table, the survival rate increases in the number of destinations served during the year previous to the incursion.

The broad message emerging from Table 7 is that the probability of export survival upon entry in a new destination is higher for experienced firms. To further study this effect, we first run the following linear probability model:

$$P_{ikt} = \alpha_1 \ln d_k + D_{it}^e + \gamma_t + \mu_{ikt}$$

where d_k is the distance from Argentina to country k, γ_t represents year-fixed effects, and D_{it}^e is an indicator variable that equals one if firm i exported anywhere in the past. Column 1 of Table 8 shows that D_{it}^e is positively associated with a higher probability of survival. Also, the effect of distance is moderately higher than the estimates reported on Table 4.

Table 7: Rate of Survival and Experience

	# Incursions	Sales (gmean)	Rate of survival upon entry
Panel A: Exporting Age			
1	43027	11409	0.29
2-5	54279	12107	0.30
More than 5	21548	9994	0.35
Panel B: Export Exposure			
Low export exposure	59420	9012	0.28
High export exposure	59420	14535	0.32
Panel C: Number of previous incursions			
0	54270	12812	0.30
1	14487	7905	0.28
2	9448	7962	0.29
3-5	16329	8951	0.31
6-15	16776	11971	0.34
More than 15	7544	25101	0.37
Panel D: Number of destinations in $t-1$			
0	50242	10458	0.28
1	16399	8407	0.28
2	10093	9702	0.30
3-5	16658	10569	0.34
6-15	17764	14214	0.35
more than 15	7698	35588	0.38
Total	118854	11445	0.31

Since we are interested in the marginal effect of experience on survival, we do not need to find observable proxies for the cross-country variation in sunk and fixed costs. Instead, we can simply include destination fixed effects to control for country-specific sunk and fixed costs and rely solely on variation in survival rates between experienced and inexperienced firms *within* a destination. In column 2 of Table 8, we verify that the effect of D^e_{it} remains positive with a slightly higher coefficient.

We turn now to the analysis of different forms of general exporting experience and estimate:

$$P_{ikt} = \gamma_k + Experience_{it} + \gamma_t + \mu_{ikt},$$

where $Experience_{it}$ is the general name for any of the four proxies for export experience described above and γ_t are year fixed effects. In columns 3-6 of Table 8, we report the specific effect of each of the proxies for experience (in logs): $Exporting\ Age_{it}$ (column 3); $Exposure_{it}$ (column 4); $Number\ of\ previous\ incursions_{it}$ (column 5); and $Number\ of\ destinations_{i,t-1}$ (column 6).[34] All these different ways to capture experience are

[34] In fact, we calculate the logarithm of $1+x$ to be able to take the log of the variable of interest when it takes a value of 0. Note that this transformation is more innocuous than, for example, transforming the dependent variable in a gravity equation since our theoretical results do not specify a functional form for the impact of these indicators of experience on the probability of survival. We prefer a logarithm specification because we expect a lower marginal impact on the probability of survival when the value of these variables are large.

positively associated with survival upon entry. In column 7, we include all controls for experience together. The estimation results suggest that, when included together, the most significant forms of export experience are exposure and the number of previously served destinations.

As a final robustness exercise we include two additional specifications. First, as previously discussed we include the value of exports at the moment of the incursion (X_{ikt}) and the number of simultaneous incursions ($NINCUR_{it}$). Then, we drop incursions failing during the first year to verify that the results are not driven by occasional exporters (column 9). The estimated effect of experience is not substantially affected by the inclusion of these additional controls.[35]

The results show that export experience induces a higher probability of export survival. The inference we can make from this finding is twofold. First, the "regular" case needs to prevail over the "reversal" case to account for the positive effect of experience on export survival. Second, the effect of export experience operating through fixed costs needs to prevail over that operating through sunk costs. This implication points to the importance of fixed costs to explain variation in survival rates between experienced and inexperienced firms, and is consistent with the results obtained by exploiting variation in survival rates across export destinations.

6.2 Specific exporting experience

The potential decrease in sunk and fixed costs needed to serve country k might be limited to export experience acquired in countries related in some way to k. We analyze this specific form of experience by exploring the effect of "extended gravities". This concept, introduced in Morales, Sheu, and Zahler (2014), captures the fall in sunk costs for a firm that has previously entered another country sharing the same (official) language, border or per capita income group. Here, we allow extended gravity variables to affect both sunk and fixed costs. The interest of this extension goes beyond its prior plausibility. Based on the theoretical results of the previous section we can expect the effect to go either way depending on the relative strength of extended gravities on sunk and fixed costs. As in the case of general experience, settling this question is an empirical matter.

