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What Explains the Low Survival Rate of Developing Country Export Flows?

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Abstract

Successful export growth and diversification require not only entry into new export products and markets, but also the survival and growth of export flows. This paper uses a detailed, cross-country dataset of product level bilateral export flows to illustrate that exporting is an extremely perilous activity and especially so in low-income countries. The authors find that unobserved individual heterogeneity in product-level export flow data prevails despite controlling for a wide range of observed country and product characteristics. This questions previous studies that have used the Cox proportional hazards model to model export survival. The authors estimate a Prentice-Gloeckler model, amended with a gamma mixture distribution summarizing unobserved individual heterogeneity. The empirical results confirm the significance of a range of products as well as country-specific factors in determining the survival of export flows. From a policy perspective, an interesting finding is the importance of learning-by-doing for export survival: experience with exporting the same product to other markets or different products to the same market are found to strongly increase the chance of export survival. A better understanding of such learning effects could substantially improve the effectiveness of export promotion strategies.

This paper—a product of the International Trade Department, Poverty Reduction and Economic Management Network—is part of a larger effort in the department to understand the constraints to export diversification and growth in low income countries. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The authors may be contacted at pbrenton@worldbank.org and csaborowski@worldbank.org.

What Explains the Low Survival Rate of Developing Country Export Flows?*

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1. Introduction

Recent work by Besedes and Prusa (2007), Brenton and Newfarmer (2007) and Amurgo-Pacheco and Peirola (2007) shows that export growth in developing countries has been driven predominantly by the intensive rather than the extensive margin of trade. That is, growth comes primarily from existing trade flows rather than from new trade flows. Brenton, Pierola and von Uexkull (2009) show that poorly performing developing countries are not inferior to stronger performing countries with regard to the introduction of new trade flows but experience much lower rates of survival. It is these low survival rates that undermine the expansion of export flows. In their seminal study, Besedes and Prusa (2006b) conclude that for developing countries the key element in achieving higher aggregate export growth is higher survival rates for existing trade flows.

From a practical policy point of view it is important not only to understand the factors driving entry into exporting but also to understand the process by which exports are sustained and export flows grow in volume. Are there factors that are amenable to public policy interventions that impact the chances of survival of a particular exporter or export flow? Do these factors impinge particularly heavily on firms in low-income countries?

This paper makes an attempt at answering these questions. We build on the initial study of the determinants of export flow duration by Besedes and Prusa (2006b)[1], first, by investigating a novel data set of more detailed product level trade flows comprising a large number of both developing and developed country imports and exports that includes low-income as well as middle and high-income exporters. Second, we pursue a more rigorous empirical approach that examines the reliability of the continuous time proportional hazards model that has to date been unquestioningly used to assess the determinants of the survival rates of export flows (Besedes and Prusa, 2006b; Blyde, 2008). This model is mis-specified in the presence of unobserved heterogeneity, a strong possibility with export data, for example, from the unobserved quality of the management of the underlying exporting firms.

[1] Blyde (2008) provides another application of the basic approach used by Besedes and Prusa (2006b).

We provide strong evidence against the validity of the proportional hazards assumption in the Cox model. A possible explanation can be the presence of unobserved individual heterogeneity that is not accounted for. Given the nature of the trade flow data where survival rates are grouped into annual observations and there are many tied failure rates, we estimate the Prentice-Gloeckler (1978) model which provides a discrete time equivalent of the Cox proportional hazards model. We augment this with a gamma mixture distribution to address unobserved individual heterogeneity (Meyer, 1990). Our analysis reveals that accounting for unobserved heterogeneity is indeed important as both coefficients and significance levels change dramatically. In general, failure to account for unobserved heterogeneity will, if it is indeed important, over-estimate the degree of negative duration dependence in the (true) baseline hazard, and under-estimate the degree of positive duration dependence. Moreover, the proportionate effect of a given regressor on the hazard rate is no longer constant and independent of survival time and the proportionate response of the hazard to variation in each regressor at any survival time is attenuated. All of this is precisely what we observe.

Our empirical results confirm that cultural and geographic ties between trading partners as well market size and exporting experience play an important role in export survival. The results moreover suggest that exporting experience is product and region specific, particularly for developing country exporters. Using the classification proposed in Rauch (1999), we also show that, in line with standard findings in the literature, factors determining search costs as well as cultural and geographic ties between trading partners matter more for differentiated than for homogeneous products. We check for the robustness of all of these results using a range of alternative models and specifications. Finally, the importance of unobserved heterogeneity in product level export flows points to the importance of using firm- as well as product level data in understanding export survival.

The paper is organized as follows. Section 2 presents the data set and provides descriptive statistics on the global pattern of duration dependence in the data as well as differences in the determinants across product groups. Section 3 provides a brief review of both the theoretical and the empirical literature on entry into and exit out of export markets. In Section 4, we discuss the econometric specification of a hazard model that incorporates country and product specific factors that influence export survival and present the empirical results including a battery of robustness checks. Section 5 concludes.

2. Data and Patterns of Export Survival

In this paper, we use a novel data set that is more comprehensive than those used in previous studies of trade flow survival in a number of important dimensions. We investigate trade flows at the 5 digit level of the SITC from 82 exporting countries to 53 importers. This amounts to a total of 2,861,394 export lifetime spells.[2]

The level of product detail in our data is finer than that of previous studies. We consider 1271 products (mineral oils are excluded) whereas the dataset of Blyde (2008) has 625 products and that of Besedes and Prusa (2007) has 380.[3] Hence, it is interesting to see if the conclusions of these previous studies hold for more detailed products but we do feel that the more detailed product data better captures the dynamics of entry and exit into exporting. At a high level of aggregation, the results may be distorted by the fact that different product sub-categories classified into one group may be subject to different survival patterns.

Our coverage of exporters is broader than previous studies with the explicit intention of including a wider range of countries with differing income levels and in particular to include more Sub-Saharan African countries. Blyde (2008) has 47 high and middle-income exporters and no low-income countries whereas Besedes and Prusa (2006b) investigate the export survival patterns of 46 countries, only one of which, Madagascar, is a low-income country. Our data set covers 82 exporters including 22 low-income countries and 22 countries from Sub-Saharan Africa.

