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Shang-Jin WEI
Columbia University

Ziru WEI
Tsinghua University

Jianhuan XU
Singapore Management University, jhxu@smu.edu.sg

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Shang-Jin Wei [abcd], Ziru Wei [e], JianhuanXu[f*]

a Columbia University, USA b FISF, USA c NBER, USA d CEPR, USA e Tsinghua University, China
f Singapore Management University, Singapore ∗Corresponding author. E-mail address:jhxu@smu.edu.sg (J. Xu).

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Abstract

An influential hypothesis states that export pioneers are too few relative to social optimum because the first exporter's action creates an informational public good for all subsequent exporters. The hypothesis has been invoked to justify certain types of government interventions. We note, however, that such market failure requires two inequalities to hold simultaneously: the discovery cost is neither too low nor too high. Neither has to hold in the data. We propose a structural estimation framework to evaluate the hypothesis, and estimate the parameters based on the customs data of Chinese electronics exports. Our key finding is that "missing pioneers" is a low-probability event for large countries, but can be a serious problem for small economies.

Keywords: Trade, Market Failure, Missing Pioneers

1. Introduction

This paper aims to gauge the empirical plausibility of an influential hypothesis that export activities are prone to a particular type of market failure, namely, due to knowledge spillovers from the first successful exporter to follower firms, there are too few export pioneers relative to social optimum. While there is a growing literature examining the "missing-export-pioneers" hypothesis, we propose the first empirical check based on a structural estimation framework, and reach a conclusion that is different from the majority in the literature.

When a firm exports a product to a new market, it has to pay a cost of discovery to learn about local taste, local regulation, and the appropriate amount of "tinkering" that may be needed to make the sale possible. If this new knowledge can be costlessly utilized by subsequent exporters to the same market, there is a gap between the social value of the first discovery and the private value to the pioneering exporter. Because the knowledge about a new export market is hard to patent, export pioneering activities may be less than socially optimal. This type of market failure has been emphasized in the theoretical models by Hoff (1997) and Hausmann and Rodrik (2003) as a possible explanation for why many developing countries fail to convert their potential comparative advantage into actual exports.[1] Since new exports can bring benefits to accelerate growth (Lucas, 1993, Amsden, 1992), missing export pioneers and under-exporting may contribute to economic under-development. Many have cited this possibility as a basis for supporting government interventions, in the form of subsidizing export discovery activities (Hausmann and Rodrik, 2003, Rodrik, 2004). Several recent empirical papers provide support for elements of this hypothesis, such as Freund and Pierola (2010) and Artopoulos et al. (2013). However, these studies are mainly based on case studies. To our knowledge, no paper so far has formally estimated the probability of missing pioneers and determined when it may be a low-probability event.

However, the existence of costly discovery and positive externality do not automatically imply missing pioneers and a need for government intervention. Such market failure also requires two inequalities to be satisfied simultaneously. First, the discovery cost for entering a new market has to be smaller than the sum of the expected profits of all potential exporters in that market. Otherwise, even a social planner would not want to pay the cost to discover that new market.[2]

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[1] This hypothesis is very influential. For example, the Hausmann and Rodrik (2003) paper has 1150 citations by Google Scholar count.

[2] We would like to stress that the new market exploration is a discrete choice. So the existence of the externality does not necessary suggest the planner's decision is different from the market's decision.

would not want to pay the cost to discover that new market.[2] Second, the discovery cost has to be greater than the expected profit of any individual firm. Otherwise, some firm will find it profitable to unilaterally pay the discovery cost in spite of its inability to capture the full value of the discovery, and the knowledge spillover will take place anyway. Since no presumption exists in economic theory that either of the two inequalities has to hold, one has to look at the empirical evidence on these inequalities. As far as we know, no existing empirical work has taken the approach of assessing both inequalities simultaneously. Hence, we are not yet able to judge if "missing pioneers" is a high probability event or not.

We develop a structural estimation framework to study this question. We apply the framework to micro-data on Chinese electronic exports (e.g., radios or television sets).[3] Specifically, we first use annual export data during 1996–1999 from the Comtrade database to identify product–destination pairs that China did not export prior to 2000, then we use monthly customs data to capture all new market explorations during 2000–2002, and track the export activities of both pioneers and follower firms at the product–destination level by month throughout 2000–2006. A structural model and a maximum likelihood estimation procedure allow us to estimate structural parameters including the discovery costs and other demand and cost parameters. Our data allows us to observe if and when a new market is explored, who the pioneers are, who the follower firms are, and how their respective export volumes and unit export values evolve over the sample period.

How do we identify the market failure? In particular, since there are many product–destination pairs for which there are zero exports from China, how do we estimate the size of the discovery costs (or the costs to explore new markets) in such markets? How do we know, in cases of zero trade, whether they represent market failure—when the discovery cost is high enough to deter any individual firm to want to be a pioneer but not too high so that the social planner still wants a pioneer? These are some of the important identification questions we have to tackle. Our identification relies on a combination of assumed economic structure and data features. In terms of the economic structure, the discovery costs are allowed to vary by region, but assumed to be the same within a given region. If some countries in a region receive exports of some products, the discovery cost for that region can be estimated. In the actual data, while many products are not exported to many countries, there are always some exports of some products to some countries in every region. This helps us to estimate the discovery costs for all regions. After estimating parameters in the demand and cost functions, we can simulate the expected profits of the firms in any given product–destination pair, and then make assessments on the likelihood of market failure.

To preview the main results, we find evidence in support of the notion that the observable action of the export pioneer is a public good. Nonetheless, we find that the probability of "missing pioneers" is only high for small economies but not for large or medium ones. For a small economy, a 20% increase of the discovery cost could increase the probability of missing pioneers by 10%. While for large economies, the missing pioneers usually is a very low probability event.

This paper is related to a large empirical literature on testing the information externality in exploring new markets. Besides the papers mentioned early, Wagner and Zahler (2011) also show data patterns that are consistent with the notion that the first exporter's action is a public good. In particular, once a pioneer becomes successful, they show that imitators tend to emerge relatively quickly. Fernandes and Tang (2014) provide both a model and evidence from China that exporting firms benefit from observing the successes and failures of other firms.

[3] The electronic export is the biggest export sector in the Chinese data. Its export share is over 20%.

We can connect the current discussion on whether an exporter pioneer produces a public good (knowledge about a new foreign market) to another literature on informational barriers to trade. Rauch (1996, 1999, 2001), Rauch and Trindade (2002) , and Casella and Rauch (2003) show that firms often tap into social networks or organize themselves in ways to overcome the informational barriers. In other words, new explorations can successfully take place in markets where information appears costly even in the absence of government interventions. This makes "missing pioneers" less likely than it first appears.

If knowledge about a foreign market is a public good, diplomatic services, government-sponsored trade missions, and export promotion agencies could play a useful role. Rose (2007), Nitsch (2007), Ferguson and Forslid (2013), and Lederman et al. (2009) provide related empirical evidence. However in these studies, a government's role may not necessarily be about producing a public good. It could include reducing financing difficulties of exporting firms or applying political pressures on a foreign government to re-direct trade flows away from other trading partners. In other words, they are not a direct support for the "missing pioneers" hypothesis.

Finally, the paper is also related to the literature on the learning and firm dynamics. Most papers consider the learning as a Bayesian updating process (Jovanovic, 1982; Abbring and Campbell, 2003; Arkolakis et al., 2018). Our paper focuses on the followers' learning from the pioneer firm. However we simplify the learning process as a one-time learning.

