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Abstract

This paper examines the determinants of firm survival in export markets by explicitly taking into account the impact of firms' previous export market experience and their product differentiation. Utilizing a 16-year panel data set for Japanese manufacturing firms obtained from the Basic Survey of Japanese Business Structure and Activities compiled by the Ministry of Economy, Trade and Industry, we employ both hazard and panel probit estimations to examine the likelihood of exit from export markets. The results of our estimations show, first, that the exit probability from export markets decreases over the export duration. Second, the probability of exiting from export markets tends to be lower when firms are more research and development (R&D) intensive both prior to and after starting exports. Third, firms in industries that manufacture differentiated products (e.g., machinery) also experience higher survivability in export markets. These results imply that learning from exporting plays an important role in firms' survival in export markets. In addition, our results imply that firms producing differentiated products likely have a greater incentive to make up-front investments to start exporting, and that these investments in turn enable such firms to survive in export markets for a longer period.

Keywords: Export duration, Hazard estimation, Panel probit estimation, Differentiated products
JEL classification: F14, C41

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1. Introduction

Given that exporters are more productive than non-exporters, a large body of literature has examined the export decision and/or export behavior of firms and provided support for the hypothesis by Melitz (2003) that a firm will only engage in exports if it is sufficiently productive to cover the sunk fixed costs of exporting. These sunk costs represent an investment that is specific to export activities and include, for example, the costs of collecting information on foreign markets or establishing a distribution network abroad, and can only be recovered through a stable stream of export revenues and profits. In other words, only firms that can reasonably expect a stable stream of profit will be willing to incur such sunk costs. However, a significant number of export starters in fact export their products only for a short period and then stop exporting. Békés and Muraközy (2012), for example, find that about a fifth of Hungarian firms that export at some point do so only in a temporary fashion. Similarly, Esteve-Pérez et al. (2013), examining export spells of Spanish manufacturing export starters, report that the median duration of export spells is six years and that 25% of spells end after the first year of exporting.[2] Our own data on Japanese manufacturing exporters show a similar median export duration (7 years) and, moreover, that only a small number of firms survive more than five years in the export market.

Given that many firms appear to be unable to continue exporting indefinitely, a considerable number of empirical studies have examined the determinants of firms' duration (or survivability) in export markets. However, a lack of firm-level data on exports and imports has meant that the majority of studies have been unable to examine the role of firm-level characteristics and instead have had to rely on country- and product-level trade statistics and focus on the role of country-of-origin and/or country-of-destination characteristics in export duration (e.g., Besedeš and Prusa 2006a, 2006b, Nitsch 2009, Brenton et al. 2010, Carrère and Strauss-Kahn 2014). Although there have recently been a number of studies focusing on firm-level characteristics in explaining export duration (e.g., Békés and Muraközy 2012, Esteve-Pérez et al. 2013, Gullstrand and Persson 2015), such firm-level empirical evidence is still comparatively scarce. This means that our knowledge on firm-level trade patterns – in particular temporary or "on-off" exporting by firms – is still limited and that it is not sufficiently clear what kind of firms become "always exporters."

Against this background, the aim of the present study is to examine firm-level determinants of the duration of exporting. Based on theoretical considerations, our empirical analysis takes the role of the sunk fixed costs involved in starting to export as well as the role of learning from exporting as determinants of firms' survival in export markets into account. Specifically,

[2] Similarly, studies using bilateral country-product-level trade data suggest most export products tend to be short-lived. For example, Besedeš and Prusa (2006a, 2006b) show that for the United States the median duration of a product being exported is 2-4 years.

following preceding studies, we assume that firms incur two types of fixed costs: the upfront sunk fixed costs required to start exporting, and per-period fixed costs to continue exporting, such as the costs involved in maintaining an overseas distribution network. These two types of fixed costs interact with export dynamics in multiple ways. For example, Békés and Muraközy (2012) suggest that firms that pay larger upfront sunk costs when entering export markets subsequently incur lower variable export costs such as transport costs. Such firms, in turn, likely will earn higher profits from exporting and are more likely to continue exporting even if they are hit by a demand or productivity shock. Therefore, firms that pay higher upfront sunk costs are expected to display higher survivability in export markets. Moreover, firms that can expect a stable stream of profits from exporting likely have a strong incentive to pay the upfront sunk cost in order to stay in export markets as long as possible. Meanwhile, per-period fixed costs are expected to fall as firms become more experienced in export markets. Such a learning effect is also likely to lead to higher survivability in export markets. Ours is the first study to explicitly examine both the effects of the upfront sunk costs when entering export markets and the learning effect arising from firms' previous export market experience.

As mentioned at the outset, more productive firms are more likely to pay the upfront fixed costs required to start exporting, since they can more reasonably expect a stable stream of profits from exporting than less productive firms, and they are also more likely to continue exporting for a longer period. However, the mechanism through which more productive firms are more profitable and hence more likely to stay in export markets is not entirely clear. One possibility is that more productive firms are more profitable because they are more cost competitive, another that they produce differentiated goods that allow them to charge higher markups. However, conventional productivity measures cannot distinguish between these different sources of productivity. In this study, we assume that firms producing differentiated products are more likely to earn a stable stream of profits from exporting once they established their product brand or distribution network. The rationale for this assumption is that irreversible investments such as investments in marketing and advertising as well as wholesale and retail distribution in foreign markets, and adapting products to local demand idiosyncrasies should matter more for profitability in the case of differentiated products than in the case of homogeneous products. Therefore, firms producing more differentiated products should have a greater incentive to incur upfront sunk fixed costs that enable them to achieve a more stable stream of profits from exporting, resulting in a higher probability of survival in export markets. Given that a number of studies suggest that export experience substantially reduces the cost of exporting, another issue that we examine in this study is the direct impact of export duration (i.e., experience in export markets) on the probability of exit from export markets.

Our major findings are as follows. First, our hazard and panel probit estimations indicate that the probability of exiting from export markets decreases as export duration increases. Given that we control for a variety of firm characteristics in the estimations, this result implies that there is a learning-by-exporting effect that influences firms' survivability in export markets. Second, the probability of exit from export markets is lower for more research and development (R&D)-intensive firms. This result suggests that firms that are more likely to differentiate their products through R&D activities prior to starting exports survive longer in export markets. This finding is consistent with the differentiated sunk cost story modeled in Békés and Muraközy (2012). Third, firms in industries that produce differentiated products (e.g., machinery) tend to experience higher survivability in export markets.

The remainder of this study is organized as follows. Section 2 briefly surveys the related literature, which provides the theoretical underpinnings of our empirical study. Section 3 explains the data and the empirical framework we use in this study. Section 4 examines and discusses the empirical results associated with the probability of exiting from export markets. Finally, Section 5 concludes and presents future research questions.

2. Related Literature

In this section, we first provide a brief survey of extant studies on the mechanism through which export experience reduces the probability that exporter firms exit from export markets. We then survey the literature highlighting the role of firm heterogeneity in explaining the variation in firms' survivability in export markets.

A considerable number of empirical studies show that experience in export markets substantially reduces uncertainty and informational frictions and hence increases the probability of survival in export markets.[3] Starting with studies focusing on uncertainty with regard to costs and profitability, Nguyen (2012), for example, concentrates on uncertainty in demand and argues that firms use realized demand in destinations they supply to forecast demand in destinations they do not supply. This ability to forecast demand leads some firms to slowly add new countries to their set of export destinations. Other studies highlighting this sequential exporting pattern include those by Eaton et al. (2007) and Albornoz et al. (2012).

Another strand of studies, which includes those by Rauch and Watson (2003) and Araujo et al. (2012), argues that asymmetric information or incomplete contracts rather than uncertainty with regard to costs explain export dynamics. In Rauch and Watson's (2003) learning model, export starters first "test" potential foreign partners by starting small, since many of the attributes of the trading partner are unobservable prior to the first transaction. Export starters therefore only continue

[3] Studies providing evidence of the importance of export experience include those by Artopoulos et al. (2013), Carrère and Strauss-Kahn (2014), and Albornoz et al. (2014).

to transact with a trade partner if the test has been successful. These studies assume that firms accumulate knowledge on their trade partners and find reliable partners through export experience. Based on this assumption, they provide a theoretical explanation for why the probability of firms to exit from export markets decreases as firms stay in export markets for longer periods.