[2] We treat an export occurrence as a flow in excess of $1000 but do test the sensitivity of our conclusions to flow size.

[3] Besedes and Prusa (2006b) and Nitsch (2007) use very detailed data at or close to the tariff line level but only analyse the duration of exports to a single market, the US and Germany respectively.

As is widely accepted, import data tend to be more reliable than export data, especially for developing countries, and so we have used mirror statistics from importing countries to put together the dataset. The dataset spans a period of 20 years from 1985 to 2005, sufficient to undertake meaningful survival analysis. Utilizing the COMTRADE database, we chose all importers that report consistent data at our desired level of disaggregation over the entire sample period. This means, however, that the number of importers in our data set is less than in previous studies.[4] We were, however, mindful to include only countries that reliably report annual import information so as to exclude the possibility that apparent export births and deaths were not the result of a country failing to report in a particular year.

Inevitably, some of the available data are left or right censored. This is the case for about a quarter of the flows in our sample. Left censoring implies that we observe flows in the first year of our sample period but do not know for how long they have been in existence. Right censoring implies that we observe flows in the final year of our sample but do not know how long they will continue to exist. The latter type of censoring is less of a problem since the estimation techniques use the information on the time of survival up to the censoring point but do not make any inference upon what happened to the spell subsequently. Left-censoring is a more serious problem. Econometric techniques that deal with left-censored spells efficiently typically have to rely on strong additional assumptions or supplementary data which is not available in our case.[5] We have therefore decided to exclude left-censored observations from our dataset.

[4] The need for consistent import data over 21 years means that most African countries and transition economies are absent from the importer group. The COMTRADE database revealed that the largest sample of importers could be obtained for data reported according to the Standard International Trade Classification (SITC) as opposed to the Harmonised System that has been more recently introduced. Working with the SITC allows for the longest possible time dimension. As the SITC has been twice revised during our sample period, we combined the data using the backwards concordance to Revision 1. In general backwards concordance leads to more consistent product level data over time but at the price of less detail. There is an issue regarding a small number of product categories that are joined together in subsequent revisions. There are around 100 categories where backward concordance appears to be problematic as shown by the appearance of zeros in the aggregate of imports from all countries in our sample. Including these product categories may therefore introduce some bias into the analysis of survival. On the other hand, the fact that these product categories are aggregated over time suggests that they have become less important and indeed may contain important information. An extreme example is the product code for steam engines.

[5] See, for example, D'Addio and Rosholm (2005)

Tables 1 and 2 contain some descriptive information on the distribution of export flows across exporters and importers at the beginning and the end of our sample period. It is immediately obvious from Table 1 that both export birth and death rates are high across the sample. On average, about 15 percent of all export relationships prevailing in a given year disappear before the next year begins. Developed country exporters typically experience death rates of less than 10%, whereas developing country exporters face much higher fatality rates with countries such as Mozambique and Zimbabwe experiencing average death rates of 50% or more. The information in Table 2 shows considerable variation in the frequency of the death rate of inflows across importers. Hence, it is important to explain considerable heterogeneity across both exporters and importers in the survival rates of trade flows.

To gain a better understanding of the pattern of duration dependence present in the data, we proceed to investigate non-parametric estimates of the survivor function. Letting T denote the time to a failure event for a particular trade flow, we define the survivor function S (t) as the cumulative probability of surviving up to some point in time t. Our data on the duration of export flows are expressed in annual observations. This means that we only know if an export flow is recorded during the year. For flows that cease in a particular year, all we know is their duration expressed in annual increments. For those flows that survive, the available information is that their duration exceeded the lower limit of the last observed duration. In effect we are working with grouped survival time data, and so we use the life table method to estimate the survival function non-parametrically. This method uses the same idea as the Kaplan-Meier product-limit estimator for continuous time data but adjusts the estimate of the survivor function for the possibility that export flows may have ended at any point during the time interval. This boils down to using an average estimate centered on the midpoint of the interval.

Defining d_j as the number of failures observed in interval i_j, N_j as the number of spells at risk of failure at start of the interval and n_j as the adjusted number of spells at risk of failure at the midpoint of the interval, we can write n_j as $n_j = N_j - \frac{d_j}{2}$ and the lifetable estimator of the survivor function as

$$\hat{S}(t_j) = \prod_{i=1}^{j}\left(1 - \frac{d_i}{n_i}\right)$$

Figure 1 illustrates the life table survival function for the entire sample. The plot shows clear evidence of negative duration dependence throughout the lifetime of the trade flows. In other words, the probability that an export flow will disappear falls the longer is the duration of the flow. Particularly during the first five years after a given trade flow first appears, hazard rates are high. Only about a third of all spells survive this initial period while a fifth survives the first twenty years. This finding is in line with previous results in Besedes and Prusa (2006a) and Blyde (2008), among others and highlights why the intensive margin of trade is so important in the process of export growth in developing countries.

Table 3 presents the estimated rates of survival for three broad income groups and a selected set of exporters. For each of these countries the presence of negative duration dependence is immediately obvious. The estimates clearly suggest that countries at higher stages of development are more likely to see their export flows survive for longer periods of time. For high-income countries 59% of trade flows survive for more than one year. For low-income countries only 39% of flows survive for more than a year. A similar finding is illustrated in Figure 1, showing that the survivor function for OECD countries lies consistently above the survivor function for the remaining countries.

Within these income groups, 70% of US export flows survive for more than one year. In contrast, less than 30% of the export flows of Burkina Faso have spells of more than one year. Whereas some 41% of US export flows survive the first 10 years after they are initiated, only 17% of Argentine, 12% of Egyptian and just 4% Burkina Faso export flows survive for a decade. Table 4 contains additional evidence showing that the average survival rates for the different World Bank defined regions are longer for exports in more developed parts of the world. In all of these cases the Log-Rank test rejects the Null of homogeneity between the different survivor functions. Survival rates are lowest in Sub-Saharan Africa. It is interesting to note that export flow survival rates for East Asia and the Pacific, the most successful developing region of the past 2 to 3 decades, are similar to those of the high-income OECD countries.

