New Exports from Emerging Markets: Do Followers Benefit from Pioneers ? *

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Abstract

Policies and models make assumptions about how less-developed-countries start exporting new products. However, there is little systematic microevidence about these early stages. Is there something special about early dynamics? Or is it trivially similar to steady-state reallocations? We show novel facts consistent with pioneer-to-follower spillovers using Chilean transactions of new exports 1990-2006. Followers were 40% more likely to enter a product if the pioneer survives exporting. Moreover, pioneers exported *less* than followers, suggesting that the first exporter may not be the firm that benefits the most from the discovery. This is inconsistent with models in which firms only differ in productivity while paying a constant off-the-shelf sunk cost of exporting (e.g. extensions of Melitz, 2003), or with models in which pioneers grow large (Grossman and Rossi-Hansberg, 2010). Our findings are rationalized with a simple model where pioneers face lower sunk exploration costs, and as pioneers' survival reveals profitability then other more productive firms follow.

JEL classification: F1, L26 , O4.

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1 Introduction

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, accessing valuable information about either technology or markets. Many models argue that these pioneers do not internalize the full social benefit of the information they create. As a result, there would be an under-provision of incentives to experiment in a new product and economies could remain in a trap with too little growth . This relation between new products and growth has also been acknowledged through exports. In particular, 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, understanding the early dynamics of new export products becomes a very relevant issue, particularly if there could be non-pecuniary interactions across firms. The goal of this paper is precisely to empirically explore pioneer-follower spillovers in the very early stages of an emerging market's new export products.

Despite the theoretical plausibility of spillovers, the empirical evidence on spillovers from pioneer to followers has been hard to develop beyond case by case industry studies. The difficulty arises in part from a lack of appropriate data sets to explore the issue on a broad base of products. To fill this gap we build a data set of all "new" export products from Chile using detailed customs data (1990-2006) and other sources in order to simultaneously (i) observe information at firm-product level over time, so we can distinguish firm behavior from industry behavior; (ii) focus specifically on new export products, where there is both something new to learn[2], and it is possible to identify the sequence of entry at this early stage; (iii) get data on the universe of disaggregated product categories ever exported in the period, to avoid hindsight biases towards ex post successful cases. We use this data to analyze empirically the pioneer-follower dynamics in our identified new export products. To the best of our knowledge, this is the first paper analyzing spillovers using data that has simultaneously all of the above mentioned characteristics.

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

[2] Foster and Rosenzweig (2010), in a review of recent empirical literature on externalities, remark that in order to statistically find learning *"there ought to be something new to learn*". Under this logic, 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) 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.

We provide three novel results in our paper. The first two are consistent with the view that followers benefit from the information revealed by pioneers when breaking into world markets with a new export product. First, the survival of pioneers is positively correlated with entry of followers, which is consistent with the idea that followers learn from the successes or failures of pioneers. Second, and more interesting, pioneers enter and remain *smaller* in size than followers, even when controlling for unobserved product-year shocks . This is inconsistent with extensions of the current standard international trade models (e.g. Melitz, 2003) in which the largest firm would be the first willing to pay a constant sunk cost to enter into exporting. While the modern theoretical emphasis on heterogeneous productivity and a homogeneous "off-the-shelf" sunk cost captures well the *steady state* of exports, it doesn't seem to fit the *early dynamics* of new export products (see for example Clerides, Lach, and Tybout (1998); Bernard and Jensen (1999)). Our point 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" that benefit larger (follower) exporters. To interpret our facts we provide a very stylized model that combines heterogeneous agents *a la* Melitz (2003), with random pioneers *a la* Hausmann and Rodrik (2003) . In the model, at the beginning domestic firms do not export a product because even the most productive firm finds the *expected* markup to be too small to pay back the sunk cost of exporting. When one random firm exogenously jumps into exports, this reveals the product-specific profitability to others which - now fully informed - can ex-post efficiently decide whether to enter or not into the new export . Without strong distributional assumptions, this simple setting parsimoniously delivers our main stylized facts.

If we interpret our two main results as consistent with a diffusion externality, our estimates imply that even pushing small exporters to attempt a new product - which could be efficient if they have a disproportionally smaller exploration cost - may have aggregate effects. This is because pioneers can reveal information to other more productive followers, and if they enter they can exploit a latent comparative advantage.

A third result qualifies the idea that spillovers *across* firms are ubiquitous in all new export products[3]. In fact, in more than half of the new products in which the pioneer firm exports for several seasons, we do *not* observe any follower firms. This is consistent with pioneers enjoying an advantage that preempts further entry of follower firms, as in Krugman (1980). In these cases it is clearly less plausible to argue in favor of *within* product informational spillovers across firms. This could be rationalized into our framword as a case in which there is only one potential entrant into exporting, for example due to fixed plant setup costs plus a small

[3]Most papers about spillovers assume that there are many potential entrants into a new product (e.g. Hausmann and Rodrik, 2003) and do not distinguish that for some products, especially in in small open economies, there might not be room for a second producer; unless country-specific comparative advantage is so high that it is the global market what matters for entry of new entrepreneurs, and domestic sales become second order.

domestic market. In short , we also provide a qualification to the debate on what Hausmann and Rodrik (2003) called self-discovery.

Our work is closely related to papers exploring spillovers. On the empirical side, most of this literature 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 using all transactions and goods for the period we study. Alternatively, another approach has been to use aggregate country-level discovery of new export products (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; because if firms can grow large enough then they can internalize the industry-learning they create by discovering a new product. Our findings, however, indicate that this is not the case since in relative terms our pioneer firms cannot grow very large, at least in comparison to followers. Conceptually, the paper also relates to the work of Hausmann and Rodrik (2003) on self-discovery of new exports, although the uncertainty and heterogeneity are different from theirs. More importantly, we focus on empirically exploring the precise timing of the discovery of new products Thus, our work is also part of the recent empirical literature analyzing export discoveries (Freund and Pierola, 2009; Iacovone and Javorcik, 2010). This literature, however, uses short run definitions to identify new products. In that sense we made a significant effort to provide what we believe is a more reliable definition of *new* products. Our longer panel allows us to take a pre-sample of five years without exports to classify a product as *new*, reducing the proportion of products that are intermittently exported and that may be misclassified as "new". We also dedicated a lot of work to construct filters to avoid misidentifying new products. Particularly, in an additional methodological contribution, we created a correspondence to follow a single product through various vintages of the Harmonized System. Overall, we get quite different results from the ones of recent papers, since we find pioneers are not larger, but smaller than followers. [4]

Our work can also be thought of as an offspring of the "new new" international economics with heterogeneous firms (Melitz, 2003 and uncountable extensions) and the related work on

[4]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. In contrast, we almost always find a single pioneer launching a product the first year, and this pioneer is usually not the ex-post largest exporter.

entry into exporting (Das, Roberts, and Tybout, 2007; Roberts and Tybout, 1997) . But unlike in our model, in most of this literature the largest and highest productivity firms export more products and are the most willing to pay a constant sunk cost to export a new product. The paper also relates to the trade literature on experimentation, in particular 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) who look at the relation between uncertainty and experimentation .

The remainder of the paper is organized as follows. Section 2 offers our simple theoretical framework where pioneers tend to be smaller exporters than followers. Section 3 explains our data of new export products, also analyzing a few canonical examples as a way to fix ideas. Section 4 empirically explores the predictions of our model. Section 5 and runs a battery of robustness checks. Finally, section 6 concludes with a few remarks. In the Appendix we also present the methodology used to build a concordance between various vintages of Harmonized System of product classification. This could be of independent interest for researchers.

2 A simple framework of profitability discovery in a new export product

This section develops a simple theoretical framework that helps us interpret the empirical findings about pioneers and followers in new products. Rather than introducing new channels, with this simple framework we aim to identify broad families of mechanisms that are consistent with our evidence. In particular, we focus on the role of sunk exploration costs vis-a-vis productivity differences.

2.1 Setup

We analyze an industry in a small open economy, which takes global (albeit unknown) prices of products as given and is populated by firms that are heterogeneous in productivity. Following Melitz (2003), we will assume that export profits are separable from domestic sales, but unlike that paper we totally abstract from production directed to the domestic market.[5]

We explore products that are not exported yet. Potential exporting firm i in the homogeneous product j would have a value $V(\varphi_{ij}) \equiv q(\varphi_{ij})[\tilde{p_j} - c]$ if it enters into exporting j; where

[5]Throughout the paper we will assume that there is a strong positive relationship between productivity and firm size. Moreover, since our analysis is based on exports, we additionally will take the stance that larger firms export larger volumes and quantities of each of their products. This is standard in new trade models and in empirical work that has tested them. Thus, we may interchangeably use the terms "size" and "export revenue"

$\varphi_i \in (0, \varphi^{max}]$ is the firm specific productivity which is heterogeneous and bounded; $q(.)$ is a reduced form function that monotonically relates productivity to the *lifetime* quantity that each firm will export during its T periods exporting with, for simplicity, zero discounting; $\tilde{p_j}$ is the product specific profitability common to all firms in j. The tilde indicates that p is unknown to all firms until a pioneer firm starts exporting; c is a variable unit cost of production unrelated to productivity and constant across all firms. Finally, we assume there is a sunk cost of exporting F that, for simplicity, is ex-ante constant across firms, although our results are robust to deviations from this assumption. [6] For notational simplicity we define the markup $\tilde{m} \equiv [\tilde{p_j} - c]$ which follows a probability distribution $h(\tilde{m})$, where $\tilde{m} \in [-c, \bar{m}]$. So $V(\varphi_{ij}) = q(\varphi_{ij})\,\tilde{m_j}$. Furthermore, we assume the distribution markups $h(\tilde{m})$ has some mass below zero so some firms would want to exit after p_j is revealed. This latter assumption is essential only if we want to have an equilibrium with exit of pioneers, which is a pervasive phenomenon in the data[7]. Related work like Hausmann and Rodrik (2003) also focuses on markups, but their narrative is more about discovering the marginal cost of production c. In contrast, given the relatively quick diffusion we infer and given that most of the firms we analyze already producing domestically when deciding to export a new product, our narrative focuses on uncertainty about $\tilde{p}$.[8] To further simplify notation, instead of looking at φ_{ij} directly, we will use the distribution of *potential quantities exported* by each firm which follows a probability density function $\hat{g}(q(\varphi_{ij}))$, or simply $g(q_{ij})$; with $q_{ij} \in (0, q(\varphi^{max})]$. Firms know exactly their productivity, although an imperfect but precise signal of their productivity would also be sufficient to derive our propositions.