To test whether an export incursion by firm i is more likely to survive upon entry in market k if this firm has already exported to a related country, we consider the following variables: $XContiguity_{ikt}$, $XLanguage_{ikt}$ and $XIncome_{ikt}$. These variables are defined as indicators taking the value of one when country k shares a border, language or per capita income quartile, respectively, with another country that firm i exported to in $t-1$. To estimate P_{ikt}, we run the following linear probability model:

$$P_{ikt} = \gamma_k + \alpha_2 XContiguity_{ikt} + \alpha_3 XLanguage_{ikt} + \alpha_4 XIncome_{ikt} + \gamma_t + \mu_{ikt}.$$

We are interested in the signs of α_2, α_3 and α_4. If positive, the associated extended gravities would

[35]To save space, we only report results using *Exporting Age* as the experience measure but note that results using any of the other three alternatives are very similar.

Table 8: Survival and General Exporting Experience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$D^e_{i,t}$	0.046***	0.052***							
	(0.006)	(0.005)							
	[0.006]	[0.009]							
$\ln d_k$	-0.033***								
	(0.003)								
	[0.003]								
ln $Exporting\ Age_{i,t}$			0.048***				0.095	0.045***	0.0406***
			(0.003)				(0.006)	(0.003)	(0.004)
			[0.008]				[0.012]	[0.004]	[0.005]
$\ln Exposure_{i,t}$				0.006***			0.002***		
				(0.0004)			(0.0007)		
				[0.0001]			[0.0009]		
ln $Number\ of\ previous\ incursions_{i,t}$					0.048***		-0.001		
					(0.002)		(0.004)		
					[0.008]		[0.006]		
ln $Number\ destinations_{i,t-1}$						0.008***	0.006***		
						(0.0004)	(0.0004)		
						[0.0001]	[0.0001]		
$\ln X_{ikt}$								0.032***	
								(0.004)	
								[0.002]	
ln $NINCUR_{it}$								0.091***	
								(0.004)	
								[0.011]	
Constant	0.552***	0.299***	0.281***	0.281***	0.277***	0.305***	0.284***	-0.0691***	0.625***
	(0.023)	(0.005)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.016)	(0.008)
	[0.027]	[0.009]	[0.015]	[0.015]	[0.015]	[0.011]	[0.014]	[0.025]	[0.014]
Year FE	yes	yes	yes	yes	yes	yes	yes		
Destination FE	no	yes	yes	yes	yes	yes	yes		
Observations	118,776	118,854	118,854	118,854	118,854	118,854	118,854	118,854	56,464
R-squared	0.009	0.015	0.017	0.019	0.020	0.024	0.026	0.065	0.014

Robust standard errors in parentheses clustered at the destination level
Robust standard errors in brackets clustered (two-way) by firm and destination
*** p<0.01, ** p<0.05, * p<0.1

imply an impact on fixed costs with a stronger effect on survival than the impact on sunk costs. Table 9 reports the results. The first column displays a basic regression including as controls only $\ln d_k$ and year fixed effects (γ_t). The extended-gravity variables are all positively associated with export survival. In column 2, we remove $\ln d_k$ and instead include destination fixed effects (γ_k) to control simultaneously for distance and other country-invariant characteristics. Doing this has no major effect on the three relevant coefficients, except for a higher estimated effect of having exported to a country with the same official language than k ($XLanguage_{ikt}$). In column 3, we include the value of exports at the moment of the incursion (X_{ikt}) and the number of simultaneous incursions ($NINCUR_{it}$) while in column 4 we drop incursions failing during the first year to verify that the results are not driven by the possibility of occasional exporting. The estimated impact of the extended gravities does not exhibit a substantial change.

A more stringent test of the effect of experience on the survival probability is to rely only on variation in specific experience for a given firm in a given year. For example, consider a firm entering two new destinations, A and B, in a given year. Let one of the two destinations, say A, be connected via an extended gravity with at least one of the markets already served by the firm, while entry in market B does not enjoy the benefits of any extended gravity. Then, we should expect the probability of survival to differ between countries A and B once country-specific characteristic are controlled for. We test this implication by including firm-year fixed effects. This ensures that the effect of extended gravities are tested on firms entering simultaneously at least two destinations differing in whether they have an extended gravity or not. Column 5 reports the results. The estimated impact of the extended gravities persists.

Finally, we regress the probability of survival upon entry on both general and specific forms of experience. As reported in column 6, including general forms of experience does not substantially affect the coefficients on the extended gravities. At the same time, the effect of general experience does not qualitatively change once specific experience is controlled for. We interpret this result as an indication that the history of a firm matters for succeeding in new export markets both as the expression of general exporting experience and as the expression of specific knowledge acquired by having previously exported to related markets.