Apart from learning, another aspect highlighted in the literature determining firms export survivability is heterogeneity across firms or across export destinations in terms of the costs of and expected returns from exporting. Focus on the role of export destinations, Gullstrand and Persson (2015), for example, argue that the importance of sunk costs of exporting as well as expected future returns from exporting differ depending on whether the export decision refers to a core or a peripheral market. They suggest that the importance of sunk costs of exporting, which include investments in marketing and/or distribution networks, etc., is higher for a core market, and that firms stay longer in more important export market, while they exit more easily from peripheral markets.

The study most closely related to ours is that by Békés and Muraközy (2012), who assume that cost structures differ across firms depending on the cost strategy – which Békés and Muraközy (2012) call "trade technology" – that firms employ when entering export markets. Specifically, in their approach, firms pick one of two trade technologies when they decide to start exporting. One is called sunk cost trade (SCT) technology, while the other is called variable cost trade (VCT) technology. The SCT technology requires upfront sunk fixed cost expenditures when a firm starts exporting. These upfront (product- or destination-specific) sunk fixed costs allow firms to establish a distribution network (for wholesale, storage, transportation, retail, etc.) and lower their transportation costs in subsequent periods. On the other hand, with the VCT technology, firms do not incur upfront sunk fixed costs, but they have to pay larger transportation costs because they do not have an established distribution network.

Using this setting, Békés and Muraközy (2012) show that firms whose productivity is sufficiently high to cover the upfront sunk fixed costs and whose potential export revenues are sufficiently high choose the SCT technology and are more likely to export permanently. In other words, firms with higher initial productivity are not only able to cover the upfront sunk fixed costs but, owing to the lower transportation costs, also are expected to be sufficiently profitable to continue exporting even when they are hit by a negative shock, so that they stay in export markets longer. On the other hand, firms below a certain cut-off productivity level cannot afford the upfront sunk fixed costs and choose the VCT technology and are more likely to exit from export markets sooner. Firms with lower initial productivity are more vulnerable to a negative shock because, due to the higher transportation costs, their exports are more likely to become unprofitable as a result of a negative shock, so that they are more likely to exit from export markets.

The model thus implies that more productive firms can expect a more stable stream of profits from exporting than less productive firms. As a result, firms choose different trade technologies depending on their initial productivity level, and the choice of technology determines the duration of exports. Employing this model to analyze Hungarian firm-product-destination level export data, Békés and Muraközy (2012) find that the likelihood that a firm exports permanently rises the higher its productivity.[4] In sum, in Békés and Muraközy's (2012) approach, short-spelled first-time exporting and longer-spelled first-time exporting are qualitatively different in the sense that the technologies involved are different.

One shortcoming of Békés and Muraközy's (2012) analysis is that they do not explain how the level of productivity interacts with firms' choice of trade technology. They simply assume that more productive firms can afford to pay the upfront sunk fixed costs. Against this background, we take the argument by Békés and Muraközy (2012) on different trade technologies one step further by focusing on the degree of differentiability of firms' products as a key factor affecting firms' decision regarding their trade technology choice between VCT and SCT. Specifically, we assume that upfront sunk fixed costs are more important for profitability in the case of differentiated products than in the case of homogeneous products, while productivity, which determines prices, is more important for profitability in the case of homogeneous products. The reason for this assumption is that the profitability of differentiated products often depends on marketing and advertising, the establishment of distribution networks, consumer tastes in local markets, and so on, so that incurring the related upfront sunk fixed costs should crucially affect the expected profit from exporting. Thus, while in Békés and Muraközy's (2012) approach, the revenues of firms choosing the SCT technology are expected to be higher by the amount of the transport cost advantage over firms choosing the VCT technology, we assume that in addition to the transport cost advantage SCT firms also enjoy higher markups that they can achieve as a result of investing in marketing, adapting products to local tastes, etc.

Based on this reasoning, we assume that firms producing more differentiated products have a greater incentive to incur the upfront sunk fixed costs and thereby realize a more stable stream of profits from exporting, which in turn results in a higher probability of survival in export markets. On the other hand, firms producing less differentiated products are assumed to choose the VCT technology and more frequently enter and exit from export markets.

In the following sections, we examine firm-level determinants of survival in export

[4] Görg et al. (2012) similarly find that higher firm productivity is associated with a higher export survival rate. However, their analysis is based on a multi-product firm setting, in which they assume that more productive firms produce more products. Their model predicts that more productive firms drop a smaller share of their products each year and therefore have a lower probability of dropping a product from export markets.

markets and discuss the role of sunk fixed costs for exporting and of export experience.

3. Data and Methodology

3.1. Data overview

The data used for this study are the firm-level unbalanced panel data for the period 1994-2009 obtained from the *Basic Survey of Japanese Business Structure and Activities* (BSJBSA; *Kigyo Katsudo Kihon Chosa* in Japanese) compiled by the Ministry of Economy, Trade and Industry. The main purpose of this annual survey is to gauge quantitatively the activities of Japanese enterprises, including capital investment, exports, foreign direct investment, and investment in R&D. To this end, the survey covers the universe of enterprises in Japan with more than 50 employees and with paid-up capital of over 30 million yen. For the analysis, we use firms' financial characteristics and their export status, including the duration of years over which they export.

Using the data on firms' export status, we construct spell data representing firms' export activities, on which our analysis focuses. To be more precise, we consider an export spell (*EXP_DURATION*) as a period in which a firm is engaged in export activities over consecutive years. Based on the finding by Roberts and Tybout (1997) that firms need to incur fixed costs associated with the entry to an export market when they exited from the export market three or more years earlier, we do not consider a one- or two-year temporary exit from export markets as an exit. Figure 1 depicts the distribution of the number of years between firms' entry to and exit from export markets (i.e., completed spells). Figure 1 shows that a lot of firms export only for one year and that the majority of firms have stopped exporting after 5-6 years. As shown in Table 1(a), the average number of years of exporting is 4.05 years with a standard deviation of 3.08 years for completed spells, confirming that only a limited number of firms continue exporting for a long time (e.g., more than ten years).

It should be noted, however, that many firms of course continue exporting after our dataset ends and many firms may have started exporting before our dataset begins. For these firms we therefore cannot observe the timing of the entry to and/or exit from export markets, i.e., the export data for these firms are censored. In the case of left-censored data – that is, firms for which we do not have exact information on the year they started exporting – we assume those firms started exporting at the beginning of our observation period. As for firms which continued exporting at the end of our observation period, we cannot identify the year in which they stopped exporting (if they did), and we call these right-censored data uncompleted or censored spells. For the empirical analysis below, we construct a variable, *EXP_DURATION*, which represents export spells and includes both completed and uncompleted spells. *EXP_DURATION* is defined as the number of years of exporting up to the current year *t*. We also identify whether a firm continues exporting in year *t* or not and construct a binary variable of "failure" which takes 1 if the firm exits from export markets and 0 otherwise. Therefore, in our dataset, a firm export spell can be either complete ("failure"=1) or right-censored ("failure"=0). The hazard estimations we employ below are appropriate to deal with such right-censored observations.

