New exports from emerging markets: do followers benefit from pioneers ?

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Abstract

Since Arrow (1962), spillovers from pioneer to follower in non-excludable innovations are central to our understanding of endogenous economic growth. Nonetheless, evidence of these spillovers in less-developed economies has been elusive. Our paper contributes by showing novel facts consistent with externalities in "new" export products. To avoid biases towards ex-post successes, we use data on the universe of customs transactions from Chile (1990-2006). We find that, first, follower firms are more likely to enter a product if the pioneer firm survives exporting. More importantly, we also find that pioneers enter and remain smaller than followers, which is indicative that the first exporter may not be the firm that benefits the most from the discovery. This fact is inconsistent with the currently standard view in international trade, in which the largest firm would be the first willing to pay a homogeneous sunk cost of exporting. In contrast, our facts are consistent with the view that smaller pioneer exporters are "data producers", whose spillovers benefit larger followers. We offer a simple model to formalize this intuition, based on the idea that large exporters have more choices on how to allocate their managerial capacity. This real option makes large exporters wait, as to assign their marginal manager on the best possible project. In contrast, smaller and more focused firms prefer to be pioneers.

JEL classification: L26 ; F14; O4.

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1 Introduction

The emergence of new export products has been associated with economic accelerations in less-developed economies (Lucas, 1993; Kehoe and Ruhl, 2009; Amsden, 1992). In this context, it is relevant to explore whether the process of new product "discovery" is fully internalized by firms or, in contrast, displays some type of external economies.

In particular, since Arrow (1962), spillovers from pioneer to followers in non-excludable innovations have been central to our understanding of endogenous economic growth[1]. Many authors since then (e.g. Bardhan, 1971; Hoff, 1997; Hausmann and Rodrik, 2003) appealed to this idea to explain why less developing countries have difficulties reallocating factors into activities with potential comparative advantage. The basic idea in these theories is that pioneers in new products are "data producers" (Schumpeter, 1934), from which the subsequent followers benefit. The problem is that pioneers do not internalize the full social benefit of the information they create. As a result, there would be an underprovision of incentives to experiment in a new product. Our goal in this paper is to empirically explore these pioneer-follower externalities, in the context of an emerging market's new export products. But since learning is not directly observable, we offer a simple model that can rationalize our stylized facts as consistent with a "product discovery" externality.

Despite the theoretical plausibility, the empirical evidence on spillovers from pioneer to followers has been harder to develop. The difficulty arises from the minimum data requirements to explore the issue on a broad base. This data needs to be: (i) at firm-product level, so we can distinguish firm behavior from industry behavior; (ii) in new products/processes, where there is both something new to learn[2] and it is possible to identify the early sequence of entry; (iii) on the widest possible universe of products, to avoid hindsight biases towards ex post successful cases. Existing empirical studies, discussed below, usually lack one or more of these attributes. A notable exception is the prolific line of research pioneered by Jaffe, Trajtenberg, and Henderson (1993), testing geographic spillovers in patent citation on a wide variety of industries. But looking at patents does not seem useful to understand how emerging or developing economies catch up by adopting off-the frontier innovations[3] . Our paper is precisely an effort to understand some of these non-patent spillovers in

[1]More recent models like Romer (1990) re-launched the idea that the non-excludable portion of innovations can be behind endogenous growth.

[2]In their *Handbook* chapter, Harrison and Rodriguez-Clare (2010) are probably the most recent review of models of externalities in new products in less developed economies. Rosenthal and Strange (2006)compile evidence on agglomeration spillovers, but we could not find in their paper any evidence for new tradable products in less developed economies. In developing countries agriculture there has been a recent literature looking at externalities. One take home of this literature, as remarked by Foster and Rosenzweig (2010), is that to statistically find some learning *there ought to be something new to learn.* For example Duflo, Kremer, and Robinson (2009) do not find learning across firms in fertilization of old crops in Kenya. In contrast, for the new and unknown pineapple crop in Ghana, Conley and Udry (2010) can distinguish learning *across* firms. The spirit of our empirical strategy is precisely to focus only on new products, to see whether we can find evidence of learning flowing from the pioneer to the follower.

[3]In fact, Jaffe, Trajtenberg, and Henderson (1993) recognize that *"[...] there are an enormous number of*

new export products, by using a method that in principle can be extended to other less-developed economies. [4]

Our first step to study the behavior of pioneers and followers was to build a dataset of arguably all "new" export products from Chile, using detailed transaction level data from Chilean Customs (1990-2006) and other sources. To the best of our knowledge, we are the first paper looking at spillovers using data that meets all three previously outlined attributes: firm level data in a wide variety of *new* products classified according to standard nomeclature. Other features of our data seem particularly suitable for our purposes. For example, Chile is a small open economy, so its firms are plausibly price takers in international markets[5]. This arguably simplifies the strategic interaction among them in our sample, allowing us to focus mostly on the decision to export.

We provide two main results consistent with the view that followers benefit from pioneers in the early stages of new export products. First, the survival of pioneers is positively correlated with entry of followers, which is a plausible prerequisite to think that followers learn from the successes or failures of pioneers. More importantly, our second finding is that pioneers enter and remain *smaller* in size than followers, even if we control for unobserved shocks to products in a year. This first mover "disadvantage" is inconsistent with extensions of currently standard international trade models (e.g. Melitz, 2003), in which the largest firm is the first willing to pay a constant sunk cost to enter into exporting. While this "selection effect" captures well the *steady state* of exports, in which larger firms become exporters[6], it does not fit the *early dynamics* of our new export products. Our point is this paper is that the beginning of a new export product is different from a simple extrapolation of the steady state.

In fact, our stylized facts are consistent with the view that smaller pioneer exporters are "data producers" and benefit larger followers. We formalize this intuition in a simple model in which larger exporters also have a wider set of *potential* new projects to pursue. Since they cannot develop all of them because of decreasing returns to scope, their problem is to allocate an indivisible scarce

spillovers with no citations, since only a small fraction of research output is ever patented."

[4] Another approach, without having firm level data, has been to use aggregate country-level adoption of particular technologies (Comin and Hobijn, 2004), or the country-level discovery of new export products (Hausmann and Rodrik, 2003; Hidalgo, Klinger, Barabasi, and Hausmann, 2007; Klinger and Lederman, 2004) Unlike these macro-level papers, we use firm-product data trying to understand whether the adoption is a spillover across firms or simply a single firm increasing its size. Grossman and Rossi-Hansberg (2010) argue that this is a crucial distinction for our understanding of market failures. They argue that if a pioneer firm has the potential to grow very large, it can *internalize* the industry level learning. Indeed, if firms have constant returns to scale then many models that justify policy base on increasing returns (the canonical model of Helpman and Krugman (1985)[p55] , or Bhagwati et al. (1971)) no longer work. Interestingly, our results clearly show that the pioneer firm has not only a lower than 100% market share in exports from the country in the product, but also that it is smaller than followers. Thus, our results clearly go against the core assumption of Grossman and Rossi-Hansberg (2010), and suggests a probable case for market failures in new exports. Nonetheless, our final results about large scale producers is more suggestive of the kind of argument defended in Grossman and Rossi-Hansberg (2010); although our setting is different, because we only explore the exporting of a product, not its production.

[5] We test our main results also for the subsample of cases where Chile has less than 30% market share in the import destination, and we still get that pioneers end up being smaller than followers.

[6] See for example Clerides, Lach, and Tybout (1998); Bernard and Jensen (1999)

resource (e.g. a new manager) to the best possible use. The extra potential scope, vis-a-vis smaller and more focused firms, generates a real option that makes larger firms strategically delay entry. In contrast, smaller exporters with fewer options tend to enter sooner, revealing information to followers about product profitability. In short, followers free-ride on the pioneer's effort.

The mechanism outlined above is a novel explanation for why first movers might end up being smaller players, which is a central topic in Business Strategy (Lieberman and Montgomery, 1988, 1998). In particular, the standard forces that rationalize why the "second fast" is larger than the pioneer do not seem to apply in many of our products (Markides and Geroski, 2005). For example the cannibalization problems discussed by Aron and Lazear (1990) look less relevant to explain why larger exporters do not enter as pioneers, since our firms export to a large international market, in which the price is more likely to be exogenous to the behavior of Chilean firms. Similarly, the products we analyze are well advanced in their product life cycle, so it seems unlikely that the optimal organizational form is to separate the R&D stage from the production stage as suggested by Aghion and Tirole (1994). Our theoretical mechanism helps us also rationalize the tendency of larger and diversified organizations to pay less attention to innovative opportunities, as shown by Seru (2007) and Bresnahan, Greenstein, and Henderson (2010).

Our third and final result challenges the idea that externalities are commonplace across all products. In fact, in more than half of the new products with sustained pioneers[7], we do *not* observe follower firms, even in cases where we have anecdotal information consistent with positive profits. When early entrants enjoy a large first mover advantage that preemt further entry, as in Krugman (1980), it is less plausible to argue in favor of *within* product learning externalities. We also find some support for the idea that in goods with large scale of production, in which the pioneer becomes a natural monopoly in the domestic market, it is less likely to observe entry of followers. This can also be interpreted in our model. When there is a single potential exporter of a product, there is no reason for this firm to delay the export experiment, because it can fully internalize all the benefits from this risky endeavor.

From an empirical perspective, we are most closely related to papers exploring spillovers. In general, the literature that documents these externalities uses industry cases, normally biased towards successful cases or industries that grew *ex-post* (Porter, 1990, 1998; Chandra, 2006; Freund and Pierola, 2009; Agosin and Bravo-Ortega, 2009; Da Rocha, Monteiro, Kury, and Darzé, 2008; Conley and Udry, 2010; Mostafa and Klepper, 2010). These cases are of course interesting, but their methodology underweights the overall failure and uncertainty present in the development of new export products, which is *ex-ante* very important for international entrepreneurs. In contrast, we include both successful and unsuccessful cases, because we have access to the universe of

[7]One possibility is that they continue because the sunk cost is paid , not because it is a good project from an ex ante perspective. Although we do not observe firms profits for our sample, so we cannot claim that the NPV of the project was positive, we studied three cases of *lonely pioneers* that claimed to pay back easily their investment and then continued exporting alone.

transactions and goods for the period we study[8]. Additionally, we provide what we believe is a more reliable definition of *new* products. Recent papers have used short run definitions for new products (Freund and Pierola, 2009; Iacovone and Javorcik, 2010) [9]. In contrast, our longer panel allows us to take a pre-sample of five years without exports to classify a product as *new*. This reduces the proportion of "old" products that are intermittently exported and that may be missclassifed as "new". Unsurprisingly, we get quite different results from the two papers above. Iacovone and Javorcik (2010) find many "pioneers" exporting "new" products from Mexico to the US immediately after NAFTA in 1994. Moreover, they find that the largest exporters entered first, according to their timeline. In contrast, in our sample of new products we almost always find a single pioneer launching a product the first year, and this pioneer tends not to be the ex-post largest exporter[10].

Our research can also be thought of as an offspring of the "new new" international economics with heterogeneous firms (a-la Melitz, 2003), particularly of models with multiproduct firms such as Nocke and Yeaple (2006); Bernard, Redding, and Schott (2006) ; Eckel and Neary (2010) and Mayer, Melitz, and Ottaviano (2010). In this literature, the largest and highest productivity firms export more products and are the most willing to pay a sunk cost to export new products. Since we do not find support for the prediction that larger exporters enter first, we offer a model to understand why these larger exporters delay experimenting. Within this trade literature on experimentation, we are related to Rauch and Watson (2003); Ruhl and Willis (2009); Albornoz, Corcos, Ornelas, and Pardo (2010); Segura-Cayuela and Vilarrubia (2008) and Eaton, Eslava, Krizan, Kugler, and Tybout (2010).

Finally, we are closely related to the innovation strategy literature on how the first mover keeps its original advantage (Gilbert and Newbery, 1982; Henderson, 1993; Prusa and Schmitz, 1994). We share with this literature the special focus on the *sequencing* of entry. However, we consider products that are well *within* the international frontier of innovation and largely non-patentable. In that sense our paper is also an empirical contribution to the International Marketing literature[11].

[8]By *universe* we mean all reported products' exports using the product definition of Customs: the Harmonized System at 6 digit level. Our data does not include services.

[9]For example, Iacovone and Javorcik (2010) define a new product as a product that was not exported by the country only for one year. Freund et al call a new product to any code that was not exported at the first year of their sample period (1994) and that was exported for at least 3 consecutive periods after 1994.

[10]Regarding data, we use similar datasets as various descriptive papers that look at the dynamics of products, firms and destinations in exports. Our main difference with them is that they do not take the perspective of new export products (Eaton, Eslava, Kugler, and Tybout, 2007, 2008; Eaton, Kortum, and Kramarz, 2004; Besedes and Prusa, 2006a,b). Other authors have looked at Chilean Data to explore patterns of trade. For example, Isabel Marshall (1991) explored industry efficiency after trade liberalization in the late 1970s and early 1980s (see also Pavcnik, 2002, presented an influential paper on the same question). In many contributions, Roberto Alvarez and various co-authors have been describing the different patterns of Chilean exporters and manufacturers in different ways. (Alvarez and Fuentes, 2009; Alvarez, 2007; Alvarez and Crespi, 2000; Alvarez and Lopez, 2005; Alvarez and Görg, 2009; Alvarez, Faruq, and Lopez, 2007; Alvarez, 2004). Macchiavello (2009) explores the duration of relationships between Chilean wineries and foreign buyers.

[11]Various papers focus on the covariates, like age, of the decision to internationalize the production of a firm (for

The remainder of the paper is organized as follows. Section 2 offers a simple theoretical framework to clarify thinking about experimentation and entry into new exports. It is important to remark that the predictions it delivers are not unique to this model, but are shared with a broader set of explanations that involve external economies across firms in a product. We are aware that the model is not completely general to interpret the evidence. The point is that, unlike in frictionless markets, there are many potential ways in which learning can happen. We do not hope to encompass all of these possible channels. Instead, we simply focus on a single parsimonius model as an instrumental lens to read the evidence. Section 3 explains and describes our dataset of new export products, also discussing a few canonical examples as a way to fix ideas. Section 4 empirically explores the predictions of our formal framework. Section 5 argues against alternative interpretations to our stylized facts, especially focusing on discarding explanations that do not involve learning. Section 6 concludes with some remarks.