At the beginning of the game we assume that products are not exported because it is not individually rational for any firm to enter export markets with the new product. As can be seen in Figure 3 this is true even for the most productive firm. Formally, for all firms i

$$q(\varphi_{i,j})\,\mathbb{E}\max\{\tilde{m_j}; 0\} < F \tag{1}$$

; where the expectation is taken over the possible realizations of the $\tilde{m}$. As we will see later, this simple assumption helps our propositions to emerge naturally, even without specific distribu-

[6]The main implications from this model are robust to deviations from the assumption that F is constant across firms. Also, the log separability of quantity q and markup $[p_j - c]$ is not essential for our results, but greatly simplifies the exposition of our main point. We only need the cross derivative $\partial^2 V/\partial\varphi\partial m$ to be below a cutoff such that currently no firm is producing, which is a natural assumption to make given our focus on products that no firm exported before. In short, we need to assume that the cost does not decrease too fast with productivity, so the assumption of a constant unit cost is valid.

[7]In fact, we observe that between 80 and 90% of new export products are exported for no longer than a year, and only by a single firm (see 1). This seems consistent with the fact that it is very unlikely to get large draws of $\tilde{m}$ due to a large probability mass for $\tilde{m} < 0$.

[8]Of course we do not think the "hard" aspect of price by itself is unknown (which is something that could be solved by posting prices online, for example).But e use it as a proxy for uncertainty on the discovery of global market demand that determines profitability and that is different from the domestic market considerations. In the language of Kline and Rosenberg (1986), Hausmann and Rodrik (2003) seem to focus more on the diffusion of *technical* knowledge while our paper focuses on the diffusion of *(global) market* knowledge.

tional assumptions for markups $h(.)$ or potential quantity exported $g(.)$. Finally, we assume that there is at least one possible scenario in which at least one firm would enter if markups were known, so $q(\varphi^{max}) \cdot \bar{m} > F$; otherwise the entire problem would be trivial.

In period zero, we follow Hausmann and Rodrik (2003) to break the *status quo, having* nature randomly shock a firm with a reduction Δ in their own sunk export cost. This Δ may come from an unexpected reduction in organizational frictions that allow the firm to hire a new product manager for exports, from other firms specific changes or even from a phone call of an importer asking for a shipment. Importantly, Δ is large enough so as to induce this random firm to start exporting. Immediately after the pioneer's entry the random markup $\tilde{m}$ is realized and *every firm* in the country learns the true m_j in product j. Thus, in our benchmark model followers learn exactly the true m_j for product j; and m_i defines an exact cutoff productivity for followers φ^{*f} such that $q\left(\varphi^{*f}\right) = F/m_i$.[9] At the end of period zero the pioneer firm decides to either continue or exit from exporting the product. If the pioneer continues exporting, it gets $V_{ij} = q(\varphi_{ij}) m_j$. So the obvious condition for continuation is $m_j \geq 0$. When $m_j < 0$ the firm exits.

In period one the firms that did *not* receive the shock Δ , which we denote $-i$ firms, have more information about the product profitability m_j, so they can decide whether to enter as followers or never enter. They will enter if the realization of $m_j$is such that

$$q(\varphi_{-i,j}) m_j \geq F \tag{2}$$

This condition defines a cutoff productivity $\hat{\varphi}$ such that all firms with productivity higher than $\hat{\varphi}$ will enter as followers. In other words,for all $\varphi_{ij} \geq \hat{\varphi}$ we have that $q(\varphi_{ij}) < F/m_j$. Importantly, inequality 2 is different from the condition that the $-i$ firms faced before the pioneer entered in Eq.1, since now the product was "discovered" by the pioneer and the realization of m_j might be higher than the ex ante expectation $\mathbb{E}\max\{\tilde{m}_j; 0\}$. Thus, the right tail of the productivity distribution of firms would like to enter into exporting the new product, because these firms know that Eq 2 is satisfied for them.

[9]One could relax this assumption and assume that the inference is imperfect. For example, if instead we use only rational expectations and allow for observing the survival /continuation of the pioneer, followers can only infer that $m_i > 0$; not knowing the exact value of the markup. This information is still informative and can reduce the cutoff productivity for entering. By assumption, before $t = 0$ there was no entry because $q(\varphi^{max}) < F/\mathbb{E}\max\{\tilde{m}, 0\}$. After pioneer's survival is revealed, the cutoff for entry of followers becomes $q\left(\varphi^{*f}\right) = F/\mathbb{E}\left[\tilde{m}|\tilde{m} > 0\right]$. Since $\mathbb{E}\left[\tilde{m}|\tilde{m} > 0\right]$ is larger than $\mathbb{E}\max\{\tilde{m}, 0\}$for any distribution with mass in the region $m < 0$; then there can be entry of followers provided that the above defined $\varphi^{*f} < \varphi^{max}$. Obviously, it is a dominant strategy not to enter as follower if the pioneer did not survive. In short, although the nature of entrants and the set of products for which there will be entry may change, the qualitative results of the equilibrium remain robust to deviations from our assumption of perfect revelation of m_i to followers.

2.2 Equilibrium and predictions

We denote an equilibrium of this game as the set of production, entry into exporting and exit from exporting in each period, such that the actions of each firm maximize the expected profits given the available information at each time. Analogous to Decamps and Mariotti (2004), we use a simplifying assumption to focus only on the equilibrium in dominant strategies in which the firm that receives the shock always enters as pioneer, assuming away cases in which the firm that gets the lowest cost of experimentation $(F - \Delta)$ prefers to strategically wait until some other firm decides to enter for random reasons.

The equilibrium defined above implies the following testable propositions, formally derived in the Appendix:

Proposition 1: Across products, the survival of the pioneer is positively related to subsequent entry of followers

***Proof**: see Appendix*

On the equilibrium path of the game, Proposition 1 comes from the fact that when the potential follower observes the survival of the pioneer, it understands that the markup is above a threshold, so they are more likely to enter than what they were before observing the pioneer's (early) survival. It is important to clarify that although Proposition 1 might be necessary for a spillover to happen, it is not sufficient. For example, higher survival could also happen in an alternative model, in which the general entry cost F is declining over time in a secular way, which induces firms to have followers if the pioneer was successful. Alternatively, one can think that the size/productivity distribution $g(.)$ is moving to the right over time. Both mechanisms generate a similar correlation between survival of the pioneer and subsequent entry as the one shown in Proposition 1, but without any inter-firm spillovers. To tell apart our model with spillover from the alternatives we take advantage of an additional prediction of our model. If the dynamics of the model are caused by a declining F or by a productivity distribution is shifting up, instead of a shock to F, then we should observe that the pioneer of the product ends up being the most productive firm, on average, which means higher export revenues in the product. Instead, as we will see in Proposition 2, in our model the pioneer is on average smaller than its follower(s).

Before stating Proposition 2 that helps in the differential diagnosis, let's make more precise the timing of export quantities $q(\varphi_{ij})$, which was a measure of the *lifetime* quantity exported so $q(\varphi_{ij}) \equiv \sum_{t=0}^{T} q_t(\varphi_{it})$, where t represents the number of years of experience exporting product j. But this quantity does not need to be constant over the exporting time frame of the firm. In particular we assume firms need some time to get into their optimal size. We base this assumption on two well documented theoretical channels. On the one hand Rauch and Watson

(2003) argue that new exporters prefer to "*start small in unfamiliar environments*" as a factor to mitigate risk. On the other hand Arkolakis (2009) shows how exporter firms need time to build a customer base in their destination markets. Both mechanisms point out that the shipments are increasing over time, $\partial q_t/\partial t > 0$, and after a few years it may reach its full potential, so $\partial q_t^2/\partial t^2 < 0$. Under this assumption, when one compares for example, a pioneer with three years of experience with a follower with only one year, we might observe that the pioneer exports more than the follower even though $\varphi^{follower} > \varphi^{pioneer}$, given that they have not reached their full export potential due to insufficient experience. That means that to interpret a export volume difference as implying a productivity φ difference between firms, one needs that the follower has enough exporting experience Δt, so the functions $q_t(.)$ and $q_{t+\Delta t}(.)$ are similar enough to each other. Or alternatively, we should control for experience in the product. To prevent this, our testable proposition should compare the volumes of pioneers and followers after both have reached some maturity, so both are close to their full potential size, which means one has to control for experience.

Proposition 2: Pioneers export less than followers

> ***Proof****: Followers enter only above a threshold productivity, while the pioneer is by defininition any random firm in the distribution. Thus, on average, pioneers are smaller than followers.*

Note that the proposition above assumes that demand conditions are the same, otherwise the function $q(\varphi)$ might be potentially different for different years and products (See Appendix for details) . It also assumes we are controlling for experience in the product to make the comparison across different experience meaningful.

