



***"Survival in Export Markets"***

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# Survival in Export Markets\*

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## Abstract

This paper explores the determinants of firm survival in export markets. Our theoretical framework includes a geometric Brownian motion for firm profitability, market-specific sunk and fixed exporting costs that are common across firms, and firm- and market-specific profitability shifters that are constant over time. We derive the probability of survival upon entry in an export market. We show that this probability 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. Combining our theoretical results with observed patterns of survival among Argentine exporters, we infer the impact of distance and experience on the magnitude of sunk and fixed costs. In our data set, survival rates upon entry decrease with distance and increase with experience. Hence, we infer that fixed costs increase more with distance than sunk cost while fixed costs fall with experience sufficiently strongly to dominate the fall in sunk costs. These results carry implications on parametrizations of theoretical models of export dynamics and serve as a benchmark to assess structural estimates of fixed and sunk costs.

JEL codes: F10, F12, F14.

Keywords: Survival, export dynamics, fixed cost, sunk cost, productivity, firm heterogeneity, geometric Brownian motion.

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# 1 Introduction

A substantial fraction of aggregate export growth is explained by new exporters (Eaton, Eslava, Kugler, and Tybout, 2008; Bernard, Jensen, Redding, and Schott, 2009; Lawless, 2009). According to Eaton, Eslava, Kugler, and Tybout (2008), new exporters explain about 50% of export growth in Colombia between 1996 and 2005. Using our dataset of Argentine firms, we find that during the period between 1995 and 2006 new exporters explain 38% of total export growth and 61% of this growth when we add old exporters entering new destinations. 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. Using Argentine firms, we find a survival rate of 31% after two years for exporters - new or old - entering a new export destination. Since export growth critically requires incursions in export markets to be sustained over time, this body of evidence strongly points to the importance of understanding the determinants of these incursions' survival. This paper aims to contribute to this understanding.

A standard framework to analyze export dynamics at the firm level consists of three key elements: a firm-specific productivity process, fixed export costs and sunk export costs. This framework is used both in theoretical (e.g. Arkolakis (2012) and Impullitti, Irarrazabal, and Oromolla (2013)) and in empirical (e.g. Das, Roberts, and Tybout (2007) and Morales, Sheu, and Zahler (2014)) studies. Confined to this standard framework, a first contribution of this paper is to 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 infer the impact of the distance to the destination country and the export experience of the firm on the magnitude of sunk and fixed costs. Observed survival rates decrease with distance and increase with export experience. Hence, these facts and our theoretical results allow us to derive the following implications. First, fixed cost increase with distance proportionally more than sunk costs. Second, fixed costs decrease with experience sufficiently strongly to dominate the decrease in sunk costs. Third, sunk costs cannot be negligible. Although we do not provide quantitative estimates of fixed and sunk costs, these empirical results contribute to the literature by imposing discipline on potential parametrizations of theoretical models of export dynamics. In addition, the restrictions they impose on how fixed and sunk costs vary with distance and export experience can be used as a benchmark to assess structural estimates of these costs.

We model firms whose profitability processes follow a geometric Brownian motion (GBM). A firm's profitability process can be derived as the combination of firm-specific GBM processes for productivity and

demand in a stationary environment. While the profitability process of a firm applies equally to all markets, each firm is also endowed with a set of idiosyncratic market-specific constant profitability shifters capturing, for instance, idiosyncratic components of demand. Therefore, as markets' relative appeal is allowed to vary across firms the order in which they enter foreign markets also varies (i.e. there is no hierarchy of markets). 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 the idiosyncratic profitability parameter does not affect the probability of survival upon entry as firms compensate a higher ability to make profits in a specific market with a lower entry and exit value of the general profitability process. This finding is critical to obtain predictions of the model 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 but they are also fixed costs 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, distance should be positively related to the magnitude of both. Hence, the effect of distance on survival probabilities can only inform us about cross-country variation in the relative importance of these costs. Using Argentine firm-level customs data, we find that the probability of survival decreases with the distance to the destination country. Through the lenses of the standard framework we use, this finding implies that the ratio of sunk to fixed costs also falls with distance. Furthermore, since complementary evidence based on exit sales suggests that fixed costs increase with distance, this finding indicates that fixed cost increase with distance proportionally more than sunk costs. As additional evidence, we also estimate the effect of other gravity variables, such as common language or having a similar per-capita income, which can also serve as proxies for both sunk and fixed costs. The results using these alternative proxies yield a similar conclusion: these additional gravity variables are found to be associated with a relatively larger decrease in fixed costs.

The export experience of a firm can also proxy for sunk and fixed costs. Since an experienced firm should

face lower sunk and fixed costs, experience, like distance, should induce opposite effects on the probability of survival through its impact on both types of costs. However, the analysis in this case is complicated by the fact that once experience in one market is allowed to affect fixed and sunk 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 over 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 the export experience of the firm.

This paper is related to several strands of literature. First, it is related to a literature that attempts to obtain quantitative estimates of fixed and sunk costs of exporting. Since the early work of Baldwin (1988); Krugman (1989); Baldwin and Krugman (1989) and Dixit (1989), the literature on export dynamics has underscored the importance of sunk and fixed costs in explaining entry and exit in export markets. The effect of these costs on the export activity of firms 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 sunk costs vary across firms according to their previous exporting experience. While they obtain, for Chilean chemical exporters, fixed cost estimates with an upper bound of US\$ 5,550, sunk costs may be above US\$ 100,000. Therefore, 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 the probability of survival which, combined with observed survival rates, impose restrictions on how 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. Nevertheless, 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), network formation (Chaney, Forthcoming), or reputation (Araujo, Mion, and Ornelas, 2014).

Our paper also contributes to an incipient literature on export dynamics primarily interested in explaining the size distribution of firms in an open economy. Impullitti, Irarrazabal, and Opromolla (2013) use the standard framework developed here 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 (2012) extends the standard framework with market penetration costs but assumes away sunk costs to develop a general equilibrium model of industry and export dynamics. Among other results, he derives the probability of survival for an incumbent cohort (rather than for an entering cohort). Compared to these papers, our main contribution is to combine theoretical and empirical results on survival probabilities to infer how geography and the export history of a firm affect the relative magnitude of sunk and fixed costs. We note that while Arkolakis (2012) assumes sunk costs away, we find that within the confines of our similar framework sunk costs are necessary to explain the observed patterns of survival across countries and types of experience.

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 point to capacity constraints as the reason for the different survival performance of those types of exporters. 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 the fact that the probability of survival is higher in proximate markets and for experienced firms provided that this type of occasional exporters are more prevalent in distant markets and less prevalent among 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. The decision to undertake this investment is driven by the amount of extra profits they would make with this investment. A key assumption is that this decision is made in period 1 (the beginning of times) when firms are given an exogenous distribution of productivities. Therefore, conditional on their given productivity, firms encounter more incentives to pay higher sunk costs in proximate markets where profits are higher due to lower variable trade costs. In our model, in contrast, firms are not imposed an exogenous instant in time 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 - i.e. with a lower productivity - precisely in those markets, fully compensating with an early entry 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, according to which 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 export survival. For example, Görg, Kneller, and Muraközy (2012) find in a panel of Hungarian exporters 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 probability of survival upon entry in a new market increases 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 export survival.

The rest of the paper proceeds as follows. In section 2, we set up the model in the case of independent markets and generate predictions about variation in survival probabilities across destination countries. In section 3, we take those predictions to the data by looking at the effect of distance and other gravity variables on export survival probabilities. In section 4, we develop the case of interdependent markets and generate predictions about variation in survival probabilities according to firms' export experience. In section 5, we estimate the effect of different forms of experience on survival probabilities. The last section presents concluding remarks.

## 2 Determinants of export survival (I): Independent markets

In this section, we present a model of export dynamics to study the probability of survival in export markets. 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 set up of the model. In section 2.2, we find the optimal entry threshold  $\theta_k^*$  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

Each firm is characterized by a general-profitability parameter  $\theta_t$  and a set of market-specific profitability shifters  $\Psi = \{\psi_k\}_{k=1,\dots,K}$  for each of  $K$  foreign markets. Although  $\theta_t$  and  $\Psi$  are specific to the firm, we omit firm subindices to simplify notation. Following Luttmer (2007), Impullitti, Irarrazabal, and Opro-

molla (2013), and Arkolakis (2012), we assume that the general profitability parameter follows a geometric Brownian motion (GBM):

$$d\theta_t = \alpha\theta_t dt + \sigma\theta_t dz \quad (1)$$

where  $\alpha$  and  $\sigma$  are, respectively, the drift and volatility parameters, and  $z$  is a standard Brownian motion. Firms are risk-neutral and have a constant discount factor  $\nu$ . We assume  $\nu > \alpha$  to ensure that expected discounted profits are bounded. The profitability parameter  $\theta_t$  captures both productivity and demand components. Appendix A.1 shows that  $\theta$  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.

The firm-specific market profitability shifters  $\Psi$  are constant over time. They capture differences across firms in the relative profitability of foreign markets arising, for example, from their ability to match idiosyncratic tastes. Hence, when a firm enters market  $k$ , its operating profits are given by  $\pi_{kt} = \psi_k \theta_t$ . Using Ito's lemma, it is readily shown that  $\pi_{kt}$  also follows a GBM with the same parameters as the stochastic process for  $\theta_t$ .