The rest of this paper is organized as follows. In Section 2, we set up a simple model to explain the main mechanism of our paper. In Section 3, we lay out the estimation model and explain the estimation procedure. We also introduce and summarize the Chinese export data at the firm–product–destination level over our sample period, highlighting a few salient features that are particularly relevant for our research questions. In Section 4, we present our baseline estimation results, including estimates for discovery costs. In Section 5, using the structural parameter estimates, we provide an assessment of the probability of "missing pioneers". We also discuss a number of extensions and robustness checks. Finally, in Section 6, we provide concluding remarks.

2. A simple model

We construct a simple two-period model in this section to explain the main mechanism. We will lay out a full model for estimation in the next section.

2.1. The decentralized economy

There are N firms in the home economy that can potentially export to a new destination. N is exogenous. To explore a new market, the first exporter is called a pioneer. There are two periods, and the discount rate is assumed to be zero for simplicity. In every period, each firm draws an export profit $\pi \geq 0$ for that period independently from a distribution G. Denote $\bar{\pi}$ as the expected value of export profit.

Consider a virgin market (where no domestic firm has ever exported). In the first period, a firm draws π and then decides on whether to explore the market as a pioneer or wait to the next period. If the firm chooses to be a pioneer, it needs to pay a discovery cost $D > 0$. The discovery cost can be interpreted as a cost to discover the extent and the nature of local regulations or the type of adjustments needed in packaging and labeling in the new destination. The pioneer's life-time value is

$$V^P(\pi) = \pi + \bar{\pi} - D \tag{1}$$

where $\bar{\pi}$ is expected profit in the second period.

If the firm chooses to wait, it will face two possibilities in the next period: (1) no one else has chosen to be a pioneer in the first period and the market remains unexplored, or (2) another firm has become a pioneer and it will have to decide to be a follower or not. In the first case, the firm draws a new profit π'. Its second-period payoff will be $\pi' - D$ if it decides to explore the market, and zero otherwise. In the second case, if the firm decides to be a follower, it can avoid paying the discovery cost D (although it still needs to pay other costs of exports).

Denote the probability that at least one firm wants to be a pioneer in the first period as x. The firm's value to wait is

$$V^F(\pi) = x\bar{\pi} + (1-x)E[max(\pi' - D, 0)] \quad (2)$$

where the expectation $E(.)$ on the right hand side is taken over π'. Eq. (2) says that if the market is opened by another firm (with probability x), since the firm is a follower, its expected profit is $\bar{\pi}$ and it loses the first period profit comparing to the pioneer. But it saves the discovery cost D. If the market is not opened (with probability $1-x$), the firm needs to pay the discovery cost D and gets an expected net profit $E[max(\pi' - D, 0)]$.

Let $\tilde{\pi}$ be the cut-off value of the profit draw that makes the firm indifferent between being a pioneer and waiting, $V^P(\tilde{\pi}) = V^F(\tilde{\pi})$. If the firm's current profit draw is greater than $\tilde{\pi}$, it will choose to become a pioneer. So the probability that the market will be explored is

$$x = 1 - (G(\tilde{\pi}))^N \quad (3)$$

where $G(\tilde{\pi})$ is the probability that a firm's profit draw is lower than the cutoff $\tilde{\pi}$. Since the profit draws are iid across firms, $(G(\tilde{\pi}))^N$ is the probability that all firms' profit draws are lower than the cutoff.

The cutoff value can be found by $\tilde{\pi} = D-(1-x)(\bar{\pi}-E[max(\pi'-D, 0)])$. Since $\bar{\pi} > E[max(\pi' - D, 0)]$, we know $\tilde{\pi} < D$. In other words, the first period net profit for the marginal pioneer, $\tilde{\pi} - D$, is negative. This is because that a pioneer can save future discovery cost. It is willing to bear a negative profit in the first period.

To obtain a closed-form solution, we assume that G follows a Bernoulli distribution. That is, the per-period profit takes one of two values $\pi_H > D > \pi_L$. With probability ψ, the profit π is π_L; and with probability $1-\psi$, the profit is π_H. As long as $\tilde{\pi}$ is between π_L and π_H, we then have $G(\tilde{\pi}) = \psi$. In this case, the firm will explore the market in the first period only if it draws π_H. So $x = 1 - \psi^N$ and $\tilde{\pi} = D - \psi^N\bar{\pi} + (1-\psi)\psi^N(\pi_H - D)$.[4] When the number of potential entrants increases, it becomes more likely that at least one of the firms will have a good profit draw which will propel it to become a pioneer.

Meanwhile, we can also see that the profit of the marginal pioneer is higher than the profit of a marginal follower. We will use the this difference between pioneers and followers to identify the discovery cost in the empirical section.

2.2. Discussion

What does a pioneer firm discover in a new market that becomes a publicly available knowledge for all other firms from the same country–industry? An individual market may have its idiosyncratic form of laws and regulations governing market entry and dispute settlement. For example, the type of product labeling, the optimal size of packaging, variations of local taste and preference, or cultural nuances in color and wording may vary from market to market and may be unfamiliar to firms from a particular exporting firms. Often a given importing country can have idiosyncratic regulations and fees beyond the more standard tariffs and value added tax. In terms of dispute settlement, some countries rely on a formal court process, while others may rely more on informal arbitration or intermediaries. Knowledge of these market-specific rules and norms is not automatically available to firms from a given exporting country–industry. Finding out such information may be costly, but a portion of such information only needs to be found out by one firm from each exporting country–industry. This makes such knowledge to have a public good feature. This can be modeled as a discovery cost paid once by a pioneering firm, but the resulting knowledge flows costlessly to all follower firms. The existence of such externality from export pioneering activity is a key insight from Hausmann and Rodrik (2003). While they take it as prima facie evidence for market failure that will justify a government intervention, we will provide novel and important qualification to the market failure argument.

Note that there are still components of the entry cost such as tariff and value added tax that even follower firms have to pay. In the empirical section, we separate the total cost of entry into a foreign market into two pieces: a discovery cost incurred only by a pioneer firm, and a normal export entry cost incurred by all firms that engage in exporting to that market.[5]

There is another way to understand the discovery cost. Assume that a firm's export profit can be written as $\theta\pi$: a firm-specific component π, and a country-level component θ that is the same for all firms from a given exporting country–industry to a given market. Each firm needs to pay a fixed cost ϕ to export. Following Hausmann and Rodrik (2003), all firms are assumed to understand their own π and ϕ, but no firm knows the actual value of θ until a pioneer firm tries out the market.[6] If one firm explores a market, all firms can learn how suitable their collective bundle is for the new market.

For simplicity, assume θ can on take one of two values. With probability τ, the country does not have a comparative advantage in a certain sector and $\theta = 0$. With probability $1-\tau$, the country has a comparative advantage and $\theta = 1$. In this case, when a pioneer firm finds out that $\theta = 0$, it suffers a loss from incurring ϕ but the knowledge about the value of θ helps all other firms. Appendix A shows formally that the "discovery of the comparative advantage" highlighted by Hausmann and Rodrik (2003) is isomorphic to our model.

In the baseline model, the only "learning" is by follower firms about the value of θ and the learning takes a very simple form since that follower firms acquire the knowledge about the new market instantly.[7] In the extensions, we will consider some additional channels for knowledge spillover.