By focusing on this equilibrium we gain tractability to explain why our facts are consistent with an informational "product discovery *spillover*", in the sense that the potential followers benefit from the knowledge created by the pioneer. However, since the pioneer in this simple model has no effort choice, our simple model does face a *market failure,* in the sense that a social planner would also like to have the low cost experimenter to enter first, following this exogenous push. This is of course different from our motivating literature on under-exploration (e.g. Chamley and Gale, 1994;Hausmann and Rodrik, 2003), but since the existence of a *spillover* is already a very hard empirical task and externalities are very contextual to the industrial organization of each sector, which in our sample could be very heterogeneous, this paper we will focus on our testable implications and will remain agnostic on whether the economic behavior we show departs from social optimality or not.

With this simple framework at hand, we are now better equipped to look into the data, but we will first explain how we built the sample of new export products and describe its characteristics.

3 Our data on new exporters

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

3.1 Data construction

To have the chance to identify between firm pioneer-follower spillovers in new exports we built a data set: (i) at firm-product level, so we can distinguish firm behavior from industry behavior; (ii) of new products, where there is potentially something new to learn, and it is possible to identify the sequence of entry; and (iii) on the universe of products, to avoid hindsight biases in ex post successful sectors.

We built our data set of new exporters using Chilean customs export transactions in all sectors between 1990 and 2006, which we aggregate at the firm-product-year level (see Appendix 7 for details). 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 a customs based database is better suited for understanding export entrepreneurship in less developed countries. [10]Also, many industrial surveys only consider firms of a minimum size. Customs data does not have restrictions in this respect.

Using this database we can observe for all exporters the product exported (at 6-digit Harmonized System classification), the year of the export, and the exported value in US dollars. Moreover, for most of the products in our database we also have the unit price and the quantity exported in the actual unit used rather than just the value per metric ton.

We want to note that in probably most cases we are not analyzing products that have been invented in Chile, but somewhere else. This will allow us to 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 United States, where our method might not be advisable to study externalities in

[10]There are previous empirical papers who use similar data sets as various to analyze 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). Some authors have looked at Chilean trade data to explore patterns of trade. For example, Marshall (1991) explored industry efficiency after trade liberalization in the late 1970s and early 1980s . In many contributions, Roberto Alvarez and various co-authors have been describing the different patterns of Chilean exporters and manufacturers (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). Also, this data has been used by Macchiavello (2009) to explore the duration of relationships between Chilean wineries and foreign buyers.

exports.

We then constructed filters to identify *new* exported products as accurately as possible. A first crucial issue is to avoid misidentifying a recoding of a product as a new product from the data. To solve this issue, we built a correspondence across three different code classifications present in the data, following the same principles of Pierce y Schott (2009) (see appendix 7 for details). Second, empirically identifying a new export from Customs data is not trivial. Many new codes exported by a firm or by a country are samples (exports with extremely low values), coding mistakes, or reexports. For this reason we needed to create filters in order to try to identify correctly new products. It was an ad-hoc process which had tradeoffs. On the one hand if we define a new product too loosely, it would be difficult to identify real spillovers and the possibility of learning *a la* Foster and Rosenzweig (2010), since many new products identified would not be so. On the other hand, if we are too tough with the definition of a new product, then the number of cases would dramatically shrink, elminating real cases of firms that made the effort of penetrating international markets with new products. In this trade-off between "distillation" of new products for the country and the quantity of products identified, we tried to lean towards "distillation" as much as possible, but still keeping enough observations to make the results statistically significant. . The details of the complete filtering process and the specific filters we used can be found in Appendix 8.

3.2 Defining new and old products, pioneers and followers

After the filtering , we first divide our data product-wise in two groups: *new* products and existing or *old* products. 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 particular year[11]. 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. 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. This definition is different from recent studies that have analyzed new exports in the sense that we use a significantly more demanding definition of what is considered new. Iacovone and Javorcik (2010) define new exports as anything that was not exported *one* year before in the sample analyzed. Freund and Pierola (2009) call a new product to any HS 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. In contrast, taking five years as a window allows us to avoid cases of products being exported in the past but that stopped being exported during a year or two. We also believe the 5 year window is appropriate because if we look at the delay

[11]For the years 1990-91, where we don't have firm level data, we counted a product as new if the product was exported in any amount above $1,000 to a destination during those years. Changing cutoffs to different amounts doesn't alter much the final database we use.

between the entrance of the pioneer and the follower, we see that in more than 70% of the cases the first pioneer appears within five years of pioneer's entry into exporting, thus if we observe a new export it is likely that it will be a real pioneer. Even if this five-year filter makes us reduce the number of observations, for our research question we need to take focus on new products.

Second, we classify *firms*, according to their 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. 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 pre-sample period of 1991-94, 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 relate to products (the left column showing old products and the right column showing new products); the rows relate to firms (pioneer or follower). The first row shows groups pioneers and the second, followers , depending on whether the firm is the first exporter from the country of that particular product or not. Each data point is a unique firm-product combination of firms that begin exporting a new product for them. Interestingly, most of the firms-product pairs indicate firms that start exporting something new for the firm but old for the country. (N=8,964 ; or 95% 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 new exports for any firm of a country since most of it is in old products.

[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 pre-sample period 1990-1994. Acccording to our previous definition, we classify these as old products. After applying our preferred filters, we identify 273 new products exported during 1995-2006. Thus, during our sample period of twelve years the country explored 13% of the

theoretical potential of products that were not exported before[12]. The total value exported of these 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). This latter value represents a modest 1.1% of non-copper exports from Chile. A total of 312 firms participate in new export products (234 firms are pioneers and only 105 firms are followers).[13] The total number of unique product-firm observations is 398, indicating that on average only a few firms participate in each product. However this average hides an interesting heterogeneity across products.

[Table 2 about here.]

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 at least one follower. Second, only one third of the products with followers have two or more followers. This quantitatively suggests that in only a few products we observe entrants into exporting who can potentially benefit from spillovers. This contrasts with the largely publicized cases of new product adoption in agriculture, where by the structure of industry there are many potential entrants (Griliches (1957), and more recently Conley and Udry (2010) and Foster and Rosenzweig (2010)). Second, in 95% of the new products there is a single pioneer (90% if we consider only products with followers). This *prima facie* discards the idea that there were many firms waiting for a single bilateral exchange rate change or trade restriction to relax in order to suddenly jump into exporting, which was the setting of Iacovone and Javorcik (2010) with Mexican manufacturing after NAFTA. Although there are exchange rate fluctuations in our period post 1995, they are in the range of +/- 10%. In fact, our results do not correspond to the beginning of an period of export surge cum depreciation as described-Freund and Pierola (2012).

Both results shown 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, as shown in Panel B of Table 2.[14]

[12]The fact that there are many 'unexplored' and that the new products identified represent a small percentage of them, suggests us that the country is far from hitting the theoretical boundary of the number of products offered by the HS classification, and thus their identification is not affected by the limit in the number total number of exportable products. In large developed economies, like the United States, this would not be the case since they exports most of the product codes and it is then difficult to observe new products in the database due to how it is constructed, even though they might be ocurring. Our method, we believe, is thus more suitable to analyze the innovative export activity in small open developing economies. See Zahler (2007) for a comparison in this dimension across countries.

[13]The sum of pioneers plus followers is larger than 312 because some firms are pioneers in a particular product and follower in a different product.

[14]Since one may be worried that our sample could be contaminated by small transactions that never intended to be sustainable exports , we run the same analysis restricting our definition of a new product to those 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

This indicates a relationship that is not an artifact of the little remaining sample time that later cohorts have available for the entry of followers. For our purposes to understand spillovers, Table 2 indicates 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 might learn something from the pioneer.

3.4 Descriptive statistics

Table 3 describes the firms that export a new product for the country, where each data point is a firm product-pair at the beginning of export. Firms that enter into exporting a new product for the country, sell overseas a mean of US$ 65 million in *other* products. However, as in most export databases there is massive heterogeneity since the median is US$ 360,000 dollars. The value of the new products exported was on average $1.1 million, with a median of $64,055. Thus, the ratio of the medians suggests new products represented initially around 15% of export sales. Most exporters of new products have already sold something else overseas before. They had a mean of 4 and a median of 3 other export products at the time of entry and, on average, they had *at least* 4 years of experience exporting. Although we do not observe domestic sales, we know that a 41% of these exporters are considered large tax payers according to the local IRS. Overall this is a sample of mostly multiproduct firms of a relevant size.

[Table 3 about here.]

3.5 A few canonical case studies.

An illustrative preview of our argument can be found in Figure 1, which shows examples of products according to the "success" of at least one firm in the product and according to the presence of followers or lack thereof. We define *success* in the introduction of a product or equivalently a *successful firm* in a product if a firm survived five or more consecutive years exporting the product (in this definition we obviously have to exclude products that began being exported after 2001, since the sample ends in 2006). Each quadrant contains the percentage 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. 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.

purposes (although, unsurprisingly, the sample of new products decreased from 273 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).

In contrast, the family of models in which "winner takes all" could generate cases like those in panel (B).

[Figure 1 about here.]

We first focus on what we label "failed experiments" of Panels b and d, , where no firm manages to survive successfully. These are are by far the most frequent case, representing together between 80 and 90% of the products. The case shown in Panel b is *Sodium Sulphides*, a chemical compound used in the production of pulp,

Second, we have products with a single surviving firm exporting, and no followers. This group of products with "successful but lonely pioneer" tend to represent more than half the cases when pioneers survive more than five seasons. The example is *Diphosphorus Pentaoxide*, a chemical (Panel a). A simple study of the industry makes clear why observing 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 large economies of scale, it would be hard to argue that the pioneer was expecting some followers. In the language of our model, the distribution of potential entrants into exporting, $g(.)$, was arguably populated by a single firm.