To examine the determinants of firms' survival in export markets, we use a comprehensive list of measures to represent firm heterogeneity. These measures include firms' total factor productivity (*TFP*) measured using the index number approach proposed by Good et al. (1997), the natural logarithm of firms' total assets (*FSIZE*), and firm age (*AGE*), which is measured as the number of years since the establishment of a firm. As variables representing the degree of product differentiation at the firm level, we use the ratio of R&D expenditure to sales (*RDRATIO*) and the ratio of advertising expenditure to sales (*ADVRATIO*). As variables representing firms' financial conditions, we use the ratio of firm liquidity assets to total assets (*CASH*) and a dummy variable taking a value of one if a firm is listed (*LISTED_DUMMY*). Further, we use several variables representing the availability of information on export markets to firms: the ratio of firms' investment and lending abroad to total assets (*FOR_INVRATIO*), the ratio of firms' imports to sales (*IMPORTRATIO*), the foreign ownership ratio of a firm (*FOREIGNOWN*), the number of firms located in the same city (*NEARBYFIRMS*), and the number of exporters in the same industry and in the same city (*NEARBYEXPORTERS_IND*). We also construct a series of dummy variables categorizing firms on basis of several of these firm characteristics. Specifically, these dummies are *HI_RDRATIO_DUMMY,* a dummy variable taking a value of one if *RDRATIO* is greater than the median; *HI_ADVRATIO_DUMMY,* a dummy variable taking a value of one if *ADVRATIO* is greater than the median; *HI_FORINV_DUMMY*, a dummy variable taking a value of one if *FOR_INVRATIO* is greater than the median; and *HI_IMPORT_DUMMY,* a dummy variable taking a value of one if *IMPORTRATIO* is greater than the median. We are particularly interested in the variables representing R&D and advertising intensities, since we consider these variables as proxies for the degree of product differentiation at the firm level.[5]

While the variables mentioned above are measured as of one period before each data point, we also include some explanatory variables to characterize firms when they enter export market. For this purpose, we construct the R&D and advertising expenditure to sales ratios as of the time a firm

[5] These measures may not be perfect as proxies for the degree of product differentiation. Firms producing intermediate goods such as parts and components usually spend much less on advertising than firms producing finished goods or consumer products. Therefore, advertising intensity may not sufficiently capture the degree of product differentiation in the case of intermediate goods producers. Moreover, a certain amount of R&D expenditure may be directed to process innovation for the purpose of cost reduction, not to product innovation associated with product differentiation. However, because it is extremely difficult to obtain measures of product differentiation at the firm level, these are the only measures we are able to use at present.

started exporting (*PREEXP_RDRATIO* and *PREEXP_ADVRATIO*). We also include the dummy variables *HI_PRE_RDRATIO_DUMMY* and *HI_PRE_ADVRATIO_DUMMY*, which take a value of one if *PREEXP_RDRATIO* and *PREEXP_ADVRATIO* are greater than the median. Summary statistics for all the variables used in our econometric analysis are provided in Table 1(b).

3.2. Empirical framework

Using our firm-level spell data, we examine how exporter firms' characteristics affect the likelihood of exit from export markets by employing both hazard and panel probit estimations with time-varying covariates. To implement a semi-parametric hazard estimation, we employ a Cox (1972) model for the estimation of the impact of firm characteristics on the hazard rate. The advantage of using a Cox model is that does not require any assumptions regarding the shape of the hazard function over time. However, both the Cox model and the parametric hazard estimation model do not really allow us to properly control for unobserved heterogeneity, and employing these models requires us to impose the restrictive assumption of proportional hazards. Given these drawbacks, we also employ panel probit estimation as an alternative to check the robustness of our results.

We start by describing the basic structure of the duration model.[6] Spell T is defined as the amount of time that passes before the occurrence of a certain random event. In our case, the random event is the exit from export markets and the beginning of the spell is set as the entry to export markets. The distribution of spells can be summarized by survivor function $S(t)$, which denotes the probability that the event has not yet occurred as of t. That is:

$$S(t) \equiv Pr(T \geq t) \tag{1}$$

The survivor function can be used to further define the hazard function $\lambda(t)$. This represents the probability that the event occurs in the next instantaneous moment, conditional on the non-occurrence of the event as of t. That is:

$$\lambda(t) \equiv \lim_{\tau \to \infty} \frac{Pr(t + \tau > T \geq t | T \geq t)}{\tau} = -\frac{d\, ln\, S(t)}{dt} = \frac{f(t)}{S(t)} \tag{2}$$

where $f(t)$: Density associated with the distribution of spells.

The aim of the duration model is to estimate the hazard function and the survivor function while considering the effects of potentially time-varying covariates. Suppose $x(t)$ and $\theta \equiv \{\alpha, \beta\}$ denote

[6] For a more detailed discussion of duration models, see Kiefer (1988).

the time-varying covariates at time t and the time-invariant model parameters, respectively. Then the survivor function takes the following structure:

$$S(t, x(t); \theta) \equiv Pr(T \geq t, x(t); \theta) \tag{3}$$

The proportional hazard model assumes the hazard function $\lambda(t, x, \theta)$ takes a multiplicative form consisting of one component (the baseline hazard) that depends only on the duration $\lambda_0(t, \alpha)$ and another component that exclusively captures the effects of the covariates $\phi(x(t), \beta)$. That is:

$$\lambda(t, x(t), \theta) \equiv \lim_{\tau \to 0} \frac{Pr(t + \tau > T \geq t | T \geq t, x(t); \theta)}{\tau} = \lambda_0(t; \alpha)\phi(x(t), \beta) \tag{4}$$

In the absence of any censoring problems, which will be discussed in a moment, and provided that we can specify the functional forms for $\lambda_0(t; \alpha)$ and $\phi(x(t), \beta)$, it is possible to estimate $\theta \equiv \{\alpha, \beta\}$ by maximizing the likelihood function for the given values of $\{t_i, x(t_i)\}_{i=1}^{n}$, where t_i and $x(t_i)$ denote the length of a completed spell for observation i out of n observations and the set of time-varying explanatory variables for observation i, respectively.

One common problem associated with duration data is censoring. If all of our observations are uncensored, we can simply apply maximum likelihood estimation (MLE) to the data. However, in the presence of censored observations, adjustments are necessary. For right-censoring, the adjustment procedure is well established and straightforward (Kiefer 1988). As we mentioned above, there are a large number of observations that are censored from the right. We adjust for these by treating right-censored observations as survivors at the end of the observation period and apply a Tobit-type adjustment to the likelihood function for the estimation. Note that if we only need to take right-censoring into account, then the survivor function can be estimated using non-parametric estimation (see, e.g., Kaplan and Meier 1958).

As for the components of $x(t)$, which are the covariates of the estimated hazard function, we use the firm-level variables introduced in Section 3.1. In order to take any potential endogeneity into account, we lag all right-hand side variables by one year. Given that the time to exit from export markets may be industry specific and year specific, we also control for industry fixed effects at the 2-digit industry level and year fixed effect. In order to control for the timing of entry to export markets, we also include entry timing-specific fixed effects, which we call the cohort effect. This cohort effect may capture, for example, that firms that started exporting at a time when the domestic currency was weak may exhibit lower survivability in export markets.

Next, we explain the structure of the panel probit estimation we employ to investigate the determinants of the exit from export markets. Following previous empirical studies on the determinants of the extensive margin (e.g., Koenig et al. 2010, Minetti and Zhu 2011), we assume that firm *i* exits from export markets if its profits are larger when doing so than when not doing so. Let π_{it}^* represent the difference between the profits of firm *i* when it exits from export markets at time *t* and its profits when not doing so. The difference is determined by the firm's characteristics, including the degree of product differentiation at the firm level, its financial condition, and the availability of information on export markets to the firm. The degree of the firm's product differentiation is assumed to affect the choice of strategy entering the export market (i.e., the trade technology in the terminology used by Békés and Muraközy, 2012). Firms producing more differentiated products are more likely to pay the upfront sunk fixed costs and therefore face lower transport costs. As a result, we expect that firms producing more differentiated products achieve higher profits by continuing rather than stopping to export. Furthermore, we also conjecture that export experience substantially lowers the uncertainty of profits and that export duration up to the current year affects the survivability of firms in export markets in the next year. If such learning-by-exporting effects are indeed present, *EXP_DURATION* should be negatively correlated with the probability that firms exit from export markets. Therefore, we parameterize π_{it}^* as follows:

$$\pi_{it}^* = \alpha_1 + \lambda EXP\_DURATION_{it-1} + Z_{it-1}\beta_1 + \varepsilon_{it} \quad (5)$$

where $EXP\_DURATION_{it-1}$ denotes the export spell length measured in the manner described above. Z_{it-1} is a vector of controls for firm characteristics including the degree of product differentiation and firms' financial condition, which are expected to affect firms' differential profits π_{it}^*, and ε_{it} captures unobserved firm characteristics and other unknown factors that may also affect differential profits. We assume that firm *i* stops exporting if differential profits $\pi_{it}^*>0$. Under the assumption that ε_{it} is a normally distributed random error with zero mean and unit variance, the probability that firm *i* stops exporting can be written as follows:

$$Prob_{it} = Prob(\alpha_1 + \lambda EXP\_DURATION_{it-1} + Z_{it-1}\beta_1 + \varepsilon_{it} > 0) \quad (6)$$

We estimate equation (6) with a random effect panel probit approach. The dependent variable $Prob_{it}$ denotes the change in export status at the firm level and takes a value of one if a firm stops exporting at time *t*. Note that, for this estimation, we only use firms which exported at time *t-1*.