The evidence in this section is suggestive in nature. We now proceed to a deeper investigation of the factors that may shorten or enhance the life of an export flow and that may explain differences in survival rates. We are particularly interested in why export flows in low-income countries have substantially lower survival rates than those for middle and high-income countries? We start by reviewing the available literature on the determinants of the duration of export flows before proceeding to an econometric analysis of our trade flow data.

3. The Literature on the Determinants of Export Survival

International trade theory has little to say about the duration of trade flows. Recent developments in trade theory have been focused on heterogeneous firms and entry into exporting and how reductions in trade costs shift resources away from lower productivity firms towards higher productivity exporters. There has been little attention as to why after entering firms may, within a short period of time, cease exporting activity. Similarly, the literature on the export behavior of firms, based extensively on information from firm surveys, has tended to concentrate on differences between exporters and non-exporters and whether the observed higher productivity of exporters is a cause or result of entry into foreign markets. Much less is available on the evolution of exporters after they enter into trade activities (see Tybout (2003)), reflecting in part the lack of continuous surveys.

Hence we do not have recourse to a well established theory on export survival. There are however, a number of studies that identify issues that are pertinent as factors explaining why some export flows may not survive. Issues relating to the information and market knowledge needed for successful entry into exporting are likely to be important in explaining exit. If firms have less than perfect information about the fixed costs of exporting a product to a particular market or there is some uncertainty about the value of these costs, then firms with relatively low productivity that are marginal entrants into exporting may subsequently find that they are unable to survive. Indeed, in the absence of full market information, firms may use entry into export markets as a mechanism for discovering the exact nature of the costs of exporting to that market and withdraw if it is found to be not profitable to incur the fixed costs of exporting. In this case initial entry is likely to take place on a small scale and exit is likely to be prevalent. Short-term entry may also reflect the search processes that are necessary to match suppliers and buyers in the overseas market. “Sometimes their product isn’t right for the market, or the country they chose was not a good fit, or their approach or agents are not right,” (export consultant quoted in Rauch (1996)).

When information on the costs of exporting is well known or can be obtained at little cost then we are more likely to observe entry on a larger scale and exit after a short period should be less frequent. Such information is likely to be more easy to obtain the greater the presence of exporters of other products to the particular overseas market and the greater the overall experience in exporting the specific product. A number of recent papers have sought to formalize the role of imperfect information in influencing the dynamics of entry and exit into exporting.

Rauch and Watson (2003) look at the initiation of export flows from the perspective of buyers in developed country markets where there is some uncertainty concerning the prospect of success of the partnership that they commence with developing country suppliers. Such uncertainty arises from whether the supplier will be able to deliver large orders to the buyer’s specification. The buyer must invest to provide training to the developing country supplier to enable it to produce large orders but that training may or may not work. The buyer may also glean information about the capacity of the supplier before making such an investment by starting with small orders that generate no profits but which reveal whether the training will be successful. In other words, the buyer has the choice of starting small or big. Finally, the buyer has the option of whether to continue or to abandon a relationship with a particular supplier and to search for a new supplier. Importantly, once a successful relationship has been started the buyer is able to access a network of other suppliers and can obtain information on new firms with incurring search costs.

The model suggests that buyers in importing countries are more likely to start a relationship with an exporter with small orders the higher is the search cost and the lower the probability that the supplier will be able to meet the buyer's requirements. The model also predicts that export flows that commence with large orders will tend to have longer duration. This is because buyers will tend to initiate large orders with suppliers that have lower production costs and will be less likely to look for an alternative supplier.

Araujo and Ornelas (2007) characterize information costs relating to exporting in terms of the weakness of contract enforcement. Potential exporters look for partnerships with distributors in overseas markets but the weak institutional environment allows some distributors with little concern for the future to behave opportunistically and to default. In such a climate, forward looking distributors seek to differentiate themselves from myopic distributors by building a reputation over time. Hence, informational costs decline as exporting experience is accumulated. Initial export flows are small but increase over time as the exporter becomes better aware of the trustworthiness of the distributor and the probability that they will default on the contract in the future. Hence, the probability of exit from exporting declines the longer the partnership with the distributor continues.

An improvement in the institutions for contract enforcement has a direct and positive effect on exports by reducing uncertainty and improving the expected return of the exporter. However, there is also an indirect negative impact on the size of exports since stronger contract enforcement reduces the value of future reputation compared to the situation under weaker enforcement. In other words, it becomes more difficult for a distributor that has built a reputation to differentiate itself from other distributors that are now less likely to default because of the threat of a more effective legal challenge. The latter effect will tend to be stronger in cases of initially weak enforcement. Stricter enforcement of contracts also increases the level of initial exports in a new partnership and supports relationships of longer duration.

In a recent study, Albornoz et al. (2009) suggest that firms discover their profitability as exporters only after actually engaging in exporting. According to what the firms learn about themselves, they adjust quantities and decide whether to exit and whether to serve new destinations. Edwards (2007) discusses the impacts of trade liberalization in a situation of search costs and matching of producers and buyers in overseas markets. Once a search process has been undertaken for a long period a proportion of firms and distributors will be matched and will be less sensitive to new potential trade partners. This would explain the negative duration dependence found by Besedes and Prusa (2006) in US import data; once a flow has been established for a period of time the probability of failure becomes much smaller. Established relationships are likely to be less sensitive to changes in the relative prices of different suppliers than for firms and distributors that are still looking for a satisfactory partner. This suggests time dependency and that inappropriate sequencing of trade policy reforms may have long run adverse impacts. For example, preferential import liberalization may lock in trade diversion (due to information costs) even after subsequent multilateral reduction of tariffs has removed tariff preferences.