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 initial investment a firm needs to make in a variety of activities when it enters market  $k$  to achieve a certain stock that needs to be maintained. This stock depreciates at rate  $\delta_k$ . 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  $S_k$ .<sup>1</sup> Hence, after entering market  $k$ , the firm is forever entitled to the flow of net profits  $\Pi_{kt} = \max\{\pi_{kt} - F_k, 0\}$ .<sup>2</sup>

<sup>1</sup>This assumption should become weaker as the period of time since entry lengthens. In any event, even in the presence of non-zero re-entry sunk costs our qualitative results should be similar as long as entry and re-entry sunk costs display a similar pattern of variation with respect to observables such as distance and experience.

<sup>2</sup>Note that under our suggested interpretation of fixed and sunk costs there is no depreciation of the investment if the firm does not export.



## 2.2 Solving for the entry threshold $\theta_k^*$

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 is “outside” market  $k$  if it has not paid it. 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  $\theta_k^*$  such that the firm stays outside market  $k$  if  $\theta_t \in [0, \theta_k^*)$  and enters this market if  $\theta_t \in [\theta_k^*, \infty)$ .

We will approach the problem as follows. First, we will compute the value of an outside firm,  $V_{0k}(\theta_t)$ . Then, we will compute the value of an inside firm,  $\Omega_k(\theta_t)$ . Armed with  $V_{0k}(\theta_t)$  and  $\Omega_k(\theta_t)$ , we will use the value-matching and smooth-pasting conditions to find the optimal entry threshold  $\theta_k^*$ .

**The outside firm** The firm does not generate any income flow in market  $k$  while it is outside this market. Over an infinitesimal period of time, the value function satisfies

$$V_{0k}(\theta_t) = \frac{1}{1 + vdt} E(V_{0k}(\theta_t + d\theta_t)).$$

Applying Ito’s Lemma and rearranging we obtain the Hamilton-Jacobi-Bellman equation (HJB),

$$\frac{1}{2} \frac{d^2 V_{0k}}{d\theta_t^2} \sigma^2 \theta_t^2 + \frac{dV_{0k}}{d\theta_t} \alpha \theta_t - v V_{0k}(\theta_t) = 0$$

The solution to this equation is

$$V_{0k}(\theta_t) = A_{0k1} \theta_t^{\beta_1} + A_{0k2} \theta_t^{\beta_2}, \quad (2)$$

where  $A_{0k1}$  and  $A_{0k2}$  are (yet unknown) constants and the roots  $\beta_1$  and  $\beta_2$  are given by:

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

Using simple algebra and the fact that  $\alpha < v$ , it can be shown that  $\beta_1 > 1$  and  $\beta_2 < 0$ .<sup>3</sup>

Since  $\theta_t$  is a GBM,  $d\theta_t \rightarrow 0$  as  $\theta_t \rightarrow 0$  (0 is an absorbing state). Hence,  $V_{0k}(\theta_t) \rightarrow 0$  when  $\theta_t \rightarrow 0$ . In equation (2),  $\beta_2 < 0$  implies that as  $\theta_t \rightarrow 0$  the value of the outside firm would increase or decrease without bound unless  $A_{0k2} = 0$ . Therefore, we obtain:

$$V_{0k}(\theta_t) = A_{0k} \theta_t^{\beta_1}. \quad (3)$$

<sup>3</sup>First, using  $\alpha < v$  show that  $\beta_1 > 1$ . Then, simple algebra yields  $\beta_1 \beta_2 < 0$ , which implies that  $\beta_2 < 0$ .

This equation characterizes the dynamics of the value function over the interval  $[0, \theta_k^*)$ .<sup>4</sup>

**The inside firm** Once the firm has paid the sunk cost  $S_k$ , it can be active or inactive in market  $k$ . Since exporting can be temporarily and costlessly suspended, the firm will be inactive in market  $k$  whenever  $\pi_{kt} < F_k$  and will resume activity when  $\pi_{kt} \geq F_k$ . Since  $\pi_{kt} = \psi_k \theta_t$ , this implies that the firm will be inactive when  $\theta_t < \frac{F_k}{\psi_k}$  and will resume activity when  $\theta_t \geq \frac{F_k}{\psi_k}$ . We will analyze each of these two cases in turn.

In the region  $\pi_{kt} \geq F_k$  (active firm), exporting is optimal and the firm generates an income flow of  $(\pi_{kt} - F_k) dt$ . Over an infinitesimal period of time, the value function satisfies

$$V_1(\pi_{kt}) = (\pi_{kt} - F_k)dt + \frac{1}{1 + vdt} E(V_{1k}(\pi_{kt} + d\pi_{kt})).$$

The HJB equation is

$$\frac{1}{2} \frac{d^2 V_{1k}}{d\pi_{kt}^2} \sigma^2 \pi_{kt}^2 + \frac{dV_{1k}}{d\pi_{kt}} \alpha \pi_{kt} - vV_{1k} + \pi_{kt} - F_k = 0$$

and the solution is given by

$$V_{1k}(\pi_t) = A_{1k1} \pi_{kt}^{\beta_1} + A_{1k2} \pi_{kt}^{\beta_2} + \frac{\pi_{kt}}{v - \alpha} - \frac{F_k}{v}$$

with identical  $\beta_1$  and  $\beta_2$  as before. If the firm were required to operate forever, despite any losses, then its value would be  $\frac{\pi_{kt}}{v - \alpha} - \frac{F_k}{v}$ . This should be the value of the firm as  $\pi_{kt} \rightarrow \infty$  since in that case there is no extra value of staying active in the market. Since  $\beta_1 > 0$ , this implies that  $A_{1k1} = 0$ . Hence, the general solution of the differential equation for the active inside firm is:

$$V_{1k}(\pi_{kt}) = A_{1k} \pi_{kt}^{\beta_2} + \frac{\pi_{kt}}{v - \alpha} - \frac{F_k}{v}, \quad (4)$$

which is valid over the interval  $\pi_{kt} \in [F_k, \infty)$ . The first term of this solution can be interpreted as the value of the option to suspend activity in the export market when net profits are negative. Since the value of this option is small when  $\pi_{kt}$  is high, this value decreases with  $\pi_{kt}$  ( $\beta_2 < 0$ ). Also, because this option value is positive,  $A_{1k} > 0$ .

In the region  $\pi_{kt} < F_k$  (inactive firm), the firm does not generate an income flow. Over an infinitesimal period of time, the value function satisfies

$$V_{1k}(\pi_{kt})dt = \frac{1}{1 + vdt} E(V_{1k}(\pi_{kt} + d\pi_{kt})). \quad (5)$$

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<sup>4</sup>Note that we abuse notation by dropping the last subindex of the constant.

The HJB equation is

$$\frac{1}{2} \frac{d^2 V_{1k}}{d\pi_{kt}^2} \sigma^2 \pi_{kt}^2 + \frac{dV_{1k}}{d\pi_{kt}} \alpha \pi_{kt} - v V_{1k}(\pi_{kt}) = 0$$

and the solution is given by

$$V_{1k}(\pi_{kt}) = B_{1k1} \pi_{kt}^{\beta_1} + B_{1k2} \pi_{kt}^{\beta_2} \quad (6)$$

with identical roots  $\beta_1$  and  $\beta_2$  as in the previous two cases. We know that  $d\pi_{kt} \rightarrow 0$  as  $\pi_{kt} \rightarrow 0$  because  $\pi_{kt}$  is a GBM. Hence, appealing to the argument made earlier,  $\beta_2 < 0$  implies that  $B_{1k2} = 0$ . This leaves:

$$V_{1k}(\pi_{kt}) = B_{1k} \pi_{kt}^{\beta_1}. \quad (7)$$

Equation (7) characterizes the value function dynamics over the interval  $\pi_{kt} \in [0, F_k)$ . In this range,  $V_{1k}(\pi_{kt})$  represents the value of the option to resume operations if conditions improve to the point that  $\pi_{kt} \geq F_k$ . As this option value is positive,  $B_{1k} > 0$ .

Since the inside firm can costlessly choose to continue or suspend operations, it must be indifferent between any of these two actions at  $\pi_{kt} = F_k$ . Hence, at this point the values and derivatives of equations (4) and (7) must coincide providing, respectively, the value-matching condition:

$$A_{1k} F_k^{\beta_2} + \frac{F_k}{v - \alpha} - \frac{F_k}{v} = B_{1k} F_k^{\beta_1} \quad (8)$$

and the smooth-pasting condition:

$$\beta_2 A_{1k} F_k^{\beta_2 - 1} + \frac{1}{v - \alpha} = \beta_1 B_{1k} F_k^{\beta_1 - 1}. \quad (9)$$

These two equations can be solved for  $A_{1k}$  and  $B_{1k}$  to obtain  $A_{1k} = \frac{F_k^{1-\beta_2}}{\beta_1 - \beta_2} \left( \frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} \right)$  and  $B_{1k} = \frac{F_k^{1-\beta_1}}{\beta_1 - \beta_2} \left( \frac{\beta_2}{v} - \frac{\beta_2 - 1}{v - \alpha} \right)$ . Since we know that  $A_{1k} > 0$  and  $B_{1k} > 0$ , this implies that  $\frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} > 0$  and  $\frac{\beta_2}{v} - \frac{\beta_2 - 1}{v - \alpha} > 0$ .