4. Empirical Analysis

4.1. Non-parametric estimation results

Before conducting detailed analyses, we first show the results based on a non-parametric estimation of the hazard of exiting from export markets. The advantage of such a non-parametric estimation is that we do not need to assume any specific functional form for the hazard function. To estimate the cumulative hazard function, we use the Nelson–Aalen estimator, which is defined as follows:

$$\widehat{\mathrm{H}}(\mathrm{t}) = \sum_{\mathrm{j}|\mathrm{t_j} \leq \mathrm{t}} \left(\frac{\mathrm{d_j}}{\mathrm{n_j}}\right) : \text{Nelson– Aalen estimator for cumulative hazard function} \quad (7)$$

where

$\mathrm{n_j}$: Number of firms that have not exited from export markets by time $\mathrm{t_j}$

$\mathrm{d_j}$: Number of firms that have exited from export markets by time $\mathrm{t_j}$

Using the Nelson–Aalen estimator, we can approximate the hazard function using a Gaussian kernel with a specific bandwidth. Figure 2 depicts the estimated hazard function, $\lambda(t)$, with the approximated hazard function smoothed by a Gaussian kernel with a bandwidth of 1 as well as its 95% confidence band.

Figure 2 shows that the hazard function is downward sloping. This implies that the longer firms stay in export markets the less likely they are to exit. The result suggests that experience in export markets helps firms predict their export profitability, judge the quality of trading partners, and understand local demand conditions, and raises firms' survivability in export markets.

In order to gain some idea of the determinants of this hazard rate of exiting from export markets, Figure 3 depicts the result of the same non-parametrically estimated hazard function, but this time observations are divided into various sub-samples based on firm characteristics. Panels (a) and (b) show the non-parametrically estimated hazard functions and 95% confidence bands when splitting observation based on *HI_RDRATIO_DUMMY* and *HI_PRE_RDRATIO_DUMMY*, respectively. The two figures show that regardless of the timing of measuring firms' R&D intensity, firms with a higher R&D intensity tend to have a higher rate of survival, especially during the first few years after entry. However, after a few years in export markets, the difference in the hazard rates of exit from export markets between firms with a higher and with a lower R&D intensity becomes statistically insignificant. Similarly, panels (c) and (d) show the non-parametrically estimated hazard functions when splitting observations based on *HI_ADVRATIO_DUMMY* and *HI_PRE_ADVRATIO_DUMMY*, respectively. Moreover, panels (e) and (f) show the non-parametrically estimated hazard functions when splitting observations based on *HI_FORINV_DUMMY* and *HI_IMPORT_DUMMY*, respectively. These four sets of figures suggest that firms with a higher advertising intensity, a higher ratio of investment and lending abroad to total assets, or a higher import-to-sales ratio tend to survive longer in export markets. In the next section, we incorporate these findings with regard to the link between firm characteristics and survivability in export markets into the hazard estimation.

4.2. Semi-parametric and parametric estimation

In this section, we estimate both the semi-parametric and parametric hazard models. We employ the semi-parametric Cox partial likelihood model (Cox 1972) and the parametric hazard model assuming a log-logistic distribution of export spells. The advantage of the former model is that we do not need to put any restrictions on the functional form of the baseline hazard function $\lambda_0(t;\alpha)$. We employ the latter model to check the robustness of the results obtained from the Cox model.

The estimation results are presented in Table 2, with columns (i) and (ii) showing the results for the covariates in the Cox proportional hazard estimation and the parametric estimation, respectively. In the Cox hazard estimation in column (i) we find that the coefficients for firms' R&D intensity and advertising intensity are smaller than one, suggesting that a higher R&D or advertising intensity lowers the hazard and therefore extends the export duration. In the parametric estimation in column (ii), the coefficients of these two variables also indicate that there is a positive association between R&D and advertising intensity and longer export duration. In Section 2, we hypothesized that firms with a higher degree of product differentiation are more likely to choose the SCT technology and stay in export markets for a longer period. If R&D intensity and advertising intensity properly capture the degree of product differentiation, the results imply that the choice of trade technology is associated with export duration, as modeled by Békés and Muraközy (2012).

Further, we find that firms more exposed to overseas markets through foreign investment (i.e., firms that have a higher *FOR_INVRATIO*) are more likely to survive in export markets. Moreover, higher liquidity (*CASH*) also contributes to longer export duration. Meanwhile, the results for *TFP*, *FSIZE*, and *IMPORTRATIO* do not show a consistent pattern in columns (i) and (ii). Hence, we conclude that the impact associated with these variables is not sufficiently robust to alternative model specifications.

Regarding the shape of the hazard curve, Figure 4 depicts the estimated baseline hazard function, $\lambda_0(t;\alpha)$, obtained from the Cox estimation, which implies that the hazard ratio is negatively related to export duration. As a considerable number of firm characteristics as well as three types of fixed effects (i.e., industry, year, and cohort) are controlled for in this estimation, this negative effect of export duration on the probability of exiting from export markets implies that firms are less likely to stop exporting the longer they continue exporting, which is consistent with the learning-by-exporting mechanism.

Table 3 shows the estimated hazard ratios associated with the corresponding explanatory variables. We can easily compute the economic impact of these firm-level characteristics on survival in export markets by using these ratios. For example, the estimated hazard ratio associated with *HI_RDRATIO_DUMMY* (0.8785) implies that the probability for firms with an *RDRATIO* above the median to exit from export markets in the next period is 12.15% lower (1-0.8785) than that for firms with an *RDRATIO* equal to or below the median. Similarly, the estimated hazard ratio associated with *HI_ADVRATIO_DUMMY* (0.8148) implies that the probability for firms with an *ADVRATIO* above the median to exit from export markets in the next period is 18.52% lower (1- 0.8148) than that for firms with an *ADVRATIO* equal to or lower than the median. Given that the hazard rates of exit from export markets over the first 1-5 years, as shown in Figure 2, are around 3-5%, the latter result, for example, means that switching from *HI_ADVRATIO_DUMMY*=0 to 1 decreases the hazard rates of exit from export markets over the first 1-5 years to around 2.5-4% (=3-5% multiplied by 0.8186), which is not negligible.

To examine industry differences in terms of the survival probability, Figure 5 plots the hazard ratio associated with each industry dummy and the 95% confidence band in ascending order of the estimated hazard ratio.[7] The figure shows that the estimated hazard ratios are significantly lower than one for firms in industries such as the miscellaneous electrical machinery equipment, rubber products, and general industry machinery industries. Therefore, the probability to exit from export markets in the next period is significantly lower for these firms, implying that firms in these industries are more likely to continue exporting than firms in the reference industry (paper products). On the other hand, the point estimates of the hazard ratio for firms in the miscellaneous foods and related products, livestock products, furniture and fixtures, and lumber and wood products industries are greater than one. Although the point estimates are not statistically significant due to the wide confidence bands, this result implies that compared to the firms in the first group of industries, firms in the second group of industries are less likely to survive in export markets for a long period. Given that products in the first group of industries are more complex manufacturing products than those in the latter group of industries, we can interpret the result as indicating that firms in industries manufacturing differentiated products are more likely to survive in export markets for a longer period.[8] Our result is consistent with that obtained by Besedeš and Prusa (2006b), who, using product-level trade data, show that differentiated goods are traded longer than homogeneous goods.

4.3. Panel probit estimation

[7] Figure 5 is based on the results of the estimation shown in column (ii) of Table 2, where, however, the estimated hazard ratios for the industry dummies are suppressed.

[8] Regarding the time-fixed effect and the cohort-fixed effect, few of the estimated coefficients were significant.