2 A model of strategic waiting by a large exporter

This section offers a simple model with a novel mechanism that induces larger exporters to delay entry. The idea is that, at the margin, larger firms have more choices on where to allocate their limited capacity to develop new projects. By entering late into riskier endeavors, large firms have the advantage of learning about the *relative* profitability of different new activities. This facilitates the allocation of "managerial talent" to the best possible project. We appeal to two assumptions to deliver this result. First is that larger firms tend also to have wider scope, in the sense that they have more real options of what new projects to undertake. This correlation between size of shipments and scope has been well known at least since Penrose (1959) and recently documented by Bernard, Redding, and Schott (2006) and Mayer, Melitz, and Ottaviano (2010). Moreover, in section 3 we show empirically that later entrants into exporting a product have on average more economic activities, measured by ISIC industry classification. The second core assumption is that size and scope do not develop overnight in firms. They grow "one step at a time". We also assume the allocation of resources to a new activity is partially irreversible, which generates an endogenous sunk cost for large firms.

In short, while a small firm faces a single sunk cost of product discovery, a large firm entering early

a review see Andersen, 1993). More recently, this literature has made a distinction between "born globals" that internationalize immediately, from other "gradual globals" that internationalize after some years in the domestic market (Moen and Servais, 2002) or in regional markets (Lopez, Kundu, and Ciravegna, 2009). Our different with this literature is the broad coverage of products and the sequence of entry. Other papers in international marketing empirically explore the order of entry (sequencing) as a determinant of profitability in a given market. For example Cui and Lui (2005) look at how early entrant multinationals in China do vis-a-vis late entrants in the same market. Magnusson, Westjohn, and Boggs (2009) look at how sequence of entry affect profitability in many destination markets, but only for multinationals in the advertisement industry. Our analysis is different from this literature because we focus on many industries and mostly on the source country rather than on the destination country.

into a new product faces two types of sunk costs. The first is a standard exogenous sunk cost, which is equal for all firms. The second is an endogenous cost, exclusively faced by large exporters, because entering early burns the real option to allocate the manager into another activity; related to the arguments in Dixit and Pindick (1994).

2.1 Setup

Our partial equilibrium setup involves three risk neutral strategic players, which want to maximize the net present value of net cash flows. Two of the firms are small and have narrow scope, and the third firm is larger and has a wider scope.

On the one hand there are two small firms with narrow-scope, called A and B, which have a choice between doing business as usual or starting a new independent risky project. Firm A is an agricultural firm and already exports some few agricultural products in which it makes profits normalized to zero. Firm A can only make one risky new export innovation close to its core competence, which we call Asparagus. Analogously, firm B is in the bath apparels industry, and can decide whether to export a new product, Bathtubs, or not. Both symmetric narrow scope firms export a small quantity $\underline{q}$, defined exogenously given the firm's type. As noted, we will abuse notation by using the same letter to denote both the product (e.g. Asparagus) and the small firm that has the option to export it (firm A).

On the other hand we have a single large firm, that can export a large quantity $\bar{q} > \underline{q}$. Although this firm is also constrained to have a single new activity, because otherwise it hits its diseconomies of scope, its decision problem is different than for small firms. In particular, the large firm can choose to start *either* Asparagus or Bathtubs, *but not both*. As discussed above, the assumption is that the large firm cannot fully diversify overnight which is consistent with Khanna and Yafeh (2007). They argue that diversified firms grow "one step at a time" because they need to accumulate some kind of organizational capital that allows them to increase the scope without affecting the other inframarginal business lines. [12]

The game has three periods, collapsing all future profits in the last period. The available alternatives for firms are: (i) enter as pioneer in the new product after paying a sunk cost F per unit of capacity; (ii) enter as follower in the new product also paying the sunk cost; (iii) never enter and remain with utility normalized to zero. Those who enter the new product can decide whether to remain in them or not. The only uncertainty faced by potential entrants in each product $i = \{A, B\}$

[12] In a richer model the restriction on a single new activity at the margin can be though as the result of endogenous investment in scope with convex costs of adjustment. For this model, however, we take a simple approach and assume that actual scope N is accumulated at an exogenous rate of one every decade or so, according to $N_{t+k} = N_t + 1$ where this is the N is the total number of activities (i.e. product, destination , processes) that a firm can handle before hitting the ceiling of diseconomies of scope, and k would be a decade. In family firms, for example, this additional managerial capacity can be thought as a new son/daughter available to be a manager.

is the profitability of the product in the international market, x_i. Thus, gross profits, without investment cost, is $\max\{0, x_i - c\}$; where c is the variable cost of production, which is assumed homogeneous across firms and products. We will treat x_i as a price, although conceptually it can represent other product level uncertainty. All the firms that consider entering a new product i face the same probability distribution for the unit revenue of their new product, x_i. Two reasons make this assumption of constant prices across firms in a product plausible . First, Chile is a small open economy, which makes it less likely that firms can impact the international prices of products. Second, in section 5 we empirically show that the prices received by firms in a product do not statistically differ between the entry of pioneers and that of followers. In the model the realization of x_i varies across products and is distributed *i.i.d.* according to $G(x^i)$, which for tractability is assumed to be a standard uniform distribution, between zero and one. The exogenous sunk cost F is assumed small enough with respect to $\mathbb{E}\max\{0, x_i - c\}$, so the choice problem is not trivial.

The extensive form of the game for each firm is shown in Figure 1. At stage 1 a firm decides whether to enter immediately, paying a sunk cost F per unit of capacity, or to wait. Immediately after $t = 1$, the presence of at least one pioneer firm in product i reveals to *everybody* the value x^i. Having that information, the pioneer can decide to continue until period 2 and collect profits , which will happen if $x^i > c$. Alternatively, the pioneer can exit the new export product. For those firms that waited, the revelation of x^i can either induce them to enter as a follower in period 2 and collect profits in period 3. Alternatively, a firm that waited at $t = 1$ can choose at $t = 2$ to never enter. For a pioneer firm, in period 3 there is nothing interesting. This period is used only for waiting firms, in order to keep the same NPV at entry using the discount factor $\beta \in (0, 1)$.

[Figure 1 about here]

2.2 How do firms choose.

We will analyze the decision problem for both small and large firms

2.2.1 Small (narrow-scope) firm

The choices are symmetric for each small firm $i \in \{A, B\}$. For them being a pioneer entails the benefit of one extra period of profits if the product is successful, but they also incur in an exogenous sunk cost of exporting, Fq, that may not pay back[13]. Alternatively, the firm can wait until next period, losing one period of potential gross profits, but being sure about the magnitude of them:

[13]We make the unconventional assumption that sunk cost are proportional to the size of the operation. This captures the intuition that large firms may have a higher opportunity cost of resources if they fail since their operations tend to be larger in whatever they do. They exact proportionality is a useful assumption to reduce the mathematical burden and keep the model with a single moving part. The results can be generalized for deviations from this proportionality assumption in the fixed cost.

$\max\{0, x^i - c\}\,\underline{q}$. This certainty that another firm will enter and publically reveals x_i is an extreme belief, representing the most tempting situation in which the small firm would prefer to wait. In the appendix we show that this assumed extreme belief is a sensible simplification, without loss of generality for our parameters of interest. By backward induction, the two value functions in period 1 are :

$$V^{small\,i}_{pioneer} = -F\underline{q} + \beta\mathbb{E}\max\left\{0, \left[x^i - c\right]\underline{q}\right\} \tag{1}$$

$$V^{small\,i}_{wait} = \beta\mathbb{E}\max\left\{0, -F\underline{q} + \beta\left[x^i - c\right]\underline{q}\right\} \tag{2}$$

In the equilibrium of interest, small firms will prefer to enter because there are no other firms besizes the large firm, and the latter will prefer to delay, as it will become clear in 2.3..

2.2.2 Large (wide-scope) firm.

For the large firm the dynamic problem is the same as when it enters as pioneer, but different if it waits. Although it can introduce only one additional product at a time, it has also wider range of alternatives between A and B (i.e. $\arg\max_{i\in\{A,B\}}\{x^i\}$). By assumption starting both products is ruled out as unprofitable, because two new products would have a negative effect on the total profits, as discussed before. This is a shortcut to avoid a full fledged investment in scope in the model. Since being pioneer in either A or B is mathematically equivalent in our setting, we will put them together in a single choice i. The value functions for being pioneer in a product and waiting are:

$$V^{large\,i}_{Pioneer} = -F\bar{q} + \beta\mathbb{E}\max\left\{0, \left[x^i - c\right]\bar{q}\right\} \tag{3}$$

$$V^{large}_{Wait} = \beta\mathbb{E}\max\left\{0, \max\left\{-F\bar{q} + \beta\left[x^A - c\right]\bar{q}, -F\bar{q} + \beta\left[x^B - c\right]\bar{q}\right\}\right\} \tag{4}$$

Note that the value of pioneering in Eq. 3 is simply proportional to the one for narrow-scope firms in Eq. 1. In contrast, the value of waiting for the wide-scope firm has one extra argument in the maximization (Eq 2 and 4). This captures the idea that the large firm cares about the best project between A and B. This is the key moving part of our model. Note that even if the *exogenous* sunk cost F per unit of capacity is the same for large and small firms, the large firm has an extra (*endogenous*) sunk cost, which emerges from its larger potential scope

2.3 Equilibrium characterization and predictions

In the Appendix we solve this model, showing that under some conditions strategic waiting is a dominant strategy for large firms, but not for the small ones. Interestingly, as we will see below, this strategic waiting by larger firms is an equilibrium when firms have high patience and when the exogenous fixed cost is not very large as a proportion of unit revenues. We believe this is a sensible parameter space for our problem, since sending an export manager to close a small deal with an importer overseas is unlikely to have large *direct* costs. Our option value framework adds an additional sunk cost to large firms, emerging from the problem of selecting a new activity.[14]

Numerically solving the inequalities for the parameter space, yields three different regions, depicted in Figure 2. In the black region Ω_1, with low values of both β and F, firms are very impatient. Thus, even if the large firm can allocate its effort in the best product by waiting, the gain does not compensate the oportunity cost of time. As a result both the large and the small firm will pioneer the product. On the other extreme we have the white region Ω_3, where firms may enter or not, following some potentially complex strategies and with few a priori ways to select an equilibrium, as usual in coordination problems. We do not focus on this region because we have nothing new to offer in terms of how a given equilibrium is selected. In contrast, we focus on the gray region Ω_2, in which $V_{pioneer}^{large\,i} < V_{wait}^{large}$, so that it is optimal for the narrow scope firm to enter as pioneer and for the wide firm to wait. Interestingly, this equilibrium turns out to be in the region with enough patience β and limited sunk costs F, which we believe is qualitatively appropriate for exporting of a good that firms already produce. We formalize this results in the following proposition:

Proposition 1. *(Existence and uniqueness). With enough patience and low exogenous sunk costs, such that $\{F, \beta\} \in \Omega_2$, there is a unique Subgame Perfect Nash Equilibrium (SPNE) in pure strategies such that:*

(i) the small (narrow scope) firm enters as pioneer , while

(ii) the large (wide-scope) firm waits. Moreover, the large firm will only follow the best project out of those started by small firms , if and only if for the best project $\bar{x} > \theta \equiv \frac{F}{\beta} + c$.

Proof: *See Appendix*

[Figure 2 about here]

Following Proposition 1 we can define the two main predictions of the model that we will bring to the data. The first is that larger followers would enter only if they observe that $\bar{x} > \theta \equiv \frac{F}{\beta} + c$. This follower-entry cutoff θ is of course larger than the cutoff c for continuation of the pioneer.

[14] This is similar to the "bandit" allocation problems. The key difference, however, is that in our model learning does not comes from pure waiting, but from waiting coupled with the other firm's decision to pioneer the product.

Since the pioneer has already paid the sunk cost F per unit of exogenous capacity , the only thing that matters for continuation is whether variable profits are positive: $x_i > c$. Even though the follower does not always want to enter, because maybe $c \leq x_i \leq \theta$, there is on average a higher likelihood that it will enter compared to the case when there is no survival by the small firm[15], since this would mean that $x_i < c$. This gives us our first first testable predictions (for a more formal derivation see appendix).

Prediction 1. *The entry of followers is positively related to the survival of pioneers in the product.*
***Proof*:** See Appendix

Our second prediction follows from assuming that the exports we observe correspond to the gray area in Figure 2 , which we endogenously define as$\{F, \beta\} \in \Omega_2$. In that region patience β is large enough and the exogenous sunk cost F is low enough, so $V^{large}_{Wait} > V^{large}_{pioneer}$. This makes the large firm prefer to delay, while the small firm enters as pioneer; which is equivalent to the following statement.[16].

Prediction 2 ("First mover disadvantage"). *Everything else constant, export quantities and revuenues in a product are larger for followers than for pioneers.* ***Proof*:** See Appendix

It is important to remark that the strategic delay comes chiefly from free riding: the large firm knows that there is another more focused firm exploring that will enter as a dominant strategy. It is not sufficient to have more alternatives from which to choose in order to deliver the equilibrium of Proposition 1. The larger firms benefits by waiting because information about x_i will be revealed, allowing the firm to choose the best project. In other words, the generation of a valuable informational externality is what generates waiting. In fact, the absence of other small firm in a sector stops free riding by the large firm. This would be the case if, for example, the large firm knows in advance that it will be the only producer in the country, at least in the medium term. This seems a likely scenario when firms have a large first mover advantage, like in large scale projects that take over the whole local market and prevent other players from exporting.