Finally, in Panel c we depict a case of a successful pioneer with followers: *Home Refrigerators*. In this product two well experienced firms survived to the trade liberalization period in the 1970s and 1980s, and started to export refrigerators during the mid 1990s. Interestingly, the year that the pioneer started to export refrigerators both firms were exporters of other products. This tells us that firms might be learning about exporting *this product*, rather than a general learning about exporting (which fits the assumption of a product specific cost F in the model). A second remark is that the pioneer firm in refrigerators is systematically smaller than the follower. This is precisely consistent with our model and we will show, in Section 4, that this holds for our sample of new products.

The case of refrigerators, unlike Diphosphorus Pentaoxide, suggests the possibility of a spillover. 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 2 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.[15]

[15] After a little qualitative research on these exporters we found that 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. After four years of "lonely pioneering", in 2003

[Figure 2 about here.]

Taking stock, the descriptive statistics and narratives we outline above indicate some characteristics that fit with our model. First,there is a chance that pioneering results in failure,which gives value to the information released by success and failure. In our model this can be understood as having a large mass of firms with actually a negative profitability once the information is revealed. Second is that sectors with followers show a distinctive pattern, in which pioneers tend to export less (ex post) and and are less diversified than followers. Finally, in some products, with successful pioneers it is hard to argue that there is learning from information released within the same product, since there are no followers.

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

4 Testing predictions

4.1 Products with surviving pioneers get more followers

Our framework implies that a potential follower can update its priors about product profitability after observing the pioneer. Interestingly, both learning from successful products and avoiding the loser products predict a positive correlation between the survival of pioneer and entry into the product. This is exactly our Proposition 1, for which we find clear support in Table 4. The far right column in the table shows that when the pioneer quits after the first year (in other words, survives less than a year exporting), then only in 25% of the products there is a follower. In contrast, when the pioneer survives more than one year exporting, there is more than 38% chance of having followers (p-value of $\chi^2 test$: 0.04). These results are robust to controls for cohort effects and change the structure of standard errors , as shown in Table 5[16] , where each observation is a different new product. The table shows that in products where the pioneer survives for more than one or two years, it is 13 to 15 percentage points more likely that we find

"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 in terms of exported value. 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.

[16]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

followers entering the product during our sample (Specifications 1 and 2). Given the baseline probabilities, the odds of having a follower increase by around 40%, lending overall support for Prediction 1 that pioneer survival is positively related to follower entry.

[Table 4 about here.]

[Table 5 about here.]

In specifications (3) and (4) we replicate specifications (1) and (2) but now controlling for the additional effect of surviving more than five years. The additional effect of long term survival is not significant, while the coefficients for short term survival remain significant and robust. This is consistent with the idea that information about profitability of exporting the product is revealed relatively quickly; a trend that we also see when we explore export revenues in subsection 4.2. This relatively quick learning seems more consistent with an interpretation in which potential followers learn about business opportunities (in fact our database was publicly available for firms), rather than learning about new technologies, that may take longer to spill over. Finding that survival of pioneers is positively related to entry is not 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 a surplus. In particular, models like Krugman (1980) with increasing returns to scale at a firm level and monopolistic competition demand, would predict a negative correlation between success of the pioneer and entry, since there is room for a single firm in each product. Now we move to our main disentangling test.

4.2 Pioneers export *less* than followers when compared on the same year and product

To test that there are spillovers, we not only need to know that survival of pioneers is associated with further 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), or facing a common decreasing entry cost F or, equivalently, having rank-preserving shifts in the productivity distribution of firms. Under these circumstances, the standard model in which firms differ only in productivity would predict that, on average, the largest ex-post exporter (the most productive firm) would be the first firm willing to pay a sunk cost of exporting. Thus, pioneers would be larger than followers (see Freund and Pierola, 2009 for a model with these chacartristics). In contrast, our model of early diffusion predicts that pioneers are *smaller* than

followers when compared on a "leveled playing field", meaning same global demand for the product and same experience. Indeed, this subsection shows that pioneers tend to be smaller than followers, which is consistent with Proposition 2 of our model and inconsistent with a mere extrapolation of models designed to explain the steady state of trade (i.e. Melitz, 2003), which would predict pioneers being larger than followers.

Table 6 presents panel estimates of the coefficients for being pioneer (vis-à-vis followers) to explain export volumes. All specifications have product-year fixed effects to compare only *within* the same product and year, so as to control for general market conditions that may impact pioneers and followers. Also, following the logic of our framework we will compare pioneers with followers after gathering some experience exporting. We will thus compare followers with firms after one year of entry, since in the first year, even when filtering the data, we have much more noise and a higher chance that we are observing early exploration behavior not captured by the coarseness of our framework. The first column shows that pioneers are *not* larger than followers, which is the couterfactual one would have expected after looking at extensions of the Melitz (2003)'s model, in which firms vary only in productivity and not exploration costs- . Moreover, we observe a point estimate suggesting pioneers are smaller ($\beta_{Pioneer} = -1.17$), although it is not statistically significant since - as argued in our framework - the raw comparison has differences in the experience of pioneers and followers exporting. Since we know that pioneers start small and then grow after they survive, we should compare pioneers and followers having the same experience in the product. Once we control for it, in specification (2) we do observe a significant difference, with pioneers being smaller.[17] . Using the coefficients of specification (2) we get that pioneers export more than an order of magnitude less than the followers ($\exp\{-2.7\} \approx 0.07$) once we control for experience. The point estimate of the pioneer dummy is arithmetically equivalent to four years of export experience (i.e 2.73/0.63), with an F-test finding that the pioneer dummy is at least equivalent to two years of export experience (p-value=0.04). In other words, a pioneer requires at least two years of experience to export a similar amount that what a follower would in it first year exporting the product, indicating a significant larger export size of followers. Specification (3) checks whether the previous result was an artifact of the linear specification for experience, but the results remain robust after adding a squared term. Specification (4) and (5) explore the alternative that maybe our coefficient of interest is driven by a few exporters with lots of product churning and low volumes. (4) controls for the number of products exported while (5) controls for the share of the product in total firm exports; but both tests indicate that the negative and significant pioneer dummy remain robust, meaning that our findings were not driven by the linear specification

[17] Comparing them on the same year deals with the problem reported by Lieberman and Montgomery (1998), who show that by imputing zero sale for the followers during the years they did not export the product, one can spuriously get a result where the first mover has more rather than less sales. We avoid that bias comparing them on the same year so controlling for global demand conditions

on experience or the relevance of the product. As a final robustness check, in specification (6) we also explore what happens when we do not control for experience in any parametric way, but we instead focus on cases in which *both* pioneer and followers are mature enough in their export experience, as suggested in our theoretical framework of Section 2. Of course this extreme exercise reduces the number of observations by half, since we are looking to exports *after* the third season, but our stylized fact remains qualitatively intact, with pioneers being smaller than followers by an order of magnitude ($\exp\{\beta_{Pioneer}\} = \exp\{-2.23\} \approx 0.1$).

[Table 6 about here.]

Taking stock, our results indicate that, conditional on multiple entrants, the pioneer might not be the firm that benefits the most (in terms of export volume) 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 they can quickly upscale. On average, pioneers in our sample do not export the largest amounts in a product; followers do. The next section proceeds with additional robustness checks of our core facts.

5 Robustness checks

This section explores alternative arguments that could weaken or explain our findings, concluding that the main stylized facts found in Section 4 are qualitatively robust to changes in definitions and the measurement of size. It also shows that some assumptions and ancillary predictions of our formal model hold.

Results are explained by export quantity rather than by prices Since we are presenting results on export revenues, it could be the case that the differences found between pioneers and followers were driven by differences in export prices rather than quantities (which is what our framework argues). Fortunately, our database also reports the unit in which the good was priced (units, cubic meters,...), the quantity and the unit price. This allows us to run additional regressions, although we lose a seven out of 208 observations because sometimes the units change and we only consider modal units within each year for our calculation.

Overall our results with quantities in Table 7 looks pretty much alike the ones we previously observed with values in Table 6, with pioneers being smaller than followers when we take into account the differences in experience. The F-test is also equivalent, indicating again that the pioneer dummy is equivalent to a penalty of at least 2 years of export experience (p-value 0.09).

In contrast to the differences in quantities, we cannot distinguish any "pioneer effect" on prices, as shown in Table 8, using the same specifications of table 7. This is consistent with our assumption that the action is on quantities rather than on prices. Also, the fact that prices are not significantly different is also reassuring since one could be worried that at the granularity we are working pioneers and followers are producing systematically different kinds of goods (for example pioneers exporting less quantity but of higher quality which would mean a higher price). But we do not find that.

In conclusion, the smaller total trade volume of pioneers vis-a-vis followers showed in Table 6 seems to be explained by quantities rather than prices, as in our theoretical framework.

[Table 7 about here.]

[Table 8 about here.]

Results are not an artifact of a particular cutoff.

As we discuss in Appendix 8, we used a focal cutoff of 10,000 dollars to identify new products. Using a cutoff in this kind of study is unavoidable. As it is well known in the empirical work with Customs Records, if we define too small a cutoff we end up with a disproportionally large share of small transactions that were never intended to be a commercial export, and for which our model would be useless because there is no expectation of future revenues (e.g. sending something to a family member overseas; returning a machine). In contrast, if we define the cutoff too high, we may lose the early dynamics and only see the pioneers "entering" together with the (early) followers, which makes completely impossible to test our model of early diffusion. Our benchmark of 10,000 is focal because it coincides naturally with what many governments consider "large" (for example both the US and Chile require to formally declare an international capital flow if it is above 10,000 USD). Also, it is an amount for which access to credit can be important, since only few people can get non-collateralized personal loan for these amounts in Chile. In any case, we tested that the main results remain robust if we change the cutoff of our calculation to 8,000 or 12,000; we also tried using real and nominal values. The bottom line of this exercise was that our results were not produced by the sharp-edged properties of one particular cutoff value.