In this section, we show the results based on the random-effects panel probit estimation. The estimation results are shown in column (iii) in Table 2. We find, first, that the probability of exiting from export markets decreases as *EXP_DURATION* becomes larger, which is consistent with our findings based on the hazard estimation. Second, unlike in the hazard estimation result, firms with higher *TFP* tend to survive in export markets for a longer period, which is consistent with the findings of previous studies such as those by Békés and Muraközy (2012), Görg et al. (2012), and Esteve-Pérez et al. (2013). Third, as expected, firms with a high *RDRATIO* or *ADVRATIO* tend to survive in export markets longer. Fourth, firms with a larger *FSIZE*, *FOR_INVRATIO*, or *FOREIGNOWN* survive in export markets longer. The result for *FSIZE* suggests that larger firms are more likely to have greater and better internal resources and therefore survive in export markets longer. The results for *FOR_INV* and *FOREIGNOWN* suggest that firms with larger overseas investment or larger foreign ownership are more likely to survive in export markets because they have greater knowledge about foreign markets and are less uncertain about their future profits from exporting.

4.4. Pre-exporting characteristics

So far, we have focused on firms' time-variant characteristics measured as of the year preceding each data point regarding whether a firm has exited or not exited from export markets. Although it makes sense to assume that firms' survivability in export markets is affected by their characteristics in the preceding year, what is more relevant in the trade technology choice model by Békés and Muraközy (2012) is firms' characteristics at the time they started exporting. Therefore, in this section we assume that more R&D- and advertising-intensive firms before starting exports are more likely to produce differentiated goods and have a greater incentive to make larger upfront investments, which affects their export survivability. Table 4 presents our estimation results based on this assumption. Specifically, using R&D and advertising intensities before a firm starts exporting (i.e., *PREEXP_RDRATIO* and *PREEXP_ADVRATIO* instead of *RDRATIO* and *ADVRATIO*) as explanatory variables, we again conduct semi-parametric hazard, parametric hazard, and random-effect panel probit estimations, which respectively are shown in columns (i) to (iii). The results are largely consistent with those in Table 2. In particular, firms with a higher R&D intensity before entering export markets tend to have a lower exit rate from export markets. In terms of Békés and Muraközy's (2012) model, this result suggests that such firms are more likely to choose the SCT technology and stay in export markets for longer. Our empirical results suggest that firms producing differentiated products expect a more stable stream of profits from exporting and therefore have a greater incentive to undertake irreversible investments when entering export markets and stay there as long as possible.

5. Conclusion

This study examined the determinants of firm survival in export markets by using survival analysis and panel probit estimation. While most extant studies rely on country-product-destination-level trade data, we used firm-level spell data of export activities to control for firms' experience in export markets. Although there is a growing number of studies examining firm-level export spells, this study is still one of only a few empirical studies relying on firm-level data. The results of our estimations show, first, that the probability of exiting from export markets decreases as export duration increases, implying that there is a learning-by-exporting effect influencing firms' survivability in export markets. Second, the probability of exiting from export markets is lower if firms are more R&D and/or advertising intensive. Based on the trade technology choice and export duration model by Békés and Muraközy (2012), we hypothesized that firms that are more likely to differentiate their products through R&D or advertising can survive in export markets longer. Our hypothesis assumes that firms producing differentiated products have a greater incentive to incur the upfront sunk fixed costs necessary to start and successfully continue exporting, since they can reasonably expect to achieve a stable stream of profits from exporting through marketing, establishing distribution networks, and/or adapting products to the idiosyncratic characteristics of local demand, resulting in longer export duration. Our estimation results support this hypothesis. Third, firms in industries producing differentiated products (e.g., machinery) show a higher survivability in export markets. This result is also consistent with our hypothesis above. Our finding that the degree to which products are differentiated matters for firms' survivability in export markets also has implications for government policy. One such implication, for example, is that policies aimed at providing support to exporters should be targeted at firms and industries producing differentiated products rather than homogeneous products. Another is that policies to support R&D activities – desirable in their own right to boost productivity growth – indirectly also contribute to increasing firms' survivability in export markets.

Finally, we would like to highlight potential avenues for future research. First, expanding the analytical framework used in the present study to examine survivability in specific export destinations is one promising future research avenue, since it would be interesting to see whether and how the learning-by-exporting mechanism and the importance of product differentiation differ across different export destinations. Second, another important extension would be to explicitly take firms' past export experience into account. In the present study, we treated each spell as independent based on the assumption that firms need to incur sunk entry costs once they have been away from export markets for a certain length of period. Yet, it is possible that firms' past export experience still matters for their survivability in export markets. Third, ideally, we would also take firms' exit not only from export markets but also from their business into account. While in this paper we did not distinguish these two types of exit, Vicard (2014) finds that firms that stop exporting permanently are also more likely to default than firms that are similar ex ante (before exporting). It would be interesting to examine the interaction between the exit from export markets and firm exit. We believe all of these potential extensions could provide further insights for a better understanding of how firms can become always exporters.

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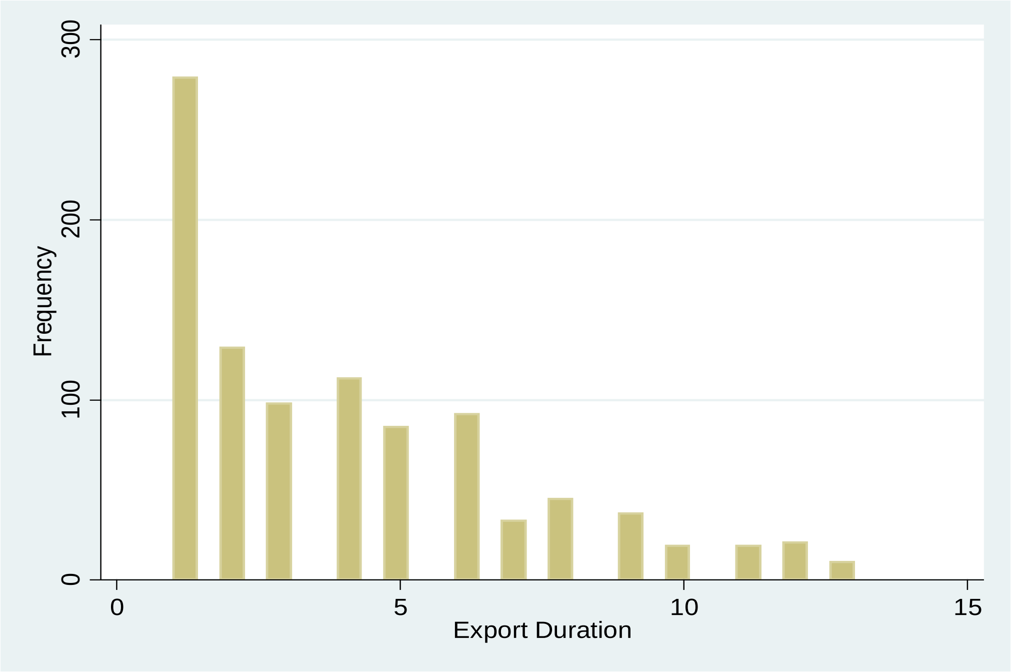
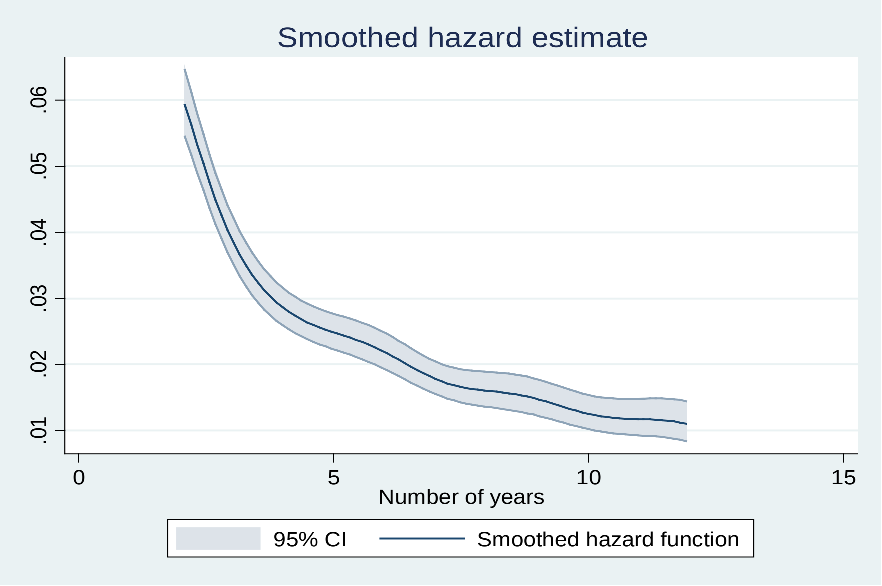
Tables and Figure

Figure 1: Distribution of the time to exit from export markets



Note: The horizontal axis represents the number of years between the entry to and exit from export markets, while the vertical axis shows the number of observations that exited from export markets.