Equations (4) and (7) provide the value function dynamics for the active and inactive firms, respectively, in terms of profits. Since  $\pi_{kt} = \psi_k \theta_t$ , we can express those equations in terms of the general profitability parameter  $\theta_t$ :

$$\Omega_k(\theta_t) = \begin{cases} A_{1k} (\psi_k \theta_t)^{\beta_2} + \frac{\psi_k \theta_t}{v - \alpha} - \frac{F_k}{v} & \text{if } \theta_t \geq \frac{F_k}{\psi_k} \\ B_{1k} (\psi_k \theta_t)^{\beta_1} & \text{if } \theta_t < \frac{F_k}{\psi_k} \end{cases} \quad (10)$$

The function  $\Omega_k(\theta_t)$  describes the value function dynamics of the inside firm. This function subsumes the optimal “entry-exit” decisions. Note that all the parameter values in  $\Omega_k(\theta_t)$  are known. Next, we use this equation to determine the unknown values  $A_{0k}$  and  $\theta_k^*$ .

**Using the thresholds to solve for the coefficients** Since firms are risk-neutral, the value matching condition, at the entry threshold  $\theta_k^*$ , states that the value of being outside,  $V_{0k}(\theta_t)$ , should equal the value of being inside, which is given by  $\Omega_k(\theta_t) - S_k$ . Hence:

$$V_{0k}(\theta_k^*) = \Omega_k(\theta_k^*) - S_k. \quad (11)$$

The smooth-pasting condition imposes that:

$$\frac{dV_{0k}(\theta_t)}{d\theta_t}\Big|_{\theta_k^*} = \frac{d\Omega_k(\theta_t)}{d\theta_t}\Big|_{\theta_k^*}. \quad (12)$$

Replacing (3) in (11) and (12) yields

$$-A_{0k}\theta_k^{*\beta_1} + \Omega_k(\theta_k^*) = S_k \quad (13)$$

$$-A_{0k}\beta_1\theta_k^{*\beta_1-1} + \Omega'_k(\theta_k^*) = 0. \quad (14)$$

Since there is no reason to incur the sunk cost  $S_k$  ahead of time to keep the project idle, the firm will not enter unless  $\theta_k^* > \frac{F_k}{\psi_k}$ . Hence, we can substitute the top line of (10) in equations (13) and (14) to obtain:

$$-A_{0k}\theta_k^{*\beta_1} + A_{1k}\psi_k^{\beta_2}\theta_k^{*\beta_2} + \frac{\psi_k\theta_k^*}{v-\alpha} - \frac{F_k}{v} = S_k \quad (15)$$

$$-\beta_1 A_{0k}\theta_k^{*\beta_1-1} + \beta_2 A_{1k}\psi_k^{\beta_2}\theta_k^{*\beta_2-1} + \frac{\psi_k}{v-\alpha} = 0. \quad (16)$$

Combining these two equations and using the solution for  $A_{1k}$ , we obtain:

$$\left(\frac{\beta_1}{v} - \frac{\beta_1-1}{v-\alpha}\right) F_k^{1-\beta_2}\psi_k^{\beta_2}\theta_k^{*\beta_2} + \frac{(\beta_1-1)}{v-\alpha}\psi_k\theta_k^* - \beta_1\left(\frac{F_k}{v} + S_k\right) = 0. \quad (17)$$

This equation determines the optimal entry threshold  $\theta_k^*$ .

Define “normalized” profitability as  $\tilde{\theta}_k \equiv \frac{\psi_k\theta_k}{F_k}$  and the “normalized” entry threshold as  $\tilde{\theta}_k^* \equiv \frac{\psi_k\theta_k^*}{F_k}$ . Provided  $F_k > 0$ , we can rewrite equation (17) in a way that clarifies the properties of the solution:

$$\left(\frac{\beta_1}{v} - \frac{\beta_1-1}{v-\alpha}\right)\tilde{\theta}_k^{\beta_2} + \frac{(\beta_1-1)}{v-\alpha}\tilde{\theta}_k - \beta_1\left(\frac{1}{v} + \frac{S_k}{F_k}\right) = 0. \quad (18)$$

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 (18). Then, there is a unique  $\tilde{\theta}_k^* \in [1, \infty)$  such that  $G_k(\tilde{\theta}_k^*) = 0$ . Furthermore, since  $G'_k(\tilde{\theta}_k) > 0$  for  $\tilde{\theta}_k \in (1, \infty)$ , then  $G'_k(\tilde{\theta}_k^*) \geq 0$ , with strict inequality if  $\tilde{\theta}_k^* > 1$ . Finally,  $\tilde{\theta}_k^* = 1$  iff  $S_k = 0$ .

*Proof.* See Appendix A.2.

Since we know that  $\tilde{\theta}_k$  has to be in the region  $[1, \infty)$ , the solution to (18) is the unique entry threshold. Note that  $\tilde{\theta}_k^*$  will not change as long as  $\frac{S_k}{F_k}$  remains constant. Hence, the (un-normalized) entry threshold  $\theta_k^*$  will be proportional to the demand shifter,  $\psi_k$ , and to the inverse of fixed costs,  $F_k^{-1}$ . For example, a firm with twice the value of the market- $k$  shifter ( $\psi_k' = 2\psi_k$ ) will enter the market with half the productivity ( $\theta_k^{*'} = \frac{1}{2}\theta_k^*$ ).

### 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  $s$  is still active in that market at time  $s + T$ . As an initial condition, we assume that all firms are born with an initial value  $\theta_0$  that is lower than  $\theta_k^*$ .<sup>5</sup> Therefore, the continuity of the process for  $\theta_t$  ensures that all firms that enter market  $k$  do it with the value of the general productivity parameter  $\theta_k^*$  at their (firm-specific) entry thresholds. In turn, the exit (or suspension) of the firm in market  $k$  will occur whenever its operating profits  $\pi_{kt}$  fall below  $F_k$ , i.e. when  $\theta_t < \frac{F_k}{\psi_k}$ . As a result, firms enter the market with  $\theta_t = \theta_k^*$  and exit it with  $\theta_t = \frac{F_k}{\psi_k}$ .

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

$$P_k(T) = P\left(\theta(s+T) > \frac{F_k}{\psi_k} \middle| \theta_s = \theta_k^*\right).$$

Since  $\theta_t$  is a GBM with parameters  $\alpha$  and  $\sigma$ ,  $\log \theta_t$  is a standard Brownian motion with drift  $\mu = \alpha - \frac{1}{2}\sigma^2$  and volatility  $\sigma$ . Hence, the distribution of  $\log(\theta_{s+T})$  conditional on  $\log(\theta_s)$  is normally distributed with mean  $\mu T + \log(\theta_s)$  and variance  $\sigma^2 T$ . Normalizing (wlog)  $s = 0$ ,  $P_k(T)$  can be computed as:

$$P_k(T) = 1 - \Phi\left(\frac{\ln\left(\frac{F_k}{\psi_k \theta_k^*}\right) - \mu T}{\sigma \sqrt{T}}\right). \quad (19)$$

Equation (19) displays a closed form solution for the probability of survival in market  $k$  as a function of model parameters and the endogenous entry threshold  $\theta_k^*$ . All the parameters of the model except for the market-specific shifter  $\psi_k$  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 ( $\alpha$  and  $\sigma$ ). Therefore, only differences in  $\psi_k$ , and those they induce on  $\theta_k^*$ , could potentially generate variation across firms in survival probabilities for a given market. However, as we show next,  $P_k(T)$  does not depend on  $\psi_k$ . As a result, this probability is the same for all firms upon entry into market  $k$ .

**Proposition 1.**  $P_k(T)$  is independent of  $\psi_k$ .

*Proof.*

<sup>5</sup>Under reasonable conditions, this assumption implies that firms serve their domestic market first. For instance, using  $d$  to denote the domestic market, a sufficient condition is that  $\psi_d \geq \max\{\psi_k\}_{k=1\dots K}$ ,  $F_d \leq \min\{F_k\}_{k=1\dots K}$ , and  $S_d \leq \min\{S_k\}_{k=1\dots K}$ .

Using our definition of  $\tilde{\theta}_k$ , we can rewrite (19) as:

$$P_k(T) = 1 - \Phi \left( \frac{-\ln \tilde{\theta}_k - \mu T}{\sigma \sqrt{T}} \right) = \Phi \left( \frac{\ln \tilde{\theta}_k + \mu T}{\sigma \sqrt{T}} \right). \quad (20)$$

Lemma 1 established that  $\tilde{\theta}_k$  is common for all firms. Therefore, (20) establishes that so is also the probability of survival in market  $k$ . *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  $\psi_k$  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  $\psi_k$  across firms or markets. In particular, since the sequence in which firms enter foreign markets is determined by their idiosyncratic set  $\Psi = \{\psi_k\}_{k=1,\dots,K}$ , the model is consistent with any entry sequence that is observed in the data.

The reason the probability of survival is unaffected by  $\psi_k$  is that 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 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 enter that market sooner. However, it will also stay longer in the market as the exit threshold will also be proportionally lower. Since entry and exit thresholds decrease proportionally with  $\psi_k$ , 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, while entry and exit thresholds will be (proportionally) lower, this fact will not generate differences in survival probabilities between these 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 19), we obtain that  $\frac{\partial P_k(\tilde{\theta}_k^*(S_k/F_k))}{\partial(S_k/F_k)} > 0$ .