Specific export experience raises the probability of survival upon entry in a new destination. As in the cases of general exporting experience and distance, this result is consistent with specific experience having an impact on fixed costs that prevails over its impact on sunk costs. This result is an interesting counterpoint to the findings of Morales, Sheu, and Zahler (2014). They find that $XLanguage_{ikt}$ reduces sunk costs but assume that extended gravities do not affect fixed costs. Our findings have a different implication. They show that the effect of the extended gravities are not confined to sunk costs. If only sunk costs varied with extended gravities, their effect on the probability of survival would be the opposite to what we find. In fact, we find that the impact on fixed costs needs to have a stronger effect than the impact on sunk costs to explain the observed relationship between extended gravities and the probability of survival upon entry.

Table 9: Survival and Specific Exporting Experience

	(1)	(2)	(3)	(4)	(5)	(6)
ln d_k	-0.034***					
	(0.003)					
	[0.004]					
$XContiguity_{kt}$	0.054***	0.059***	0.048***	0.032***	0.047***	0.045***
	(0.007)	(0.006)	(0.006)	(0.009)	(0.009)	(0.005)
	[0.007]	[0.01]	[0.016]	[0.007]	†	[0.013]
$XLanguage_{kt}$	0.029***	0.048***	0.035***	0.027***	0.033***	0.04***
	(0.008)	(0.006)	(0.006)	(0.008)	(0.012)	(0.007)
	[0.008]	[0.015]	[0.016]	[0.014]	†	[0.010]
$XIncomeQuartile_{it}$	0.057***	0.057***	0.042***	0.041***	0.033***	0.047***
	(0.006)	(0.006)	(0.006)	(0.009)	(0.01)	(0.006)
	[0.006]	[0.012]	[0.016]	[0.012]	†	[0.011]
$\ln X_{ikt}$			0.031***			
			(0.002)			
			[0.002]			
ln $NINCUR_{it}$			0.084***			
			(0.004)			
			[0.010]			
ln $Exporting\ Age_{i,t}$						0.012**
						(0.005)
						[0.007]
ln $Exposure_{i,t}$						-0.002
						(0.001)
						[0.001]
ln $Number\ of\ previous\ incursions_{i,t}$						-0.01
						(0.03)
						[0.06]
ln $Number\ of\ destinations_{i,t-1}$						0.006***
						(0.0004)
						[0.0001]
Constant	0.546***	0.284***	-0.043**	0.634***	-0.136***	0.286***
	(0.027)	(0.006)	(0.017)	(0.007)	(0.05)	(0.006)
	[0.03]	[0.01]	[0.019]	[0.009]	†	[0.014]
Year FE	yes	yes	yes	yes	yes	yes
Destination FE	no	yes	yes	yes	yes	yes
Firm-Year FE	no	no	no	no	yes	no
Observations	118,776	118,854	118,852	56,464	118,854	118,854
R-squared	0.018	0.025	0.067	0.015	0.578	0.030

Robust standard errors in parentheses clustered at the destination level
Robust standard errors in brackets clustered (two-way) by firm and destination
†Two-way clustering by firm and destination cannot be performed
*** p<0.01, ** p<0.05, * p<0.1

7 Concluding remarks

In this paper, we study the empirical and theoretical determinants of survival upon entry in a new export market. In a model where firms face uncertainty about future profitability and exporting involves fixed and sunk costs, we show that the probability of survival increases with the ratio of sunk to fixed costs and is insensitive to constant profitability shifters that are firm- and market-specific. We also show that the magnitude of fixed costs does not affect the probability of survival if sunk costs are zero. We extend the model to allow for interdependence across markets due to the effect of experience on both exporting costs. We find that when sunk costs are interdependent, experienced exporters survive less, while the result is ambiguous in the case of interdependent fixed costs.

In addition to our theoretical results, we uncover two basic facts: export survival rates upon entry are lower in distant markets and higher for experienced exporters. Using these observed patterns and the theoretical predictions of our model, we infer that fixed costs increase with distance proportionally more than sunk costs. Also, the impact of experience on fixed costs dominates the impact on sunk costs. The implications for distance are confirmed when we posit a linear relationship between distance and the ratio of sunk to fixed costs and use the model to structurally estimate the parameters of this relationship. As expected, the estimation results indicate that this relationship is negative. The results also indicate that sunk costs are relatively small. In particular, in a counterfactual exercise we find that removing those costs would increase aggregate exports by at most 1%. We conduct additional counterfactual experiments to study the response of the economy to fixed costs and trade liberalization shocks. Our estimates imply the economy converges very quickly to the new steady state across all distances. This suggests that, at our estimated level of sunk-to-fixed cost ratio, the model does not generate a significant difference between the long-run and the short-run trade elasticities.