To finish it is important to remark some distinctive properties of our model. First is that the proposed mechanism works even with no (exogenous) disproportional sunk cost for the pioneer firm, no matter which firm is it, because we assumed F is constant across firms. This is different from models, like Hausmann and Rodrik (2003), which assume the pioneer pays an additional cost of experimentation. Second is to clarify the source of the externality. Under some parameters values a social planner would also want the more focused firm to be pioneer, both because it is cheaper for society to spend $F\underline{q}$ rather than $F\bar{q}$, and because the focused firm has fewer real options of waiting. In comparison with the competitive equilibrium of Proposition 1, the difference is that the social planner would let the pioneer enter in a range of cases in which the pioneer would not

[15]It is interesting to note that in the region of parameters defined in Figure 1 there is no region in the equilibrium for which the wide scope enters and the narrow scope does not.

[16]The Appendix offers a generalization of these predictions for the case where the wide scope firm has more than two new projects from which to choose.

be privately willing to enter. In terms of Figure 2 the social planner would like the gray area, to be more extended towards the right. The more potential entrants, the wider the area to the right in which the pioneer will be willing to enter if it can internalize the social benefit to potential followers.[17]

With this simple framework at hand, will are now better equipped to to look at the data.

3 Our data on new exporters

This section described our data sources as well as our procedure for constructing a database of new products. Later on, it also describes the data both quantitatively and with a few specific examples of products

3.1 Data construction

To understand pioneer-follower externalities in new exports we needed to build a dataset: (i) at firm-product level, so we can distinguish firm behavior from industry behavior; (ii) in new products/processes, where there is both something new to learn and it is possible to identify the sequence of entry; and (iii) on the widest possible universe of products, to avoid hindsight biases in ex post successful sectors. We are not aware of any other study *of externalities* within producers of a product that uses a dataset with all these three characteristics

We built our dataset of new exporters based mostly on the Chilean database of export transactions in all sectors. In total, Customs recorded more than 10 million transactions between 1990 and 2007. Relying on Customs data allows us to observe the development of new export industries that are outside of the coverage of manufacturing censuses, which are a more traditional source of data for firm level empirical trade papers. In particular, since diversification in agriculture and mining are important for developing countries, we believe our database can be useful for understanding export entrepreneurship in less developed countries, compared to just using industrial level data[18]. For all firms, we observe the product exported (in 6 digit Harmonized System classification), the year of the export, the destination and the export value is US dollars. Moreover, for the majority of products we have the unit price and the quantity in the unit of export. Having revenues at a product level is not very common in the literature on innovation, especially for economywide studies. For example, the literature on patents normally does not have the price that each firm gets for selling patented products or processes.

[17]The derivation of the social planner's problem is available in the web appendix.

[18]Also, many industrial surveys only consider firms of a minimum size. In the Chilean case, firms with less than 10 workers are not surveyed.

To construct these filters we required additional sources of data: First some very basic tax firm level records from the Internal Revenue Service. These include the economic sector(s) of the firm according to a code analogous to the ISIC classification. This information was crucial to discriminate between firms that are actually producers of the exported good and firms that only traders according to the Chilean IRS. IRS data was also important to disentangle the end of an exporting spell on the one hand, and the death of the firm, on the other [19]. This is relevant because some firms may still be selling in the local market even if they are not exporting. Second we filtered out small transactions and reexports [20]. The details of this filtering process can be found in the Appendix . Similarly, we wanted to avoid misidentifying a recoding of a product as a new product. In our sample there were 3 major code re-classifications (HS-1992, HS-1996 and HS-2002), which we needed to homologate[21]. We built a correspondence across these three different vintages following the same theoretical principles of Pierce and Schott (2009)[22].

We want to note that in probably most cases we are not analyzing products that have been invented in Chile. These are products invented somewhere else, so we can more focus solely on the issue of exporting rather than on more complex R&D processes. This would not be the case for an advanced economy, like the Unites States, where our method might not be advisable to study externalities in exports.

3.2 Defining new and old products, pioneers and followers

After applying all the filters[23], we first divide our data productwise in two groups: *new* products and *existing* or *old* products (the two columns of Table 1) We define an *old* product as any HS6 code that was exported during 1990-1994 by a firm for at least \$10,000 during a year[24]. Our analysis of new product thus begins in 1995, and a product is defined as *new* when it has not been exported in 1990-94 and it is exported between 1995-2006 by at least one firm with a minimum of \$10,000.[25]

[19] By having the dates when the firms stops operating.

[20] For this we merged our data with an available firm level panel from customs on all imports for the period 1990-2006.

[21] The change in coding as a problem to identify new products has been remarked by Kehoe and Ruhl (2009), although in a different context. They look at the huge jump in "births" of new SITC 4 digit products in various countries during the years 1988 and 1989, which where precisely the years when customs around the world moved their classification to the Harmonized System.

[22] Appendix 9 explains the details of the transformation.

[23] For a detailed definition and analysis of the filters, please see the Appendix.

[24] We call these products *old*, in the sense that there is some amount of experience *in the country* about how and where to export it

[25] Given that we wanted to create a five year pre-sample window, the period 1990-1994 was probably the earliest we could take, because exactly before that period - around 1988 and 1989 - is the time when customs around the world started to use the Harmonized System. As reported by Kehoe and Ruhl (2009), going beyond this date would create many "new products" that emerge only for a year due to the new classification. On the other hand, we believe the 5 year window is appropriate because if we look at the delay between the entrance of the pioneer and

Second, we classify firms, according to the sequence of entry in a product, as *pioneers* or *followers*. For a new product , we define a *pioneer* as a firm that starts exporting the product in the first year[26]. A *follower is a firm that began exporting the product at least one year after the pioneer did.* For the case of old products we do not define a pioneer, because it is (highly) possible that the product was first exported before our presample period of 1990-94, so we are unable to distinguish which firm was the first to export the product. For example, there are many cases where we have certainty that these products started before 1990, and some of them well before 1900, like nitrates or wines. For old products we also define a *follower*, mostly for benchmarking purposes. These *followers of an old product* are firms that began exporting an old product after 1994. This means that the product, although being old for the country is still new for the firm.

Table 1 shows a summary of the taxonomy we defined. The columns refer to products; the left column showing old products and the right column showing new products. The rows refer to firms, which depending on the sequence of entry: *pioneer* (first row) or *follower* (second row), depending on whether the firm is the first exporter from the country of that particular product or not.

Table 1 also shows the number of firms in each category. Interestingly, most of the firms-product pairs start exporting something new for the firm but *old* for the country. ($N = 10,294$; or 95.8% of the observations). This makes clear that, in the study of the early stages of new exports, we are working with a small fraction of the overall export structure of a country.

[Table 1 about here]

3.3 Patterns of entry

After concording HS 6-digit products codes for the period 1990-2006, we find that out of 4632 possible product-codes in the classification Chile already exported 2571 products during our presample period 1990-1994. We will classify these as "old products". Our preferred filter allows us to identify 295 *new* products exported during 1995-2006, but not during our five year presample period. Thus, during our sample period of twelve years the country explored 14% of the theoretical potential of products that were not exported before [27] The total value exported of these

the follower, we see that in more than 70% of the cases the first pioneer appears before five years of pioneer's entry into exporting.

[26] There could be more than one pioneer in the first year of a product. However, as we will see later, in most cases have a single pioneer. Although we do have the exact date of entry, we prefer to keep the year as our minimum unit of analysis

[27] 14%. The fact that Chile during a decade exported around 10% of the theoretical products that were not yet exported before is in itself a symptom that our method is relevant, because the country is far from hitting the theoretical boundary of the number of products offered by the HS classification. In large developed economies, like

new products steadily increased from US$1.5 million in 1995 ($46,000 per product) to $353 million in 2006 ($4.3 million per product)[28]. This latter value represents a modest 1.1% of non-copper exports from Chile.

[Table 2 about here]

A total of 345 firms participate in new export products [29]. The total number of unique product-firm observations is 444, indicating that on average only a few firms participate in each product. However this average hides an interesting heterogeneity across products. Table 2 analyzes this heterogeneity at the product level decomposing the products according to their number of pioneers and follower firms. For the period 1995-2005, it shows that less than 30% of products have followers. Second, only one third of the products *with* followers have two or more followers.[30] This quantitatively suggests that only few potential entrants into exporting can benefit from learning, which contrasts with the largely publicized cases of new product adoption in agriculture, where by the structure of industry there are many potential entrants[31]. Second, in 96% of the new products there is a *single pioneer*. This prima facie discards the idea that there were many firms waiting for a single bilateral exchange rate change or trade restriction to improve in order to suddenly jump into exporting, which was the focus of Iacovone and Javorcik (2010) with Mexican manufacturing after NAFTA[32].

Both results above, the low fraction of products with followers and the prevalence of products with single pioneers, are robust to modifications to the definitions of new products and to considering only early cohorts of products before 2000 [33]. For our purposes to understand externalities, the

the United States, we do not expect this to be the case, except for a couple for products directly based on natural resources not produced in the US. Our method, we believe, is more suitable to measure innovative activity in small open developing economies.

[28] The increase is clearly overwhelmingly due to the survival of new products which were introduced before 2006, and which have significantly increased their values since the year of their introduction into export markets)

[29] 250 firms are pioneers and only 127 firms are followers. See analysis on table 2.

[30] That is, for each random pioneer in our sample, 17% have one follower and 11% have a little "herd" of at least two followers

[31] Like the traditional case of Griliches (1957), and more recently Conley and Udry, 2010; Foster and Rosenzweig, 2010

[32] Additionally, three reasons might explain part of the difference between their study and ours. First, their study calls "new export product" to anything that was not exported *one* year before their sample. In contrast, our study takes *five* years to get closer to effective "new" products. Second, we include all sectors, not only manufacturing. Finally, Iacovone and Javorcik (2010) focus on a very large experiment of trade integration, as the NAFTA. Our sample period lacks these extreme events of integration.

[33] Since one may be worried that our sample could be contaminated by small transactions that never intended to be sustainable exports (like a Tobacco company re exporting a special machine it bought from another firm), we run the same analysis restricting the sample to products where the pioneer lasted at least two consecutive years exporting it. This filter takes away the above mentioned noise, but also many true pioneer failures. However, the previously described pattern remains unaltered for most practical purposes (although, unsurprisingly, the sample of new products decreased from 270 to 121). Reducing the cutoff for exports to a minimum of $ 1,000 does not greatly changes the above percentages (although with a higher number of products: 524). Panel B of Table 2 shows that the same figure holds for the cohorts before 2000, indicating a robust relationship that is not an artifact of the little remaining sample time that later cohorts have available for the birth of some followers.

results of Table 2 indicate that having followers is infrequent and, when it happens, it tends to be in limited numbers. However, it also shows that not all firms enter immediately, making it plausible to think that in the few cases with followers, these learn something from the pioneer.

3.4 Descriptive statistics

Table 3 shows the characteristics of the export spells for each firm that we will be analyzing. The first thing to notice is that firms that export new goods are much larger exporters than the firms that enter only into an old product. As expected in multi-product models of exports in the steady state, like Mayer, Melitz, and Ottaviano (2010), the difference is concentrated in the exports of existing goods (i.e excluding the pioneered product). While the mean $\log_{10}$ exports of other goods for new firms is 4.54, the value for old exporters is 3.91, almost half an order of magnitude and statistically significant. Second, and reflecting something similar, exporters of new goods for the country also are more likely to be large taxpayers, according to the Chilean IRS. This tends to rule out the idea that the average exporter of new products might be a small firm. We will show later that pioneers in new products tend to be smaller than followers in these same new products. But overall, the exporters of new products are larger than those which simply export old products.

Interestingly though, the probability of lasting more than one season with the export experiment does not significantly differ between followers of new products and followers of old products, both are around 35%. If we take a weighted average for pioneers, taking into account those with followers and those without followers, we also get a surprisingly similar 34%.

After this general comparison we focus on the macro differences between pioneers with followers, and their followers. This is more meaningful since they deal with the same set of products. Here one can remark that followers export larger amounts, which is something we will be testing more formally in subsection 4.2. Importantly, the firms entering as followers seem more diversified in terms of their economic activities. According to the Chilean IRS, followers have 0.7 more ISIC codes per firm than the pioneers of the same products (2.66 versus 1.90, respectively). These two facts are consistent with our model, which predict that more diversified firms would enter as followers. Notably, some of these trends are visible even without controlling by product or destination characteristics. Before testing the implications more formally, however, we will briefly review some case studies to remark qualitatively our results

[Table 3 about here]

3.5 A few canonical case studies.

An illustrative preview of our argument can be found in Figure 3 , which shows examples of products according to the "success"[34] of at least one firm in the product and the number of entrants (only one entrant or more than one). Each quadrant contains the frequency of firms in each group as well as a graph with a canonical example of a product in that category. In each graph the horizontal axis shows the year and the vertical the ($\log_{10}$) exports of each firm in the product in a given year, connected by a line for the same firm; so different lines correspond to different firms. As a preview, the theories that focus on externalities from pioneer to follower (like Hoff, 1997; or Hausmann and Rodrik, 2003) would focus mostly on case (C), of pioneers with followers. In contrast, the family of models in which "winner takes all" the domestic market (extreme "first mover advantage") would generate cases like those in panel (B).

[Figure 3 about here]

We first focus on the "failed experiments" of Panel A, which is by far the most frequent case. Depending on the filter we use, this groups represents between 85 and 90% of the products, where no firm manages to survive sustainably[35]. The case shown is *Zeolite, a mineral adsorbent*, pioneered by two firms in the same year, but after after an experiment both discontinued the endeavor. We interviewed one of the firms, which was a multiproduct exporter of mineral fertilizers. In the conversation the manager suggested that the lack of complementary inputs, namely proper transportation and certification, was responsible for the failure of this potentially sustainable export experiment.