2.3. The planner's problem

We assume that the social planner cares about the total value of all firms. The planner could require all entrants to share the discovery cost regardless of the sequence of entry. In the first period, before a market is explored, all firms draw their individual potential profit π independently from the same Bernoulli distribution G. Given the

[4] Notice that $E[max(\pi - D, 0)] = (1-\psi)(\pi_H - D)$ since $\pi_H > D > \pi_L$.

[5] Moxnes (2010) assumes a one-time entry cost plus a repeated entry cost for each exporter in a market, but there is no distinction between a pioneer and followers. There is no positive externality associated with export pioneering activity. Alvarez et al. (2013) provide evidence that firms can save the fixed entry cost by learning from their own export experience (rather than other firms' experience).

[6] This can be rationalized by assuming that the foreign preference has two layers. The representative foreign consumer first chooses his consumption bundle by country origin and then chooses the varieties by firm from a given exporting country. All exporting firms understand the foreign allocation of expenditure across different varieties but are uncertain about the total expenditure on goods from a given exporting country. In other words, exporting firms understand π and ϕ, but are uncertain about θ.

[7] Some other papers Dickstein and Morales (2018), Li (2018), and Morales et al. (2014) study firms' learning behaviors under Bayesian setups. The key difference between our model and other learning models is that firms learn from pioneers in just one period, rather than gradually update their beliefs. There are two reasons for our simplification. First, our data only covers a short time horizon (4 years). It would be difficult to allow followers to gradually update their beliefs. Second, even with one period learning, we can still capture the key idea in Hausmann and Rodrik (2003) that export pioneering creates positive externality.

realizations of the profit draws, the planner decides on whether the new market should be explored in this period, and if the answer is affirmative, picks the most profitable firm to be the first exporter (the pioneer).

We denote the maximum profit draw in the first period among the N firms as π_1. Since all firms that choose to export in the second period can do so without having to pay the discovery cost, the expected total profit in the second period is $N\bar{\pi}$. The social planner's value if she decides to have a pioneer, $J^P(\pi_1)$, is defined as

$$J^P(\pi_1) = \pi_1 - D + N\bar{\pi}$$

where π_1 is the profit of the most profitable firm in the first periods, and $N\bar{\pi}$ is the sum of expected profits of all N firms in the period 2.

If there is no pioneer in the first period, the expected profit of each firm is $E[max(\pi' - D, 0)]$. The planer's value is denoted by $J^W = NE[max(\pi' - D, 0)] = N(1-\psi)(\pi_H - D)$.

If $J^P > J^W$, the planner would want to explore the market in the first period. That is

$$D < \pi_1 + N(\bar{\pi} - (1-\psi)(\pi_H - D)) \tag{4}$$

The right hand side is the gain from exploring the market. The first term is the pioneer's first period profit. The second term captures the gain that in the next period, all firms can save D and have an opportunity to export. The left hand side is the cost of exploring the market. When N increases, the gain from exploring the market is larger. Thus the probability that the planner wants to have a pioneer increases with N as well.

In the first period, given the profit draws for all firms (an $N \times 1$ vector $\vec{\pi}$), the "missing pioneer" market failure can be defined as a situation in which the planner wants to have a pioneer but no individual firm wants to be a pioneer. We use η to denote the probability of a "missing pioneer". Formally,

$$\eta = Pr\left(\vec{\pi}: \pi_1 < \tilde{\pi} \text{ and } J^P(\pi_1) > J^W\right)$$

The market failure happens when (1) the maximum profit draw by all firms is lower than the cut-off $\tilde{\pi}$ so that no firm wants to be a pioneer in the decentralized market; but at the same time (2) the planner finds it socially optimal to explore the market. Since $\tilde{\pi}$ is between π_L and π_H, condition 1 suggests that every firm's π is π_L. The probability of this event is ψ^N. Then condition 2 suggests that if $N(\bar{\pi} - (1-\psi)(\pi_H - D)) > D - \pi_L$, the planner wants to explore the market. So the probability of missing pioneer is

$$\eta = \begin{cases} \psi^N & \text{, if } N \geq \frac{D-\pi_L}{\psi\pi_L + (1-\psi)D} \\ 0 & \text{, otherwise} \end{cases}$$

Does this imply that the missing pioneer is a large probability event when N is small? Not necessarily. Even when N is small, since the planner also sees a smaller social benefit of exploring a new market, it is possible that the gap between the social planner's choice and the decentralized market equilibrium is small as well. In other words, the probability of market failure may be small as well. In the, current example, $\eta = 0$ when $N < \frac{D-\pi_L}{\psi\pi_L + (1-\psi)D}$. On the other hand, a larger N tends to raise the social benefit of exploring the market. This means that the planner is more likely to want to have a pioneer. A larger N also implies more profit draws. Since the maximum profit draw is also more likely to be greater than $\tilde{\pi}$, the probability of a "missing pioneer" could be low too. In the above example, η decays with the rate ψ when N is large. Intuitively, it may exist a range of N which makes this kind of market failure easy to happen. In the following analysis, we interpret N as the size of an industry. Hence for a big country, such as China, India, Brazil, or Indonesia, the case of "missing pioneers" may be a low probability event.

We are interested at exploring some quantitative relationships between the probability of this market failure and the number of potential exporters as well as the size of the discovery cost. In the following paper, we take China as an example to quantify whether the "missing pioneer" is a large probability event or not.

3. Estimation procedure and data

3.1. Estimation model

This section sketches the main structure of the estimation model. More details can be found in Appendix B. Consider one broad sector (electronics) consisting of four 4-digit HS product categories or 21 6-digit HS product lines. The economic environment is assumed to be characterized by monopolistic competition since the Chinese firms in this sector face many foreign competitors in the world market.

3.1.1. Demand

We use i to denote both an individual firm and the variety that the firm produces. The demand for firm i's variety in destination d at time t is denoted as

$$\ln q_i^d(t) = \delta_i^d(t) + \ln Y_k^d(t) \tag{5}$$

where $q_i^d(t)$ is the quantity of firm i's output, $\ln Y_k^d(t)$ is an aggregate demand shifter for product k in destination d and time t. Here k denotes a 4-digit HS code, and $\delta_i^d(t)$ is a shifter that is specific to the firm's variety. The firm-specific term $\delta_i^d(t)$ is assumed to be:

$$\delta_i^d(t) = \xi_i - \alpha^d \ln p_i^d(t) + \rho H_i(t) + u_i^d(t) \tag{6}$$

The first term, ξ_i, is a firm-specific demand component. Time invariant firm characteristics, such as ownership, are absorbed by this component. The second term, $p_i^d(t)$, is the price paid by consumers in destination d for variety i in period t. α^d is the demand elasticity in the destination d. $H_i(t)$ is an observed firm characteristic that may be correlated with demand (such as whether the firm is processing trader or not). The last term, $u_i^d(t)$, is a random noise whose distribution will be specified later.

3.1.2. Variable cost

The logarithm of the marginal cost for firm i to produce and export to market d in period t is given below:

$$\ln c_i^d(t) = \gamma_k^d(t) + \kappa W_i(t) + \omega_i + v_i^d(t) \tag{7}$$

$\gamma_k^d(t)$ is a product–destination–year specific cost shifter. $W_i(t)$ represents a set of observable components that affect a firm's marginal cost. An example of the observable component is the local wage in the city where the firm is located. Another example is whether a firm is a processing exporter or not; a processing exporter can enjoy tariff exemption on imported inputs and may therefore enjoy a cost advantage over normal exporters. κ is the coefficient of $W_i(t)$.