Information asymmetries and formal institutions for contract enforcement will tend to be more important for buyers searching amongst suppliers providing products of different quality. In other words, the matching of exporters and buyers will tend to be easier for standard and homogeneous products. Much of the discussion concerning export diversification in developing countries centers on increasing exports of differentiated products, especially manufactures, and reducing the importance of homogenous products, particularly commodities. Rauch (1999) presents, albeit tentative evidence, that search costs are higher and matching more difficult for differentiated products and that proximity and common language and colonial links are more important for differentiated than for homogenous products that are traded on organized international exchanges.

The importance of quality introduces an additional set of institutions that may be important in influencing bilateral trade. Poor quality metrology, testing and conformity assessment facilities in developing countries entail either that additional costs will have to be incurred in sending products to more developed countries to assess quality and conformity with private or public standards or that there will be a degree of uncertainty concerning these issues. There may be additional uncertainty regarding the ability of the exporter to consistently deliver the quality of product specific by the buyer. Rauch (2007) shows how domestic institutional reform that reduces the costs of entry into low quality production may undermine the synergy between trade reform and income and, possibly, growth. Thus, institutional reform that targets reducing the costs of entry into high-quality production and reduces search costs related to quality will support exporters in finding and sustaining matches with overseas buyers.

On the basis of the discussion above and following the studies by Besedes and Prusa (2006b), Blyde (2008) and Brenton, Peirola and von Uexkull (2009), we identify the following variables that are likely to influence the hazard rate of export flows:[6]

- The initial value of the trade relationship as a crude proxy for the level of confidence the trading partners originally had in the profitability of the trade relationship.
- The geographic distance between the exporter and the importer is included to capture two types of costs a firm may encounter when engaging in a trade relationship, namely trade costs and the initial cost of searching for an appropriate trading partner. These costs are likely to be lower in neighboring countries that share a common language or common border and countries that historically had colonial ties with each other.
- We include a range of measures in the model in order to capture exporting experience in general and exporting experience at the product- and industry level in particular. Other important determinants can be the exporter's knowledge of the import market as well as the size of the import market. In order to account for these factors, we include the total value of trade between the trading partners and the global value of

[6] Precise definitions of these variables are included in Appendix 1. The reference year for all variables is the year in which the trade relationship starts or, in the case of left-censored observations, 1985, the year in which the sampling period begins.

the importer's imports of the respective product. The larger these flows the greater the potential spillovers of information to new entrants.

- In order to test the importance of trial and error patterns of learning to export to a market, we include a dummy variable indicating whether there have been previous exporting spells of the product to the respective importer.
- Economic size and the wealth of both trading partners should facilitate the survival of trade flows. The reason is that there are likely to be a larger number of buyers in bigger markets, thus increasing the chance of the exporter finding a suitable match. We have experimented with different variables and decided to include the product of the trading partners' GDP in the model to capture this effect. In the robustness section, we will focus on this effect more closely. In addition, we test for whether exporting experience follows a geographic pattern: If market experience with a product is specific to the importing region, then existing export relationships with countries that neighbor the import market should facilitate survival in a new market. We therefore include a dummy variable that indicates whether the exporter is already exporting a given product to a country that is a neighbor of the importing country.
- Finally, we include a number of policy variables. First, we add a measure of the variability of the bilateral exchange rate around the time that the flow is initiated. Second, we include a measure of the deviation of the bilateral exchange rate in the year of entry in the respective exporting relationship from the period average, as a crude proxy for exchange rate misalignment. Finally, we include a dummy variable for the presence of a preferential trade agreement between the trading partners as an indicator for trade policy restrictiveness. Obviously, it would be preferable to include the actual tariff rate faced by the exporter in the import market for each product. Unfortunately, this information is only available for much fewer countries and years such that an attempt to include this information would come at the expense of a strongly reduced sample size.

4. Econometric Specification and Empirical Results

Previous studies that have sought to explain export survival including those by Besedes and Prusa (2006) and Blyde (2008) have used the continuous time proportional hazard

(PH) model proposed by Cox (1972), which is widely used in the field of survival analysis. This model is based on the assumption that variables influencing survival have a proportionate impact on the base hazard function, that is, a change in variable z would increase or reduce the hazard function by the same factor in any period. The mathematical form of the hazard function $\lambda_i(t)$ for export flow i in the Cox model is

$$\lambda_i(t) = \lambda_0(t)\exp(Z_i(t)'\beta)$$

where $\lambda_0(t)$ is the baseline hazard at time t, $z_i(t)$, the vector of covariates for flow i that have a proportional impact on the hazard function and β is a vector of coefficients to be estimated that characterizes how z impacts the hazard function.

The popularity of the Cox model is due to the fact that it allows estimating the relationship between the hazard rate and a set of explanatory variables using a partial likelihood approach without having to make any assumptions about the shape of the baseline hazard function. This is why the model is often referred to as a semi-parametric model. However, this convenient fact relies heavily on the proportional hazard assumption, namely that the baseline hazard function summarizing the pattern of duration dependence can be separated from the individual specific non-negative function of covariates. Hence, the function of covariates scales the baseline survivor function with a constant factor independently of survival time. In a situation in which the data is not consistent with this assumption, the model is mis-specified. Possible reasons for the failure of this assumption could for instance be the omission of relevant time-dependent variables or the presence of unobserved individual heterogeneity. Previous studies of export flow survival at the product level have not tested the proportional hazards assumption and have not investigated unobserved individual heterogeneity (Besedes and Prusa, 2006b; Blyde, 2008).

We begin by estimating a simple Cox model. We initially exclude left censored observations as well as trade flows with a value below 1000 USD. We stratify the sample by our 1271 product categories. Hence we do not force the baseline hazards to be proportional across products and allow a separate baseline hazard function for each product group. The amount of observations in our data set allows us to use such a fine stratification without incurring a problematic drop in the degrees of freedom. The estimation results are presented in Table 5 for our preferred specification of the variables discussed in the previous section. We do not discuss the coefficient estimates at this point as we are only interested in testing for the validity of the model specification, that is, the validity of the PH assumption. A comprehensive discussion of applicable testing procedures for the Cox model can be found in Horowitz and Neumann (1992). An interesting first descriptive check is a plot of the log of non-parametric estimates of the hazard function against time for different subgroups of trade flows in the sample. If the PH assumption is appropriate, we should observe the plots moving in parallel. Although not reported here, we have experimented with different subgroups of the sample and conclude that the evidence from these plots does not support the PH assumption.