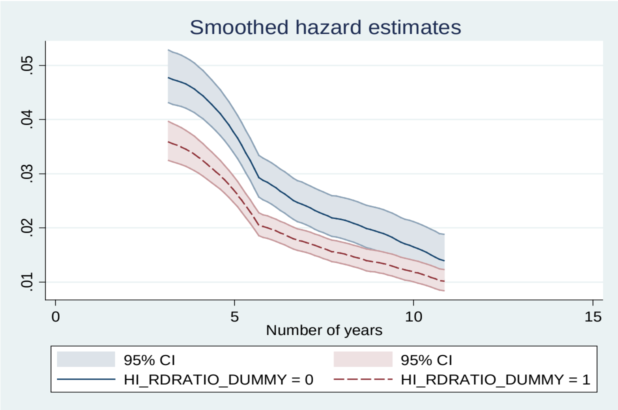
Figure 2: Non-parametrically estimated hazard function



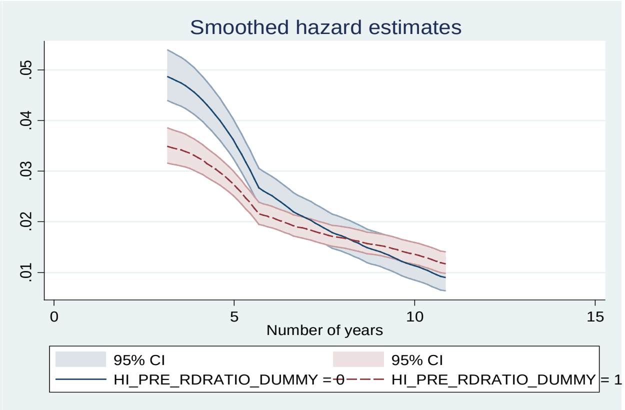
Note: The horizontal axis shows the number of years measured from the entry to export markets, while the vertical axis represents the probability that a firm exits from export markets in the next period, conditional on the non-occurrence of this event as of *t*.

Figure 3: Non-parametrically estimated hazard functions (sub-samples)

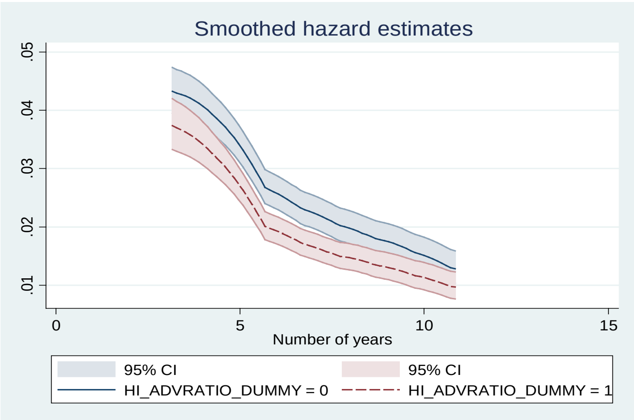
Panel (a) R&D ratio



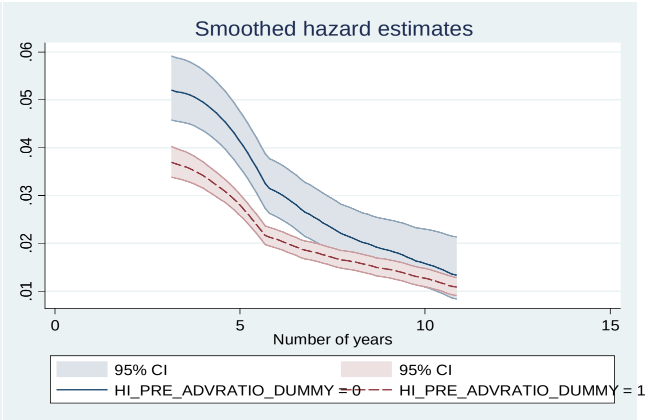
Panel (b) R&D ratio in year prior to starting exporting



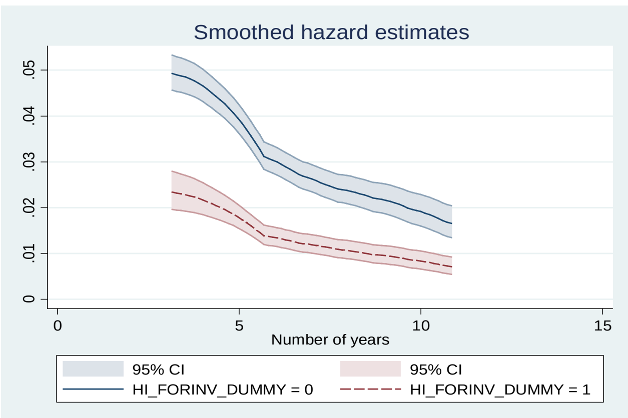
Panel (c) Advertising ratio



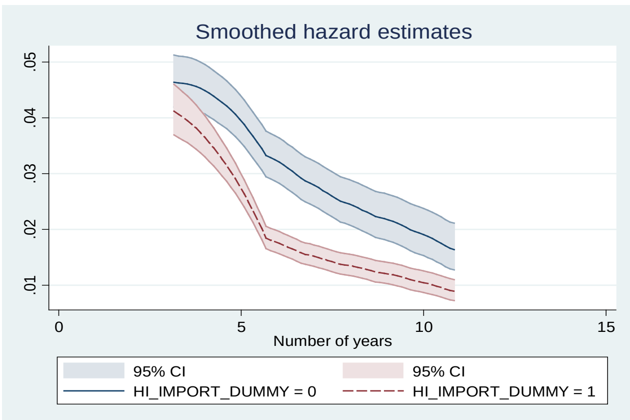
Panel (d) Advertising ratio in year prior to starting exporting



Panel (e) Foreign investment

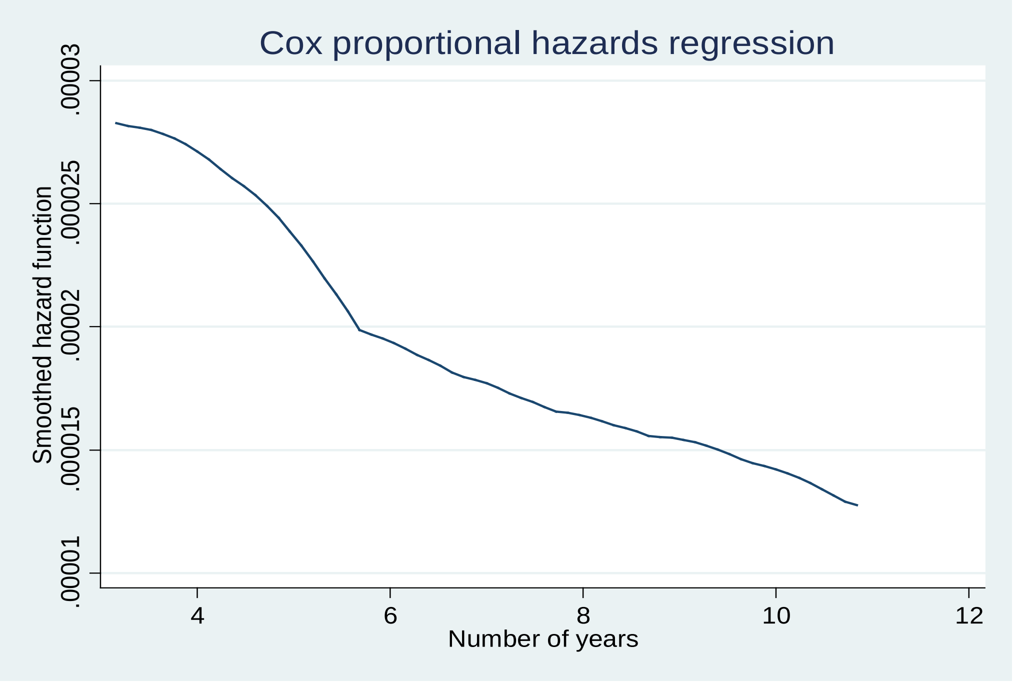


Panel (f) Imports



The horizontal axis shows the number of years measured from the entry to export markets, while the vertical axis represents the probability that a firm exits from export markets in the next period, conditional on the non-occurrence of this event as of *t*.