The last two terms are meant to capture two different aspects of a firm's productivity. While ω_i is a permanent or time invariant component. Time in-varying firm characteristics, such as ownership, are absorbed by ω_i. $v_i^d(t)$ is a transitory or noise term.

Between the demand and the cost functions, there are four random variables. We assume ω_i and ξ_i are observed by the firm but not by the researcher. $v_i^d(t)$ and $u_i^d(t)$ are noise shocks realized after the firm has made the decisions about production and exports. We assume that $u_i^d(t)$ and $v_i^d(t)$ follow an i.i.d. joint normal distribution with mean 0 and variance–covariance matrix Σ.

Since this is a monopolistically competitive industry, a profit-maximizing firm facing the demand in Eq. (6) will charge a price of

$$\ln p_i^d(t) = \ln\left(\frac{\alpha^d}{\alpha^d - 1}\right) + \gamma_k^d(t) + \kappa W_i(t) + \omega_i + v_i^d(t) \tag{8}$$

where $\frac{\alpha^d}{\alpha^d - 1}$ is a constant markup.

We will use the unit export value as a proxy for the price charged by a firm. The pricing equation contains a set of destination, product, and period effects, $\gamma_k^d(t)$, a firm-specific cost term $W_i(t)$, and an unobserved productivity shock term ω_i. The markup term depends on price elasticity α^d which varies by destination. The noise term, $v_i^d(t)$, can capture, among other things, measurement errors in the price term.

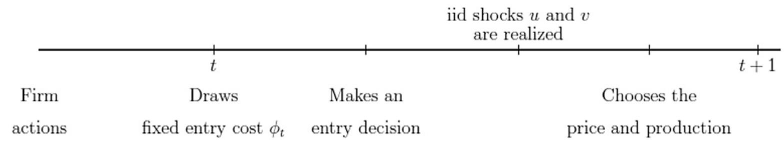

Fig. 1. Timing.

3.1.3. The firm's problem

We introduce the firm's problem in two steps. First, consider a period $t \geq 1$, which suggests the market has been opened in t. For a given destination and a given time period, a firm draws an entry cost $\phi_i^d(t)$ from a normal distribution G_d.[8] We assume parameters of G_d (mean and standard deviation) are destination specific. Based on this information, the firm chooses to export or not. Transitory shocks $u_i^d(t)$ and $v_i^d(t)$ will be realized after i makes the export decision. Fig. 1 shows the timing of the firm problem. Let $\pi_i^d(t)$ denote the expected one-period profit before paying the entry cost as

$$\pi_i^d(t) = E_{u,v}\left[s_i^d(t)\left(p_i^d(t) - c_i(t)\right)\right] \tag{9}$$

In the period t, the net export profit after paying the entry cost is $\pi_i^d(t) - \phi_i^d(t)$. If the firm draws the entry cost low enough, the firm will export otherwise it will exit from the market. We denote this cutoff as $\bar{\phi}_i^d(t)$.

The firm state variables which characterize $\pi_i^d(t)$ include (i) observed firm-specific demand/cost shifters $H_i(t), W_i(t)$; (ii) unobserved firm-specific demand/productivity components ω_i, ξ_i; and (iii) destination–product demand/cost shifters $Y_k^d(t), \gamma_k^d(t)$. We assume all of them are perfectly foreseen. The random draw of $\phi_i^d(t)$ determines the entry/exit on the export market for period $t \geq 1$.

We then switch to the period 0 when the market is still unexplored. If the firm chooses to be the pioneer, it needs to pay a discovery cost D^d that varies by destination (on top of a random generic entry cost that needs to be paid by any exporter in any market and period). However, if it chooses to wait, it may either become a follower if another firm chooses to be the pioneer or the market may remain unexplored in the next period. The key is that to be a follower, the firm can save discovery cost as a free rider but lost the initial period profit. As shown in Appendix B.1, the optimization of the firm problem is a cutoff rule: when the firm draws the entry cost in period 0 lower than $\tilde{\phi}_i^d$, the firm chooses to be a pioneer otherwise it chooses to wait.

Let x denote the probability that at least one firm chooses to become the pioneer and E_0 be the set of all potential entrants, then

$$x = \Pr\left(\min_{i \in E_0} \phi_i^d(0) - \tilde{\phi}_i^d < 0\right)$$

3.1.4. From the social planner's problem to market failure

The setup of the planner problem is similar as Section 2. By choosing whether to ask a firm to enter the market, the planner maximizes the total value of all firms.[9]

Let J^P be the social value when the planner assigns a firm to be a pioneer in the first period, and J^W be the social value when the planner decides not to have a pioneer in the first period. The probability of "missing pioneers" can be formally defined as

$$\eta = \Pr\left[\min_{i \in E_0} \phi_i^d(0) - \tilde{\phi}_i^d > 0, J^P > J^W\right] \tag{10}$$

In other words, given individual state variables such as demand shocks, productivity shocks and random entry costs for each firm, the market failure of a missing pioneer is an event in which no firm wants to be a pioneer in the decentralized market but the planner would want to have a pioneer. The probability of the market failure will depend on the values of the structural parameters. We now use the Chinese data to quantify the likelihood of the market failure.

3.2. Data and identification of pioneers and followers

We have monthly firm–product–destination level export data from the Chinese customs covering the 84 months from January 2000 to December 2006. We also have annual product–destination level export data for China from the UN Comtrade database for a much longer time period.

We focus on the Chinese exporters in a set of sectors broadly related to electronics(HS852).[10] It includes four 4-digit products (HS8525-8528) or 21 6-digit products. Key features of these four products are reported in Appendix D.

We call a product–destination pair a market. Based on UN Comtrade data (available at the bilateral product level), we first identify a set of markets to which China did not export during 1996–1999 but did during 2000–2002.[11] We then use the Chinese customs data from 2000–2006 to identify, for each of the newly explored market, who the first exporter is, who the followers are, and how their sales and prices (unit values) evolve. In other words, we identify all the export pioneering activities during 2000–2002 and trace the dynamics of both the pioneers and the followers during 2000–2006.[12] However, if we work on 4-digit HS codes to define the new markets, the pioneer behavior is very rare since we only have 880 total markets (4 products x 220 countries). Thus to increase the observation of the pioneer activities, we identify the new market within 6-digit HS code product–country pairs.

A firm is defined as a pioneer if it is the very first Chinese exporter of a particular product to a particular destination. All subsequent entrants (for the same product–destination pair) are followers. While it is possible to have more than one pioneer firm for a given product–destination pair, it is extremely rare in practice. We find that in 97% of all the newly explored markets during 2000–2002, there is a single pioneer firm; in the remaining 3% of the cases, there are two pioneers. There is never a case with more than two pioneers. Therefore, for practical purposes, it is reasonable to assume a single pioneer.

Importantly, when a product is not exported to a particular destination, some other products are often still exported to this destination. It is relatively uncommon to have a destination in which no product is exported. This feature of the data is important in our ability to identify discovery cost parameters and other parameters.

[8] Although we call ϕ an entry cost, it can take a negative value (e.g., from an export subsidy).

[9] The details of the planner's problem is in Appendix B.

[10] They constitute one of the largest export sectors in China. As there are a large number of firms in these sectors, we can see enough variations in pioneer decisions across markets. As important, many other Chinese sectors face accusations of government subsidies or "dumping". If there is pioneering activity in the other sectors, we cannot rule out the role of subsidy. However, in searching over foreign cases filed against Chinese subsidies or dumping in the sample years, we do not find such cases in the broad electronics sector. This makes electronics especially suitable for our purpose.