Second, we have products with a single surviving firm exporting, and no other followers. This group of products with "sustained but lonely pioneer" tend to represent more than half the cases when pioneers survive more than 5 seasons[36]. The example is *Diphosphorus Pentaoxide, a chemical* (Panel B). A simple study of the industry makes clear why having it as a single exporter is not surprising. "Fosfoquim", founded in 1986, was not only the single producer of this chemical in Chile, but also the only one in South America at the time. In a context of high economies of scale, it is hard to argue that the pioneer was expecting some followers. Thus, one can expect that in these cases there is no gap between the social and the private incentives to experiment in exporting this product. [37]

Finally, in Panel C we depict a canonical case of successful pioneer with followers: *standard home Refrigerators.* In this product two well experienced firms survived to the trade liberalization period

[34]We define success in a product if a firm survived five or more consecutive years exporting the product. In this definition we obviously exclude products that began being exported after 2001. Otherwise we would not have time to even have a single firm nsurviving more than five years, since the sample ends in 2006

[35]By sustainably we mean more than 5 years, even controlling by cohort effects

[36]see Table 4

[37]An analogous case might be the well known case of aircrafts in the United States (Boeing) or Europe (Airbus)

in the 1970s and 1980s, and starte to export refrigerators during the mid 1990s. Interestingly, the year that the pioneer started to export refrigerators, both firms were exporters of some other product, which is a general trend in our data[38]. This tells us that firms might be learning about exporting *this product*, rather than a general learning about exporting. A second remark is that the pioneer firm in refrigerators is systematically smaller and less diversified than the follower. This is precisely consistent with our model and we will show, in Section 4, that this trend holds for our sample of new products [39]

The case of refrigerators, unlike the one for Phosphate, suggests the possibility of an externality. Nonetheless, refrigerators are still a product with few potential entrants into exporting, because there are few firms in the country, and it is unlikely that the structure of the industry would change so much after starting to export. Successful pioneers receive more followers in, for example, the meat packing industry, where there are more players. For example, Figure 4 shows five firms following the pioneer exporter of *frozen beef tongue*, which in 2006 had around 3 million dollars in exports from Chile, mostly to Japan.[40]

[Figure 4 about here]

Taking stock, the descriptive statistics and narratives we outline above indicate some characteristics that anecdotally fit with our model. First is the massive risk of a failed experiment, that justify learning. Second is that sectors with followers show a distinctive pattern, in which pioneers tend to export less (ex post) and and are less diversified that followers. Finally, in some sectors it is harder to argue that there is learning within the same product, since there are no followers.

In the next section we make a more systematic test of the different hypotheses.

4 Testing predictions

[38]Almost none of the firms in our sample start exporting all new products in the same year

[39]These are the cases of single index models, similars in the mechanism to Hopenhayn (1992) or Melitz (2003)

[40]Exports of this product began in 1999 by "Nippon Meat Packers ", which was already an important exporter of frozen pork meat. Until 2002 it was the only exporter of "*Bovine tongues, frozen*" from Chile. This was a company with little expertise in bovine production, but a lot of expertise on frozen meats and in the Asian market. Despite having no clear advantage in the production it was the pioneer. After four years of "lonely pioneering", in 2003 "Frigorificos Lo Valledor" started to export, with a first year's shipment more than 30% larger than the one used by the Pioneer in its first year . In 2004 many other firms entered (Frigorifico de Osorno ; Carnes Nuble ; Procesadora Insuban). Interestingly, the followers are overwhelmingly mature firms in the bovine processing industry, which of course did produce beef tongue, but did not freeze or export them to the a market where it was more valuable. Four years after having followers, the pioneer was eventually surpassed. Not surprisingly, the new leader in sales was the largest meat packer of the country. We do not interpret this surpassing as if it were a closed oligopolistic market (as usual in the Industrial Organization or Business Strategy literature) because many other countries export beef tongue to Japan (Chile represents less than 5% of Japanese imports in this product). Overall, it seems that the pioneer had a comparative advantage in exploring rather than at exporting this particular product.

4.1 Surviving pioneers get more followers.

A potential follower can update its priors about product profitability given the failure of the pioneer [41] Interestingly, both learning from successful and avoiding the loser products predict a positive correlation between the survival of pioneer and entry into the product. This is exactly our Prediction 1, for which we find clear support in Table 4. According to Panel B when the pioneer quits in the first season, then only in 26% of the products there is a follower. In contrast, when the pioneer survives the first season, there is more than 40% chance of having followers (p-value of $\chi^2 test: 0.018$). These results are robust when we control for cohort effects, as shown in Table 5[42] . In products where the pioneer survives for more than one or two seasons, it is 12 percentage points more likely to find followers entering the product (Specifications 1 and 2). Thus, we get overall support for Prediction 1, that pioneer survival is positively related to follower entry. Section 5.1 uses price information and placebo tests to reduce concerns about an alternative interpretetation of this result, in which followers may not learn from pioneers, but simply have a different entry threshold.

[Table 4 about here]

[Table 5 about here]

Finding that survival of pioneers is positively related to entry is neither trivial nor obvious. In our sample there are products with extreme first mover advantage, like the Phosphate exporter discussed in section 3. In these cases the survival of pioneers would arguably *discourage* entry of other firms, since the pioneer takes over the domestic market and exports an excedent. In particular, models with increasing returns to scale at a firm level, like a simple monopolistic competition demand with a firm setup cost, would predict either a zero or a negative correlation between success of the pioneer and entry. In these models a follower may want to enter in the same product only if the pioneer exits.

To explore why some products have followers and others do not, we run additional tests in Table 5. In specifications (3) and (4) we observe that surviving at least 5 seasons, does not make a statistical difference for entry, at least not across the board[43]. However, a large duration of the pioneers seems to have an heterogeneous effect on the entry of followers. In particular, on those goods that CEPII (2010) classifies as "Consumption goods", having a successful and longlasting pioneer

[41] See for example Segura-Cayuela and Vilarrubia (2008)

[42] This robustness check is important because there could something particular about a given entry year. For example, products that are started to be exported later have mechanically less time to have followers. Similarly, a particular year can have systematically more or less products being born, for example because of exchange rate changes as in the case with the neighboring Argentina in 2002

[43] Here we needed to restrict our sample to products started until 2000, to have enough time to evaluate whether the pioneer lasted 5 years of not and whether it has followers

seems to induce entry by large and significant 68 percentage points (F-$stat$= 26)[44]. Checking anecdotes case by case, we observe that these "Consumption goods" tend to have more domestic firms operating, and thus have a large number of potential entrant into exporting, which is an indication that many followers can potentially benefit from finding a good export product close to that industry. For "Intermediates" (non-Consumption goods), the large duration of a pioneer has a negative point estimate for the effect on duration, although it is not statistically significant. In the context of our model, we think of "Consumer goods" as a proxy for potential entrants into exporting. A different proxy we use is an index of the "scale" of some industries used by Antràs (2003), which corresponds to the average turnover of an establishment in the US (see Data subsection). In specification (6) a 1% larger scale implies a decrease in 0.05 percentage points in the probability of having followers. We feel that all these proxies are imperfect, but seem consistent with the idea that industries supporting a larger number of firms can support post-pioneer entry into exporting. In short, on our aggregate sample we do find strong support for prediction 1, that survival of the pioneer induces entry. However, we recognize that pioneer-takes-all models do have empirical byte in some sectors, because in more than half of the cases of "longlasting"[45] pioneers we do *not* observe followers.

4.2 Pioneers export *less* than followers.

To test that there are externalities, we not only need to know that survival of pioneers is associated with entry. In fact, maybe both the pioneer and the follower can just be observing a public signal (like the international price of a commodity, available in the newspapers). In these cases one firm may react faster than the other, but there is no true learning. Under these circumstances, the standard model in which firms differ only in productivity would predict the largest ex-post exporter would be, on average, the first firm willing to pay a sunk cost of exporting[46]. In this subsection we find exactly the opposite , that pioneers tend to be smaller, which is consistent with prediction 2 of our model.

4.2.1 Pioneers are smaller at entry

Many papers note that firms tend to enter small and then grow in volume (Ruhl and Willis, 2009; Rauch and Watson, 2003; Albornoz, Corcos, Ornelas, and Pardo, 2010; Arkolakis, 2009). Here we not only find this positive slope within firm, conditional on survival, but we get an additional result that would not be available if we omit - as previous papers do - the sequence of entry into

[44]This value is obtained by adding the coefficients of the interaction [Duration pioneer$\geq$ 5$*$Consumption Good] and that of [Duration pioneer$\geq$ 5] in specification (6). We obtain a similar result in specification (5).

[45]Meaning that the export spell lasted at least five seasons, as in Table 4 Panel B

[46]Freund and Pierola (2009) have a model with these characteristics

exporting a product. Table 6 shows that *after taking into account product fixed effects*, pioneers enter with approximately 40% less quantity (p-value<0.1) and have 20% fewer ISIC activity codes (p-value<0.05) than followers. In contrast, we cannot distinguish that pioneers enter with different prices. A different way to show the same phenomenon is Table 7, where pioneers are 30% less likely to have the largest exported value in the product at entry. This result is qualitatively robust to the inclusion of different time controls (Specifications 1 to 4[47]). When we restrict the sample only to those products that got a follower at most three years after the pioneer (specification 6)[48] the coefficient for pioneers is more negative than in other specifications, showing that early followers are almost 50% more likely to be the largest firm in comparison to pioneers. [49]

[Table 6 about here]

[Table 7 about here]

In short, conditional on entry, followers tend to start exporting the product in larger volumes. Although it is not the only possibility, this pattern is consistent with learning by the follower from the pioneer about for example shipment size, demand or perceived risk at entry. It can be also that followers tend to be larger exporters in general, which is what we find in Figure 5, and what Prediction 2 would predict. In Figure 5, we observe that the distribution of exports in *other* products is shifted to the right, in comparison to pioneers[50], a fact that is statistically significant at 95% confidence according to the Kolmogorov-Smirnov test. Although we do not observe domestic sales, this test is reassuring as a way to show that pioneers tend to be smaller than followers. The non parametric kernel density of Figure 5 (Panel C) also shows that pioneer entrants have fewer economic activity codes than followers, which fits overall with our assumption in the model.

[Figure 5 about here]

4.2.2 Pioneers are also smaller, on average, after entry

One could argue that the advantage for followers was only about the size at entry, but not in subsequent periods, like in models where firms start smaller only in the experimentation phase

[47]Results do not change qualitatively if we introduce a time trend (specification 2) for the entry year, year of entry fixed effects (specification 3) or time of entry trend and a dummy for firms that survive until 2006 (specification 4).

[48]Its hard to argue that there might be learning from the pioneer if the follower starts a decade after the entry of the pioneer, at least the type of learning that we are describing, which seems to be more related to internationalizing your products rather than production itself. For this reason our specifications we restrict the entry of followers to a certain number years after the entry of the pioneer, specification 5 being the one that allows the largest lag between pioneer and follower.Even in that specification the effect can be observed.

[49]The results are in nominal US Dollars. Using real local currency (Chilean Pesos corrected by inflation) just magnifies the effect

[50]To be clear, this includes all exports in the year of entry, but without counting the volume in the new product they just entered. Note also that this is comparing firms in the same set of new products (i.e. pioneer with followers and their followers)

(see Rauch and Watson, 2003). However, we also find that an average early follower exports more than the pioneer when we compare them in subsequent years when they both export strictly positive quantities[51]

Table 10 shows regressions of post entry quantities after correcting by product-year fixed effects, which means we are comparing pioneers and followers within a product and within the same year. Regression (1), restricted to all observations post entry, shows a negative point estimates for the pioneer dummy, though we cannot statistically reject the hypothesis that pioneers and followers sell the same amounts when we do not condition on the experience the firm has in exporting the product. However, we know that it takes some time to build a customer base, so incorporating experience is an important factor, as argued by Arkolakis (2009). Indeed in specification (2) we restrict to a more mature phase of product penetration, in which firms have at least three seasons exporting a product. Here our result clearly emerges: pioneers are smaller than followers by an order of magnitude ($0.1 \approx \exp\{-2.4\}$), fitting the example of refrigerators we observed in section 3.

[Table 10 about here]

[Table 9 about here]

Specifications 3 and 4 take a broader sample, but correct for experience in the product, finding qualitatively similar results. Since we know that pioneers have by definition more experience than a follower in a given year, it is useful to compare the coefficient of the pioneer dummy with that of an additional year of experience to get a sense of the magnitudes . Roughly speaking, to export the equivalent of a first year follower a pioneer requires three or four years of experience exporting the product. (by dividing the coefficient for pioneer, -3.2, by the coefficient for year, 0.70, one gets 3.8 for the point estimate) . We run specifications with a more flexible pattern for experience in regression (4), including quadratic terms and dummies, but we still find that the pioneer sells less quantity. In contrast to the differences in quantities, we cannot distinguish any "pioneer effect" on prices, as shown in the different specifications of Table 9. As a result, the total trade volume differences between pioneers and followers (Table 10) display the same pattern as the quantity data. The disadvantage is explained by quantities rather than prices. [52]

[Table 10 about here]

[51] This deals with the problem reported by Lieberman and Montgomery (1998), who show that by having a zero share in some years one can falsely get a result where the first mover has an advantage rather than a disadvantage.

[52] The sample with trade volume (price times quantity) is slightly larger than the sample with separate data on prices and quantities. Our result of first-mover disadvantage on total trade volume are not sensitive to which of the two samples we use.

[Figure 6 about here]

To make the first mover disadvantage clearer, Figure 6 graphs the simulated sales implied by regression (3), computing 95% confidence intervals using the Delta method for a product that was discovered seven years ago. This allows us to show how expected sales vary *within* a product as the timing at entry changes. The horizontal indicates the normalized year of the product in which they have entered. Thus, those at $t = 0$ are the pioneers of the product, while those at $t = 1,2$ ... 6 are followers entering one, two and up to six years after the pioneer. We observe that experience and selection are important, because the earlier you enter, the more you sell. However, that is not valid for the pioneers[53], which have lower average export sales than early followers. As discussed before, the point estimate of sales for pioneers is, with a 95% confidence, consistently lower than for early followers. The difference is only equivalent to the the revenues for firm entering in three or fours years later. This persists, when controlling for all fixed characteristics in a product-year combination (e.g. taste shock, international demand shift, price of traded inputs, exchange rate...). In any case, specification 2 in Table 8 shows that after three years in a product, an average follower is unconditionally larger, despite having less experience in a given year.