We cannot reject equal survival of pioneer and followers *in the same set of product*s.

As a sanity check we test an ancillary prediction of the model (which is formally discussed in the Appendix):: since risk is mostly product-specific then there should not be systematic differences in survival rates between pioneers and followers *in the same set of products*. Table 9 tests this proposition presenting the hazard rates of stopping an export spell. The estimates

cannot reject the hypothesis that pioneers and followers do not differ systematically in this dimension. Specification (1) uses a Cox proportional hazard model showing that only pioneers *without* followers (so in a different group of products) have a 27% higher hazard rate than our benchmark group (p-value<0.1); but as mentioned, the additional hazard rate for pioneers *with* followers is not statistically different from one; which in hazard rate notation means the same probability that the export spell "dies", when compared to the benchmark group of followers As additional robustness, specification (2) estimates hazard rates using now a Weibull parametric duration model, finding the same qualitative results: pioneers with followers do not differ in their hazard rates in comparison to followers. As expected, the estimates are not very precise since there are many other reasons why firms survive exporting that we do not take into account in the model. But overall it is reassuring that we cannot reject this ancillary prediction about similar survival once you are in the same set of product.

[Table 9 about here.]

Probability that the pioneer is the top exporter. As a final robustness check, it is worth emphasizing that our model predicts that pioneers are *qualitatively* smaller than followers. In some products they might be smaller by just cents; and in some other products they might be smaller by orders of magnitude. Despite that *qualitative* prediction, in sections 4 and 5 we preferred sticking our analysis to standard econometric techniques and estimate the *quantitative* magnitude of the smaller revenue, at a risk of imprecisely estimating an average due to the potential heterogeneity of the effects across products. Thus, to complement our baseline exercise Table 10 explores the probability of being *the largest* exporter within a product and year combination.
.

The results of Table are consistent with previous findings in Table 6. Column (1) shows that a pioneer is 40% less likely to be the largest exporter, supporting our qualitative claim. When in specification (2) we control for experience, as in the rest of the paper, the pioneer dummy is even stronger, representing a "handicap" of at least three years of export experience (p-value for the F-test lower than 0.05). Mimicking our baseline analysis in Table 6, columns (3) to (5) show that the effect remains consistent across specifications. Also, in column (6) we restrict our sample to comparing product-years in which both pioneer and followers have at least three seasons exporting and, analogous to our findings in Table 6, the results are even stronger with pioneers being 83% less likely to be the largest exporter. As suggested in our theoretical framework, the more we compare mature export histories of pioneers and followers, the stronger the effect that pioneers are more likely to be smaller than followers (Column 1 vs 6). We perfome this exercise either with boostrapped or clustered standard errors and the results remain largely unchanged. Overall, the qualitative prediction that pioneers are smaller looks highly significant.

[Table 10 about here.]

To conclude this section of robustness checks,[18] we can say that the first order assumptions behind the model get support in the data: the results are about quantities rather than prices, our qualitative results do not change when we move the threshold a few thousand dollars above or below, and although other sources of risk are important, we do not see systematic survival differences between pioneers and followers. Furthermore, when we look at the probability of being the largest, the results are very supportive of our framework.

[18]It is worth remarking that we attempted including product and industry characteristics to see whether our effects were systematically more intense in some industries/products than others . But overall, we did not detect robust correlations. We acknowledge the sample size is unlikely to be large enough as to have enough power for the analysis of heterogeneity across sectors

6 Concluding remarks.

The process of export diversification is at the center of many debates about Economic Growth and structural transformation in less developed economies. This paper explores the beginnings of this process by investigating how is it that countries start exporting new products they did not export before. The theoretical interest on this issue, however, contrasts with the limited *quantitative* firm-level evidence available on how this actually happens. In this paper we use detailed customs data from Chile to build a panel of firms that export new products. We show evidence consistent with pioneer-to-follower informational spillovers in the discovery of new export products. First, we find that products with surviving pioneers have a higher chance of having followers, which is congruent with followers either learning from the successes or avoiding the failures of pioneers. Second, we find that pioneers are smaller than followers in their exports, suggesting that the first explorer may not be the firm that benefits the most from its discovery, at least in terms of future revenues.

Our main finding (pioneers being smaller than followers in their exports) seems inconsistent with simple extensions to heterogeneous firm models of export entry in which firms differ only in productivity/size and face homogeneous sunk costs (Melitz (2003)), where the largest firm has the greatest incentive to enter into exporting for a given entry cost. Our interpretation is that the early dynamics of a new export product not only depends on the now standard "selection of the fittest" into exporting, which explains well the steady state of exporting across firms, but supports the idea that shocks and heterogeneity in the costs of exploring or entry into exporting may play an important role in the early stages of new exports. In our simple theoretical framework we model this heterogeneous cost of exploration as a random shock independent to firm productivity/size. Of course this is not because we believe the process is truly exogenous, but because we remained agnostic on both the specifics of these organizational frictions and on whether the documented spillover constitutes a true externality or just a spillover internalized by Coasian side payments. Disentangling these hypotheses, however, requires a product-by-product analysis and would be clearly an opportunity for further research.

In case we interpret our results as evidence of a true diffusion externality, our estimates imply that even pushing small exporters to attempt a new product - which could be efficient if they have a disproportionally smaller exploration cost - may have aggregate effects since after the pioneer reveals information, then other more productive followers could enter. Nonetheless, if diffusion of this knowledge among existing firms is the dominant market failure, then sectors in which there will be only *one* producer in the country (e.g. due to scale effects) would *not* be subject to such market pathology.

References

AGOSIN, M., AND C. BRAVO-ORTEGA (2009): "The Emergence of New Successful Export Activities in Latin America: The Case of Chile," *Inter American Development Bank RES Working Papers*.

ALBORNOZ, F., G. CORCOS, E. ORNELAS, AND H. F. C. PARDO (2010): "Sequential Exporting," *Centre for Economic Performance Discussion Paper No 974*.

ALVAREZ, R. (2004): "Sources of export success in small-and medium-sized enterprises: the impact of public programs," *International Business Review*, 13(3), 383–400.

——— (2007): "Explaining export success: firm characteristics and spillover effects," *World development*, 35(3), 377–393.

ALVAREZ, R., AND G. CRESPI (2000): "Exporter performance and promotion instruments: Chilean empirical evidence," *Estudios de economia*, 27(2), 226.

ALVAREZ, R., H. FARUQ, AND R. A. LOPEZ (2007): "New Products in Export Markets: Learning from Experience and Learning from Others," *Indiana University*.

ALVAREZ, R., AND R. FUENTES (2009): "Entry into Export Markets and Product Quality Differences," *Banco Central de Chile working paper*, 536.

ALVAREZ, R., AND H. GÖRG (2009): "Multinationals and Plant Exit: Evidence from Chile," *International Review of Economics and Finance*, 18(1), 45–51.

ALVAREZ, R., AND R. A. LOPEZ (2005): "Exporting and performance: evidence from Chilean plants," *Canadian Journal of Economics*, pp. 1384–1400.

AMSDEN, A. H. (1992): *Asia's next giant: South Korea and late industrialization*. Oxford University Press, USA.

ARKOLAKIS, C. (2009): "Market Penetration Costs and the New Consumers Margin in International Trade," *NBER working paper No. 14214*.

ARROW, K. (1962): "The economic implications of learning by doing," *The review of economic studies*, pp. 155–173.

BERNARD, A. B., AND J. B. JENSEN (1999): "Exceptional exporter performance: cause, effect, or both?," *Journal of international economics*, 47(1), 1–25.

BESEDES, T., AND T. J. PRUSA (2006a): "Ins, outs, and the duration of trade," *Canadian Journal of Economics*, 39(1), 266–295.

——— (2006b): "Product differentiation and duration of US import trade," *Journal of International Economics*, 70(2), 339–358.

CHAMLEY, C., AND D. GALE (1994): "Information Revelation and Strategic Delay in a Model of Investment," *Econometrica*, 62(5), pp. 1065–1085.

CHANDRA, V. (ed.) (2006): *Technology, Adaptation and Exports. How some developing countries got it right*. World Bank.

CLERIDES, S., S. LACH, AND J. TYBOUT (1998): "Is learning by exporting important? Micro-dynamics from Colombia , Mexico and Morocco," *The Quarterly Journal of Economics*, pp. 903–947.

CONLEY, T., AND C. UDRY (2010): "Learning about a New Technology: Pineapple in Ghana," *The American Economic Review*, 100(1), 35–69.

DA ROCHA, A., J. MONTEIRO, B. KURY, AND A. DARZÉ (2008): "The Emergence of New and Successful Export Activities in Brazil: Four Case Studies from the Manufacturing and the Agricultural Sector," *RES Working Papers*.

DAS, S., M. J. ROBERTS, AND J. R. TYBOUT (2007): "Market Entry Costs, Producer Heterogeneity, and Export Dynamics," *Econometrica*, 75(3), 837–873.

DECAMPS, J.-P., AND T. MARIOTTI (2004): "Investment timing and learning externalities," *Journal of Economic Theory*, 118, 80–102.

DUFLO, E., M. KREMER, AND J. ROBINSON (2009): "Nudging Farmers to Use Fertilizer. Theory and Experimental Evidence from Kenya," *NBER Working Paper 15131*.

EATON, J., M. ESLAVA, C. KRIZAN, M. KUGLER, AND J. TYBOUT (2010): "A Search and Learning Model of Export Dynamics," .

EATON, J., M. ESLAVA, M. KUGLER, AND J. TYBOUT (2008): "Export dynamics in Colombia: Transactions level evidence," *The Organization of Firms in a Global Economy*.