[11] By our procedure, we have bypassed a reclassification of HS codes from 1995 to 1996.

[12] As a robustness check, we have also performed an exercise in which we restrict the pioneering activities to newly explored markets during 2000–2001 (i.e., before China joined the WTO). The main results are similar.

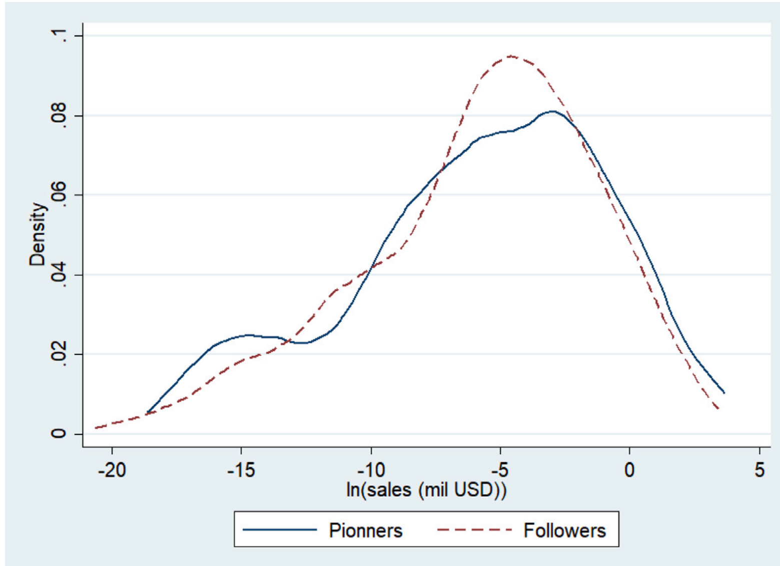

Fig. 2. ln(Sales) of pioneers and followers.

3.3. Estimation procedure and identification

In the data, for each firm i, we observe a sequence of demand/cost shifters $H_i(t), W_i(t)$, and a sequence of participation choices $I_i^d(t)$. When a firm exports, we observe its unit export value, $p_i^d(t)$, and export sales $s_i^d(t)$. Of all the firms that export to a particular market, we can easily tell which one is the pioneer and which ones are the followers. Our empirical model consists of four structural equations: a demand equation (6), a pricing equation (8), an export decision rule $\bar{\phi}_i^d$ and a pioneer decision rule $\tilde{\phi}_i^d$.

Our estimation strategy can be divided into two steps.[13] Intuitively, we first jointly estimate the demand equation (6) and the pricing equation (8) using data on an individual firm's prices and quantities. To handle the classical endogeneity issue, we use the average price of the same product by different firms in different destinations as the instrument of the $p_i^d(t)$ in the demand equation, such as Hausman et al. (1997). The idea behind this identification is that the average price of the other producers of the same product in other destinations correlates with $p_i^d(t)$ through the cost shifter rather than through the demand shifter. We can the back out the expected one period profit $\pi_i^d(t)$ for each firm.

Second, conditional on a set of demand and cost parameters, we estimate the distribution of the random entry cost G^d and the discovery cost D^d from the MLE to match the entry and exit patterns given the profit estimated above. To provide more information about our identification, we draw the annual sales (in log) of pioneers and followers in Fig. 2. We can see that the annual sales of pioneers (with a mean around 0.73 million USD) are higher than followers (with a mean around 0.53 million USD). As we show in Section 2, since the discovery cost imposes a selection, pioneers are more profitable than followers. The sales difference between pioneers and followers will help us to identify the discovery cost.

To reduce the computational burden, we cluster all countries into 6 destination regions according to their geographical and socioeconomic features: (i) the Western Hemisphere, (ii) Former Soviet Republics (FSR), (iii) Europe (excluding FSR countries), (iv) Japan, Korea, Australia, New Zealand, (v) Rest of Asia, and (vi) Africa. We assume that all countries within the same region share the same coefficients. We list all the parameters to be estimated in Appendix C.

What happens if there are zero exports from China in certain product–destination pairs? How do we estimate the size of the discovery costs in such markets? Our identification relies on a combination of assumed economic structure and data features. In terms of the economic structure, the discovery costs are allowed to vary by region, but assumed to be the same within a given region. If some countries in a region receive exports of some products, the discovery cost for that region can be estimated. In the actual data, while many products are not exported to many countries, there are always some exports of some products to some countries in every region. This helps us to estimate the discovery costs for all regions. Such features of the data, together with the assumptions on the structures of demand and cost, allow us to uncover all the parameters in the demand and cost functions in all markets.

4. Empirical results

In this section, we apply the structural model to our sample.

4.1. Demand equation estimate

Table 1 reports the estimates of the demand equation parameters (Eq. (6)). Standard errors are reported in the brackets. The first six rows report the price elasticities α^d. For example, the price elasticity in Western Hemisphere is −3.085, indicating that an increase in price by one percent is associated with a decline in export sales by 3.085%; the result is statistically significant. Moreover, we find that the demand elasticities across destinations are similar. All of them are around −3.

In the demand equation estimation, we control one observed firm characteristic: whether the firm involves in the processing trade or not. The result suggests that the processing trade firm has a significantly higher demand.

4.2. Pricing equation estimates

The first column of Table 2 reports parameter estimates of the pricing equation (Eq. (8)). We control for two observed firm characteristics: the processing exporter status and the log of city-level annual wage per worker. The coefficient on processing exporters is negative and statistically insignificant. As processing exporters enjoy tariff exemption on imported inputs, their lower marginal cost likely reflects this cost advantage. The coefficient on the local wage is around

[13] Details of the estimation procedure are explained in Appendix C.

Table 1
Estimates for the demand equation.

	Point-est	Std
Price elasticity—Western hemisphere	−3.085***	(0.425)
Price elasticity—Former Soviet Republics	−3.068***	(0.387)
Price elasticity—Rest of Europe	−3.160***	(0.435)
Price elasticity—JPN/KOR/AUS/NZL	−3.096***	(0.465)
Price elasticity—Rest of Asia	−3.250***	(0.452)
Price elasticity—Africa	−3.452***	(0.430)
Processing trade status	2.331***	(0.344)
Firm FE	Y	
Destination–product–year FE	Y	
Obs.	3883	
R-sq	0.87	

Notes: This table reports the estimation results of Eq. (6). The dependent variable is the ln(sales)-ln(price). Standard errors are reported in the parenthesis and clustered at product, destination, year level. *** p<0.01, ** p<0.05, * p<0.1.

Table 2
Estimates for the pricing equation.

	(1)		(2)	
Processing trade status	−0.052	(0.103)	−0.038	(0.103)
ln(wage)	0.325*	(0.171)	0.312*	(0.169)
ln(Own Export-Dif Des)			−0.005	(0.009)
ln(Other Export-Same Des)			−0.009***	(0.003)
Firm FE	Y		Y	
Destination–product–year FE	Y		Y	
Obs.	3883		3883	
R-sq	0.91		0.91	

Notes: This table reports the estimation results of Eq. (8). The dependent variable is the ln(price). "Own Export-Dif Des" is the export value of the same firm in different destinations. "Other Export-Same Des" is the export value of other firms in the same destination. Standard errors are reported in the parenthesis and clustered at product, destination, year level. *** p<0.01, ** p<0.05, * p<0.1.

0.325 and statistically significant. It suggests that the high wage will increase the marginal cost and hence the price.