The results of our paper carry potentially important implications for the quantitative literature on sunk and fixed exporting costs. In particular, Das, Roberts, and Tybout (2007) and Morales, Sheu, and Zahler (2014) find that sunk costs are substantially higher than fixed costs. Our findings suggests that existing estimates of exporting costs may need to be re-evaluated in light of their ability to explain survival patterns across distance and export experience.

We propose an interpretation of sunk costs as a stock of export associated activities that depreciates over time while fixed costs are the activities required to restore the depreciated stock. Under this interpretation, our results suggest that the stock of export activities depreciates more rapidly in more distant countries and for less experienced firms. Although we believe this to be is a plausible description of exporting costs, we have no direct evidence of our suggested interpretation. Understanding the exact nature of exporting costs is an open question to which we hope the empirical literature will soon provide an answer.

We have studied theoretical determinants of the probability of survival upon entry confining ourselves to what we believe is the most parsimonious dynamic model that is relevant for the study of this phenomenon. The theoretical and empirical implications that we have derived are certainly dependent on the specific features of this model. This model could be extended to include additional features such as learning about country-specific uncertainty (Albornoz, Calvo Pardo, Corcos, and Ornelas, 2012), network formation (Chaney, 2014) or reputation (Araujo, Mion, and Ornelas, 2014). We leave this task for future research.

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A Appendix

A.1 Proof of Lemma 1

We will first characterize the function $G_k(\tilde{\theta}_k)$. Take the derivative of $G_k(\tilde{\theta}_k)$,

$$G'_k(\tilde{\theta}_k) = \beta_2 \left(\frac{\beta_1}{\upsilon} - \frac{\beta_1 - 1}{\upsilon - \alpha} \right) \tilde{\theta}_k^{\beta_2 - 1} + \frac{\beta_1 - 1}{\upsilon - \alpha};$$

Take the second derivative. Since $\beta_2 < 0$ and $\frac{\beta_1}{\upsilon} - \frac{\beta_1 - 1}{\upsilon - \alpha} > 0$ (see section 2), we can establish that $G_k(\tilde{\theta}_k)$ is strictly convex:

$$G''_k(\tilde{\theta}_k) = \beta_2(\beta_2 - 1) \left(\frac{\beta_1}{\upsilon} - \frac{\beta_1 - 1}{\upsilon - \alpha} \right) \tilde{\theta}_k^{\beta_2 - 2} > 0.$$

Next, evaluate $G_k(\tilde{\theta}_k)$ and $G'(\tilde{\theta}_k)$ at $\tilde{\theta}_k = 1$. Using (1):

$$\begin{aligned} G_k(1) &= \left(\frac{\beta_1}{\upsilon} - \frac{\beta_1 - 1}{\upsilon - \alpha} \right) + \frac{(\beta_1 - 1)}{\upsilon - \alpha} - \beta_1 \left(\frac{1}{\upsilon} + \frac{S_k}{F_k} \right) \\ &= -\beta_1 \frac{S_k}{F_k} \leq 0, \end{aligned} \tag{8}$$

with strict inequality if $S_k > 0$. Furthermore,

$$\begin{aligned} G'_k(1) &= \frac{\beta_2 \beta_1}{\upsilon} - (\beta_2 - 1) \frac{\beta_1 - 1}{\upsilon - \alpha} \\ &= \left(\frac{\beta_2 \beta_1}{\upsilon} - \left(\frac{\beta_2 \beta_1 - \beta_2 - \beta_1 + 1}{\upsilon - \alpha} \right) \right) \\ &= (\beta_2 \beta_1 (\upsilon - \alpha) - \upsilon \beta_2 \beta_1 + \upsilon \beta_2 + \upsilon \beta_1 - \upsilon) \\ &= (-\alpha \beta_2 \beta_1 + \upsilon(\beta_2 + \beta_1 - 1)) \\ &= -\alpha \left(-\frac{2\upsilon}{\sigma^2} \right) - \upsilon \frac{2\alpha}{\sigma^2} = 0. \end{aligned}$$

Since $G'_k(1) = 0$ and the function is strictly convex, $G'_k(\tilde{\theta}_k) > 0$ for $\tilde{\theta}_k > 1$. In fact $G_k(\tilde{\theta}_k) \to \infty$ as $\tilde{\theta}_k \to \infty$.

Since $G_k(1) \leq 0$ and $G_k(\tilde{\theta}_k)$ is continuous and strictly convex, it follows that there is a unique $\tilde{\theta}_k^* \geq 1$ such that (1) holds. Finally, it follows immediately from (8) that $\tilde{\theta}_k^* = 1$ iff $S_k = 0$.