Figure 4: Estimated hazard curve in Cox model



Note: The figure depicts the estimated baseline hazard function obtained from the Cox hazard estimation. The horizontal axis shows the number of years measured from the entry to export markets, while the vertical axis represents the baseline probability that a firm exits from export markets which depends only on the duration.

Figure 5: Hazard ratio associated with industry-level dummy variables

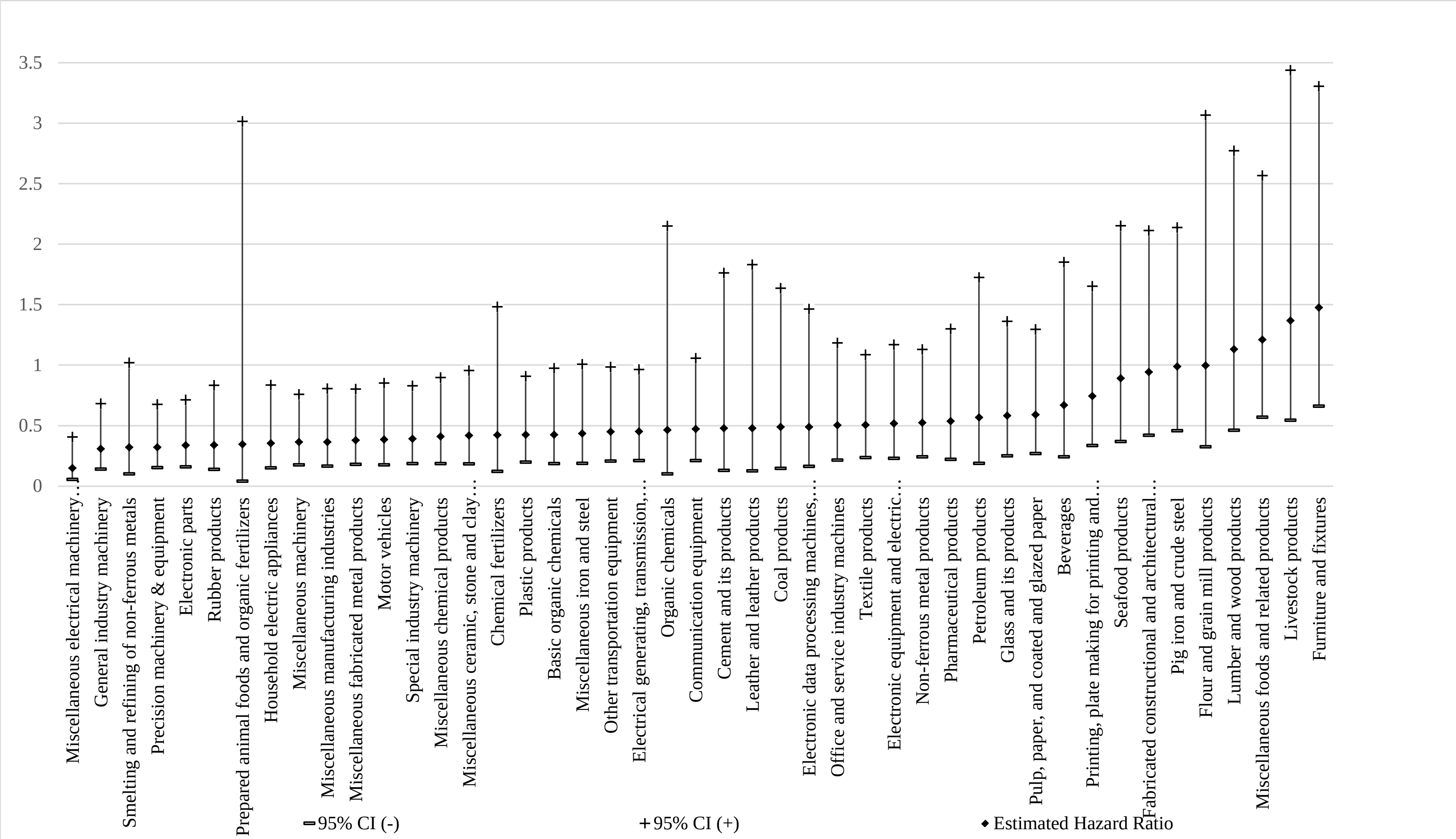


Table 1 (a): Summary statistics of *EXP_DURATION* for completed spells

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
EXP_DURATION	979	4.05	3.08	1	13

Table 1 (b): Summary statistics of variables

Variable	Definition	Obs.	Mean	Std. Dev.	Min.	Max.
EXP_DURATION	Duration of export measured by a number of years	35,292	6.64	3.75	1	15
TFP	Total factor productivity measured using the approach by Good et al. (1997)	35,292	0.05	0.15	-0.65	0.59
RDRATIO	R&D expenditure / Sales	35,292	0.01	0.02	0.00	1.20
HI_RDRATIO_DUMMY	Dummy variable taking a value of one if RDRATIO is greater than zero	35,292	0.70	0.46	0	1
PREEXP_RDRATIO	R&D expenditure / Sales as of entering export markets	35,292	0.01	0.01	0.00	0.06
HI_PRE_RDRATIO_DUMMY	Dummy variable taking a value of one if PREEXP_RDRATIO is greater than zero	35,292	0.70	0.46	0	1
ADVRATIO	Advertising expenditure / Sales	35,292	0.00	0.01	0.00	0.50
HI_ADVRATIO_DUMMY	Dummy variable taking a value of one if ADVRATIO is greater than zero	35,292	0.51	0.50	0	1
PREEXP_ADVRATIO	Advertising expenditure / Sales as of entering export markets	35,292	0.00	0.00	0.00	0.02
HI_PRE_ADVRATIO_DUMMY	Dummy variable taking a value of one if PREEXP_ADVRATIO is greater than zero	35,292	0.85	0.36	0	1
FSIZE	Natural logarithm of firm total assets	35,292	9.04	1.46	3.81	16.18
AGE	Firm age (data year - establishment year)	35,214	44.56	17.26	0	162
CASH	Firm liquidity assets / Total assets	35,292	0.58	0.15	0.00	1.00
LISTED_DUMMY	Dummy variable taking a value of one if firm is listed	35,292	0.08	0.26	0	1
FOR_INVRATIO	Firm lending abroad / Total assets	35,292	0.03	0.09	0.00	13.57
HI_FORINV_DUMMY	Dummy variable taking a value of one if FOR_INVRATIO is greater than zero	35,292	0.48	0.50	0	1
IMPORTRATIO	Firm imports / Sales	31,283	0.04	0.09	0.00	0.94
HI_IMPORT_DUMMY	Dummy variable taking a value of one if IMPORTRATIO is greater than zero	35,292	0.67	0.47	0	1
FOREIGNOWN	Foreign ownership share	35,292	15.18	86.61	0	1000
NEARBYFIRMS	Number of firms located in the same city	35,292	366	573	0	2068
NEARBYEXPORTERS_IND	Number of exporter firms in the same industry and city	35,292	4	7	0	260