In most of our analysis, we assume followers can only benefit from a pioneer firm's action in the same destination by reducing the discovery cost. However, we may think that the firm's marginal export cost may also benefit from the actions of other firms or even their own prior actions. In the second column of Table 2, we allow for two more cost-saving channels. The first is a firm's own export value to different destinations in period $t-1$, which captures possible knowledge spillover from one's own exports. Albornoz et al. (2012) explore this idea. The second is other firms' total exports to the same destination in period $t-1$, which captures knowledge spillover from other firms on the marginal cost.[14] From the results we can see that other firms' previous export experience in the same destination can reduce the firm's marginal cost significantly. If the previous year's other firms' export value increase by 1%, the marginal cost would reduce by 0.009%. However, the firm's own export experience to other destinations does not have a significant impact.

4.3. Parameters for the permanent and transitory shocks

There are four random variables in the demand and pricing equations. First, a permanent firm-specific demand shock, ξ_i, in the demand equation, and a permanent firm-specific productivity draw, ω_i, in the marginal cost function. Second, a transitory demand shock, $u_i^d(t)$, in the demand equation, and a transitory productivity shock, $\upsilon_i^d(t)$, in the marginal cost function. We assume $u_i^d(t)$ and $\upsilon_i^d(t)$ are jointly normally distributed.

[14] Fernandes and Tang (2014) study this kind of spillover effects.

Table 3
Estimates for the permanent and transitory shocks.

A: Permanent shock		
	Mean	Std
ξ	−0.011	1.202
ω	−0.087	1.211
B: Transitory Shock		
u	–	2.594
v	–	0.707
cor(u,v)		−0.736***
		(0.000)

Notes: This table reports the summary statistics of the permanent and transitory shocks. For the co-variance between u and v, the standard error is reported in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Table 4
Estimates for the export cost.

	Point-est	Std
Mean—Western hemisphere	0.378***	(0.025)
Mean—Former Soviet Republics	1.093***	(0.205)
Mean—Rest of Europe	0.410***	(0.032)
Mean—JPN/KOR/AUS/NZL	0.506***	(0.095)
Mean—Rest of Asia	0.202***	(0.015)
Mean—Africa	3.317***	(0.960)
Std—Western hemisphere	0.145***	(0.009)
Std—Former Soviet Republics	0.411***	(0.074)
Std—Rest of Europe	0.174***	(0.013)
Std—JPN/KOR/AUS/NZL	0.218***	(0.038)
Std—Rest of Asia	0.078***	(0.006)
Std—Africa	1.163***	(0.330)

Notes: This table reports the estimation results of the parameters in the export cost distribution. The unit of the export cost is in million USD. Standard errors are reported in the parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

Panel A of Table 3 reports the summary statistics of the ξ_i and ω_i. We note that the standard deviation for the permanent demand shock (1.202) is similar when comparing to the dispersion of the permanent productivity shock (1.211).

Panel B of Table 3 reports the co-variance matrix of $u_i^d(t)$ and $\upsilon_i^d(t)$. First, we can see that the demand shock is much more dispersed than the productivity shock. This pattern is consistent with the findings reported in Aw et al. (2011) for Taiwanese footwear exporters. Second, $u_i^d(t)$ and $\upsilon_i^d(t)$ are significantly negatively correlated.

4.4. Export cost and discovery cost

We assume that the discount factor $\beta = 0.9$. Following Xu (2017) and Lee and Xu (2018), we also assume that the firm would die with an exogenous probability 0.1 annually.[15] So that the firm discounts the future profits by 0.8 effectively. Given the estimates of the demand and pricing equations, we evaluate the expected value of exporting or exploring a market.[16] Then the export cost and the discovery cost are identified from a MLE procedure to match the observed firms' entry/exit decisions.[17]

The export costs are assumed to be a random variable that follows a normal distribution with region specific parameters. Thus for each region, we have two parameters (mean and standard deviation). The first 6 rows of Table 4 report the estimates of the mean by region, together with associated standard errors. The next 6 rows report the estimates

[15] In our model, a firm exits from an export market either because it draws a non-favorable export cost or because it dies exogenously.

[16] In our benchmark analysis, we use parameters from the first columns of Table 2. However, in the robustness analysis, we utilize other columns as well.

[17] The model fit is good. The likelihood ratio is around 3,404 and significant at 1% level.

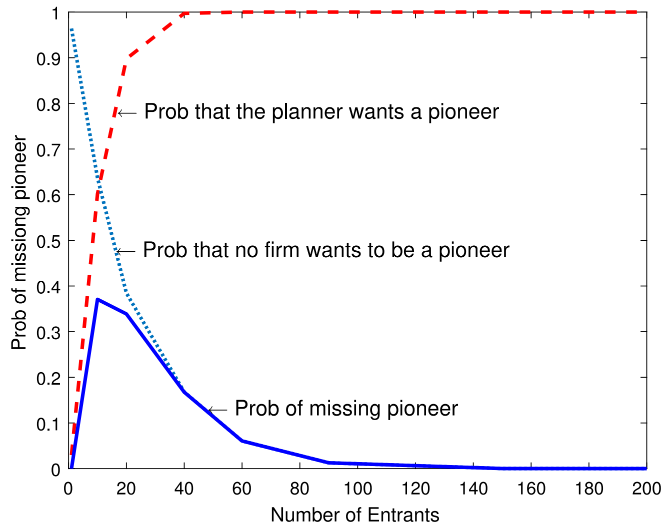

Fig. 3. Probability of market failure.

Table 5
Estimates for the discovery costs.

	Point-est	Std	$\frac{D}{\phi}$
Discovery cost—Western hemisphere	1.854***	(0.293)	4.904
Discovery cost—Former Soviet Republics	1.929***	(0.298)	1.764
Discovery cost—Rest of Europe	1.398***	(0.296)	3.410
Discovery cost—JPN/KOR/AUS/NZL	1.134***	(0.281)	2.243
Discovery cost—Rest of Asia	1.781***	(0.298)	8.812
Discovery cost—Africa	2.301***	(0.295)	0.694

Notes: This table reports the estimation results of the discovery cost. The unit of the discovery cost is in million USD. Standard errors are reported in the parenthesis. The last column reports the ratio of discovery cost to export cost. *** p<0.01, ** p<0.05, * p<0.1.

of the standard deviation by region, together with the standard errors. As we can see, across all regions, the mean export costs range from \$0.202 million to \$3.317 million. The lowest export cost is the Rest of Asia (\$0.202 million), which may be because its distance to China is close. While the highest export cost shows in the Africa region (\$3.317 million). This reflects the data feature that the exit behavior is very common in the Africa.

The discovery cost is assumed to vary across regions. Table 5 presents the estimates. The discovery cost ranges from \$1.134 million to \$2.301 million and all of them are significant. In the last column, we report the relative ratio between discovery cost and the export cost by region. On average, the discovery cost is about 3 years export cost. However, the ratio is quite different across regions. Africa has the lowest ratio (0.694). This may reflect the pattern that Africa has lots of pioneer activities but the exit decision after exploring the market is quite common as well. The Asia region has the highest ratio (8.812), suggesting that the pioneering activity is rare.

Notice that we do not impose the discovery cost must be positive in the estimation, while allow the data to tell us the sign of the discovery cost. Hence our finding of positive discovery costs also implies the action of the first exporter is a public good existence of a public good—it reduces the total entry cost by all follower firms. In this sense, we confirm the findings in Freund and Pierola (2010) and Artopoulos et al. (2013) that positive spillover exists. As we show below, however, the existence of public good does not automatically lead to market failure.