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  $S_k/F_k$  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  $\theta_t$  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  $s$  remains above that point at time  $T + s$ . That probability does not depend on the particular entry/exit point.

The sharp results of propositions 1 and 2 hinge on our functional form assumptions about the profitability process following a GBM and the market-specific profitability shifters being multiplicative. However, those assumptions are useful to generate a clean benchmark to understand 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, we note that the result on the probability of survival increasing with sunk costs is robust to the specification of the stochastic process, the demand structure, and the costless suspension of exporting activities.

Finally, note that we can allow for variation in the distribution of  $S_k$  and  $F_k$  across firms. Since the probability of survival increases with  $\frac{S_k}{F_k}$ , the average probability of survival in market  $k$  will be larger than in market  $k'$  if the distribution of firm's  $\frac{S_k}{F_k}$  upon entry in market  $k$  stochastically dominates the distribution upon entry in market  $k'$ .<sup>6</sup>

### 3 Testing for determinants of export survival (I)

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.

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<sup>6</sup>If one is willing to make assumptions about the birth rates of firms and their initial distribution over  $\theta_0$ ,  $\psi_k$  and  $\frac{S_k}{F_k}$ , then it is possible to derive the distribution upon entry using simulations.

### 3.1 Data

The primary source of information that we use comes from Argentine customs data (ACD) and covers the years spanning from 1994 to 2006. The ACD describes every export transaction by Argentine firms. Each transaction record includes a unique 10-digit tax code (national identification tax number, CUIT); the exported good identified at the 12-level NCM (Nomenclador Común del Mercosur); destination country; value of the transaction in US\$; and year of transaction.

Our empirical strategy in this section consists in evaluating the impact of geographical distance and other gravity forces. The CEPII Gravity Dataset puts together gravity variables from a variety of sources. This dataset includes measures of bilateral distances (in kilometers), GDP and population. It also indicates whether a country pair shares a border, an official language, or has signed a preferential trade agreement.

Before turning to the descriptive statistics, we introduce the following terminology to describe exporting and survival in foreign markets:

- (i). **Export Instance** : any firm-destination-year combination. That is, an export instance is defined by a positive value of exports of firm  $i$  to destination  $k$  in year  $t$ .
- (ii). **Export Experience** : a string of instances over time (it could be only 1 year).
- (iii). **Export Incursion** : the first year of a new export experience in a new firm-destination-year combination (i.e. re-entering a market previously served is not considered an incursion).
- (iv). **Export Survival** is defined as the probability for an Export Incursion to be active after 2 years.<sup>7</sup>

### 3.2 Facts about Argentine exports and export survival

During the period of our study, Argentine total 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 and increased more than 80% between 2002 and 2006. Figure 1 displays this evolution. We also note a similar trend for manufacturing and differentiated goods.

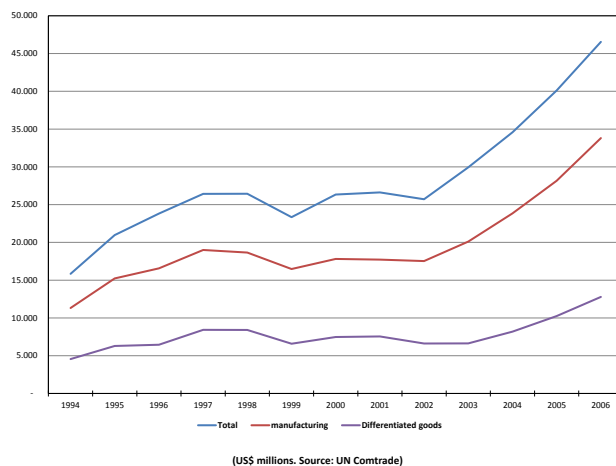
Table 1 provides basic information about exports from Argentina. The value of exports almost tripled during the period, whereas the number of firms selling abroad increased by about 50%; from 9559 exporting firms in 1994 to 14960 in 2006. The number of incursions per year followed a u-shaped trajectory. 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\$ 9321 in 2004). Finally, the last column reports the survival rate, that is the fraction of surviving incursions. This

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<sup>7</sup>Alternative measures of survival will be used to check the robustness of our results.



Figure 1: Argentine Exports (1994 - 2006)



fraction is generally low (around 31%) and slightly higher during 1995 and 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.

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:	364100	Average: 12392	Total: 118854	Average: 12161	Average: 0.31

### 3.3 Empirical analysis: independent markets

Proposition 2 states that the probability of survival increases with the ratio  $S_k/F_k$ . 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  $S_k/F_k$ . 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  $S_k/F_k$ , we cannot perform a test of Proposition 2. However, we can use this proposition and the observed cross-country variation in survival rates to infer how  $S_k/F_k$  varies across countries. Learning how this ratio varies across countries serves two main purposes. In the first place, it imposes discipline on potential parametrizations of theoretical models of export dynamics. In the second place, it provides a benchmark for empirical models that estimate sunk and fixed costs using a theoretical framework that is similar to the one laid out in this paper.

In our analysis, we first study cross-country variation in sunk and fixed costs as a function of the distance between Argentina and market  $k$ . To do this, we assume that exporting to more distant countries involves higher sunk and fixed costs. In addition to the theoretical plausibility of this assumption, its empirical plausibility is supported by a direct implication of our model. A firm will exit a destination whenever net profits become zero, that is when operating profits equal fixed cost. Since profits are proportional to sales under CES preferences, sales of exiting firms have to be larger the higher are the fixed costs. Hence, if distance serves as a proxy for country-specific fixed costs, we should observe that export sales at exit increase with distance. This is an empirical implication that can be tested by estimating 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  $\gamma_t$  to capture year fixed effects. Table 2 reports the results excluding (in column 1) and including (in column 2) the time fixed effect. In both cases, the results show that exit sales increase with distance.

Exit export sales increasing with distance indicates that fixed costs are larger in more distant destina-

Table 2: Exit Sales and Distance

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

Standard errors in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05

tions.<sup>8</sup> As sunk and fixed costs involve similar activities it is reasonable to assume that, analogously, sunk costs also increase with distance. Nevertheless, while both costs are assumed to increase with distance we still need to determine how distance affects the ratio  $S_k/F_k$ .

Table 3 displays the probability of survival 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, language and trade agreements raises the probability of survival by about 10%. Finally, we group countries according to whether their level of income 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:

$$P_{ikt} = \alpha_1 \ln d_k + \gamma_t + \mu_{ikt}, \quad (21)$$

where  $P_{ikt}$  is the probability of establishing an export experience that is active  $T$  years ( $T = 2$ ) after the export incursion of firm  $i$  in market  $k$  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  $\gamma_t$  to control for year fixed effects.<sup>9</sup> Since the main regressor varies at a more aggregate level ( $k$ ) than the unit of observation

<sup>8</sup>This result also holds if we include firm fixed effects.

<sup>9</sup>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  $\theta_t$ . 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  $\theta_t$  above the entry threshold.

Table 3: Rate of Survival by Year and Region

	# Incursions	Sales (gmean)	Probability 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
Preferential Trade Agreement	40920	10894	0.34
Panel C: Income			
Low and Middle Income Country	73644	12184	0.33
High Income Country	45210	10336	0.27
Total	118854	12161	0.31

(i), we allow the error term ( $\mu_{ikt}$ ) 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).<sup>10</sup>

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<sub>k</sub>* (whether country  $k$  shares the same language with Argentina), *Contiguity<sub>k</sub>* (whether country  $k$  and Argentina share a border), and *PTA<sub>k</sub>* (whether country  $k$  and Argentina have implemented a preferential trade agreement). These three variables can arguably be associated with lower sunk and fixed costs of exporting. 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. Similarly, a PTA may reduce exporting costs if the agreement involves harmonizing regulations and/or exporting procedures. Contiguity, in turn, is a proxy for geographical distance and cultural similarities. Column 3 shows that only having a common language has an additional and significantly positive effect on the probability of survival. The effects of a PTA and contiguity are not significant. In any event, the effect of distance persists.

There is a mismatch between our theoretical results and their empirical implementation. In our model,

<sup>10</sup>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 A.1. and 7) because the estimated variance matrix is non 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*** (0.003) [0.003]	-0.028*** (0.003) [0.003]	-0.024*** (0.007) [0.006]	-0.037*** (0.008) [0.008]
<i>Common Language<sub>k</sub></i>			0.025** (0.013) [0.012]	0.041** (0.017) [0.018]
<i>Contiguity<sub>k</sub></i>			0.023 (0.023) [0.023]	-0.003 (0.013) [0.018]
<i>PTA<sub>k</sub></i>			0.012 (0.012) [0.023]	-0.014 (0.014) [0.013]
$\ln X_{ikt}$				0.031*** (0.002) [0.001]
$\ln NINCUR_{it}$				0.014*** (0.001) [0.001]
Constant	0.533*** (0.022) [0.023]	0.542*** (0.021) [0.026]	0.496*** (0.063) [0.058]	0.265*** (0.091) [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	0.025

Robust standard errors in parentheses clustered at the destination level  
Robust standard errors in brackets clustered by destination and at the firm level

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

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  $\theta_t$  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  $i$  at 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  $\theta_t$ , 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 not only survives but also increases 27%.