Another interesting testing procedure is suggested in Kay (1977). He derives residuals for the Cox model and tests the PH assumption by plotting these so-called Cox-Snell residuals against the Nelson-Aalen cumulative hazard function. In order for the PH assumption to be valid, the plot should deviate little from the 45 degree line. Figure 2 shows that this condition is clearly violated in our data. This result holds independently of whether we stratify the sample or not and whether we include or exclude left censored observations. We experimented with different combinations of covariates including interactions and time-dependent variables in the model to capture as much information as possible. However, the failure of the PH assumption is a result that is robust across all of these specifications.

A formal statistical testing procedure of the PH assumption within the Cox model is based on residuals derived by Schoenfeld (1982). He defines residuals that do not vary over time if the model specification is correct. Table 6 presents the results of testing for a zero slope of the plot of the Schoenfeld residuals against survival time both globally and for each individual covariate. The test statistics and the associated p-values reveal that the Null of a constant slope is rejected with confidence for all but two covariates individually as well as for the model as a whole.

We have provided strong evidence for the failure of the proportional hazard assumption in our data. In the above testing procedures, we experimented with time-dependent covariates as well as with interaction terms and concluded that they appeared to be neither the reason for nor the solution to this problem. Another possible cause of the failure of the PH assumption is the presence of unobserved individual heterogeneity which could arise, for example, from omitted firm specific variables, such as managerial capacity, that capture risk of failure in addition to the observed covariates. In general, failure to account for unobserved heterogeneity will, if it is indeed important, over-estimate the degree of negative duration dependence in the (true) baseline hazard, and under-estimate the degree of positive duration dependence. Moreover, the proportionate effect of a given regressor on the hazard rate is no longer constant and independent of survival time and the proportionate response of the hazard to variation in each regressor at any survival time is attenuated.

We now proceed to estimate a model that addresses the issue of unobserved heterogeneity. First, however, we believe that a discrete time model is more appropriate for trade flow data than the continuous time model that has been applied by Besedes and Prusa (2006b) and followed by others such as Blyde (2008). As discussed above, our data are organized in annual observations. There are also many tied failure times. Such data is properly accommodated in the framework of discrete duration models (see Lancaster (1990)). For this reason we start from the model of Prentice-Gloeckler (1978)[7], which is a discrete time equivalent of the continuous time proportional hazards model. If unobserved heterogeneity is assumed to take a multiplicative form, the hazard function can be expressed as

$$\lambda_i(t) = \theta_i \lambda_0(t) \exp(z_i(t)' \beta)$$

θ_i is an unobserved random variable that is assumed to be independent of the $z_i(t)$, the vector of covariates for flow i. Maximum likelihood estimates of the parameter vector

[7] The Prentice Gloeckler model is an interesting complement to the Cox model as both estimators make no assumption about the shape of the baseline hazard. For suitably re-organized data in export flow-period format, its log-likelihood function is the same as the log-likelihood function for a generalized linear model of the binomial family with complementary log-log link (Jenkins, 1995).

and baseline hazard can be obtained by conditioning the likelihood function on θ_i and then integrating over the distribution of θ. This approach requires specifying a distribution function for θ. Following Meyer (1990), one commonly used approach is to use the gamma distribution with mean one and variance σ^2, which gives a closed form expression for the likelihood function.

Table 7 presents the results from estimating our preferred specification using both the Prentice Gloeckler model and the Prentice Gloeckler model incorporating a gamma mixture distribution summarizing individual heterogeneity.[8] In addition to the explanatory variables of interest to this study, we have included the variable log of time in order to capture the pattern of duration dependence. However, the table also shows that the results are not very sensitive to the exclusion of this additional variable.

A first glance at the results reveals two key findings. First, the p-values for all variables of the model are virtually zero and the LR test strongly rejects the null of the absence of unobserved individual heterogeneity in the data. This result is confirmed when a Normal distribution is used instead of the Gamma mixture distribution to summarize unobserved heterogeneity. Second, the proportional response of the hazard to changes in almost all of the regressors is under-estimated in the basic Prentice-Gloeckler model. Furthermore, the degree of negative duration dependence in the hazard is over-estimated when unobserved individual heterogeneity is not taken into account. This result holds independently of whether we use a Gamma or a Normal distribution to summarize unobserved individual heterogeneity. In fact, the models indicate that the strongly negative duration dependence found in the survivor functions in the previous section is well explained by our regressors once unobserved heterogeneity is taken account of. The coefficient on the log of time term in the two models suggest a slightly downward or even marginally upward sloping baseline hazard.

The strong evidence in favor of the presence of unobserved individual heterogeneity is further emphasized by Tables 8 through 10. The heterogeneity terms are significant no

[8] Throughout this paper, the estimated coefficients are presented in exponential form.

matter whether we examine different product or income groups only or whether we exclude very small trade flows or trade flows for which previous spells are in the sample. An important avenue for future research is thus to better understand the source of the heterogeneity. It is likely that it can be found in the failure to account for firm-specific characteristics in product level data. In this context, it is interesting that a recent application of a discrete time proportional hazards model to firm level Spanish export data (Esteve-Perez, Pallardo and Requena, 2008) indeed found no evidence for the presence of unobserved heterogeneity.