5. Market failure in a decentralized economy

As we have stated earlier, the missing pioneer problem occurs if and only if two inequalities are satisfied simultaneously. First, the discovery cost for entering a new market has to be smaller than the sum of the expected profits of all potential exporters in that market. Otherwise, even a social planner would not want to pay the discovery cost to explore the new market. Second, the discovery cost has to be greater than the expected profit of any individual firm. Otherwise, some firm will find it profitable to unilaterally pay the discovery cost in spite of its inability to capture all the value of the discovery, and the knowledge spillover will take place anyway.

5.1. *Probability of market failure*

To start with, we note an important role played by the number of potential exporters (which is a measure of the size of a country-sector). Even without doing any estimation, we may conjecture that the relationship between the probability of "missing pioneers" and the number of potential exporters should resemble an inverse V. At one extreme, if there is only one firm, it is clear that there is no market failure because the social planner's and the individual firm's optimization problems coincide (hence $\eta = 0$). At the other extreme, if the number of firms is infinite and the distributions for the permanent productivity and the demand shock are not bounded on the right, which are satisfied if productivity distribution or demand shock distribution is normal, log normal, or Pareto, then some firm is bound to get a productivity draw so high (or a demand draw so favorable) that it wants to be a pioneer anyway even if its action benefits other firms. Therefore, the probability of "missing pioneers" is likely to be higher only for some intermediate values of the number of potential exporters. This is the limit of our intuition. How fast does the probability of "missing pioneers" increase when the number of firms increases? Where does the probability peak? How fast would the probability decline after it peaks? We will now use estimated structural parameters and simulations to answer these questions.[18]

For any particular value for the number of potential exporters in E_0, we randomly draw permanent productivity and demand shocks and the fixed entry costs from the estimated distributions of these variables. Based on the realization of the shock, we can determine if the missing pioneer problem arises or not. For 10 000 random draws, we can compute the probability of market failure η for that particular number of potential exporters E_0. We trace out the probability of missing pioneers in Fig. 3 by varying E_0 from 1 to 200.

In Fig. 3, we plot three lines. A dotted line traces out the probability that no firm wants to be a pioneer as a function of the number of potential exporters. This is a declining function because, as the number of firms increases, it becomes increasingly likely that some firm will get a very lucky draw so that it would want to be a pioneer. A dashed line denotes the probability that the social planner prefers to have a pioneer. This probability rises with the number of firms because the sum of the expected profits across firms from successfully exporting to a new destination – something that the social planner cares about – tends to rise with the number of exporters. Finally, a solid line represents the probability of missing pioneers (i.e., when the social planner wishes to have an export pioneer yet no individual firm wants to be one). Logically, the probability of "missing pioneers" should be lower than the smaller of the first two probabilities. Because "no firm wants to be a pioneer" and "the planner wants a pioneer" are not independent events, the probability of "missing pioneers" can be lower than the lower envelope of either the dashed line or the dotted line.

Interestingly, we find that one cannot make a blanket statement about this type of market failure. The probability of missing pioneers depends on the size of a country-sector (or the number of potential exporters to be precise). This type of market failure can be a serious problem for a small country-sector, with a peak probability of missing pioneers around 38% when the number of potential exporters is about

[18] We explain how we solve the planner problem in Appendix C.

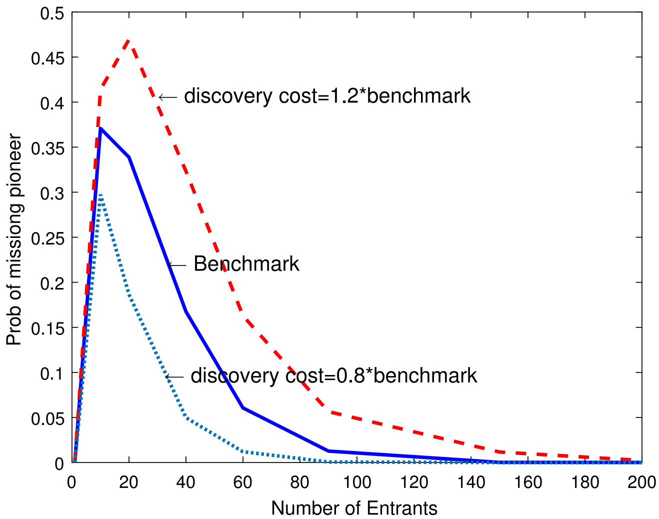

Fig. 4. Varying discovery cost.

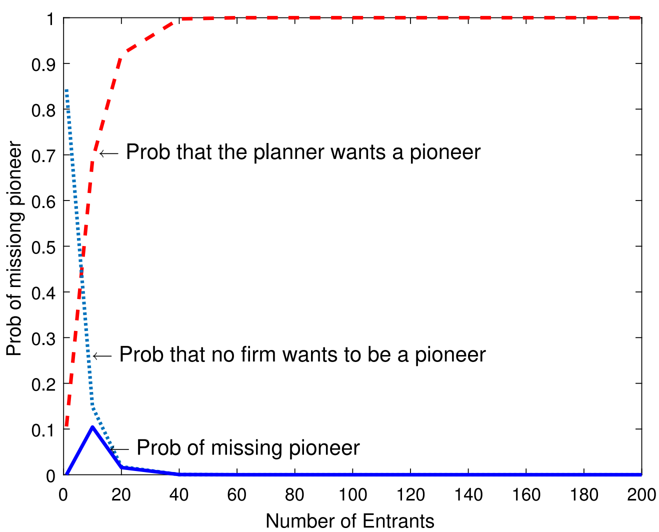

Fig. 5. Additional learning channels.

20.[19] On the other hand, since the mean and median numbers of actual exporters are 394 and 295 for a product in our Chinese example, and the potential number of exporters is likely to be greater than the actual number, the probability of missing pioneers is close to zero for a large country.[20]

5.2. Extensions and robustness checks

We conduct several extensions in this section, focusing on the sensitivity of the results on missing pioneers in a new destination market.[21]

5.2.1. Varying the size of the discovery cost

If we decrease or increase the discovery cost, how much the market failure will change? We now vary the size of the discovery cost to see how it changes the probability of missing pioneers.

In Fig. 4, we plot the probability of missing pioneers corresponding to three different values of discovery cost (1.2 times the baseline estimates, and 0.8 times the baseline estimates, respectively), while keeping all other parameters at the values of their baseline estimates. When the discovery cost increases, the probability of missing pioneers increases since firms are more reluctant to pay the cost. We find that when the discovery cost increases about 20%, the peak value of missing pioneer probability increases by around 10% (dashed line). Similarly, when the discovery cost decreases, the probability of missing pioneers decreases. In our current exercise, the peak value decreases by 8% when the discovery cost declines by 20% (dotted line). When the discovery cost increases, the event of lacking pioneers becomes more likely to happen in both the decentralized economy and the planner economy. Our calculation suggests that given the parameters estimated from Chinese electronics sector, the first effect dominates. Hence the market failure increases when we increase the discovery cost.