EATON, J., M. ESLAVA, M. KUGLER, AND J. R. TYBOUT (2007): "Export dynamics in Colombia: Firm-level evidence," *NBER Working Paper*.

EATON, J., S. KORTUM, AND F. KRAMARZ (2004): "Dissecting trade: Firms, industries, and export destinations," *American Economic Review*, 94(2), 150–154.

FOSTER, A. D., AND M. R. ROSENZWEIG (2010): "Microeconomics of Technology Adoption," *Economic Growth Center; Yale University. Center Discussion Paper*, 984.

FREUND, C., AND M. D. PIEROLA (2009): "Export Entrepreneurs: Evidence from Peru," Discussion paper, World Bank Research Working Paper.

FREUND, C., AND M. D. PIEROLA (2012): "Export surges," *Journal of Development Economics*, 97(2), 387 – 395.

GRILICHES, Z. (1957): "Hybrid corn: An exploration in the economics of technological change," *Econometrica, Journal of the Econometric Society*, pp. 501–522.

GROSSMAN, G. M., AND E. ROSSI-HANSBERG (2010): "External Economies and International Trade Redux," *Quarterly Journal of Economics*, 125(2), 829–858.

HAUSMANN, R., AND D. RODRIK (2003): "Economic Development as Self-Discovery," *Journal of Development Economics*, 72, 603–33.

HIDALGO, C. A., B. KLINGER, A. L. BARABASI, AND R. HAUSMANN (2007): "The product space conditions the development of nations," *Science*, 317(5837), 482.

HOFF, K. (1997): "Bayesian learning in an infant industry model," *Journal of International Economics*, 43(3-4), 409–436.

HOPENHAYN, H. A. (1992): "Entry, Exit, and firm Dynamics in Long Run Equilibrium," *Econometrica*, 60(5), pp. 1127–1150.

IACOVONE, L., AND B. JAVORCIK (2010): "Multi-product Exporters: Product Churning, Uncertainty and Export Discoveries," *Economic Journal, forthcoming*.

KEHOE, T., AND K. RUHL (2009): "How Important is the New Goods Margin in International Trade?," *Federal Reserve Bank of Minneapolis Research Department Staff Report 324*.

KLINE, S., AND N. ROSENBERG (1986): "An overview of innovation," *The positive sum strategy: Harnessing technology for economic growth*, 275, 305.

KLINGER, B., AND D. LEDERMAN (2004): "Discovery and development: an empirical exploration of new products," *World Bank working paper*.

KRUGMAN, P. (1980): "Scale Economies, Product Differentiation, and the Pattern of Trade," *The American Economic Review*, 70(5), pp. 950–959.

LIEBERMAN, M. B., AND D. B. MONTGOMERY (1998): "First-mover (dis) advantages: Retrospective and link with the resource-based view," *Strategic Management Journal*, 19(12), 1111–1125.

LUCAS, R. E. (1993): "Making a miracle," *Econometrica*, 61(2), 251–272.

MACCHIAVELLO, R. (2009): "Development Uncorked: Reputation Acquisition in the New Market for Chilean Wines in the UK," *BREAD Working Paper*.

MARSHALL, I. (1991): "Trade Liberalization in Chile Politics and Impact on Industrial Efficiency.," Ph.D. thesis, Harvard University.

MELITZ, M. J. (2003): "The impact of trade on intra-industry reallocations and aggregate industry productivity," *Econometrica*, pp. 1695–1725.

MOSTAFA, R., AND S. KLEPPER (2010): "Industrial Development through Tacit Knowledge Seeding: Evidence from the Bangladesh Garment Industry," *Mimeo*.

PORTER, M. E. (1990): "The Competitive Advantage of Nations," *Harvard Business Review*, 90(2), 73–93.

——— (1998): "Clusters and the New Economics of Competition," *Harvard Business Review*, 76(6), 77–90.

RAUCH, J. E., AND J. WATSON (2003): "Starting small in an unfamiliar environment," *International Journal of Industrial Organization*, 21(7), 1021–1042.

ROBERTS, M. J., AND J. R. TYBOUT (1997): "The decision to export in Colombia: an empirical model of entry with sunk costs," *The American Economic Review*, pp. 545–564.

ROMER, P. (1990): "Endogenous technological change," *Journal of Political Economy*, 98(S5).

RUHL, K., AND J. WILLIS (2009): "New Exporter Dynamics," *mimeo*.

SCHUMPETER, J. A. (1934): *The theory of economic development: an inquiry into profits, capital, credit, interest, and the business cycle*. Transaction Publishers (1982 Edition).

SEGURA-CAYUELA, R., AND J. M. VILARRUBIA (2008): "Uncertainty and entry into export markets," *Documentos de Trabajo Banco de Espana*.

7 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 of 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 simply 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 classification 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 us 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, in contrast, 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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[19] 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 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 which altered the codes in the way explained above . 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.

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 about here.]

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 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. 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 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.

The procedure Here we explain the procedure we undertook. Following analogous principles to Pierce and Schott (2009) (but before they published their work) we built a STATA code that first takes two classifications (for example HS92 and HS96) and collapses into a single code any original codes that have expanded or contracted between both classifications. In the example of table 11, it allocates three unique codes to each of the three examples depicted. 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 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. We then 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.

8 Appendix: Database construccion details and filters used to define new export products.

We built our data set of new exporters using Chilean Customs export transactions in all sectors between 1990 and 2006, which we aggregate at the firm-product-year level. For 1990-91 we did not have firm level information. We thus merged the firm level Customs database with COMTRADE product level export data, which was available from 1990. Thus our full database comprehends the period 1990-2006. Having two years of product level data instead of firm level data doesn't pose a problem because, as we explain in section 3.2 we use the first 5 years only as a window to identify old products.

Empirically identifying a new export from Customs data is not trivial. Many new codes exported by a firm or by a country are samples (exports with extremely low values), coding mistakes, or reexports. For this reason we needed to create filters in the data in order to try to identify correctly new products. This ad-hoc process has problems though. On the one handif we define a new product too loosely, it would be difficult to identify real spillovers and the possibility of learning *a la* Foster and Rosenzweig (2010), since many new products identified would not be so . On the other hand, if we are too tough with the definition of a new product, then the number of cases would dramatically shrink, eliminating real cases of firms that made the effort of penetrating new markets with new products. In this trade off between "distillation" of new products for the country and the quantity of products identified, we tried to lean towards "distillation" as much as possible, but still keeping enough observations to make the results statistically significant.

The filters focus first on ignoring exports of a firm that imported the same product in the recent past. For this we merged our data with an available firm level panel from customs on all imports for the period 1990-2006 . Also, since many small retailer transactions across the border, with Argentina or Perú for example, are also considered exports, and these firms tend to export an unrealistically large number of products we defined a cutoff of number of products and dropped the firms that export more than 30 products in a given year. Third, we wanted to separate between firms that are actually producers of the exported good (the actual innovators behind a new product) and firms that were exclusively traders or retailers. For this we merged the data with publicly available firm level activity codes from the Chilean Tax Revenue Service (SII in Spanish), excluding from the data firms that were exclusively traders. We follow the tradition of most of the trade literature of exploring export costs for firms that do produce goods they export. Intermediaries are a hot area of research, but models recognize that this process is quite distinctive so we kept it out from our current study. SII 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. This, by providing the dates when the firms stop operating. This is relevant because some firms

may still be selling in the local market even if they are not exporting.

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 returns (especially machines)	− Can lose products with single transaction	Bias towards less failure

9 Proofs of propositions

The unique equilibrium is described as follows. After the pioneer enters, the pioneer continues whenever $m_i > 0$ so it makes positive profits at the margin; after the sunk entry cost were paid. If $m_i < 0$ then the pioneer exist. After the markup m_i is revealed, whenever $m_i > F/q\left(\varphi^{max}\right)$ there will be entry of at least one follower; except in the obvious case when the random pioneer was precisely the firm with high productivity, which is unlikely except in cases where the distribution of productivity $g\left(q\left(\varphi\right)\right)$ contains only a single firm. When m_i is below $F/q\left(\varphi^{max}\right)$ there is no entry of followers. When the product-specific markup is larger, more followers enter up to the cutoff productivity level $\varphi^{*f}\left(F, m_i\right)$; which denotes the productivity level that makes a follower indifferent between not exporting and exporting the product as a

follower (i.e. after $m_i$is known).

A schematic picture of the equilibrium for a given realization of m_i could be found in Figure 3 that depicts three connected graphs. Panel A shows the probability density function for markups. Panel B shows the probability density function of sizes $g\left(q\left(\varphi\right)\right)$. Finally Panel C shows, in the same coincidental axes of graphs A and B, the indifference condition for the entry of followers given the realization of m_i. So for each m_i it gives the cutoff size level $q^{*f}\left(F, m_i\right)$ that would enter as follower. The picture also shows that if m_i needs to be large enough in order to have at least the most productive follower.

[Figure 3 about here.]

Proof of Proposition 1.

In the equilibrium described above, there would be no entry of followers when the pioneer exits because by definition if $m_i < 0$ then of course it implies that $m_i > F/q\left(\varphi^{max}\right)$. On the contrary, when the pioneer survives, there is a probability $\Pr\left[m_i > F/q\left(\varphi^{max}\right) \middle| m_i > 0\right]$ that there will be entry of at least one follower. The pattern above creates an imperfect correlation between survival of pioneer and entry of followers. Regarding differences in survival between pioneer and follower within the same product (so we need that there is subsequent entry of followers, otherwise we cannot make the comparison), the model predicts no difference. Of course in this simplified version of the model survival conditional on having followers is 100%. In a trivial generalization where we add an exogenous probability of exit that is orthogonal to productivity (like HugoHopenhayn (1992) and Marc Melitz (2003) do), we would still observe no systematic difference in survival between pioneer and followers when averaging across products i, but both at a survival probability lower than 100%.