A.2 Estimation procedure in Section 4

A.2.1 Estimation of $\frac{S_k}{F_k}$

We estimate $\frac{S_k}{F_k}$ for each market k using the GMM estimator. We first specify a log-linear relation between $\frac{S_k}{F_k}$ and distance:,

$$\frac{S_k}{F_k} = \varsigma_0 + \varsigma_1 \ln d_k. \tag{9}$$

Then, using equation (3) in the main text, the model delivers a prediction for the probability of survival at horizon $T = 2$ for an arbitrary market at distance d_k. Let y_i denote whether incursion i survived and $P(d_i; \varsigma_0, \varsigma_1)$ denote the theoretical prediction on the probability of survival when $\frac{S_k}{F_k}$ is given by (9). Then, the residual ε_i is given by

$$\varepsilon_i = y_i - P(d_i; \varsigma_0, \varsigma_0).$$

We postulate the moment conditions:

$$E[\mathbf{x}_i' \varepsilon_i] = 0$$

where $\mathbf{x}_i = [1, d_i]'$. Let H denote the set of all $\{\varsigma_0, \varsigma_1\}$ such that $\frac{S_k}{F_k}$ is nonnegative for all potential distances in our database. Then, the GMM estimator solves

$$\min_{\{\varsigma_0, \varsigma_1\} \in H} Q_N(\varsigma_0, \varsigma_1) = \left\{ \frac{1}{N} \sum \mathbf{x}_i' \varepsilon_i(\varsigma_0, \varsigma_1) \right\}' \mathbf{W} \left\{ \frac{1}{N} \sum \mathbf{x}_i' \varepsilon_i(\varsigma_0, \varsigma_1) \right\}$$

where $\mathbf{W}$ is a weighting matrix. In a first stage, we set $\mathbf{W}$ to be the identity matrix. To compute the standard errors, we cluster errors at the firm level to take into account that shocks may be correlated across destinations,

$$\hat{\mathbf{\Lambda}} = \sum_i \sum_m \sum_{m'} \hat{\mathbf{g}}(y_{im}, x_{im}; \varsigma_0, \varsigma_1)\, \hat{\mathbf{g}}(y_{im'}, x_{im'}; \varsigma_0, \varsigma_1)'$$

We then set $\mathbf{W} = \hat{\mathbf{\Lambda}}^{-1}$ and re-estimate the coefficients $\varsigma = \{\varsigma_0, \varsigma_1\}$.[36] Finally, the asymptotic variance is computed as

$$Avar = \frac{1}{N} \left\{ \left(\sum_i \sum_m \left(\frac{\partial \mathbf{g}_{im}}{\partial \varsigma} |_{\hat{\varsigma}} \right) \right)^{-1\prime} \hat{\mathbf{\Lambda}}^{-1} \left(\sum_i \sum_m \left(\frac{\partial \mathbf{g}_{im}}{\partial \varsigma} |_{\hat{\varsigma}} \right) \right)^{-1} \right\}$$

A.2.2 Estimation of $\tilde{\theta}_{k0}$

We specify a linear relation between $\tilde{\theta}_{k0}$ and distance in logarithms:

$$\ln \tilde{\theta}_{k0} = \eta_0 + \eta_1 \ln d_k.$$

[36] Although the model is just-identified, we find that the nonnegativity constraint binds so the choice of $\mathbf{W}$ becomes relevant. In any event, the results only change slightly between stages 1 and 2.

Then, using equation (5) in the main text, the model delivers a prediction for the share of exporting firms for an arbitrary market at distance d_k. Let y_k denote the observed share of exporting firms in market k and $\chi_k(d_k;\eta_0,\eta_1)$ denote the theoretical prediction on this share. Then, the residual ε_k is given by

$$\varepsilon_k = y_k - \chi_k(d_k;\eta_0,\eta_1).$$

In this case, the moment conditions are

$$E[\mathbf{x}_k'\varepsilon_k] = 0$$

where $\mathbf{x}_k = [1, \ln(d_k)]'$. Since the model is just-identified we solve $\sum \mathbf{x}_k'\varepsilon_k(\eta_0,\eta_1) = 0$. We finally compute the asymptotic variance allowing for heteroskedascity.[37]

A.3 Proofs in section 4.2

Proof that the cross-sectional distribution of (normalized) profitability $\tilde{\theta}_{kt}$ is a double Pareto. We know $\ln\tilde{\theta}_{kt} \sim N(\ln\tilde{\theta}_{k0} + \mu t; \sigma^2 t)$. To find the stationary distribution, we only need to accumulate the probability distributions at each point in a firm's "history" since each represents a different cohort of firms. This yields:

$$f\left(\ln\tilde{\theta}_k\right) = \int_0^\infty g_B e^{-g_B t}\frac{1}{\sigma\sqrt{t}}\phi\left(\frac{\ln\tilde{\theta}_{kt} - \ln\tilde{\theta}_{k0} - \mu t}{\sigma\sqrt{t}}\right)dt. \tag{10}$$

Solving this integral yields the expression (4) in the main text (see Reed 2001 for a proof).