5.2.2. Additional knowledge spillover

In the benchmark case, we assume followers can only benefit from a pioneer firm's action in the same destination pair by reducing the discovery cost. In this subsection, we broaden the set of channels in which a firm can benefit from the actions of other firms or their own prior activities. In particular, inspired by the results in second column of Table 2, we allow firm's own export experience and other firm's export experience to alter the marginal export cost.[22]

Using the expanded set of structural parameters, we re-compute the probabilities of market failures and present it in Fig. 5. Compared to the baseline case, we find that the probability of missing pioneers has now dramatically declined for smaller country sectors, with the peak probability now around 11% (as opposed to 38% in the baseline case). The change in the probability of market failure is consistent with the intuition that, by reducing the marginal cost (and increasing the expected profit from exporting), the additional learning channels make it more likely for firms to want to be a pioneer.

5.2.3. Separating first-time entry costs from generic entry costs

In our baseline setup, an exporting firm faces two fixed costs of entry: a discovery cost that is paid for only by a pioneer, and a generic fixed entry cost that needs to be paid for by every exporting firm. It is possible that there is a third type of entry cost, one that is paid for by an exporter the first time it enters a new market whether or not it is a pioneer. In other words, if a market is new to a firm even if it is not new to the exporting country, the firm may have to pay a cost on top of the generic entry cost.[23] Without considering this third type of

[19] We identify pioneers for each HS 6-digit product. If we instead do it for 4-digit product, missing pioneers would become less likely. The reason is intuitive: whenever a pioneer appears for a 6-digit product, there will be no missing pioneer not only for that 6-digit product, but also for the entire 4-digit product category. Some 6-digit products that used to be characterized by missing pioneers would be re-classified as no missing pioneers as long as a pioneer has occurred for another 6-digit product in the same 4-digit category. In other words, broadening the definition of a product would strengthen our argument that the market failure of missing pioneers is not as economically important as what the Hausmann–Rodrik hypothesis implies.

[20] One may wonder whether our result is robust for a sector with fewer pioneers. In Appendix E, we re-estimated our model using only data from sub-sectors HS8525 and HS8526, the two sub-sectors that have the least number of exporters. We find that the broad conclusions are similar to our baseline estimation.

[21] The analysis has mainly focused on missing pioneers in discovering new markets when firms export existing products to new destinations. A different type of discovery involves firms exporting brand new products to the world market. In Appendix F, we explore the likelihood of "missing pioneers" in this type of activity, and find that the country size is still an important factor.

[22] Other learning channels may also shift demand curves. However, for the entry/exit decision, only profits matter. So we do not distinguish between whether other learning channels affect the demand side or the production side.

[23] For instance, an example of the discovery cost may be the cost to find whether certain market requires special certification for exports. This cost is paid only by pioneers. The generic one-time fixed entry cost could be the actual cost to get this certificate. It needs to be paid by all firms in their first export.

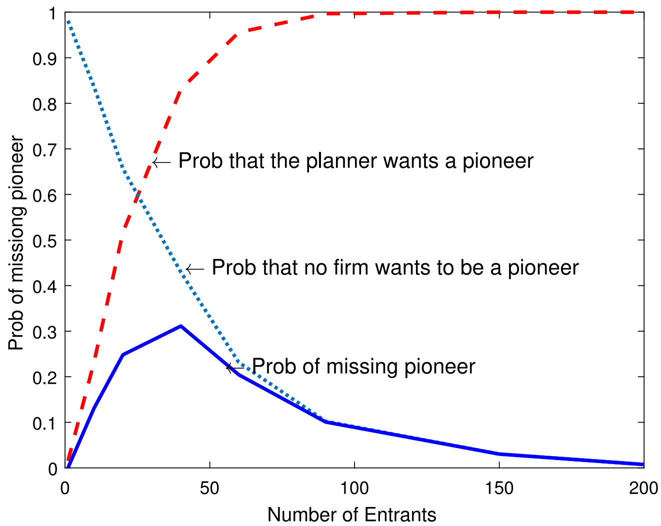

Fig. 6. Separating first-time entry costs.

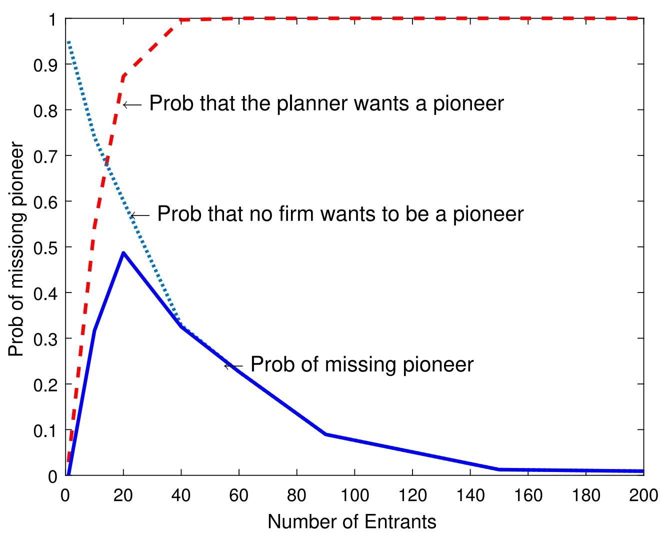

Fig. 7. Probability of market failure in Southeast Coastal Provinces.

cost, we may bias the estimation of the discovery cost. Thus we extend our benchmark model to allow for this possibility. We assume this third type of entry cost, denoted by F^d, only depends on destinations. The identification of F^d comes from the difference of sales and survival rates between new and old followers.

Fig. 6 plots the probability of missing pioneers in this case. As we can see, the peak probability of missing pioneers (about 30%) is lower than the corresponding number in the baseline case. Otherwise, this generalization does not materially alter our inference. In particular, the probability of missing pioneers is low for large country-sectors though it can be higher for smaller ones.

5.2.4. Knowledge spillovers within regions

In the baseline case, we assume that the knowledge from an export pioneer can spill over to all firms in the same sector in China. Since China is geographically large, one may wonder what happens to the probability of market failure if the knowledge can only spill over to firms in a smaller geographic region. Our baseline results suggest that the market failure can become more likely as the country size shrinks. We can investigate this idea in another way by restricting the geographic area for knowledge spillover.

We perform an exercise in which the sample is restricted to the coastal areas of China (i.e., five coastal provinces of Zhejiang, Jiangshu, Shanghai, Fujian, and Guandong). The model is re-estimated on this smaller sample. Fig. 7 reports the result. As we can see, the probability of missing pioneers is indeed (moderately) higher relative to the benchmark case. Still, when the number of potential entrants exceeds 100, the probability of market failure is lower than 10%. Therefore, we still conclude that socially inefficient missing pioneers is a low probability event.

6. Concluding remarks

The paper aims to assess the empirical plausibility of a highly cited hypothesis in the international trade literature, namely export pioneering activities are prone to market failure. Existing empirical papers tend to focus on documenting that the action of the first exporter has public good features and then often jump to the conclusion that a market failure exists and some government intervention is needed. However, for market failure to occur, one has to evaluate whether two inequalities specified in this paper hold simultaneously. No existing paper in the literature has adopted this approach.

We propose a structural framework to estimate the relevant parameters. We provide supportive evidence that the action of the first exporter has public good features. Nonetheless, we find that the problem of "missing pioneers" is a low probability event for large or medium-sized country-sectors. This conclusion appears robust in a number of extensions and checks we have examined.

For international trade, there are two contributions from the paper: (a) a new framework to assess two types of market failure in export pioneering activities, and (b) an application to the Chinese data. The framework can in principle be applied to firm–product–destination–time data from other countries. Such applications could allow one to develop more insight about how country characteristics may affect probability of market failure.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jdeveco.2021.102705.

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