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 2.4733 (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 re-define “Export Survival” more strictly by imposing that a new export incursion has to be active three years later instead of two; (iv) we also use a definition of survival that imposes consecutive export spells (at least three years) and considers re-entries as new export incursions. 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 higher in countries related by other gravity variables.

The fact that the probability of survival is decreasing in distance and increasing in other gravities implies that  $S_k/F_k$  also decreases with distance and increases with other gravities. This implies, in turn, that fixed costs increase proportionally more with distance and decrease proportionally more with other gravities than sunk costs. This result informs an empirical literature that structurally estimates fixed and sunk costs. Specifically, Das, Roberts, and Tybout (2007) estimate fixed costs by assuming that they are paid to gain

access to an aggregate export market while Morales, Sheu, and Zahler (2014) allow for cross-country variation in fixed costs but postulate them as a function of a set of gravity variables that does not include distance. In contrast, our results suggest the importance of distance as a systematic determinant of the magnitude of fixed costs. Furthermore, 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. While we do not estimate the magnitude of exporting costs, our focus on survival probabilities highlights the important role played by fixed costs - at least within the confines of a standard framework that includes sunk costs, fixed costs, and a GBM profitability process - in explaining the observed patterns of geographical variation in survival rates.<sup>11</sup> Our findings also relate to Arkolakis (2012)'s claim that sunk costs are not necessary to explain key features of firms' export dynamics. Proposition 2 and the empirical evidence of this section suggest that, also within the confines of the standard framework we use here, sunk costs are necessary to explain the observed variation of survival rates across countries.

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 firms need to maintain to restore the depreciated stock, a potential interpretation of our empirical results is that the stock of export activities depreciates more rapidly in distant countries and in countries unrelated through other gravity variables. 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 learn about and adapt to changing market conditions. This interpretation would also be consistent with marketing activities that become more preponderant in distant markets.

## 4 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. In other words, *history matters*. We first develop analytically the case of interdependent sunk costs. Then, we treat the case of interdependent fixed costs.

### 4.1 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:

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

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<sup>11</sup>Although we choose to work with a GBM for tractability our results would be similar by assuming instead a highly persistent autoregressive process.

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 5 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 (17) 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  $\theta_{Ek}^*$  the entry threshold for experienced firms,  $\theta_{Ik}^*$  the entry threshold for inexperienced firms entering only market  $k$ , and  $\theta_{IM}^*$  the entry threshold for inexperienced firms entering  $M$  markets (including  $k$ ) simultaneously. Since exit thresholds are the same in all cases, to compare survival probabilities of experienced and inexperienced firms we just need to compare their entry thresholds.

Experienced firms pay a lower sunk cost than inexperienced ones to enter market  $k$ . Following Proposition 2, we would guess that a lower sunk cost would induce earlier entry and hence a lower survival probability. However, this result may not hold when sunk costs are interdependent. 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.**  $\theta_{Ek}^* \leq \min \{ \theta_{Ik}^*, \theta_{IM}^* \}$ . Hence,  $P(\theta_{Ek}^*) \leq \min \{ P(\theta_{Ik}^*), P(\theta_{IM}^*) \}$

*Proof.*

The case of the experienced firm is straightforward. To enter market  $k$ , this firm must only pay the idiosyncratic sunk cost  $\tilde{S}_k$ . Entering this market has no strategic implications for entry into other markets since no further reductions in sunk costs can be realized. Hence, the problem of the experienced firm is equivalent to that in the independent case with sunk costs  $\tilde{S}_k$ . Therefore,  $\theta_{Ek}^* = \theta_k^*(\tilde{S}_k)$ .

The inexperienced firm can enter market  $k$  alone or it can enter a subset of  $M$  markets in group  $g$  (including  $k$ ) simultaneously. If the firm decides to enter only market  $k$ , the entry thresholds for entering all other markets in  $g$  must be higher – even after taking into account that  $S_g$  need not be repaid. This implies that  $\theta_{Ik}^* < \theta_{Ek'}^*, \forall k' \in g$ . Although the sunk cost to enter  $k'$  drops immediately after entering  $k$ , the lower entry threshold must still be higher than the entry threshold for  $k$ . This implies that entering market  $k$  has no “strategic value”. Therefore, the entry threshold is simply the one derived in the independent case



with *total* sunk costs. Hence,  $\theta_{Ik}^* = \theta_k^*(S_k)$ .<sup>12</sup> Since  $S_k > \tilde{S}_k$ , using Proposition 2 we can establish that  $\theta_{Ik}^* > \theta_{Ek}^*$ .

If the firm enters  $M$  markets simultaneously, it enters them at the entry threshold  $\theta_{IM}^*$ . We want to show that  $\theta_{IM}^* \geq \max_{k'} \{\theta_{Ek'}^*\}_{k'=1, \dots, M}$ . Let  $l = \arg \max_{k'} \{\theta_{Ek'}^*\} = \arg \max_{k'} \{\theta_{k'}^*(\tilde{S}_{k'})\}$ . To obtain a contradiction, suppose that  $\theta_{IM}^* < \theta_l^*(\tilde{S}_l)$ . Given that the firm is already entering at least one other market in the region, the extra cost of entering  $l$  is just the sunk cost  $\tilde{S}_l$ . However, since  $\theta_{IM}^* < \theta_l^*(\tilde{S}_l)$ , for  $\theta_t = \theta_{IM}^*$  the firm would rather wait than enter market  $l$ . But then  $l$  is not one of the  $M$  markets, which is a contradiction. This establishes that  $\theta_{IM}^* \geq \max_{k'} \{\theta_{k'}^*(\tilde{S}_{k'})\}_{k'=1, \dots, M}$ . Since  $k$  is one of those  $M$  markets, this implies in particular that  $\theta_{IM}^* \geq \theta_k^*(\tilde{S}_k) = \theta_{Ek}^*$ . Combining the results obtained thus far, we can establish that  $\theta_{Ek}^* \leq \min \{\theta_{Ik}^*, \theta_{IM}^*\}$ . Since exit thresholds are equal in the three cases, this result immediately implies that  $P(\theta_{Ek}^*) \leq \min \{P(\theta_{Ik}^*), P(\theta_{IM}^*)\}$ .

*QED*

Proposition 3 shows that the probability of survival in market  $k$  is always lower for an experienced firm than for an inexperienced one when previous export experience lowers the sunk costs of entry. In a regression framework that controls for destination fixed effect, this result implies that the experience of a firm should have a negative effect on its survival probability. We will assess the empirical relevance of this prediction in the next section. Appendix A.3 further demonstrates that a strategic value is indeed realized when the inexperienced firm enters group  $g$  by entering  $M$  markets simultaneously. Formally, it shows that  $\theta_{IM}^* \leq \theta_{Ik}^*$ . In other words, a strategic value of entry only exists when the presence of interdependent sunk costs changes the order in which the firm decides to enter export markets.

## 4.2 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

<sup>12</sup>Note that there is no reason a firm entering only market  $k$  would want to enter this market earlier, i.e. with  $\theta_t < \theta_k^*(S_k)$ , for strategic reasons. This firm would gain by waiting until it can realize the strategic value by also entering other markets.

are interconnected across markets. Since the order in which firms exit these markets starts to matter, 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 is sufficient to show how the counter-intuitive prediction for survival probabilities can arise.

Define  $\psi_i \equiv \frac{\psi_{iA}}{\psi_{iB}}$ . We know that there is a  $\psi_{iA}$  sufficiently high (relative to  $\psi_{iB}$ ) 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  $\psi_i > \bar{\psi}_A^{entry}$ . There is also a threshold  $\bar{\psi}_B^{entry}$  ( $\bar{\psi}_A^{entry} > \bar{\psi}_B^{entry}$ ) such that firm  $i$  will want to enter market  $B$  first if  $\psi_i < \bar{\psi}_B^{entry}$ .<sup>13</sup> Similarly, we can find  $\bar{\psi}_A^{exit}$  and  $\bar{\psi}_B^{exit}$  such that firm  $i$  will exit market  $A$  last if  $\psi_i > \bar{\psi}_A^{exit}$ , will exit  $B$  last if  $\psi_i < \bar{\psi}_B^{exit}$ , and will exit both markets simultaneously if  $\psi_i$  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  $\bar{\psi}_B^{entry} > \bar{\psi}_A^{exit}$  to show the possibility of contradictory predictions on survival probabilities for experienced and inexperienced firms. Given this assumption,  $\bar{\psi}_A^{entry} > \bar{\psi}_B^{entry}$  also implies that  $\bar{\psi}_A^{entry} > \bar{\psi}_A^{exit}$ .

Consider a firm (firm 1) with a sufficiently high relative profitability in market  $A$  such that  $\psi_1 > \bar{\psi}_A^{entry} > \bar{\psi}_A^{exit}$ . 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 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 ( $\theta_A^*$ ) is the same as in the independent case (see Appendix A.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 Appendix A.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

<sup>13</sup>In between these two thresholds, the firm will enter the two markets simultaneously.

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 5, the predictions of the regular case will be those with the ability to explain the estimated effect of experience on observed survival rates.

## 5 Testing for determinants of export survival (II): Trajectories matter

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, enhance 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 destinations to which it has previously exported. Then, in subsection 5.2, 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.

### 5.1 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 5 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  $Exposure_{it} = \sum_{1994}^{t-1} X_{it}$  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.