Table 2: Baseline estimation

(i) Cox Proportional Hazard Estimates (Time to exit from export markets) Metric = Hazard			(ii) Parametric (Loglogistic) Hazard Estimates (Time to exit from export markets) Metric = Accelerated Failure Time			(iii) Random Effect Panel Probit Estimates (Dummy variable for exiting from export markets)		
Independent Variables	Hazard Ratio	Effect on Duration	Independent Variables	Coef.	Effect on Duration	Independent Variables	Coef.	Effect on Duration
						EXP_DURATION	-0.0689	+++
TFP	1.3749		TFP	-0.2142	−	TFP	-0.3137	+
RDRATIO	2.2E-05	+++	RDRATIO	4.5630	+++	RDRATIO	-3.1376	++
ADVRATIO	4.4E-08	++	ADVRATIO	8.0376	++	ADVRATIO	-10.9769	++
FSIZE	0.9656		FSIZE	0.0242	+	FSIZE	-0.1213	+++
AGE	1.0021		AGE	-0.0010		AGE	-0.0004	
CASH	0.5094	+++	CASH	0.3615	+++	CASH	-0.1878	
LISTED_DUMMY	0.8107		LISTED_DUMMY	0.0936		LISTED_DUMMY	0.0145	
FOR_INVRATIO	0.0010	+++	FOR_INVRATIO	2.9725	+++	FOR_INVRATIO	-0.6905	+
IMPORTRATIO	0.3981		IMPORTRATIO	0.4945	++	IMPORTRATIO	-0.3481	
FOREIGNOWN	1.0000		FOREIGNOWN	0.0001		FOREIGNOWN	-0.0006	+
NEARBYFIRMS	0.9999		NEARBYFIRMS	0.0000		NEARBYFIRMS	0.0000	
NEARBYEXPORTERS_IND	1.0000		NEARBYEXPORTERS_IND	0.0042		NEARBYEXPORTERS_IND	0.0013	
						constant term	-5.6541	
Industry Dummies	Yes		Industry Dummies	Yes		Industry Dummies	Yes	
Year Dummies	Yes		Year Dummies	Yes		Year Dummies	Yes	
Cohort Dummies	Yes		Cohort Dummies	Yes		Cohort Dummies	Yes	
No. of Obs.	31,214		No. of Obs.	31,214		No. of Obs.	29,562	
No. of Subjects	5,471		No. of Subjects	5,471		No. of Groups	5,008	
No. of Failures	795		No. of Failures	795		Obs. per Group Avg.	6	
Time at Risk	31,214		Time at Risk	31,214		Obs. per Group Max.	12	
Wald Chi2	756075.19		LR Chi2	1083.54		Wald Chi2	273.65	
Prob > Chi2	0.0000		Prob > Chi2	0.0000		Prob > Chi2	0.0000	
Log Pseudo-Likelihood	-5883.77		Log Likelihood	-2175.50		Log Likelihood	-2941.65	

Notes: The dependent variable is either the dummy variable taking a value of one when a firm exits from export markets or the hazard of exiting from export markets. Definitions of the independent variables are provided in Table 1. All independent variables are lagged by one year. The group unit for the panel and hazard analyses is the firm. All standard errors in column (i) are adjusted for clusters (firm-level). The column labeled "Effect on Duration" shows the sign of the response of the estimated duration with respect to each covariate (+/- implies that the duration becomes longer/shorter as the covariate becomes larger). +++/---, ++/--, and +/- denote significance at the 1%, 5%, and 10% level, respectively.

Table 3: Economic Impacts

Discretely measured independent variables		
Cox Proportional Hazard Estimates (Time to exit from export markets) Metric = Hazard		
Independent Variables	Hazard Ratio	Effect on Duration
HI_TFP_DUMMY	1.0240	
HI_RDRATIO_DUMMY	0.8785	+
HI_ADVRATIO_DUMMY	0.8148	+++
HI_FSIZE_DUMMY	0.8817	+
AGE	1.0043	−−
HI_CASH_DUMMY	0.9663	
LISTED_DUMMY	0.8093	+
HI_FORINV_DUMMY	0.5147	+++
HI_IMPORT_DUMMY	0.7342	+++
HI_FOROWN_DUMMY	0.8623	
NEARBYFIRMS	0.9999	
NEARBYEXPORTERS_IND	1.0003	
Industry Dummies	Yes	
Year Dummies	Yes	
Cohort Dummies	Yes	
No. of Obs.	35,217	
No. of Subjects	5,718	
No. of Failures	983	
Time at Risk	35,217	
Wald Chi2	584239.85	
Prob > Chi2	0	
Log Pseudo-Likelihood	-7442.5675	

Notes: The dependent variable is the hazard of exiting from export markets. Definitions of the independent variables are provided in Table 1. All independent variables are lagged by one year. The group unit for the panel and hazard analyses is the firm. All standard errors in column (ii) are adjusted for clusters (firm-level). The column labeled "Effect on Duration" shows the sign of the response of the estimated duration with respect to each covariate (+/- implies that the duration becomes longer/shorter as the covariate becomes larger). +++/---, ++/--, and +/- denote significance at the 1%, 5%, and 10% level, respectively.

Table 4: Estimation with pre-export characteristics

(i) Cox Proportional Hazard Estimates (Time to exit from export markets) Metric = Hazard			(ii) Parametric (Loglogistic) Hazard Estimates (Time to exit from export markets) Metric = Accelerated Failure Time			(iii) Random Effect Panel Probit Estimates (A dummy variable for exiting from export markets)		
Independent Variables	Hazard Ratio	Effect on Duration	Independent Variables	Coef.	Effect on Duration	Independent Variables	Coef.	Effect on Duration
						EXP_DURATION	-0.0691	+++
TFP	1.3931		TFP	-0.2164	−	TFP	-0.2667	
PREEXP_RDRATIO	3.7E-06	+++	PREEXP_RDRATIO	5.0871	+++	PREEXP_RDRATIO	-6.2179	+++
PREEXP_ADVRATIO	8.3E-09	+	PREEXP_ADVRATIO	9.5390	++	PREEXP_ADVRATIO	-1.0936	
FSIZE	0.9661		FSIZE	0.0243	+	FSIZE	-0.1160	+++
AGE	1.0023		AGE	-0.0011		AGE	-0.0004	
CASH	0.5152	+++	CASH	0.3538	+++	CASH	-0.1977	
LISTED_DUMMY	0.8170		LISTED_DUMMY	0.0918		LISTED_DUMMY	0.0152	
FOR_INVRATIO	0.0009	+++	FOR_INVRATIO	3.0025	+++	FOR_INVRATIO	-0.6768	
IMPORTRATIO	0.4061		IMPORTRATIO	0.4882	++	IMPORTRATIO	-0.3707	
FOREIGNOWN	1.0000		FOREIGNOWN	0.0001		FOREIGNOWN	-0.0006	+
NEARBYFIRMS	0.9999		NEARBYFIRMS	0.0000		NEARBYFIRMS	0.0000	
NEARBYEXPORTERS_IND	1.0001		NEARBYEXPORTERS_IND	0.0043		NEARBYEXPORTERS_IND	0.0011	
						constant term	-5.6734	
Industry Dummies	Yes		Industry Dummies	Yes		Industry Dummies	Yes	
Year Dummies	Yes		Year Dummies	Yes		Year Dummies	Yes	
Cohort Dummies	Yes		Cohort Dummies	Yes		Cohort Dummies	Yes	
No. of Obs.	31,214		No. of Obs.	31,214		No. of Obs.	29,562	
No. of Subjects	5,471		No. of Subjects	5,471		No. of Groups	5,008	
No. of Failures	795		No. of Failures	795		Obs. per Group Avg.	6	
Time at Risk	31,214		Time at Risk	31,214		Obs. per Group Max.	11	
Wald Chi2	590045.38		LR Chi2	1081.03		Wald Chi2	274.17	
Prob > Chi2	0.0000		Prob > Chi2	0.0000		Prob > Chi2	0.0000	
Log Pseudo-Likelihood	-5884.71		Log Likelihood	-2176.76		Log Likelihood	-2941.75	

Notes: The dependent variable is either the hazard of exiting from export markets or the dummy variable taking a value of one when firms exit from export markets. Definitions of the independent variables are provided in Table 1. Except for PREEXP_RDRATIO and PREEXP_ADVRATIO, both of which are measured one period before firms start exporting, all independent variables are lagged by one year. The group unit for the panel and hazard analyses is the firm. All standard errors in column (i) are adjusted for clusters (firm-level). The column labeled "Effect on Duration" shows the sign of the response of the estimated duration with respect to each covariate (+/- implies that the duration becomes longer/shorter as the covariate becomes larger). +++/---, ++/--, and +/- denote significance at the 1%, 5%, and 10% level, respectively.