Next, let $h_1\left(\ln\tilde{\theta}_k, t\right)$ denote the measure of firms that have already paid the sunk cost and satisfy $\ln\tilde{\theta}_{kt} = \ln\tilde{\theta}_k$. Noting that $\ln\tilde{\theta}_{kt} \sim N(\ln\tilde{\theta}_k^* + \mu(t-\tau); \sigma^2(t-\tau))$ for any $t > \tau$, where τ is the time of first entry, we can write h_1 as follows,

$$h_1\left(\ln\tilde{\theta}_k, t\right) = \int_0^t \frac{1}{\sigma\sqrt{t-s}}\phi\left(\frac{\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^* - \mu(t-s)}{\sigma\sqrt{t-s}}\right)\Pr\{\tau = s\}\,ds$$

Then,

$$\int_0^\infty g_B e^{-g_B t} h_1\left(\ln\tilde{\theta}_k, t\right)dt = \int_0^\infty g_B e^{-g_B t}\left\{\int_0^t \frac{1}{\sigma\sqrt{t-s}}\phi\left(\frac{\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^* - \mu(t-s)}{\sigma\sqrt{t-s}}\right)\Pr\{\tau = s\}\,ds\right\}dt$$

Using Foubini to interchange integrals,

$$\int_0^\infty g_B e^{-g_B t} h_1\left(\ln\tilde{\theta}_k, t\right)dt = \int_0^\infty g_B e^{-g_B s}\left\{\int_s^\infty e^{-g_B(t-s)}\frac{1}{\sigma\sqrt{t-s}}\phi\left(\frac{\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^* - \mu(t-s)}{\sigma\sqrt{t-s}}\right)dt\right\}\Pr\{\tau = s\}\,ds$$

[37] Thus, the formula is a special case of the one considered in the sunk-cost estimation. Here, we do not need to cluster at the market level because we only use one observation per market.

Since the inside term does not depend on s this simplifies to

$$\int_0^{\infty} g_B e^{-g_B t} h_1\left(\ln\tilde{\theta}_k, t\right) dt = \left(\int_0^{\infty} e^{-g_B s} \Pr\{\tau = s\}\, ds\right)\left(\int_0^{\infty} g_B e^{-g_B t} \frac{1}{\sigma\sqrt{t}} \phi\left(\frac{\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^* - \mu t}{\sigma\sqrt{t}}\right) dt\right).$$

The second term in parenthesis coincides with (10) except that we have $\tilde{\theta}_k^*$ instead of $\tilde{\theta}_{k0}$. To transform $\int_0^{\infty} g_B e^{-g_B t} h_1\left(\ln\tilde{\theta}_k, t\right) dt$ into a probability measure we need to divide by $\int_0^{\infty} e^{-g_B s} \Pr\{\tau = s\}\, ds$. Then, using the same result as before with $\tilde{\theta}_k^*$ instead of $\tilde{\theta}_{k0}$, we obtain

$$f_1\left(\tilde{\theta}_k\right) = \left\{ \begin{array}{l} \frac{r_1 r_2}{r_1+r_2} \tilde{\theta}_k^{r_1-1} \tilde{\theta}_k^{*-r_1} \text{ if } \tilde{\theta}_k < \tilde{\theta}_k^* \\ \frac{r_1 r_2}{r_1+r_2} \tilde{\theta}_k^{-r_2-1} \tilde{\theta}_k^{*r_2} \text{ if } \tilde{\theta}_k \geq \tilde{\theta}_k^* \end{array} \right\}. \tag{11}$$

Note that the distribution of exporters is this distribution truncated at $\tilde{\theta}_k = 1$.