Table 5: 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

The broad message emerging from Table 5 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:

$$P_{ikt} = \alpha_1 \ln d_k + D_{it}^E + \gamma_t + \mu_{ikt} \quad (22)$$

where  $d_k$  is the distance from Argentina to country  $k$ ,  $\gamma_t$  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 6 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.

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 the variation in survival probabilities between experienced and inexperienced firms *within* a destination. In column 2 of Table 6, we verify that the effect of  $D_{it}^E$  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  $\gamma_t$  are year fixed effects. In columns 3-6 of Table 6, we report the specific effect of each of the proxies for experience (in logs): *Exporting Age* <sub>$it$</sub>  (column 3); *Exposure* <sub>$it$</sub>  (column 4); *Number of previous incursions* <sub>$it$</sub>  (column 5); and *Number of destinations* <sub>$i,t-1$</sub>  (column 6).<sup>14</sup> All these different ways to capture experience are positively associated with survival upon entry. In column 7, we include all controls of 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 ( $NINCUR_{it}$ ) to control for the mismatch stemming from the fact that the model is in continuous time but the data is reported in discrete periods (column 8). 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.<sup>15</sup>

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

<sup>14</sup>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.

<sup>15</sup>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.

destinations.

## 5.2 Specific exporting experience

The effect of exporting experience on the magnitude of the sunk and fixed costs of serving country  $k$  might be limited to the background acquired only 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  $\alpha_2$ ,  $\alpha_3$  and  $\alpha_4$ . If positive, the associated extended gravities would imply an impact on fixed costs with a stronger effect on survival than the impact on sunk costs. The opposite should be true when these coefficients are negative. Table 7 reports the results. The first column displays a basic regression including as controls only  $\ln d_k$  and year fixed effects ( $\gamma_t$ ). 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 ( $\gamma_k$ ) 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

Table 6: Survival and General Exporting Experience

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$D_{i,t}^c$	0.046*** (0.006) [0.006]	0.052*** (0.005) [0.009]							
$\ln d_k$	-0.033*** (0.003) [0.003]								
$\ln \text{Exporting Age}_{i,t}$			0.048*** (0.003) [0.008]				0.095 (0.006) [0.012]	0.045*** (0.003) [0.004]	0.0406*** (0.004) [0.005]
$\ln \text{Exposure}_{i,t}$				0.006*** (0.0004) [0.0001]			0.002*** (0.0007) [0.0009]		
$\ln \text{Number of previous incursions}_{i,t}$					0.048*** (0.002) [0.008]		-0.001 (0.004) [0.006]		
$\ln \text{Number destinations}_{i,t-1}$						0.008*** (0.0004) [0.0001]	0.006*** (0.0004) [0.0001]		
$\ln X_{ikt}$								0.032*** (0.004) [0.002]	
$\ln \text{NINCUR}_{it}$								0.091*** (0.004) [0.011]	
Constant	0.552*** (0.023) [0.027]	0.299*** (0.005) [0.009]	0.281*** (0.007) [0.015]	0.281*** (0.006) [0.015]	0.277*** (0.006) [0.015]	0.305*** (0.006) [0.011]	0.284*** (0.006) [0.014]	-0.0691*** (0.016) [0.025]	0.625*** (0.008) [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 by destination and at the firm level

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 7: Survival and Specific Exporting Experience

	(1)	(2)	(3)	(4)	(5)	(6)
$\ln d_k$	-0.034*** (0.003) [0.004]					
$XContiguity_{kt}$	0.054*** (0.007) [0.007]	0.059*** (0.006) [0.01]	0.048*** (0.006) [0.016]	0.032*** (0.009) [0.007]	0.047*** (0.009) †	0.045*** (0.005) [0.013]
$XLanguage_{kt}$	0.029*** (0.008) [0.008]	0.048*** (0.006) [0.015]	0.035*** (0.006) [0.016]	0.027*** (0.008) [0.014]	0.033*** (0.012) †	0.04*** (0.007) [0.010]
$XIncomeQuartile_{it}$	0.057*** (0.006) [0.006]	0.057*** (0.006) [0.012]	0.042*** (0.006) [0.016]	0.041*** (0.009) [0.012]	0.033*** (0.01) †	0.047*** (0.006) [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*** (0.027) [0.03]	0.284*** (0.006) [0.01]	-0.043** (0.017) [0.019]	0.634*** (0.007) [0.009]	-0.136*** (0.05) †	0.286*** (0.006) [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 by destination and at the firm level

†Multi-way clustering at the firm and destination levels cannot be performed

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1



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 not only remains positive but also the relevant coefficients are higher.

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.

## 6 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 fixed and sunk costs. We find that, although the results are ambiguous in general, they are consistent with the results under independent markets in the empirically relevant case.

In addition to our theoretical results, we uncover two basic facts about Argentine exporters: 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 results of our paper carry potentially important implications for the quantitative literature on sunk and fixed exporting costs. This literature commonly assumes that fixed costs are invariant across destinations (Das, Roberts, and Tybout, 2007; Morales, Sheu, and Zahler, 2014) and over the exporting history of the firm (Morales, Sheu, and Zahler, 2014). Our framework instead allows for this variation. The findings impose restrictions on how fixed costs and sunk costs should vary across destinations and experience, and suggest that existing estimates of exporting costs may need to be re-evaluated upon this light.

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 a plausible description of exporting costs and have provided some supportive examples, 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, Forthcoming) or reputation (Araujo, Mion, and Ornelas, 2014). We leave this task for future research.

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## A Appendix

### A.1 Derivation of the stochastic process of $\theta_t$

Suppose preferences are CES across varieties with a time-varying demand shifter  $\lambda_{ikt}$  so that the demand for variety  $i$  in market  $k$  at time  $t$  is given by

$$q_{ikt} = \lambda_{ikt} p_i^{-\varepsilon} \frac{E_k}{P_k^{1-\varepsilon}}.$$

As we are not modeling foreign firms, we take  $E_k/P_k^{1-\varepsilon}$  as exogenous. Next, assume constant marginal costs given by  $c_{ik}/\varphi_t$ , where  $c_{ik}$  is a positive constant and  $\varphi_t$  is a time-varying productivity index. If goods require only home labor and transport cost are of the iceberg form, we can write  $c_{ik} = w\tau_{ik}$ . Assuming a monopolistic competition market structure yields the usual pricing rule,

$$p_{ik} = \left( \frac{\varepsilon}{\varepsilon - 1} \right) \frac{c_{ik}}{\varphi_t}$$

which implies that gross operating profits are given by

$$\pi_{ikt} = \frac{1}{\varepsilon} \left( \frac{\varepsilon}{\varepsilon - 1} \right)^{1-\varepsilon} c_{ik}^{1-\varepsilon} \frac{E_k}{P_k^{1-\varepsilon}} \lambda_{ikt} \varphi_{it}^{\varepsilon-1}.$$

We assume  $\lambda_{ikt}$  is perfectly correlated across markets. Therefore, we can write  $\lambda_{ikt} = \bar{\lambda}_{ik} \lambda_{i,t}$ . Next, define

$$\begin{aligned} \psi_{ik} &\equiv \frac{1}{\varepsilon} \left( \frac{\varepsilon}{\varepsilon - 1} \right)^{1-\varepsilon} c_{ik}^{1-\varepsilon} \frac{E_k}{P_k^{1-\varepsilon}} \bar{\lambda}_{ik} \\ \theta_{it} &\equiv \lambda_{it} (\varphi_{it})^{\varepsilon-1} \end{aligned}$$

and write

$$\pi_{ikt} = \psi_{ik} \theta_{it}.$$

Assuming  $(\lambda_{it}, \varphi_{it})$  follow a multivariate geometric brownian motion,  $\theta_{it}$  is also a geometric brownian motion. (Note that we omit subindex  $i$  in the text).

## A.2 Proof of Lemma 1

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

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

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

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

Next, evaluate  $G_k(\tilde{\theta}_k)$  and  $G'(\tilde{\theta}_k)$  at  $\tilde{\theta}_k = 1$ . Using (18):

$$\begin{aligned} G_k(1) &= \left( \frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} \right) + \frac{(\beta_1 - 1)}{v - \alpha} - \beta_1 \left( \frac{1}{v} + \frac{S_k}{F_k} \right) \\ &= -\beta_1 \frac{S_k}{F_k} \leq 0, \end{aligned} \tag{23}$$

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

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

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

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 (18) holds. Finally, it follows immediately from (23) that  $\tilde{\theta}_k^* = 1$  iff  $S_k = 0$ .

## A.3 Proof that there may be strategic value in the first entry into group $g$

Proposition 3 established that there is no strategic value to realize when the inexperienced firm enters only market  $k$ . Here, we prove that in general there is a strategic value of entry when the firm enters  $M$  markets simultaneously.