Finally, it is important to remark that this effect of the pioneer being smaller survives even when we focus on a specific destination with enough sample size. Specification (5) of Table 8 replicates specification (2) , but restricting our attention to exporters to Argentina. Our results look very similar and statistically significant, despite having less than a quarter of the sample size.

Taking stock, our results conditional on multiple entrants indicate that the pioneer might not be the firm that benefits the most from the discovery of a new product. Interestingly, this is not only counterfactual to what one would expect from extrapolating current trade models of the steady state (i.e.Melitz, 2003), but it is also contrary to the *assumption* of Grossman and Rossi-Hansberg (2010) that pioneers have a roughly constant returns to scale technology. On average, pioneers in our sample do not export the largest amounts in a product, followers do.

5 Alternative explanations that do not imply externalities

Our findings, even though they suggest a story consistent with externalities, could still be driven by alternative explanations. Below we analyze three potential alternatives which do not consider external economies and that could generate similar patterns in the data. For each case we provide evidence that tends to undermine them as a potential challenge to our interpretation.

[53] The decreasing slope can be consequence of both experience accumulation as well as the the entry of smaller firms as in the now standard Melitz (2003) selection effect.

5.1 Both pioneers and followers react to a publicly available signal

A positive time trend in the international price of a product, or in any other publicly available signal of export profitability, can make the smaller firms enter first into a product, if one assumes that these smaller pioneers have an (exogenously) lower sunk cost of exploration vis-a-vis the large exporters. This story would be consistent with our stylized facts so far, but would not have any learning flowing from pioneers to followers. In this scenario the large firms would react later only because they have a larger exogenous sunk cost, so they need a larger threshold profitability to enter into exporting this product, as in any standard dynamic investment problem. Here we show, however, that other stylized facts render this scenario less likely. First, Table 6 shows that prices received at entry into exporting are not statistically different between pioneers and followers. Thus, we cannot distinguish the upward trend in prices hypothesized by the alternative explanation. A second counterargument comes from a falsification exercise. If what really matters for entry is not the survival of the pioneer, but simply a public signal, then entry into our new products would be correlated with the survival of *any firm* , rather than being disproportionally correlated to the survival of the pioneer. When we implement this test in Table 5 (specification 3), the survival of the pioneer keeps being statistically significant, while the duration of a randomly chosen firm in the product is not. This suggests that the survival of the pioneer is more informative to explain entry . A final counterargument is that many of our firms seems to be already producing the product for the domestic market. This makes unlikely that the exogenous sunk costs vary disproportionally across firms. At the end of the day, the direct costs are simply about sending an export manager to a foreign market to close an export deal. In our view, differences in sunk cost do not come from exogenous differences between small and large firms, but from the fact that large firms have difficulties figuring out what product to focus on. In conclusion, these three arguments reduce concerns abour our results being driven by a public signal, available to anyone, rather than by some external economies.

5.2 Product life cycle

Another possible alternative argument is that what we are seeing are not discovery externalities, but simply differential mortality of firm-product lines, which are different over the life cycle of the product (early producers are better at R&D than at discovering large quantities in standardized markets). However, our sample focuses on products that are new for the country; which is completely different from starting products that are new to the world, as in the studies of Agarwal and Gort (1996); Agarwal (1997) and Klepper (1996). According to Vernon (1966), less developed countries start exporting a product once these are more advanced in the product life cycle, so there is much less uncertainty about how to produce the good. Intuitively, frozen beef tongue or a phosphate chemical are hardly new products in the world in the last 50 years. Beyond this anecdotal argument, we again point out that we find no statistical difference between the prices faced by pioneers and followers when they entered into exporting (Table 6). If products were evolving quickly during our time frame this statistically flat price would be extremely unlikely.

5.3 Pioneer is being pushed away from the domestic market

One can argue that pioneers are smaller not because they decided to innovate, but because they were pushed by larger domestic players into a low profit export market. This would rationalize our facts about smaller pioneers, but in a way that does not require an externality. We do not have data on domestic prices and quantities, which are very unlikely to exist at the level of disaggregation we are working with exports. Even if we had them, in multiproducts firms there is always the criticism that one does not observe profits of product lines. Despite this problem, we offer some arguments that can reduce our concerns about the scenario of "pushed pioneers". A first counterargument is the positive covariance between the survival of pioneer and the entry of followers, discussed in section 4.1. If a large firm chooses to delay its internationalization in the product because the domestic rangeland was greener, it is hard to understand why it would decide to systematically enter later on. It is even less likely if one thinks that the price received by exporters did not statistically change between the time the pioneer and the follower decided to enter (Table 6). A second counterargument is that, when firms are losing domestic market share, they may escape to markets with lower quality requirements. To test this possibility, we replicated the procedure in Table 8, but excluding exports to neighboring countries with lower GDP level than Chile (Bolivia and Peru). We did not find qualitative changes in our results, which reduces our priors about this potential concern. [54]

5.4 Reflection and identification

One can finally argue that larger exporters may be exogenously and intrinsically slower to react, rather than endogenously slower due to sunk cost (section 5.1). This flexible ad-hoc hypothesis can generate our stylized facts without any learning. In fact, this "large-exporter-is-just-slow" counterargument is simply a statement of Manski's (1993) reflection problem, in which an endogenous social effect, like learning between firms, cannot be separately identified in the cross section from pure firm characteristics that are collinear with the social effect. We partially escape from this reflection problem by using time-series variation within a product rather than just a cross-section. To rule out further ad-hoc hypotheses we need an identification assumption: that the *ability* to re-

[54] A third possibility to test the "pushed pioneers" would be to check whether mortality of pioneer firms is higher, as one would expect if they are losing market share. We are currently working on this possibility using IRS data on firm deaths.

spond fast to signals does not systematically differ between large and small exporters of a product. For identification we need the speed of reaction to be a *choice*. [55]

[55] A final alternative possibility we cannot fully tell apart in our paper is as follows. Immagine that the first export event is simply the result of an exogenous phone call received from a potential customer overseas, which generates a pioneer event by a *random* firm in the country. After this first export, however, all firms learn about this new export possibility, but endogenously only the larger and most productive decide to enter, while the pioneer remains exporting simply because of hysteresis. This can generate a systematic "first mover disadvantage", as we find in the data. The above story has indeed learning, which is what we wanted to explore since the title of our paper. However, in this story the innovation is exogenous and effortless, so there is no social waste and no role for policy. Our view is that there is an effort in discovering a new export product, which is indeed the theme of many export promotion programs.

6 Concluding remarks.

Using detailed customs transactions from Chile (1990-2006), our paper presents facts consistent with pioneer-to-follower externalities in new export products. First, we find that products with surviving pioneers have more followers, which is consistent with either learning from the successes or avoiding the failures of pioneers. Second, we find that pioneers both enter and remain smaller than followers, suggesting that the first explorer may not be the same firm that benefits the most from the discovery.

We rationalize these facts in a simple model, in which larger firms have a wider set of *potential* new projects to pursue. Since they cannot develop all of them, because of decreasing returns to scope, their problem is to allocate an indivisible scarce resource to the best possible use. The extra potential scope, vis-a-vis smaller and more focused firms, generates an incentive for larger firms to strategically delay entry. In contrast, smaller exporters with fewer options tend to enter sooner, giving information to followers. This mechanism, though simple, is novel and rich enough to explain the potential for external economies: followers may free-ride on the pioneer's experiment.

Our goal in this paper was to update existing priors about the existence of pioneer-follower externalities in new exports from emerging markets. If the reader came from a more agnostic position, our research offers a set of facts that do not fully prove, but seriously suggest industry learning. In contrast, if the reader has been previously exposed to the seductive successes of garments in Bangladesh, flowers in Kenya or Salmon in Chile; our paper becomes a cautionary note. Our non selected sample of products shows for the first time the very high risk of new exports, in which more than 85% of new products do not survive beyond 5 seasons. This risk ought to be considered by any serious export promotion program, as well as by any strategy of international entrepreneurship. Even among these sustained exports not all products suggest externalities. Indeed, at least half the products have "lonely pioneers". If the pioneer is really successful and nobody is copying, maybe the market offers enough reward to internalize any learning that the pioneer is creating. From a policy perspective, sectors where the pioneer has a natural first-mover-advantage, like the Phosphate case, may not be the most likely case of *within* product externalities.

We conclude with opportunities for further research. The first is to learn more about how new products start being produced, rather than exported. While for "born global" firms both production and exporting happen at the same time, other firms are much more dependant on domestic demand for their early growth. A second extension is to understand better what determines the exploration of products for different distances from the firm's current capabilities. Finally, it is important to check whether our results can be replicated, or reversed, in other countries; as we are currently doing with Colombian exporters.

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7 Figures

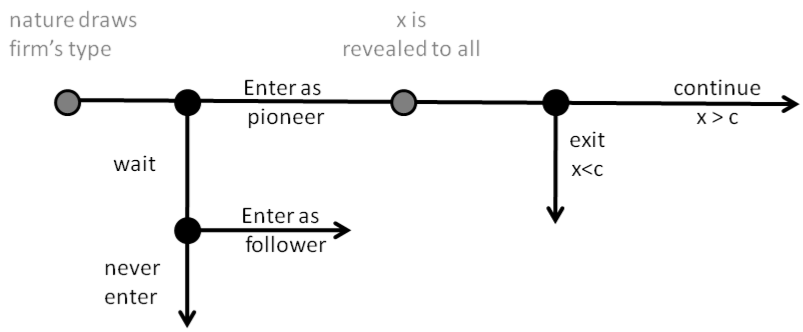


Figure 1. Diagram showing the extensive form of the game for each firm, depending on type.

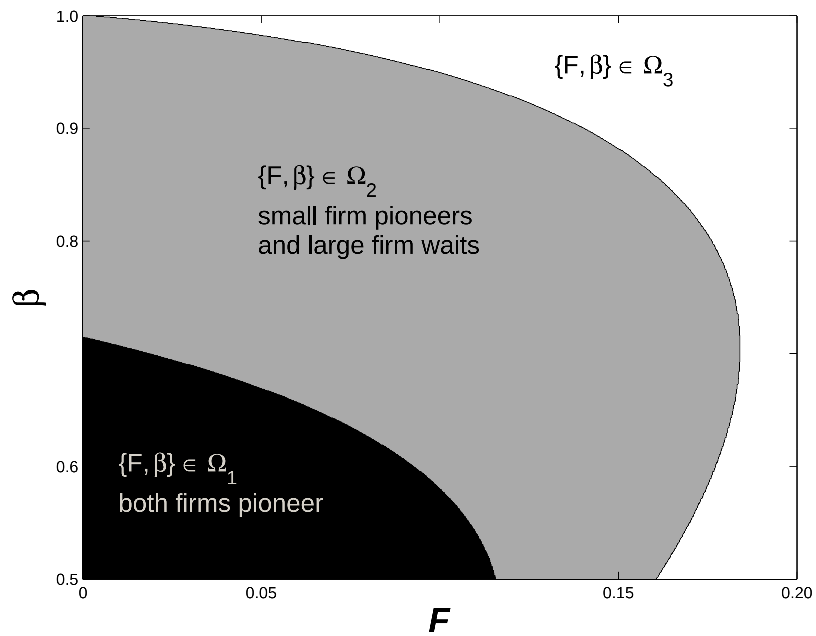


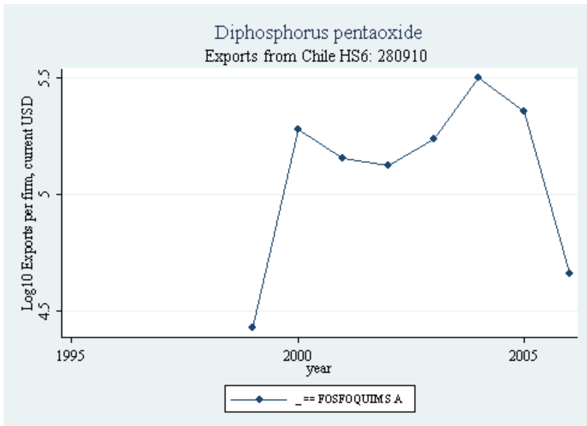
Figure 2. Equilibria depending on the values of patienceβ and exogenous sunk cost F. Region Ω_1 in black has a unique equilibrium in dominant strategies in which both firms enter immediately as pioneers. Region Ω_2 , in grey, has the unique equilibrium of interest in this paper, in which being pioneer is the dominant strategy for the small firm and waiting is the dominant strategy for the large firm. Region Ω_3 can potentially have multiple equilibrium, with the outcome depending on more sophisticated equilibrium concepts. Values plotted at $c = 0.1$

Figure 3. Graphs showing the export sales (in $\log_{10}$ US Dollars) of all firms exporting a given product. Each firm is connected by a line of the same color. In addition, if one firm does not have a scatter point in a given year it means that it did not export

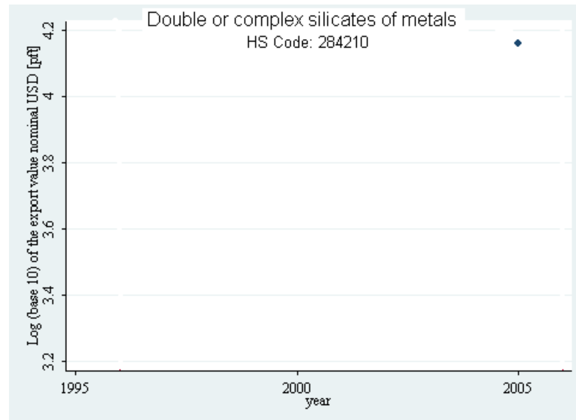
Duration of the export spell

"sustained" | "failed experiment"

$N_{firms} = 1$

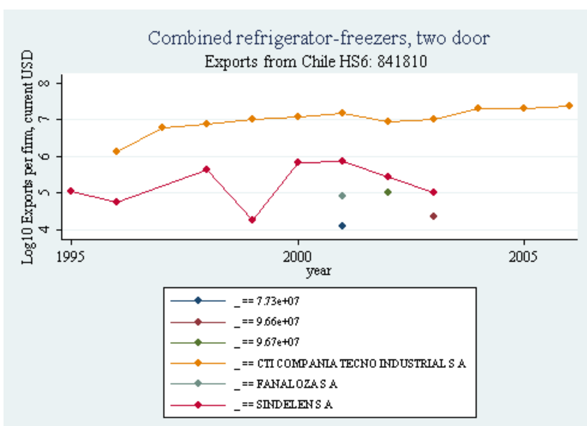


(b) "Successful but lonely pioneer": (5 to 10 % of products)



(a) "Failure": 80 to 90% of cases

$N_{firms} > 1$



(c) "Pioneer with follower catches up": $\leq$ 3-5% of cases

The pioneer can be distiguished because it corresponds to the line that starts closer to the left of each graph.