Proof that the entry rate into k is given by $\frac{M_{kt}}{M_t} = \left\{1 - \frac{r_2}{r_1+r_2}\tilde{\theta}_k^{*-r_1}\right\}\left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2}$. Our results on f_1 imply that the share of these firms that are exporting at any given point in time $\frac{M_\tau^x}{M_\tau}$ is given by

$$\begin{aligned} \frac{M_\tau^x}{M_\tau} &= \frac{r_1 r_2}{r_1+r_2}\left\{\int_0^{\ln\tilde{\theta}_k^*} e^{r_1(\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^*)} d\ln\tilde{\theta}_k + \int_{\ln\tilde{\theta}_k^*}^{\infty} e^{-r_2\left(\ln\tilde{\theta}_k - \ln\tilde{\theta}_k^*\right)} d\ln\tilde{\theta}_k\right\} \\ &= 1 - \frac{r_2}{r_1+r_2}\tilde{\theta}_k^{*-r_1}. \end{aligned}$$

To find the total mass of exporters, we just need to integrate across all potential "entry cohorts",

$$\begin{aligned} \frac{M^x}{M} &= \int_0^{\infty} e^{-g_B t} \frac{M_\tau^x}{M_\tau} \Pr(\tau = t)\, dt \\ &= \left\{1 - \frac{r_2}{r_1+r_2}\tilde{\theta}_k^{*-r_1}\right\}\left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2}, \end{aligned}$$

where we used the following result on discounted stopping times (see Stokey (2008, Ch. 5)),

$$\int_0^{\infty} e^{-g_B t} \Pr(\tau = s)\, dt = \left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2}.$$

A.4 Counterfactual

Aggregate exports (per firm) in the initial steady state are given by

$$\begin{aligned}
\left(\frac{X}{M}\right)_k^I &= F_k \frac{r_1 r_2}{r_1+r_2}\left\{\int_0^{\ln\tilde{\theta}_k^*} \tilde{\theta} e^{r_1\left(\ln\tilde{\theta}-\ln\tilde{\theta}_k^*\right)} d\ln\tilde{\theta} + \int_{\ln\tilde{\theta}_k^*}^{\infty} \tilde{\theta} e^{-r_2\left(\ln\tilde{\theta}-\ln\tilde{\theta}_k^*\right)} d\ln\tilde{\theta}\right\}\left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2} \\
&= F_k \frac{r_1 r_2}{r_1+r_2}\left\{\int_1^{\tilde{\theta}_k^*} (\frac{\tilde{\theta}}{\tilde{\theta}_k^*})^{r_1} d\tilde{\theta} + \int_{\tilde{\theta}_k^*}^{\infty} (\frac{\tilde{\theta}}{\tilde{\theta}_k^*})^{-r_2} d\tilde{\theta}\right\}\left(\frac{\tilde{\theta}_{k0}}{\tilde{\theta}_k^*}\right)^{r_2} \\
&= \tilde{\theta}_{k0}^{r_2} F_k \frac{r_1 r_2}{r_1+r_2}\left\{\frac{1}{r_1+1}(\tilde{\theta}_k^{*1-r_2} - \tilde{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\tilde{\theta}_k^{*1-r_2}\right\}.
\end{aligned}$$

First, consider aggregate exports in a new steady state with no sunk costs. Firms are still born with the same normalized profitability but now $\tilde{\theta}_k^* = 1$. Hence aggregate exports in the new steady state are given by

$$\left(\frac{X}{M}\right)_k^S = \tilde{\theta}_{k0}^{r_2} F_k \frac{r_1 r_2}{r_1+r_2}\frac{1}{r_2-1}.$$

Thus, this policy increases exports by

$$\frac{\left(\frac{X}{M}\right)_k^S}{\left(\frac{X}{M}\right)_k^I} = \frac{\frac{1}{r_2-1}}{\frac{1}{r_1+1}(\tilde{\theta}_k^{*1-r_2} - \tilde{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\tilde{\theta}_k^{*1-r_2}}.$$

Second, consider aggregate exports in a new steady state with the old sunk cost but with a proportional reduction of fixed costs, i.e. $F_k' = (1-\tau_F)F_k$ with $\tau_F \in (0,1)$. Let $\hat{\theta} \equiv (1-\tau_F)^{-1}\tilde{\theta}$ denote profitability normalized by the new fixed costs. Furthermore, let $\hat{\theta}^*$ denote the new normalized threshold. Note $\hat{\theta}^* > \tilde{\theta}^*$ since now $\left(\frac{S_k}{F_k}\right)'$ is higher. Hence aggregate exports in the new steady state are given by

$$\left(\frac{X}{M}\right)_k^F = (1-\tau_F)^{1-r_2}\tilde{\theta}_{k0}^{r_2} F_k \frac{r_1 r_2}{r_1+r_2}\left\{\frac{1}{r_1+1}(\hat{\theta}_k^{*1-r_2} - \hat{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\hat{\theta}_k^{*1-r_2}\right\}.$$