**Proposition A.1.**  $\theta_{IM}^* \leq \theta_{Ik}^*$

*Proof.*

Let  $V_{0M}$  be the option value of entering  $M$  markets simultaneously and let  $\theta_{IM}^*$  be the associated entry threshold. The value-matching condition is given by

$$V_{0M}(\theta_M^*) = \sum_k \Omega_k(\theta_{IM}^*) - \sum_k \tilde{S}_k - S_g. \quad (24)$$

Similarly, the smooth-pasting condition is given by

$$\left. \frac{dV_{0k}(\theta_t)}{d\theta_t} \right|_{\theta_t=\theta_{IM}^*} = \sum_k \left( \left. \frac{d\Omega_k(\theta_t)}{d\theta_t} \right|_{\theta_t=\theta_{IM}^*} \right). \quad (25)$$

Using the results of section 2, these two equations can be written, respectively, as:

$$-A_{0M}\theta_{IM}^{*\beta_1} + \sum_k \left( A_{1k}\psi_k^{\beta_2}\theta_{IM}^{*\beta_2} + \frac{\psi_k\theta_{IM}^*}{v-\alpha} - \frac{F_k}{v} \right) = \sum_k \tilde{S}_k + S_g \quad (26)$$

$$-\beta_1 A_{0M}\theta_{IM}^{*\beta_1-1} + \sum_k \left( \beta_2 A_{1k}\psi_k^{\beta_2}\theta_{IM}^{*\beta_2-1} + \frac{\psi_k\theta_{IM}^*}{v-\alpha} \right) = 0. \quad (27)$$

Multiplying (26) by  $\beta_1$  and (27) by  $\theta_{IM}^*$ , subtracting the latter equation from the former, and replacing  $A_{1k} = \frac{F_k^{1-\beta_2}}{\beta_1-\beta_2} \left( \frac{\beta_1}{v} - \frac{\beta_1-1}{v-\alpha} \right)$  as found in Section 2 we obtain:

$$\sum_k \left( \left( \frac{\beta_1}{v} - \frac{\beta_1-1}{v-\alpha} \right) F_k^{1-\beta_2} (\psi_k\theta_{IM}^*)^{\beta_2} + \frac{(\beta_1-1)}{v-\alpha} \psi_k\theta_{IM}^* - \frac{\beta_1 F_k}{v} - \beta_1 \tilde{S}_k \right) - \beta_1 S_g = 0, \quad (28)$$

which parallels (17) for the case of simultaneous entry into several markets.

Since the experienced firm faces the entry problem analyzed in section 2 for independent markets, we know that  $\theta_k^*(\tilde{S}_k)$  solves equation (17). Thus:

$$(\beta_1 - \beta_2) A_{1k} (\psi_k \theta_k^*(\tilde{S}_k))^{\beta_2} + \frac{(\beta_1 - 1)}{v - \alpha} \psi_k \theta_k^*(\tilde{S}_k) - \frac{\beta_1 F_k}{v} - \beta_1 \tilde{S}_k = 0,$$

or  $G(\theta_k^*(\tilde{S}_k)) = 0$ . Since  $G(\cdot)$  is increasing in  $\theta$  (Lemma 1) and  $\theta_{IM}^* \geq \theta_k^*(\tilde{S}_k)$ , then:

$$(\beta_1 - \beta_2) A_{1k} (\psi_k \theta_{IM}^*)^{\beta_2} + \frac{(\beta_1 - 1)}{v - \alpha} \psi_k \theta_{IM}^* - \frac{\beta_1 F_k}{v} - \beta_1 \tilde{S}_k \geq 0.$$

The latter inequality implies that every term in the summation of equation (28) is positive or zero. Hence, including only one of these terms rather than the sum, we obtain:

$$(\beta_1 - \beta_2) A_{1k} (\psi_k \theta_{IM}^*)^{\beta_2} + \frac{(\beta_1 - 1)}{v - \alpha} \psi_k \theta_{IM}^* - \frac{\beta_1 F_k}{v} - \beta_1 \tilde{S}_k - \beta_1 S_g \leq 0.$$

The left-hand-side of this equation is again the function  $G(\cdot)$ , which is increasing in  $\theta$ . Hence  $\theta_{IM}^* \leq \theta_k^*(S_k)$ .

*QED*

## A.4 Survival probabilities with interdependent fixed costs

We develop the analysis for a firm that can enter two markets,  $A$  and  $B$ , with interdependent fixed costs (but independent sunk costs). To match the empirical specification, we need to compare two firms, 1 and 2, that enter the same market (w.l.o.g. market  $A$ ) with different export experiences, and compare their survival probabilities, respectively  $P_{1A}(T)$  and  $P_{2A}(T)$ . We will develop the analysis for firm 1 assuming that this firm enters market  $A$  first and leaves this market last, i.e. it is a “regular” firm as defined in section 4. The case for a regular firm 2 is exactly the opposite so we will not need to develop it.

**Set up** There is a common fixed cost  $F_g$  and an idiosyncratic fixed cost  $\tilde{F}_k$ ,  $k = A, B$ . We will study the optimal strategy of the firm as a function of its parameters  $\psi_1 \equiv \frac{\psi_{1A}}{\psi_{1B}}$ . We normalize  $\psi_{1B} = 1$ , so  $\psi_1 = \psi_{1A}$ . Since we assume that the firm leaves market  $B$  first – in case it has entered both markets – it has to be the case that  $\frac{\tilde{F}_A + F_g}{\psi_1} < \tilde{F}_B$ .

**The exit-reentry problem** Suppose the firm has entered both  $A$  and  $B$ . Given our assumption about the exit order, if it is making profits in market  $B$ , then it is also making profits in market  $A$ . Thus, the firm is never active only in  $B$ . Also, there is a range of  $\theta$  where it makes positive profits in  $A$  (paying the full fixed costs) and yet prefers not to operate in  $B$ . Therefore, we have three possible states of the firm  $\{AB, A, 0\}$ .

In the  $AB$  case, the firm is making profits in both markets and has the option of leaving  $B$  to be only in  $A$  (there is no option value when  $\theta$  goes up). Hence, the value of the active firm is given by

$$V_{AB}(\theta_t) = A_{AB}\theta_t^{\beta_2} + \frac{(\psi_1 + 1)}{v - \alpha}\theta_t - \frac{\tilde{F}_A + \tilde{F}_B + F_g}{v}.$$

In the  $A$  case, the firm is making profits only in  $A$ . The value of the firm also captures the option value of reentering  $B$  (positive root) and the option value of leaving  $A$  (negative root). Hence,

$$V_A(\theta_t) = A_A^{UP}\theta_t^{\beta_1} + A_A^{DOWN}\theta_t^{\beta_2} + \frac{\psi_1}{v - \alpha}\theta_t - \frac{\tilde{F}_A + F_g}{v}.$$

Finally, in the 0 case, the firm is not making profits. There is only the option value of entering  $A$ :

$$V_0(\theta_t) = A_0\theta_t^{\beta_1}.$$

There are VM and SP conditions at two thresholds. The first threshold,  $\bar{\theta}$ , determines the transition from  $AB$  to  $A$ . This threshold is given by  $\bar{\theta} = \tilde{F}_B$ . The second threshold,  $\underline{\theta}$ , determines the transition from  $A$  to 0. This second threshold is given by  $\underline{\theta} = \frac{\tilde{F}_A + F_g}{\psi_1}$ . The VM and SP conditions at the first threshold ( $\bar{\theta}$ )

are given by:

$$\begin{aligned}
A_{AB}\bar{\theta}^{\beta_2} + \left(\frac{\psi_1 + 1}{v - \alpha}\right)\bar{\theta} - \left(\frac{\tilde{F}_A + \tilde{F}_B + F_g}{v}\right) &= A_A^{UP}\bar{\theta}^{\beta_1} + A_A^{DOWN}\bar{\theta}^{\beta_2} + \left(\frac{\psi_1}{v - \alpha}\right)\bar{\theta} - \left(\frac{\tilde{F}_A + F_g}{v}\right) \\
\beta_2 A_{AB}\bar{\theta}^{\beta_2} + \left(\frac{\psi_1 + 1}{v - \alpha}\right)\bar{\theta} &= \beta_1 A_A^{UP}\bar{\theta}^{\beta_1} + \beta_2 A_A^{DOWN}\bar{\theta}^{\beta_2} + \left(\frac{\psi_1}{v - \alpha}\right)\bar{\theta}.
\end{aligned} \tag{29}$$

Multiplying the first equation by  $\beta_1$ , subtracting the second equation from the first, and doing basic algebra, we get:

$$A_{AB} = -\left(\frac{\beta_1 - 1}{\beta_1 - \beta_2}\right)\left(\frac{1}{v - \alpha}\right)\bar{\theta}^{1-\beta_2} + \left(\frac{\beta_1}{\beta_1 - \beta_2}\right)\frac{\tilde{F}_B}{v}\bar{\theta}^{-\beta_2} + A_A^{DOWN}. \tag{30}$$

Similarly, using the VM and SP conditions at the second threshold ( $\underline{\theta}$ ), we obtain:

$$\begin{aligned}
A_A^{UP}\underline{\theta}^{\beta_1} + A_A^{DOWN}\underline{\theta}^{\beta_2} + \left(\frac{\psi_1}{v - \alpha}\right)\underline{\theta} - \left(\frac{\tilde{F}_A + F_g}{v}\right) &= A_0\underline{\theta}^{\beta_1} \\
\beta_1 A_A^{UP}\underline{\theta}^{\beta_1} + \beta_2 A_A^{DOWN}\underline{\theta}^{\beta_2} + \left(\frac{\psi_1}{v - \alpha}\right)\underline{\theta} &= \beta_1 A_0\underline{\theta}^{\beta_1}
\end{aligned} \tag{31}$$

where again, following similar steps, we obtain

$$A_A^{DOWN} = -\left(\frac{\beta_1 - 1}{\beta_1 - \beta_2}\right)\left(\frac{\psi_1}{v - \alpha}\right)\underline{\theta}^{1-\beta_2} + \left(\frac{\beta_1}{\beta_1 - \beta_2}\right)\left(\frac{\tilde{F}_A + F_g}{v}\right)\underline{\theta}^{-\beta_2}. \tag{32}$$

The last equation determines  $A_A^{DOWN}$ . Given this value and replacing the thresholds, equation (30) determines  $A_{AB}$ ,

$$A_{AB} = \left(\frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha}\right)\left(\frac{\tilde{F}_B^{1-\beta_2} + \psi_1^{\beta_2}(\tilde{F}_A + F_g)^{1-\beta_2}}{\beta_1 - \beta_2}\right).$$

From equation (29) we obtain  $A_A^{UP}$  and, lastly, from equation (31) we obtain  $A_0$ . Hence, the value of the firm once it has entered both markets can be fully solved.