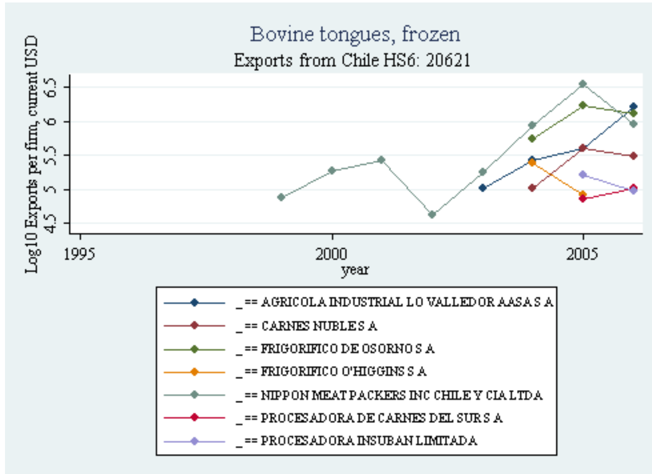
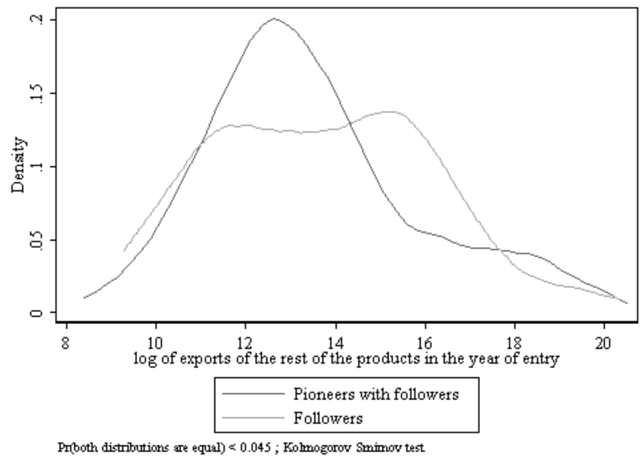
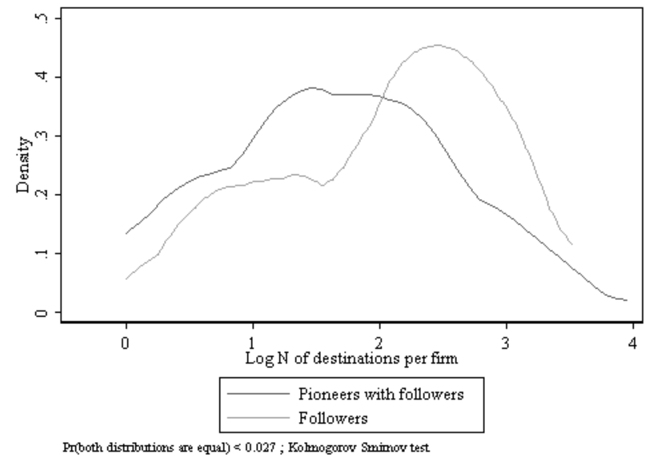


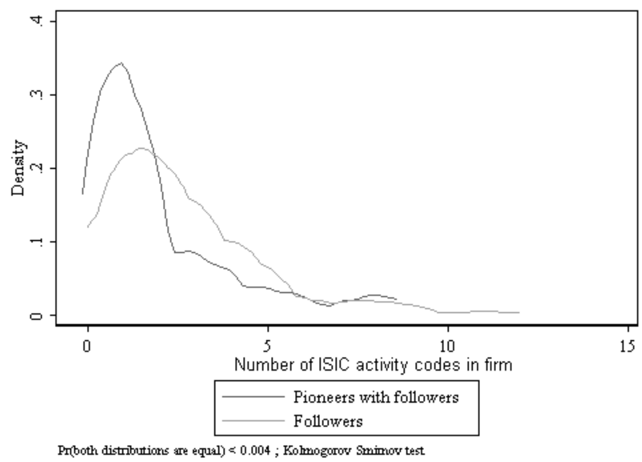
Figure 4. A case with many potential entrants into exporting



(a) Total Exports in other products at entry (log USD)



(b) Number of destinations served by the firm (log)



(c) Firm scope: Number of ISIC activity codes

Figure 5. Empirical distribution (kernel density) of (a) the volume of other exports, (b) the number of destinations served , (c) the scope of firms measured in terms of numbers of CIIU activities. Logarithmic scale for (a) and (b). For all cases the distribution for followers has more mass to the right of the distribution, with 5% significance according to the Kolmogorov-Smirnov test of distribution equality. (p-value 0.045 for export volume, p-value 0.027 for destinations, p-value 0.004 for scope).

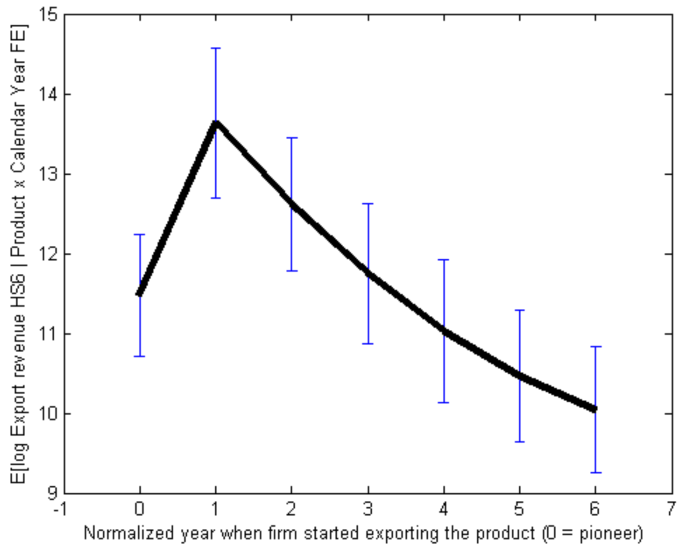


Figure 6. Simulation of the regression coefficients showing no first mover advantage. Confidence intervals at 95%.

8 Tables

Table 1. Taxonomy of different events of a firm exporting a product

		Has any firm exported this product from the country before 1995 ?	
		YES "*old* product"	NO "*new* product"
Is it the first firm exporting the product from the country ?	YES	N/A $N = 0$	$Pioneer_{new\,product}$ $N = 136$
	NO	$Follower_{old\,product}$ $N = 10,294$	$Follower_{new\,product}$ $N = 308$

Table 2. New export products for Chile, classified according to number of pioneers and followers. Cohorts of products started by some firm in 1995-2005 (A) and 1995-2000 (B).

(A) Only product cohorts before Dec 31, 2005

	N of Pioneers			
N followers	1	2	3	Total %
0	185	5	1	70.7%
1	43	4	0	17.4%
2	19	0	0	7.0%
3	6	1	0	2.6%
4 to 6	6	0	0	2.1%
Total %	95.9%	3.7%	0.4%	100%
				$N = 270^{*}$

(B) Only product cohorts before Dec 31, 2000

	N of Pioneers		
N followers	1	2	Total %
0	110	5	66%
1	27	4	18%
2	17	0	10%
3	5	1	3%
4 to 6	6	0	3%
Total %	94%	6%	100%
			$N = 175^{**}$

Cutoff to define a new product is $10,000 minimum of exports in a given year by a firm. (*) The cohort of products "born" in 2006 is excluded from the calculation in Panel A because there are no followers by definition. That reduces the total sample from 295 products to 270. (**) As a robustness Panel (B) includes only the cohorts of products strictly before 2001, to check that the pattern described before is robust across cohorts.

Table 3. Descriptive statistics of product-firm pairs

Type of product-firm pair in the sample		$\log_{10}$ Exports of product $t_{pf}=0$	N of ISIC activity codes	IRS Large taxpayer dummy	$\log_{10}$Exports *other* products $t_{pf}=0$	Spell truncated in 2006 dummy	Duration ≥ 1 season dummy	N
Follower in new products	mean	4.70	2.66	0.36	4.38	0.35	0.37	
	SE(mean)	*0.05*	*0.19*	*0.04*	*0.24*	*0.04*	*0.04*	
	median	4.52	2.00	0.00	5.30	0.00	0.00	136
Pioneer with follower	mean	4.57	1.90	0.32	4.32	0.11	0.48	
	SE(mean)	*0.06*	*0.22*	*0.05*	*0.30*	*0.03*	*0.05*	
	median	4.34	1.00	0.00	5.32	0.00	0.00	84
Pioneer w/o followers	mean	4.62	2.00	0.39	4.72	0.21	0.29	
	SE(mean)	*0.04*	*0.11*	*0.03*	*0.18*	*0.03*	*0.03*	
	median	4.43	2.00	0.00	5.60	0.00	0.00	224
Total New products	mean	4.64	2.19	0.37	4.54	0.23	0.35	
	SE(mean)	*0.03*	*0.09*	*0.02*	*0.13*	*0.02*	*0.02*	
	median	4.45	2.00	0.00	5.46	0.00	0.00	444
Follower of old products	mean	4.68	-	0.23	3.91	0.25	0.45	
	SE(mean)	*0.01*	-	*0.00*	*0.03*	*0.00*	*0.00*	
	median	4.53	-	0.00	5.09	0.00	0.00	10294

Export values are in USD. The expression $t_{pf}=0$ refers to the year of entry of a firm into this new product that the firm did not export before. Duration ≥ 1 season dummy indicates that the export spell for that firm in that product survived more than one season exporting. Large Taxpayer is a classification of the Chilean Internal Revenue Services. The number of ISIC categories in which the firm participates is actually an adaptation of the ISIC system, with more granularity, used by the Internal Revenue Service in Chile.

Table 4. Percentage of products classified according to the survival of pioneers and entry of followers.

(A) Five year duration of pioneer

	Product has follower(s)		
	No	Yes	Total
Pioneer duration < 5	69.3	8.0	77.3
Pioneer duration ≥ 5	13.3	9.3	22.7
Total	82.7	17.3	100 %
			$N = 75^*$

Pr $\left(\text{Pearson's } \chi^2(1) > 8.72\right) = 0.03$

(*) Sample includes only products started by someone until 2001, otherwise our definition of success would be tautologically zero in later cohorts. Also, the sample is restricted to products having at least one follower lasting more than one season. If the short term followers are included, the difference is even larger against the null hypothesis

(B) One year duration of pioneer

	Product has follower(s)		
	No	Yes	Total
Pioneer duration ≤ 1	44.4	15.9	60.3 %
Pioneer duration > 1	23.4	16.3	39.7
Total	67.8	32.2	100 %
			$N = 239$

Pr $\left(\text{Pearson's } \chi^2 \geq 5.67\right) = 0.018$

(**) Observations only of products started until 2003, to give enough time to have followers.

Table 5. Linear probability regressions of followers' entry on pioneer performance and product characteristics

	Dependent variable: **1** [Entry of followers > 0]					
	(1)	(2)	(3)	(4)	(5)	(6)
Duration pioneer ≥ 1	0.120**		0.481*	0.177**	0.156**	0.161**
	(0.057)		*(0.263)*	*(0.077)*	*(0.0785)*	*(0.0793)*
Duration pioneer ≥ 2		0.111*				
		(0.065)				
Duration pioneer≥ 5			-0.093	-0.086	-0.193	-0.196
			(0.158)	*(0.151)*	*(0.149)*	*(0.153)*
Consumption good				0.065	-0.019	-0.081
				(0.109)	*(0.114)*	*(0.122)*
Duration pioneer ≥ 5 * Consumption good					0.773***	0.876***
					(0.180)	*(0.186)*
log Scale of production						-0.059*
						(0.033)
Duration placebo pioneer ≥ 1			-0.316			
			(0.268)			
Year when prod started	FE	FE	FE	FE	*year*& $year^2$	*year*& $year^2$
Observations	295	295	175	174	174	166
R-squared	0.116	0.111	0.084	0.080	0.071	0.093

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The duration of pioneer variables correspond to the duration in years of the export spell of the pioneer in that product. The duration beyond five years accepts at most one year of interrupted exports within a spell. Consumption good is a dummy for CEPII's classification of HS6 codes as consumer, as opposed to diffeernt categories of intermediate goods (See Data). Log scale of production is a product characteristic that corresponds to the average establishment sales of the industries producing these products in the US (see Data). Sample sizes in specifications (3) to (6) are smaller because the sample is restricted to products started until 2000, so it is possible to observe a pioneer for at least five years and have followers. Regression (6) has 8 fewer observations because not all sectors NAICS sectors can be matched to the HS6 codes to merge the variable "Scale of production". "Duration placebo pioneer" is the duration of a randomly chosen firm in the product. In the cases of products with a single firm, it coincides with the true pioneer, but in products with followers it does not necessarily coincide. All the regressions have a constant and year coefficients, not reported because of space constraints.