Proof of Proposition 2

Since any random firm could be a pioneer given our game, the average productivity for pioneer independent of the product is simply $\mathbb{E}\left[\varphi\right]$, where the expectation is taken over all levels of productivity. Instead, the distribution of followers requires $\mathbb{E}\left[\varphi \middle| \varphi > \varphi^{*f}\left(F, m_i\right)\right]$ where $\varphi^{*f}\left(F, m_i\right)$ denotes the cutoff productivity that makes a follower indifferent between not exporting and exporting the product after the product-specific markup m_i is revealed. Naturally, the latter average productivity is larger than than the former whenever $q\left(\varphi^{*f}\left(F, m_i\right)\right) > 0$; but the latter is guaranteed because the firm with almost zero quantity (which in expectation can be pioneer) would never be a follower since it would never recover the sunk cost F given the

low export revenues it would have on the product. Note that this works even under our very general assumptions about the distribution of product-specific markups and productivity.

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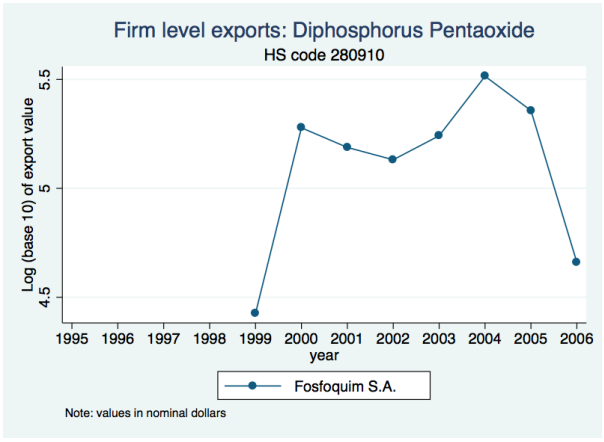
Figure 1. Graphs showing the export sales (in $\log_{10}$ US Dollars) of all firms exporting a given product. Each firm is connected by a line of the same color. In addition, if one firm does not have a scatter point in a given year it means that it did not export

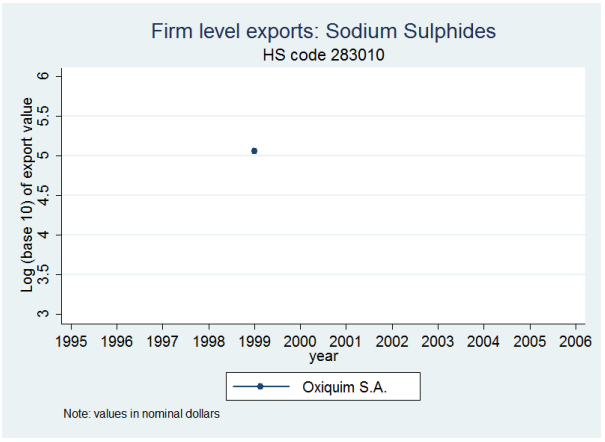
Duration of the export spell

"successful" "failed experiment"

$N_{firms} = 1$

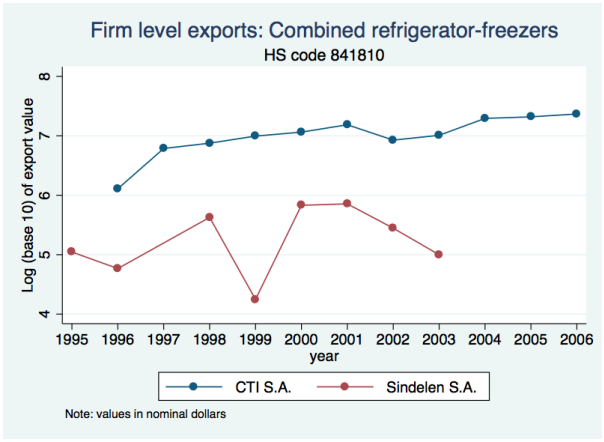


(a) "Successful but lonely pioneer": 7.9 %

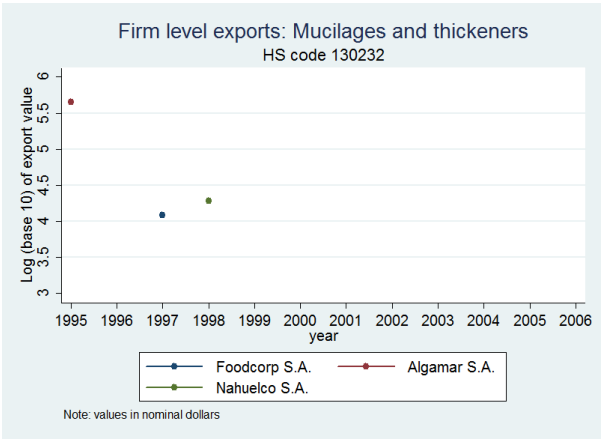


(b) "Failure": 61.6% of products

$N_{firms} > 1$



(c) "Pioneer with follower catching up": 5.7%



(d) Failure with further entry: 24.9%

(b) + (d) Failures: 86.4% of products

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

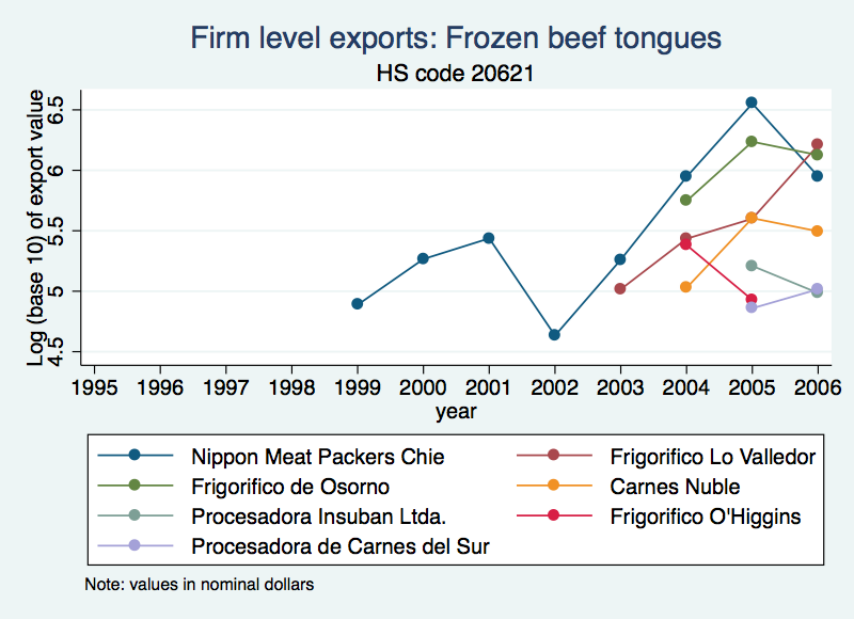


Figure 2. A case with many potential entrants into exporting

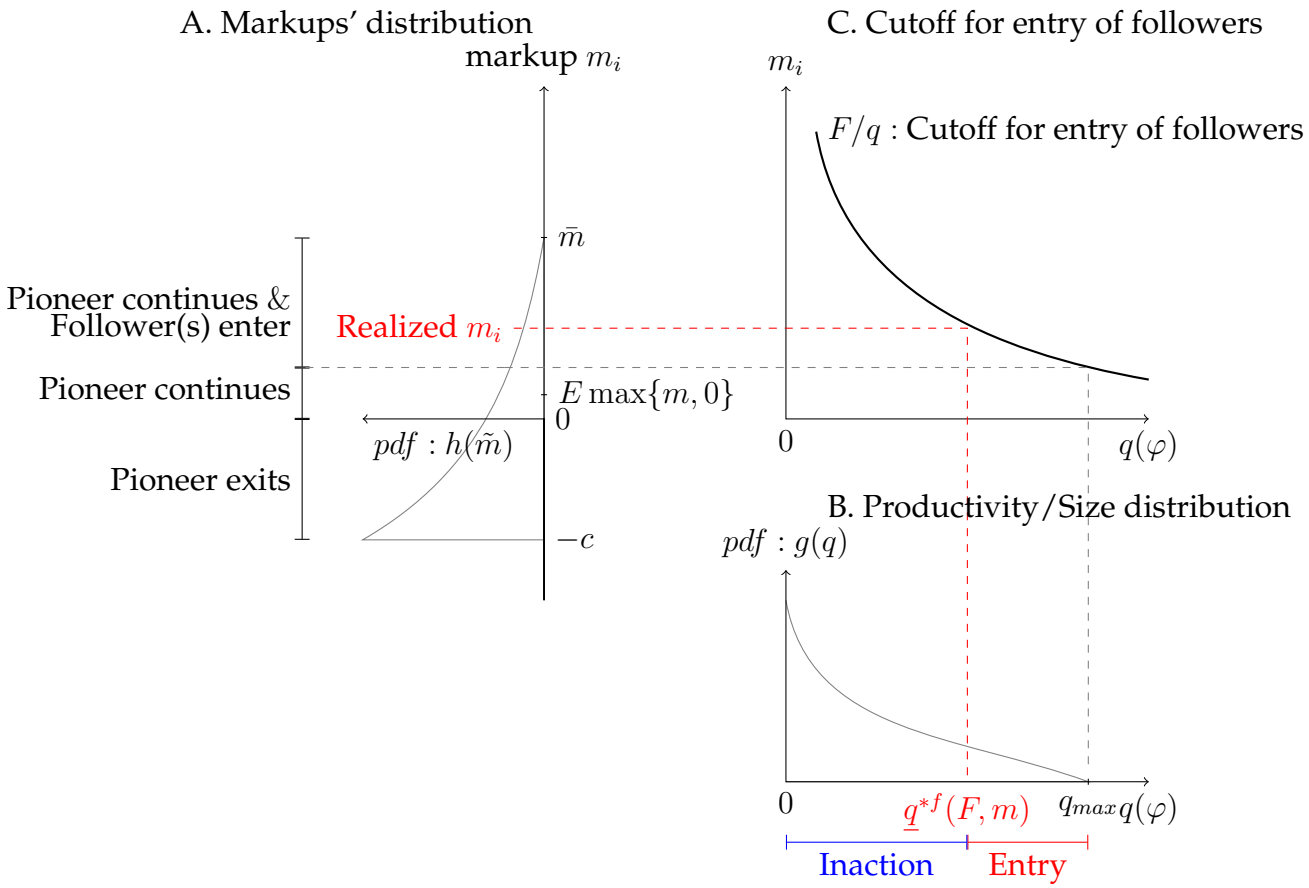


Diagram (A) shows the probability distribution for markups $h(\tilde{m})$. Diagram (B) shows the probability distribution for firms' potential size $g(q)$, where q is a monotonic function of φ. Diagram (C) is used to visually pivot the diagrams and displays the curve for the cutoff level of productivity that would enter as follower for a given markup. Note the logic works with any distribution of markups and productivity provided the assumption $\mathbb{E}\max\{\tilde{m},0\} < F/q(\varphi^{max})$; which is the sufficient condition for the product being "new" in the sense of not exported before $t=0$ in the game.