We now move on to discuss the interpretation of the coefficients in our preferred specification in Table 7, the Prentice-Gloeckler model using a Gamma mixture distribution to summarize unobserved individual heterogeneity. Table 10 contains additional robustness checks on these findings. The results strongly support the prediction that hazard rates are lower for export flows with larger initial values. A 100 percent increase in the initial export value lowers the hazard ratio by about 4 percentage points.[9] The high hazard rate for initially small flows suggests caution in public policy interventions that are aimed specifically at exporters that start small (see also Rauch, 2007). This conclusion is only reversed once all trade flows with initial values smaller than 55000 dollars are excluded from the sample (Table 10). The hazard rate is also shown to increase strongly with distance, with a doubling of the distance between the trading partners resulting in a jump in the hazard by 44 percentage points. Intuitively, we would expect trade costs to be the main driver of this effect. It also appears that colonial ties and in particular a common language and a common border significantly increase the likelihood of sustaining bilateral trade flows over time. Qualitatively, all of these results are consistent with what is found in Besedes and Prusa (2006a) and Blyde (2008). However, the coefficient estimates differ markedly in some cases.

Our results also support the hypothesis that previous experience in exporting is important in maintaining a trade relationship. First and foremost, we find that the occurrence of

[9] The importance of the initial size of exports is consistent with work by Brenton and von Uexkull (2007) who find that technical assistance targeted at specific export products tends to be more effective, in terms of the subsequent growth of exports, for larger export flows

previous export spells in the same product category increases the probability that a later flow will survive by more than 50%. Moreover, the results suggest that exporting experience is product rather than market specific. A 100 percent increase in total exports of goods within the same 5 digit product category translates into a reduction of 17 percentage points in the hazard rate. The impact of industry specific and global exporting experience is weaker but not negligible. In addition, the size of the importer's market for a given product also appears to matter.[10] Finally, we confirm the results of previous studies such as Blyde (2008) and Baldwin and Harrigan (2007) in finding that the economic size of both trading partners contributes to facilitating trade flow survival. A likely reason is that the number of possible matches between firms increases with the size of the two economies.

An interesting measure included in our model is the variable indicating whether the exporter already sells the given product to other countries within the region of the importer. The coefficient of 0.67 suggests that the regional nature of exporting experience should not be neglected. It appears that there are learning effects specific to the product and the importing regions that help exporters sustain their trade relationships. This complements the finding of Roberts and Tybout (1995) who show that experience matters for the initiation of trade flows as well. In conjunction with the general result that the intensive margin is crucially important for export growth, this finding suggests that exporters should not look too far when trying to expand exports of their products to additional markets and that existing exporters can assist new export flows by sharing knowledge and information about existing markets.

We also find evidence that both an initial overvaluation of the exporters' exchange rate and higher exchange rate volatility during the initiation period of the export flow decrease hazard rates. This is in line with the idea that a trade flow that was initiated despite adverse initial conditions is initiated because the importer regards it as particularly promising. Moreover, a decrease in the exporter's exchange rate during the lifetime of the trade flow implies that the importer's purchasing power in the exporter's

[10] In the next section, we exclude observations with re-occurring spells from the sample.

currency rises. Naturally, the exporter's products become more attractive and trade flows are more likely to be sustained.

Finally, the coefficient on the PTA dummy indicates that the presence of a preferential trade agreement between the exporter and the importer increases hazard rates significantly. This result is counterintuitive as one would expect preferential trade agreements to facilitate the initial search for an appropriate trading partner as well as maintaining the relationship. A possible reason for this finding could be related to the definition of the relevant variable, namely the fact that the reference year for the dummy is the starting year of the trade relationship. This implies that trade flows, which are subject to a trade agreement, only after they are initiated, are recorded as not being subject to the agreement.[11] Another explanation for this surprising finding could be that some agreements actually facilitate bilateral trade whereas others merely exist on paper. Ideally, one would like to distinguish the de facto impact of the agreements.

Factors such as common language, common border, proximity and other indicators of search barriers to trade may play a greater role for differentiated than for homogeneous goods (see also Besedes and Prusa, 2006a). We formally investigate this notion by dividing our sample into three sub-samples, each corresponding to one of the product categories classified in Rauch (1999).[12] The results in Table 8 confirm that the determinants of export survival differ strongly between the three product groups. As expected, distance, common border, common language and colonial ties appear are factors that play a more decisive role in the survival pattern of differentiated as compared to homogeneous products. The effect of each of these variables on the hazard rate differs by around 10 percentage points between the two different types of products. Intuitively, differentiated products are not traded on organized exchanges such that the exporter must gather information and engage into an extensive search process, both to initiate and to

[11] This is particular problematic for trade relationships that last for the entire sampling period. Many of them have a 'zero' for the PTA dummy simply because the number of PTAs in 1985 was much lower than it is today. As an illustration, only about 16% of trade relationships in 1985 were under a PTA whereas 40% where in 2005.

[12] We have experimented with both of Rauch's classification schemes. Our results are not sensitive to the classification scheme chosen. We report results for the conservative classification.

sustain the trade flow. Factors facilitating this search process then correspond with a higher probability of trade flow survival. Similar arguments can be made for the variables characterizing exporting experience at the product level, economic size of both trading partners and the size of the import market for the respective product. It is also interesting that the positive effect of PTA on the hazard rate is markedly stronger for differentiated than for homogeneous goods. Intuitively speaking, the existence of a preferential trade agreement might be less important in facilitating trade for differentiated products as they are differentiated by nature and might retain their markets even in the presence of higher tariffs.

In Table 9, we distinguish trade flows involving exporters from different income groups. The goal here is to understand whether there are factors affecting the survival of developing country exports more strongly than others. It is first of all interesting to see that the previously surprising positive effect of preferential trade agreements on the hazard is significantly higher for low-income exporters. This result might be explained by the fact that a range of preferential trade agreements in the developing world simply do not function well. Another compelling finding is that both regional exporting experience and the presence of previous trade relationships between two trading partners are most important for low-income exporters, indicating that experience in exporting a particular product to a particular trading partner plays an especially big role in these economies. Similarly, it is perhaps not surprising to find that a colonial relationship between two countries helps high and middle-income exporters less in sustaining their export flows than developing country exporters. Finally, it is interesting to observe that a common border between trading partners has a significantly smaller positive impact on the probability that a trade flow will survive when the exporter is a developing country. This suggests that low-income countries still have a long way to go to fully exploit the advantages of lower trade costs when trading with neighbouring countries.