Table 6. Regressions of differential behavior of pioneers at entry

			HS 6 Commodity under study ay entry			
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ln ($N\, codes + 1$)	ln (PQ other prod)	ln (PQ)	ln (P)	ln (Q)	1*[Duration≥ 2]
$1 * [pioneer]$	-0.230**	0.192	-0.172	0.178	-0.458*	0.072
	(0.116)	*(0.781)*	*(0.151)*	*(0.243)*	*(0.252)*	*(0.096)*
Constant	0.824***	9.962***	10.60***	2.968***	7.913***	0.313***
	(0.0654)	*(0.478)*	*(0.0825)*	*(0.151)*	*(0.160)*	*(0.0642)*
Product	FE	FE	FE	FE	FE	FE
N	192	220	220	180	180	154
R^2	0.411	0.548	0.501	0.912	0.906	0.499

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 7. Linear Probability Regressions on a dummy for being the largest exporter in the product at entry . Every observation is a single firm in a product, demeaned by the product fixed effects.

	(1)	(2)	(3)	(4)	(5)	(6)
	entry within 5 years after the pioneer				entry within 10 years	entry within 3 years
1 [Pioneer in product]	-0.229**	-0.377**	-0.490***	-0.367**	-0.307***	-0.472*
	(0.0946)	(0.174)	(0.180)	(0.177)	(0.116)	(0.270)
year of entry		-0.0560	FE	-0.0559	-0.0426**	-0.106
		(0.0552)		(0.0559)	(0.0203)	(0.132)
1 * [Lasts until end of sample]				0.0956		
				(0.143)		
Constant	0.452***	112.5	1.512***	112.4	85.75**	211.8
	(0.0632)	(110.5)	(0.494)	(111.8)	(40.59)	(263.2)
Observations	177	177	177	177	223	145
R-squared	0.323	0.331	0.431	0.334	0.187	0.483

By definition only products with followers are included in the analysis. Robust standard errors in parenthesis.

*** p<0.01, ** p<0.05, * p<0.1. All the specifications contain product fixed effects.Run in STATA on 18:04:40, 29 Apr 2010

Table 8. Regressing quantities exported on pioneer dummies controlling by product-year shocks

	log quantity exported by a firm in a product and year				
	All destinations				Only ARG
	(1)	(2)	(3)	(4)	(5)
1 if pioneer in product	-1.108	-2.485**	-3.250***	-2.707**	-2.630***
	(1.243)	(1.085)	(1.014)	(1.076)	(0.44)
t_{pf} : experience exporting the product			0.880***	1.025	
			(0.239)	(0.808)	
t_{pf}^2				-0.0370	
				(0.0831)	
Number of products exported by firm				0.287	
				(0.191)	
Share of product in exports of firm				3.009	
				(2.629)	
Constant	10.81***	12.07***	8.812***	6.471***	12.31**
	(0.607)	(0.612)	(0.693)	(1.851)	(0.14)
Observations	179	90	179	179	33
R-squared	0.93	0.97	0.96	0.97	0.99

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 .

Quantities are measured in the units in which the Customs transaction is recorded. t_{pf} corresponds to the experience exporting a given product. Specification (1) restricts to post entry events. Specification (2) does it for survivers of at least three seasons. Specification (3) is like specification (1) , but controlling for experience. Specification (4) includes various additional controls, like product diversification and the share of the value exported in the product as fraction of all exports, to measure the importance for the product for the firm.

Table 9. Regressing prices on pioneer dummies controlling by product-year shocks

	log median export price of firm in a product in a year		
	(1)	(2)	(3)
Restriction	$t_{pf} \geq 1$	$t_{pf} \geq 2$	$t_{pf} \geq 3$
1 if pioneer in product	0.0801	0.0460	0.0461
	(0.0960)	(0.0885)	(0.0953)
Constant	1.749***	1.789***	1.707***
	(0.0471)	(0.0442)	(0.0550)
Observations	179	128	90
R-squared	0.999	0.999	0.999

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 .

t_{pf} corresponds to the experience exporting a given product. Specification (1) restricts to post entry events. Specification (2) does it for survivers of at least two seasons , and specification (3) for survivers of three seasons. This justifies the lower sample size as we move to the right. In a different specification without including the pioneer dummy we see that almost all of the variation (by R^2) is taken up by the fixed effect, there is little firm level variation in prices.

Table 10. Linear regression of firm's export value [log US$] taking product and year fixed effects

	dependent variable: firm's export value [log US$]				
	(1)	(2)	(3)	(4)	(5)
1 if pioneer in the product	-3.338***	-3.391***	-2.250*	-3.521***	-2.844**
	(1.034)	*(0.968)*	*(1.154)*	*(0.926)*	*(1.190)*
log exported value at entry in prod			0.803**		
			(0.396)		
experience in product (years)	0.971**	0.880	0.345	0.923**	0.906**
	(0.384)	*(0.958)*	*(0.860)*	*(0.360)*	*(0.382)*
experience in product squared		0.0141	0.0605		
		(0.115)	*(0.117)*		
N of products exported by firm				0.249	
				(0.152)	
Share of prod in firm's bundle					1.614
					(2.818)
Constant	10.20***	10.29***	1.551	9.317***	9.654***
	(0.980)	*(1.390)*	*(4.511)*	*(1.131)*	*(1.482)*
Product- Year	FE	FE	FE	FE	FE
Observations	204	204	204	204	204
R^2	0.885	0.885	0.920	0.904	0.889

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

9 Appendix: New correspondence for HS commodity codes 1992-2006

To measure the decision to export a new product for the country it was necessary to homologate HS6 product codes through time. The Harmonized System consists in close to 5000 product codes. However once every 5 years the classification is internationally updated. This implies that several codes are expanded into new codes (i.e. what before could have been portable music players in 1990, could have been expanded into "portable cassette music players" and "portable CD music players", and later on into "MP3 players"). Other codes are collapsed into a single code (i.e. products that are seldom exported) or are taken out of the classification. Some codes are just relabeled. And there are combinations of the above (i.e. a code that becomes part of two different codes which encompass other codes that are absorbed by each new code). Thus, it is possible that what we observe as new codes are not new products being exported but simply a new codification of a product that could have been exported before under a different code.

Given the above problem, what we need is a common clasification across time. This was unavailable in existing correspondences for HS classifications at 6 digits. Correspondences which can be obtained, with different access levels, from WTO, World Customs Organization, UN-COMTRADE, and the World Bank, only allow to connect different classifications, but do not provide unique common product codes across time, which is what we need for our paper. In other words, what they provide is a code by code correspondence *between* different classifications. What we need, however is to generate common codes *across* classifications . To the best of our knowledge, the only work that recently provides this is Pierce and Schott (2009). In their technical paper they provide a homologation procedure across time in order to have consistent codes for US HS 10-digit export and import codes. Although we began working on this homologation before they published their working paper, we have a similar program that shares the same principles of their product code homologation: creating common unique codes for product codes that expand or contract through time. We prefer our algorithm and program to theirs, because of the suitability of the data input (we use 6 digit level full classifications) and the output that we needed (a single homologated HS classification).

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The HS classifications considered: 1992, 1996 2002

Our data consists of a customs database for the period 1994-2006, which we complemented using COMTRADE data since 1990. All the data is classified under the Harmonized System (HS) codification. However the period considers 3 different classifications: HS1992, HS1996 and HS2002. These were major reclassifications of codes which altered the codes in the way explained above [57]. This implies in practice that we need to homologate codes that changed from one classification to the other. There are two major changes: from HS1992 to HS1996 and from HS1996 to HS2002.

[56] We needed a procedure that considers 3 *complete* classifications and their correspondences (HS-1992 to HS-1996, and HS 1996 to HS 2002) and that could provide us with a unique new classification that could be corresponded to each HS1992, 1996 and 2002 directly. Although using the same principle to concord classifications through time, Pierce and Schott specific program was not ideally suited for what we needed because the input data they use, which is the US HS 10 digit code changes, is incremental, providing a list of codes codes that change and (many) different dates in which they change. Our data consists of 2 full correspondences between 3 classifications which were better handled with a different code. In them, we had data of all codes of an "old" classification and the corresponding codes for the "new" classification. This included codes that did not change through time. Also, the output that we needed was a full correspondence of each original HS classification with an "homologated" HS classification which would allow us to work directly the data with the homologated codes in our paper, and which the procedure of Pierce and Schott did not provide directly.

[57] The only exception is HS1992, which is practically the same as the classification that existed since 1990.

The problem and an example

What we need to do is to avoid counting new codes if they are codes that appeared due to a reclassification. We also need to take into account cases of products that are collapsed into a single code, since we do not know if the new code exists due to which old product. This implies that whenever there is an expansion of codes we need to consider the original code as the correct code, and when there is a collapse of codes we need to consider the new code as the correct and unique code. Since there could be combinations of both and multiple collapses into one product, the most conservative way of avoiding reclassification is an iterative collapsing of codes into a "minimum common code" that subsumes all codes that could reclassified in one or another code category.

For example, Table 11 shows what the procedure would do to the following codes:

Table 11. Example of product homologation procedure

HS92	HS96	Final Code
011100	011200	011200
011200	011200	011200

HS92	HS96	Final Code
150140	150150	150140
150140	150160	150140

HS92	HS96	Final Code
140400	140400	200199
140400	140600	200199
140500	140500	200199
200199	140400	200199
200199	140500	200199

In the first set of codes we have two codes that collapse into one. The final code then must be the merged code since we cannot know if it came from the first or second code. The second set shows a split. Since we cannot know if the code in HS92 was 150150 or 150160 we have to consider the most aggregated one. The third case is a little more complicated. 140400 is split, 140500 is not, but 200199 is incorporated into 140400 and 140500. The minimum common code in this case is 200199[58]. The process of generating a minimum common code must be iterative and must be done also across more than one classification (must be done also considering HS2002 codes).

The procedure Following analogous principles to Pierce and Schott (2009), but before they published their work, we built a STATA code[59] that first takes two classifications (for example HS92 and HS96) and collapses into a single code any original codes that have expanded or contracted

[58] For example, lets assume that a firm starts exporting a code 140500 in 1998, under HS96. How can we know if that export corresponds to actually a new product or an old 200199 code? Since it is impossible we need to collapse the code to avoid the chance of wrong classification of new codes as new products.

[59] We are thankful to Alex Culiuc, who kindly provided the central portions of this STATA do file. We found helpful to explain the code here so the reader have a better understanding of it. The files will also be available on the web appendix.

between both classifications. In the example of table 11, it allocates three unique codes to each of the three examples depicted in the table[60]. The same is then done for the next two classifications (HS96 and HS02). We thus end up with two new *hybrid* product classifications, one that unifies hs92-hs96 and another for hs96-hs02. We join both new codifications using the HS96 codes as connectors (which are common in both unified classifications), allowing us to have a correspondence between the two, and we repeat the process one more time. This allows us to have a final unique code throughout the period 1990-2006.

Caveats and limitations The main limitation of this procedure is that it requires collapsing many different codes into single ones, significantly reducing the number of codes available for analysis, since it collapses any codes that are expanded or contracted across classifications. The consequence is that we lose several and potential relevant disaggregated information.

Downloading the data The correspondence files are available on the author's website under the name "transcode_XX.dta" where XX is the year of the original HS.

[60] We use actual HS codes as minimum common code in cases of simple expansion or contraction of codes. For cases of complex code grouping the chosen code is the code with the highest exported value in the group, for the whole sample period.

10 Appendix: Filters used to define new export products.

Empirically understanding what is a new export is not trivial. On the one hand , if we define a new product too loosely, then it would be very difficult to find any learning, since we would be having a low share of true new products in our sample, because we expect learning to take a place disproportionally in truly new products, as one could infer from Foster and Rosenzweig (2010) . On the other hand, if we are too tough with the definition of a new product, then the number of cases would dramatically shrink. In this trade off between "distillation" of new products for the country and the quantity of products, we tried to lean towards "distillation" as much as possible, but still keeping enough observations to make the results statistically significant. The following table details the filters, their effect on arguably true new products and in the sample size.

Review of how the filters impact the new firms and the number of products

Filters to define product as new for the country.		Competing Goals: Have a high share of "true new products" in sample	Competing Goals: Have a sample of products as large as possible	Comments
For 1990 $\sum_f x_{pf} \leq X$ (for 1990 only aggregate but no firm data)	$X = US\$1,000$	+	−	risk of re-exports
Only considering exports post 1991 by producer firms (traders do not count) {careful with closed firms w/o tax activity code !!}		+	−	Traders are important but out of scope of paper
Re-exports are not counted as export ($x_{pfy} > \theta m_{pfy}$): Higher θ	$\theta = 2$	+if θnot too large	−	
Drop products with description containing "others" and "NES".		+	-	
Cutoff $x_{pfy} >\geq X$ in **pre**-sample (1991 to 1994)	$X = US\$1,000$	-	+	If X =0 here ; then almost no products are left
Cutoff $x_{pfy} \geq X$ in sample (1995 to 2006)	X =?	+	-	
Implausible jump filter (for machinery)		+	-	Has some ad-hoc component in its definition
Export transactions per year to be considered.	$x_{pfy} \geq 2$	+ To avoid returnd (especially machines)	− Can lose products with single transaction	Bias towards less failure

11 Proofs

This appendix works out the proofs for existence and uniqueness of an equilibrium of the type we are interested.