Figure 3. The entry decision of followers depending on the realization of the random markup m_i

List of 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	NO
		"*old* product"	"*new* product"
Is it the first firm exporting the product from the country ?	YES	N/A $N = 0$	$Pioneer_{new\,product}$ $N = 110$
	NO	$Follower_{old\,product}$ $N = 8,964$	$Follower_{new\,product}$ $N = 288$

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			
	1	2	3	Total %
N followers				
0	175	5	1	72.4%
1	38	4	0	16.8%
2	18	1	0	7.6%
3	4	1	0	2.0%
4 to 6	2	1	0	0.8%
Total %	94.8%	4.8%	0.4%	100%
				N=250

(B) Only product cohorts before Dec 31, 2000

	N of Pioneers		
	1	2	Total %
N followers			
0	102	5	68.2%
1	24	4	17.8%
2	15	1	10.2%
3	3	1	2.5%
4 to 6	2	0	1.3%
Total %	93.0%	7.0%	100.0%
			N=157

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 273 products to 250. (**) 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 firms in new products

Variable	Mean	S.E. (Mean)	Median	N firms
Exports of new product (US$ thousands)	1,184	586	64	148
Exports of all other products (US$ thousands)	65,010	54,600	360	148
Number of products exported	3.98	0.24	3.0	148
Export experience in any product (*)	4.1	0.3	4.0	148
Prob of being a large tax payer	0.41	0.04	0	148

Note: Each data point is a firm product-pair.descriptive statistics were calculated after one year of experience in the product by each firm, given the volatility and noise of the first year exporting. Comparing the medians, one gets that the share of new products at the median is $64/(64+360) \approx 15\%$.
(*) The measure of export experience is censored because we observe firm behavior until the beginning of our sample at the firm level, in 1991, so many firms could have more experience.

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

Distribution of products according to whether the pioneer survived more than one year

	Product has follower(s)		Total	% with followers
	No	Yes		
Pioneer duration ≤ 1	45.6	15.4	60.9	25.2
Pioneer duration > 1	24.2	14.9	39.1	38.0
Total	69.8	30.2	100.0	
			N=215	

Pr (Pearson's chi2 >=4.04) = 0.044

Observations only of products started until 2003, to give enough time to have followers. When export spells are interrupted by a single or two years without exporting, we still consider them an export spell.

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

	Dependent variable: $\mathbf{1}$ [Entry of followers > 0]			
	(1)	(2)	(3)	(4)
Duration pioneer$\geq$1	0.136*		0.177**	
	(0.0741)		(0.0851)	
Duration of pioneer $\geq$2		0.158*		0.277**
		(0.0882)		(0.119)
Duration of pioneer $\geq$5			-0.129	-0.242
			(0.130)	(0.155)
Constant	0.338***	0.350***	0.339***	0.351***
	(0.107)	(0.102)	(0.107)	(0.0996)
Year FE (1st year)	YES	YES	YES	YES
Observations	177	177	177	177
R-squared	0.070	0.071	0.076	0.087

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

In all regressions we used the relevant sample to calculate durations of 5 or more years. We exclude years 2002-2006 to give a chance of followers to appear after the pioneers so durations could be plausibly analyzed. [Duration ≥ 1] refers to a dummy indicating if the pioneer had an exporting spell in the product of *more* than one year, and zero otherwise. Note that zero duration in our setting is just the first season. There is an analogous definition for other cutoff durations

Table 6. Linear regression of firm's export value [log US$] taking product and year fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
1[pioneer]	-1.174	-2.776***	-3.105***	-2.774***	-2.334**	-2.391**
	(0.886)	(0.823)	(0.970)	(0.813)	(1.004)	(1.025)
experience in prod. (years)		0.633*	1.939*	0.519	0.585	
		(0.344)	(1.029)	(0.341)	(0.350)	
experience squared			-0.137			
			(0.108)			
N of prod. exported by firm				0.293		
				(0.179)		
Share of new prod. in firm's exports					1.737	
					(2.928)	
Constant	12.58***	11.32***	9.483***	10.43***	10.67***	13.62***
	(0.514)	(0.987)	(1.439)	(0.824)	(1.552)	(0.670)
Product-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	212	212	212	212	212	108
R-squared (including FE)	0.784	0.841	0.867	0.863	0.846	0.926

Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1. experience in the product means experience e

Table 7. Panel regressions for quantities exported controlling by product-year fixed effects

	log quantity exported by a firm in a product and year		
	(1)	(2)	(3)
1 if pioneer in product	-1.052	-2.508**	-2.132*
	(0.939)	(0.963)	(1.131)
Experience exporting the product		0.575	1.942**
		(0.417)	(0.868)
Experience squared			-0.168
			(0.101)
N products exported by firm			0.387*
			(0.207)
Share of product in exports of the firm			3.051
			(2.334)
Constant	10.96***	9.837***	5.254***
	(0.547)	(1.170)	(1.791)
Observations	201	201	201
R-squared (including FE)	0.924	0.938	0.962

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 . All regressions are estimated using product-year fixed effects. Quantities are measured in the standard units in which the Customs transaction is recorded (e.g. number of computers rather than metric tons of computers). Since the units are different for different products most of the R2 comes naturally from product Fixed Effects. Experience corresponds to the experience exporting a given product. Specification (2) is like specification (1) , but controlling for experience. Specification (3) 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. In specification (2) the F-test indicates that the pioneer coefficient is equivalent to at least two years of experience (p-value 0.04).

Table 8. Panel Regression of median product prices for each firm , controlling by product-year fixed effects

	log median export price of firm in a product in a year		
	(1)	(2)	(3)
1 if pioneer in product	-0.0271	-0.2582	0.0749
	(0.224)	(0.269)	(0.172)
Experience exporting the product		0.091	-0.239
		(0.074)	(0.146)
Experience squared			0.0337*
			(0.017)
N products exported by firm			-0.0031
			(0.032)
Share of product in exports of the firm			0.4030
			(0.795)
Constant	1.644***	1.465***	1.783***
	(0.128)	(0.195)	(0.321)
Observations	201	201	201
R-squared (including FE)	0.996	0.996	0.997

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1 .
Specifications include product-year fixed effects. Prices are measured in the same units it is recorded, which varies greatly by product., which explains why a large share of variation (and thus R^2) is explained by across-product variation.

Table 9. Hazard rate for duration of firm exporting a product depending on whether they were pioneers or followers, as well as the type of pioneer.

	Hazard rate for duration of firm in a product	
	(1)	(2)
Model type	Cox Proportional Hazard	Hazard with Weibull Parametric model
Followers is omitted category		
Pioneer with follower	1.183	0.990
	(0.201)	(0.168)
Pioneer without followers	1.271*	1.297*
	(0.180)	(0.183)
Constant		0.279***
		(0.0362)
ln P		1.239***
		(0.0486)
Year FE		
N	398	398

Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1; Note: coefficients are hazard rates so a hazard rate of one means that it has the same hazard as the benchmark group. If the hazard rate is above one then it has a higher hazard of ending the export spell. The coefficient of followers is the omitted category. Regressions (1) uses Cox proportional hazards model. Regression (2) uses a Weibull parametric survival model.

Table 10. Linear panel regression of being the largest exporter in a product-year

	(1)	(2)	(3)	(4)	(5)	(6)
1[pioneer]	-0.409**	-0.827***	-0.947***	-0.826***	-0.701**	-0.833***
	(0.185)	(0.152)	(0.137)	(0.189)	(0.285)	(0.186)
experience in prod. (years)		0.165***	0.641***	0.145**	0.152**	
		(0.0610)	(0.138)	(0.0673)	(0.0593)	
experience squared			-0.050***			
			(0.0143)			
N of prod. exported by firm				0.0526		
				(0.0460)		
Share of new prod. in firm's exports					0.495	
					(0.618)	
Constant	0.980***	0.651***	-0.0176	0.492***	0.465	1.292***
	(0.110)	(0.193)	(0.227)	(0.158)	(0.295)	(0.124)
Product-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	212	212	212	212	212	108
R-squared (including FE)	0.121	0.292	0.444	0.324	0.311	0.521

Bootstrapped robust standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1. All the specifications contain product-year

Table 11. Example of product homologation procedure

HS92	HS96	Final Code	HS92	HS96	Final Code
011100	011200	011200	150140	150150	150140
011200	011200	011200	150140	150160	150140

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