Third, consider aggregate exports in a new steady state with the old sunk and fixed cost but with a decrease in the tariff charged by the foreign government of market k. In a CES-monopolistic competition framework, this increases potential sales to $(1-\tau_U)^{-\varepsilon}\tilde{\theta}_{kt}$, where ε is the elasticity of substitution across varieties and τ_U is the proportional reduction in the tariff. Let $\bar{\theta}_{kt} \equiv (1-\tau_U)^{-\varepsilon}\tilde{\theta}_{kt}$. Note that, in terms of $\bar{\theta}$, the new steady state distribution is the same as the old one with $\tilde{\theta}$ except that now $\bar{\theta}_{k0} = (1-\tau_U)^{-\varepsilon}\tilde{\theta}_{k0}$. In fact, this is just a special case of our result for ψ_k: thresholds are proportional to multiplicative shifters so $\tilde{\theta}^* = \bar{\theta}^*$. Thus, aggregate exports in the new steady state are

$$\left(\frac{X}{M}\right)_k^U = (1-\tau_U)^{-\varepsilon r_2}\tilde{\theta}_{k0}^{r_2} F_k \frac{r_1 r_2}{r_1+r_2}\left\{\frac{1}{r_1+1}(\tilde{\theta}_k^{*1-r_2} - \tilde{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\tilde{\theta}_k^{*1-r_2}\right\}.$$

In our counterfactual we pick τ_F and τ_U such that $\left(\frac{X}{M}\right)_k^S = \left(\frac{X}{M}\right)_k^F = \left(\frac{X}{M}\right)_k^U$,

$$\begin{aligned}
(1-\tau_F)^{1-r_2}\left\{\frac{1}{r_1+1}(\hat{\theta}_k^{*1-r_2} - \hat{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\hat{\theta}_k^{*1-r_2}\right\} &= \frac{1}{r_2-1} \\
(1-\tau_U)^{-\varepsilon r_2}\left\{\frac{1}{r_1+1}(\tilde{\theta}_k^{*1-r_2} - \tilde{\theta}_k^{*-(r_1+r_2)}) + \frac{1}{r_2-1}\tilde{\theta}_k^{*1-r_2}\right\} &= \frac{1}{r_2-1}.
\end{aligned}$$

Furthermore, we simulate the transitional dynamics following the approach described in Online Appendix 3.

A.5 Survival and Gravities, Robustness

Table A.1: Survival and Gravities, Robustness

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	P_{ikt}	P_{ikt}	P^{2CY}_{ikt}	P^{3Y}_{ikt}	P_{ikt}	P_{ikt}	P_{iktp}
Estimation Method	OLS	Probit	OLS	OLS	OLS	OLS	OLS
ln d_k	-0.034***	-0.067***	-0.02***	-0.019***	-0.025***	-0.029***	-0.045***
	(0.004)	(0.019)	(0.007)	(0.006)	(0.009)	(0.008)	(0.008)
	†	†	[0.006]	[0.009]	[0.009]	[0.007]	[0.008]
$Common\ Language_k$	0.027***	0.074**	0.027**	0.021*	0.024*	0.016	0.023
	(0.005)	(0.036)	(0.012)	(0.013)	(0.014)	(0.013)	(0.017)
	†	†	[0.01]	[0.014]	[0.014]	[0.013]	[0.016]
$Contiguity_k$	0.058***	-0.032	-0.006	-0.021	-0.022*	-0.005	-0.032**
	(0.007)	(0.036)	(0.014)	(0.009)	(0.013)	(0.018)	(0.013)
	†	†	[0.014]	[0.035]	[0.012]	[0.018]	[0.013]
Constant	0.511***	0.095	0.42***	0.383***	0.518***	0.545***	0.669***
	(0.036)	(0.178)	(0.068)	(0.057)	(0.08)	(0.078)	(0.079)
	†	†	[0.064]	[0.084]	[0.078]	[0.072]	[0.077]
Year FE :	yes	yes	yes	yes	yes	yes	yes
Firm FE :	yes	no	no	no	no	no	no
Sample :	1995-2004	1995-2004	1995-2004	1995-2004	1998-2004	1995-2004 excluding 2000-2002	1995-2004 manufacturing goods
Observations	118,776	118,776	118,776	118,776	81,258	87,308	153,322
R-squared	0.386	0.001	0.007	0.044	0.006	0.009	0.011

Robust standard errors in parentheses clustered at the destination level
Robust standard errors in brackets clustered (two-way) by firm and destination
†Two-way clustering by firm and destination cannot be performed
*** p<0.01, ** p<0.05, * p<0.1
P_{ikt}: Probability of establishing an export experience that is active for 2 years after an incursion of firm i in market k in period t
P^{2CY}_{ikt}: Probability of establishing an export experience that is active 2 consecutive years after an incursion of firm i in market k in period t
P^{3Y}_{ikt}: Probability of establishing an export experience that is active 3 years after an incursion of firm i in market k in period t
P^{3Y}_{iktp}: Probability of establishing an export experience that is active 3 years after an incursion of firm i in market k in period t of product p