5. Discussion and Conclusions

Exporting is a perilous activity, particularly in low-income countries. Understanding the determinants of export survival rates is therefore an important challenge for empirical analysis. A policy focus only on entry into exporting will miss a fundamental aspect of the dynamics of exporting. A strategy that seeks to increase and sustain export growth rates should address constraints to growth of the intensive margin and especially the reasons for low survival rates of exports.

In this paper we have sought to extend the initial path-breaking studies of export survival by applying statistical survival techniques to a broad dataset of bilateral export flows with a high level of product and exporter-country detail. In particular we investigate exporters with a wide range of income levels including many low-income countries and countries in Sub-Saharan Africa. Unlike previous studies we formally test, and reject, the assumption of proportional hazards that underlies the standard Cox (1972) model that has typically been used in the literature. We discuss that unobserved individual heterogeneity is a likely cause of the failure of the proportional hazards assumption and estimate a Prentice Gloeckler (1978) model augmented by a gamma mixture distribution, to summarize unobserved individual heterogeneity. The results revealed that accounting for unobserved heterogeneity is indeed important as both coefficients and significance levels change dramatically. These findings also point to the importance of survival analysis using firm-level data to complement studies using product level flow data in modeling export survival.

Our analysis found that the initial size of an export flow is among the important determinants of its survival. The associated high hazard rate for initially small flows suggests caution in public policy interventions that are aimed specifically at exporters that start small. This confirms the reasoning in Rauch (2007), namely that broad institutional changes favoring small rather than large firms are likely to have a relatively small impact on export growth.

We also confirm that cultural and geographic ties between trading partners as well market size and exporting experience play an important role in export survival. In particular, the results showed that exporting experience is product and region specific. Whereas both regional and product specific experience appears to matter most for low-income economies, these countries appear to insufficiently exploit the advantages of trading with their neighboring economies. These findings suggest that policy measures creating a bias against exports of existing products may undermine opportunities for export growth. For example, an export tax on a raw material or intermediate export, designed to support exports of the finished product, may act to constrain export diversification by limiting both the flow of information from overseas markets and the experience in exporting to the respective trading partner. For the same reason, taxing existing exports to fund an export promotion agency is likely to be highly problematic.

Finally, using the classification proposed in Rauch (1999), we showed that, in line with standard theories in the literature, factors determining search costs as well as cultural and geographic ties between trading partners matter more for differentiated than for homogeneous products. This is in line with the often cited view that search costs are higher and trading ties more important for exporting differentiated products.

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Appendix 1: Variable Sources and Definitions

Variable	Definition	Source
Initial Value	ln of the trade value in first year of spell	COMTRADE
Distance	ln of the distance between most populated city in km	CEPII
Border	dummy, 1 for shared border	CEPII
Common Language	dummy, 1 for common language	CEPII
Colony	dummy, 1 if exporter is a former colony of importer	CEPII
GDP Product	product of GDP of importer and exporter in PPP terms	WEO
Total Exports	ln of total exports of the exporter	COMTRADE
Industry Exports	ln of exporter's total exports in industry	COMTRADE
Product Exports	ln of exports of the product to all countries by the exporter in first year of trade relationship	COMTRADE
Product Imports	ln of imports of the product from all countries by the importer in the first year of trade relationship	COMTRADE
Neighbour	dummy, 1 if exporter exports the same product to a neighboring country	COMTRADE
Bilateral Trade	ln of exports of all products from exporter to importer in the fist year of trade relationship	COMTRADE
Previous Spell	dummy, 1 if previous spells within sample period	COMTRADE
FX Volatility	Average absolute value of the monthly percentage change in the exchange rate between exporter and importer in years t=-1, 0 and 1 around the beginning of the trade relationship	IMF
FX Misalignment	exchange rate between exporter and importer in the year the trade relationship starts relative to the period average.	IMF
PTA	dummy, 1 if exporter and importer are in a preferential trade agreement when trade flow commences	World Bank
PP, PR, RP, RR	dummy variables, 1 for exports from poor to poor (PP) poor to rich (PR), rich to poor (RP) and rich to rich (RR). We define 'poor' as low and low middle income, rich as high and upper middle income.	

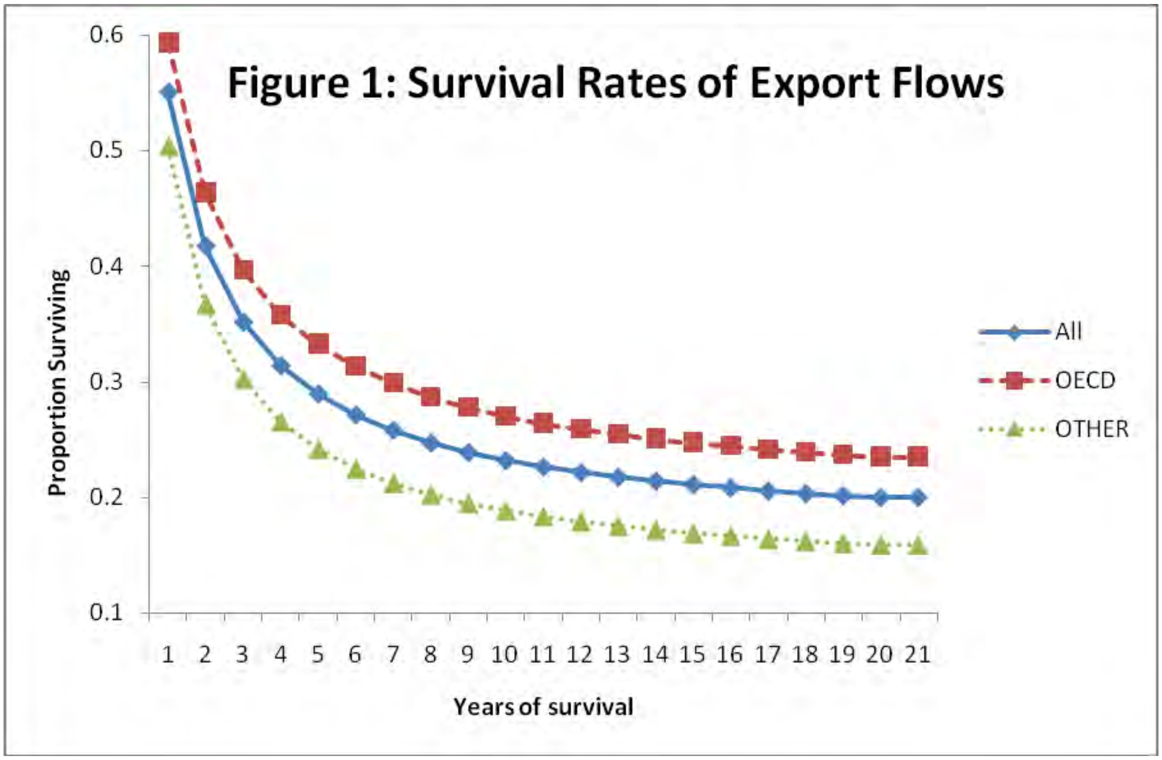
Figure 1: Survival Rates of Export Flows
Proportion Surviving
0.6
0.5
0.4
0.3
0.2
0.1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21
Years of survival
All
OECD
OTHER