11.1 Detailed derivations of the setup

11.1.1 Value of being pioneer

Value of entering immediately for any firm is proportional to q. Namely $V^i_{pioneer} = -Fq + \beta\mathbb{E}\max\{0,[x-c]\,q\}$; which in the case of Uniform distribution becomes:

$$\frac{1}{q}V^i_{pioneer} = -F + \beta\left\{\frac{1}{2}(1-c)^2\right\} \tag{5}$$

11.1.2 Value of being follower

The value of waiting is going to be different for different firms.

$$\frac{1}{q}V^{small\,i}_{wait} = \beta\mathbb{E}\max\{0,-F+\beta\,[x-c]\}$$

; which we can manipulate. Defining making for simplicity $\theta \equiv \frac{F}{\beta} + c$ we get:

$$\frac{1}{q}V^{small\,i}_{wait} = \beta^2\left[\mathbb{E}\max\{\theta,x\} - \theta\right] \tag{6}$$

The expected value above can be decomposed and get

$$\frac{1}{q}V^{small\,i}_{wait} = \beta^2\left[\{\theta \times \Pr(x\leq\theta) + \mathbb{E}\,[x|x>\theta] \times \Pr(x>\theta)\} - \theta\right]$$

Using the $Uniform(0,1)$ distribution for x and various algebraic manipulations we get

$$\frac{1}{q}V^{small\,i}_{wait} = \beta^2\left[\frac{1}{2}(1+\theta)^2\right] \tag{7}$$

Note that Equation 7 is is similar to Equation 5 , but with two main differences. First, the cutoff for entry after uncertainty is revealed, $\theta \equiv \frac{F}{\beta} + c > c$, is larger than the cutoff for continuation in the project when the entry cost is already sunk. After the information is reveled, the decision to enter simply uses the standard NPV criteria to enter, since there is no option value of waiting after x_i is revealed . The second difference is that the project is pushed one period into the future, so there is additional discounting.

This is slightly more complex, because the distribution of order statistic $\bar{x} \equiv \max\left\{x^A, x^B\right\}$is not uniform. We can start with the same Eq 6, but now adapting to the fact that we care about the probability distribution of $\bar{x}$

$$\frac{1}{q}V_{wait}^{large}=\beta^{2}\left[\mathbb{E}\max\left\{\theta,\bar{x}\right\}-\theta\right] \tag{8}$$

To move forward we need the expectation of the maximum, which can be computed analytically if we assume that the *iid.* distribution of x_i is standard uniform. Although the model is for a potential scope $s=2$, we will calculate the results for any positive (integer) potential scope s. To calculate the expectation, we can use the fact that the k-th order statistic of N *iid* draws from a $Uniform(0,1)$ is distributed according to the $Beta_{pdf}\left(k,[N+1-k]\right)$ probability density function. In our case, we are interested in the maximum $N\equiv s$ (i.e. the s-th order statistic). Thus $\bar{x}\left(s\right)\sim Beta_{pdf}\left(s,1\right)$. In particular the expected value of interest is[61]:

$$\mathbb{E}\left(\max\left\{\theta;\bar{x}\left(s\right)\right\}\right)=Beta_{cdf}\left(\theta,s,1\right)\theta+\left(1-Beta_{cdf}\left(\theta,s,1\right)\right)\mathbb{E}\left[\bar{x}\left(s\right)|\bar{x}\left(s\right)>\theta\right] \tag{9}$$

; where $Beta_{cdf}\left(y,s,1\right)$is the cumulative density function of a variable y distributed $Beta_{pdf}(N,1)$. In practice, this cumulative density of the Beta distribution is given by the "*Regularized Incomplete Beta Function*", which in this case is [62]

$$Beta_{cdf}\left(\theta,s,1\right)=I_{\theta}(s,1)=\theta^{s} \tag{10}$$

With this we solve for the probability weights in Equation 9: $\Pr\left(\bar{x}\left(s\right)\leq\theta\right)=\theta^{s}$; so $\Pr\left(\bar{x}\left(s\right)>\theta\right)=1-\theta^{s}$. The only unsolved portion in Equation 9 is the expectation $\mathbb{E}\left[\bar{x}\left(s\right)|\bar{x}\left(s\right)>\theta\right]$, which is the expected value of the beta distribution of $x^{max}\left(s\right)$ when but left-truncated at θ. Following the definition this expectation becomes:

$$\mathbb{E}\left[\bar{x}\left(s\right)|\bar{x}\left(s\right)>\theta\right]=\frac{\int_{\theta}^{1}\bar{x}\left(s\right)Beta_{pdf}(x^{max}\left(s\right),s,1)dx^{max}\left(s\right)}{\int_{\theta}^{1}Beta_{pdf}(x^{max}\left(s\right),s,1)dx^{max}\left(s\right)}$$

; where the density function is defined by[63] $Beta_{pdf}(x;s,1)=\frac{x^{s-1}}{\int_{0}^{1}u^{s-1}du}=\frac{x^{s-1}}{\left[\frac{1}{s}u^{s}\right]|_{0}^{1}}=\frac{x^{s-1}}{s^{-1}}=sx^{s-1}$.

Replacing this we get [64]

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[61] We are just using the law of total probability to express

$$\mathbb{E}\left(\max\left\{\theta;\bar{x}\left(s\right)\right\}\right)=\Pr\left(\bar{x}\left(s\right)\leq\theta\right)\theta+\Pr\left(\bar{x}\left(s\right)>\theta\right)\mathbb{E}\left[\bar{x}\left(s\right)|\bar{x}\left(s\right)>c\right]$$

[62] The "*Regularized Incomplete Beta Function*" with parameters y, a and b is $I_y(a,b)=\sum_{j=a}^{a+b-1}\frac{(a+b-1)!}{j!(a+b-1-j)!}y^{j}(1-y)^{a+b-1-j}$. Also, $I_y(a,b)=\frac{B(y;a,b)}{B(a,b)}=\frac{\int_0^y t^{a-1}(1-t)^{b-1}dt}{\int_0^1 t^{a-1}(1-t)^{b-1}dt}$. Where $B(y;a,b)$ is the "*Incomplete Beta Function*" $B(y;a,b)=\int_0^y t^{a-1}(1-t)^{b-1}dt$; and $B(a,b)$ is the Beta function $B(a,b)=\int_0^1 t^{a-1}(1-t)^{b-1}dt$ (which is not the same as the beta probability density function!). Mechanically applying the function to this problem yields

$$I_c(s,1)=\sum_{j=s}^{s}\frac{s!}{j!(s-j)!}c^{j}(1-c)^{s-j}=\frac{s!}{s!0!}c^{s}(1-c)^{0}$$

[63] In general, the beta distribution with parameters a and b for a random variable y is $Beta_{pdf}(y;\alpha,\beta)=\frac{y^{\alpha-1}(1-y)^{\beta-1}}{\int_0^1 u^{\alpha-1}(1-u)^{\beta-1}du}$

[64] As one should expect, the denominator of Equation 11bounded between zero and one; while the numerator is smaller than the denominator, because $x^{max}\left(s\right)<s$, since $\bar{x}\left(s\right)\in[0,1]$, while $s\geq1$. This is a sanity check that the expectation is smaller than one, which ought to be the case since $x\sim Uniform(0,1)$.

$$\mathbb{E}\left[\bar{x}\left(s\right)|\bar{x}\left(s\right)>\theta\right]=\frac{\int_{\theta}^{1}\bar{x}\left(s\right)s\left[\bar{x}\left(s\right)\right]^{s-1}d\bar{x}\left(s\right)}{\int_{\theta}^{1}s\left[\bar{x}\left(s\right)\right]^{s-1}d\bar{x}\left(s\right)} \tag{11}$$

; which implies [65]

$$\mathbb{E}\max\left\{\theta,\bar{x}\left(s\right)\right\}=\frac{\theta^{s+1}+s}{s+1} \tag{12}$$

Note that for $\theta=0$ and this corresponds to the standard maximum of s uniform random variables, $\frac{s}{s+1}$, and when $\theta=1$ the expected value is one. Both extreme conditions are reassuring of our calculations.

Now we have enough ingredients to re write Equation 8

$$\frac{1}{q}V_{wait}^{large}=\beta^{2}\left[\frac{\theta^{s+1}+s}{s+1}-\theta\right] \tag{13}$$

11.2 Existence of equilibrium

Here we show the existence of an equilibrium for our model in Section 2, in wich two firms that have potential scope in new products $s=1$ and one large firm has potential scope $s=2$. In some cases, we will show the more general calculations for $s>2$. The value functions to for a firm of potential scope s in new activities is proportional to:

$$\begin{aligned} V_{pioneer} &= -F+\beta\left\{\frac{1}{2}(1-c)^{2}\right\} \\ V_{wait}(s) &= \beta^{2}\left[\frac{\theta^{s+1}+s}{s+1}-\theta\right] \end{aligned}$$

11.2.1 Decision to pioneer or wait by the small firm

The small firm will enter if $\beta^{2}\left[\frac{1}{2}\left(1-\theta\right)^{2}\right]<-F+\beta\left[\frac{1}{2}(1-c)^{2}\right]$, which after some manipulations becomes:

$$1<\frac{(1-\beta)\left(1-2\left(\frac{F}{\beta}+c\right)+c^{2}\right)}{F\left(\frac{F}{\beta}+c\right)} \tag{14}$$

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$$\mathbb{E}\left[x^{max}\left(s\right)|x^{max}\left(s\right)>\theta\right]=\left(\frac{1}{1-\theta^{s}}\right)s\int_{\theta}^{1}\bar{x}\left(s\right)^{s}d\bar{x}\left(s\right)=\left(\frac{1}{1-\theta^{s}}\right)\frac{s}{s+1}\left[\bar{x}\left(s\right)^{s+1}\right]\Big|_{\theta}^{1}=\left(\frac{1}{1-\theta^{s}}\right)\frac{s}{s+1}\left[1-\theta^{s+1}\right]$$

For the special case of with $c = 0$, Inequality 14 becomes

$$F < (1-\beta)\left(\frac{\beta}{F} - 2\right)$$

; since F is restricted to be positive, we need $\frac{\beta}{F} > 2$; which can be obtained with β close to one (high patience, but not infinite) , and F close to zero. For example $F = 0.1$ and $\beta = 0.9$ yields a possible case. The search for all the cases for which this is true is available on Figure 2

11.2.2 Decision to pioneer or wait by the large firm

The decision to enter will depend on

$$\begin{gathered} V_{wait}^{large} < V_{pioneer}^{i} \\ \beta^2\left[\frac{\theta^{s+1}+s}{s+1} - \theta\right] < -F + \beta\left\{\frac{1}{2}(1-c)^2\right\} \end{gathered} \tag{15}$$

For $s = 2$ this becomes

$$\left[\frac{2}{3}\beta + \frac{2}{3}\beta\left(\frac{F}{\beta} + c\right)^3 - F - \beta c - \frac{1}{2} + c - c^2\right] < -\frac{F}{\beta}$$

Figure 2 performs a gridsearch to define the the region of parameters for which this the case.

11.3 Proof of uniqueness of equilibrium

In the specification above we focused on firms' strategies if they know *for sure* that another firm will enter in the next period. Here we relax this assumption to show that for the region of parameters $\Omega = \Omega_1 \cup \Omega_2$ defined in Proposition 1 and Figure 2 the assumption that at least one firm enters as pioneer is without loss of generality. Interestingly, we will show that the equilibrium defined in Proposition 1 is unique for the (endogenous) region Ω_2

To generalize the setup of section 11.1 let's denote by p_j as the (endogenous) probability that firm j enters as pioneer, while $\tilde{p}_{-j}$ denotes the belief that the *other* firm enters as pioneer. Then the value functions for a firm of type φ become:

$$\frac{1}{q(\varphi)} V_{pioneer}^{i} = -F + \beta \mathbb{E} \max\{0, [x-c]\, q\} \tag{16}$$

$$\frac{1}{q(\varphi)} V_{wait}(\varphi) = \tilde{p}_{-j} \times \beta^2 \left[\frac{\theta^{s(\varphi)+1} + s(\varphi)}{s(\varphi)+1} - \theta\right] + (1-\tilde{p}_{-j})\, \beta \frac{1}{q(\varphi)} \max\left\{V_{pioneer}^{i}, 0\right\} \tag{17}$$

The difference with the previous setup is that the expected value of waiting depends on the beliefs that a given firm may have with respect of what the other firm will do. We will concentrate in the case where $\{\beta, F\} \in \Omega_2$, as defined in Proposition 1. To prove the argument by contradiction we will also assume, contrary to Proposition 1, that the large firm believes the small firm may not enter as pioneer for sure: $0 \leq \tilde{p}_{small} < 1$; where $\tilde{p}_{small}$ represents the belief that the large firm has about the entry of the small firm.

From section 11.2 we know that in region $\Omega = \Omega_1 \cup \Omega_2$ it is a dominant strategy for the small firm to enter immediately, even if it knows for sure that somebody else will be entering as pioneer. That means, even with the belief $\tilde{p}_{large} = 1$, the small firm still prefers to enter immediately. Of course, in the case with $\tilde{p}_{large} = 0$ it will also want to enter, because there is no reason to wait and delay potential profits without a benefit from better information. By continuity of the expected profit function in Equation 17, then for any belief $\tilde{p}_{large} \in [0, 1]$, the small firm will play strategy $p_{small} = 1$ as a dominant strategy if $\{\beta, F\} \in \Omega$. As a result, it would be an inconsistent belief for the large firm to expect $\tilde{p}_{small} < 1$. This concludes our proof by contradiction of the uniqueness of equilibrium in region Ω, with $\tilde{p}_{small} = p_{small} = 1$ as the unique rational belief about the small firm entry pattern. Interestingly, this makes the assumption that at least one firm enters as pioneer, made in section 11 to be without loss of generality in equilibrium. Since $p_{small} = 1$, the unique dominant strategy of the large firm in region Ω_2 is to wait $(p_{large} = 0)$, since by definition of Ω_2 $V_{wait}^{large} > V_{pioneer}^{i}$. The equilibrium is then unique. ***q.e.d.***

11.4 Proofs of predictions

11.4.1 Proof of prediction 1

Across products, the unconditional probability of follower entry in the most successful sector is $\Pr[x > \theta] = 1 - \frac{F}{\beta q} - c$; while the probability of entry in that same sector conditional on pioneer survival is $\Pr\left[x > \theta \middle| x > c\right] = \frac{1}{c}\left(1 - \frac{F}{\beta} - c\right) > \Pr[x > \theta]$. Thus, the probability of having a follower is positively related to the success of the pioneer.

11.4.2 Proof of prediction 2

It follows directly from Proposition 1 , because small firms will be pioneers exporting $\underline{q}$, while larger firms enter as followers exporting $\bar{q}$.