**The entry problem** If the firm has still not entered both markets, it can either be completely inactive or it may have entered  $A$  but not  $B$ . Let us first consider the latter case. In that case, the firm has only paid the sunk for entering  $A$ . For such a firm, there is (i) an option value of entering  $B$ , going to the relevant  $AB$  case above, (ii) an option value of exiting  $A$  (without entering  $B$ ), (iii) the discounted profits. To avoid confusion, we will call  $K_0$  and  $K_1$  the associated constants in this case. On the other hand, after entering  $B$  the firm would receive the  $AB$  payoff derived above.

The VM and SP conditions at the entry threshold for market  $B$  ( $\theta_B^*$ ), are given by:

$$\begin{aligned}
A_{AB}\theta_B^{*\beta_2} + \left(\frac{\psi_1 + 1}{v - \alpha}\right)\theta_B^* - \left(\frac{\tilde{F}_A + \tilde{F}_B + F}{v}\right) &= \psi_1\left(\frac{\theta_B^*}{v - \alpha}\right) - \left(\frac{\tilde{F}_A + F}{v}\right) + K_0^B\theta_B^{*\beta_1} + K_1^B\theta_B^{*\beta_2} + S_B \\
\beta_2 A_{AB}\theta_B^{*\beta_2} + \left(\frac{\psi_1 + 1}{v - \alpha}\right)\theta_B^* &= \beta_1 K_0^B\theta_B^{*\beta_1} + \beta_2 K_1^B\theta_B^{*\beta_2} + \psi_1\frac{\theta_B^*}{v - \alpha}.
\end{aligned}$$



Note that we have two equations in three unknowns  $(\theta_B^*, K_1^B, K_0^B)$ . However,  $K_1^B$  is not really an unknown since it comes from the entry-reentry conditions of being only in  $A$ , which are analogous to  $A_1$  in the independent case (just note slight difference due to the fact that the value function here is written in terms of  $\theta$  rather than  $\pi$ ):

$$K_1^B = \frac{\psi_1^{\beta_2} (\tilde{F}_A + F)^{1-\beta_2}}{\beta_1 - \beta_2} \left( \frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} \right).$$

Hence, we can solve for  $K_0^B$  and  $\theta_B^*$  following the usual steps to obtain:

$$(\beta_1 - \beta_2)(A_{AB} - K_1^B)\theta_B^{*\beta_2} + \left( \frac{\beta_1 - 1}{v - \alpha} \right) \theta_B^* - \beta_1 \left( \frac{\tilde{F}_B}{v} + S_B \right) = 0. \quad (33)$$

Equation (33) determines the entry threshold for market  $B$ . Using the solutions we obtained for  $A_{AB}$  and  $K_1^B$  we can write:<sup>16</sup>

$$A_{AB} - K_1^B = \left( \frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} \right) \left( \frac{\tilde{F}_B^{1-\beta_2}}{\beta_1 - \beta_2} \right). \quad (34)$$

Substituting (34) back into (33) yields the equation that determines the solution for the entry threshold into market  $B$ . Comparing the resulting equation with equation (17), which determines the entry threshold in the independent case, we can easily note that they are identical. Hence, we establish that the entry threshold for the experienced firm is the entry threshold in the independent case that corresponds to (lower) fixed costs  $\tilde{F}_B$ .

If the firm has still not entered any of the two markets, then the only relevant transition is to enter market  $A$ . Hence, the relevant VM and SP conditions are given by:

$$\begin{aligned} K_0^A \theta_A^{*\beta_1} + S_A &= \left( \frac{\psi_1}{v - \alpha} \right) \theta_A^* - \left( \frac{\tilde{F}_A + F_g}{v} \right) + K_0^B \theta_A^{*\beta_1} + K_1^B \theta_A^{*\beta_2} \\ \beta_1 K_0^A \theta_A^{*\beta_1} &= \beta_1 K_0^B \theta_A^{*\beta_1} + \beta_2 K_1^B \theta_A^{*\beta_2} + \left( \frac{\psi_1}{v - \alpha} \right) \theta_A^*. \end{aligned}$$

Following once again the usual steps, we obtain the equation that determines the entry threshold into market  $A$ ,  $\theta_A^*$ :

$$\left( \frac{\beta_1}{v} - \frac{\beta_1 - 1}{v - \alpha} \right) \left[ \psi_1^{\beta_2} (\tilde{F}_A + F_g)^{1-\beta_2} \right] \theta_A^{*\beta_2} + \left( \frac{\beta_1 - 1}{v - \alpha} \right) \psi_1 \theta_A^* - \beta_1 \left( \frac{\tilde{F}_A + F_g}{v} + S_A \right) = 0. \quad (35)$$

The interesting finding here is that the entry of the firm in the first market ( $A$ ) is determined by the same equation that determines entry into market  $A$  in the independent case. This implies that the entry threshold into that first market is the same in both cases even when the potential later entry into market  $B$  may reduce the firm's imputed fixed costs in  $A$ . Hence, we establish that the entry threshold for the inexperienced firm

<sup>16</sup>Equation (33) is also valid if the exit order is different than the one we postulate here. For example, the firm could leave market  $A$  first or it could leave markets  $A$  and  $B$  simultaneously. In those cases, however, the constant  $A_{AB}$ , which already contains the information about the optimal decision in the exit-reentry subproblem, would be different.

is the entry threshold in the independent case that corresponds to (higher) fixed costs  $F_A$ .

**The probability of survival** Given that  $F_A$  is also the fixed cost that determines exit from market  $A$  and given that  $\tilde{F}_B$  is the fixed cost that determines exit from market  $B$  – as in the independent case – we finally establish that the probabilities of survival of firm 1 in markets  $A$  and  $B$  are those calculated in the independent case when fixed costs are  $F_A$  and  $\tilde{F}_B$ , respectively.

For firm 2 the results are analogously opposite so we do not need to develop this case. This firm enters market  $B$  as an inexperienced firm and market  $A$  as an experienced firm. In this case the entry and exit thresholds for market  $B$  will be equivalent to those of the independent case with (higher) fixed cost  $F_B$  while the entry and exit thresholds for market  $A$  will be equivalent to those of the independent case with (lower) fixed cost  $\tilde{F}_A$ . Combining these results, we obtain:  $P_{1A}(T) \leq P_{2A}(T)$ ;  $P_{1B}(T) \geq P_{2B}(T)$ .



## A.5 Survival and Gravities, Robustness

Table A.1: Survival and Gravities, Robustness

	(1)	(2)	(3)	(4)
	$P_{ikt}$	$P_{ikt}$	$P_{ikt}^{CS}$	$P_{ikt}^{3Y}$
Estimation Method	OLS	Probit	OLS	OLS
$\ln d_k$	-0.034*** (0.005)	-0.066*** (0.019)	-0.017*** (0.007)	-0.019*** (0.006)
	†	†	[0.006]	[0.009]
<i>Common Language</i> <sub>k</sub>	0.027*** (0.006)	0.074** (0.036)	0.027** (0.012)	0.021* (0.013)
	†	†	[0.01]	[0.014]
<i>Contiguity</i> <sub>k</sub>	0.014 (0.019)	0.065** (0.027)	-0.018 (0.020)	-0.019 (0.015)
	†	†	[0.018]	[0.045]
<i>PTA</i> <sub>k</sub>	0.046*** (0.018)	0.035 (0.033)	0.019* (0.01)	-0.014 (0.017)
	†	†	[0.019]	[0.043]
Constant	0.459*** (0.045)	0.092 (0.176)	0.361*** (0.027)	0.383*** (0.058)
	†	†	[0.063]	[0.085]
Year FE :	yes	yes	yes	yes
Firm FE :	yes	no	no	no
Observations	118,776	118,776	118,776	118,776
R-squared	0.386	0.001	0.001	0.044

Robust standard errors in parentheses clustered at the destination level

Robust standard errors in brackets clustered by destination and at the firm level

†Multi-way clustering at the firm and destination levels 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  $t$

$P_{ikt}^{CS}$ : Probability of establishing an export experience that is active 2 consecutive years after an incursion of firm  $i$  in market  $k$  in period  $t$

$P_{ikt}^{3Y}$ : Probability of establishing an export experience that is active 3 years after an incursion of firm  $i$  in market  $k$  in period  $t$