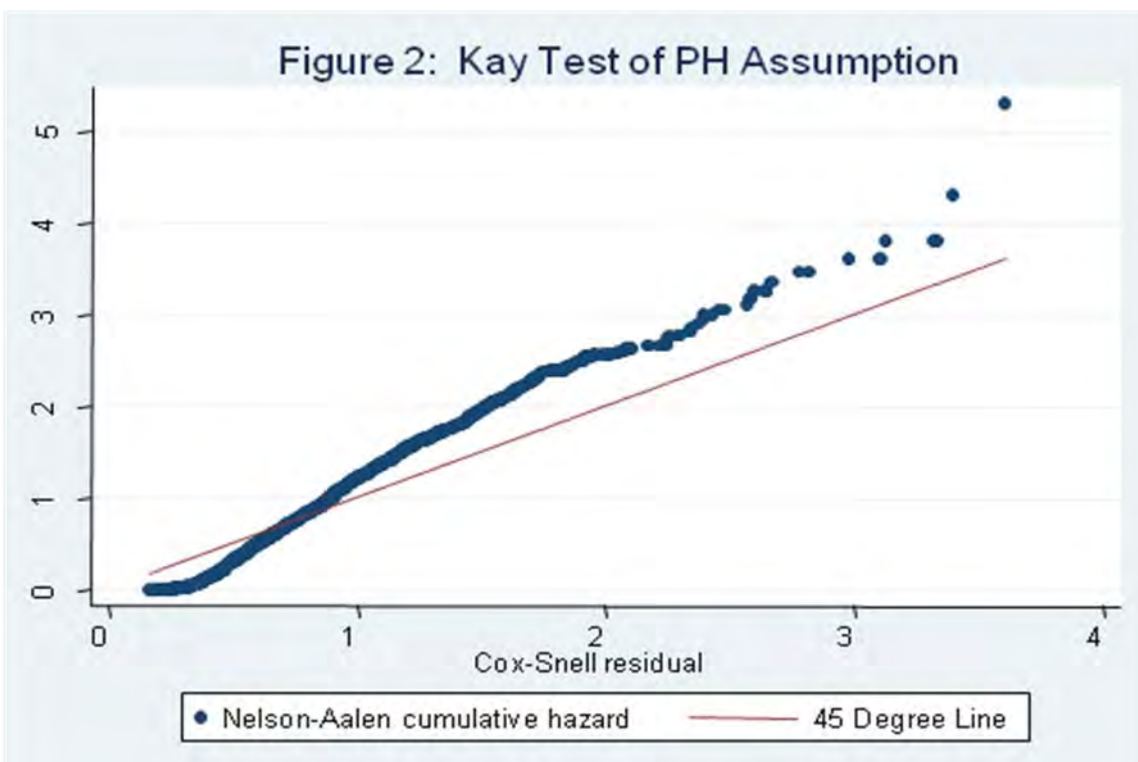
Figure 2: Kay Test of PH Assumption
0 1 2 3 4 5
0 1 2 3 4
Cox-Snell residual
Nelson-Aalen cumulative hazard
45 Degree Line

Table 1: Descriptive Statistics: Exporters										
Exporter	Number of Outflows			Annual Death Rate		Exporter	Number of Outflows			Annual Death Rate
	Total	1985	2005				Total	1985	2005	
Argentina	48,989	4,493	11,706	22%		Malawi	2,031	189	234	39%
Australia	63,276	8,618	15,247	18%		Malaysia	48,945	4,506	14,139	17%
Austria	70,523	12,936	17,112	17%		Mali	4,223	223	517	53%
Bangladesh	11,240	667	2,308	30%		Mauritania	2,517	87	295	54%
Bolivia	8,634	324	1,496	38%		Mauritius	8,623	524	1,390	35%
Brazil	75,319	11,363	19,615	17%		Mexico	58,561	4,742	14,931	19%
Burkina F	2,718	105	274	51%		Morocco	19,301	1,463	3,969	27%
Cameroon	6,926	476	1,036	42%		Mozambique	3,681	270	337	51%
Canada	87,352	12,467	20,486	18%		Nepal	6,918	376	1,458	31%
Cape Verde	1,454	43	182	60%		Netherlands	96,703	22,076	27,445	13%
Chile	37,643	2,064	8,023	25%		Nicaragua	8,140	356	1,208	43%
China	88,530	11,125	37,146	10%		Niger	4,058	215	375	66%
Costa Rica	18,347	993	3,433	32%		Nigeria	8,949	544	1,248	40%
Croatia	8,220	795	906	38%		Pakistan	25,302	1,931	5,385	26%
Denmark	71,049	13,718	17,203	16%		Panama	28,279	2,531	4,679	31%
Ecuador	18,597	890	3,476	34%		Papua NG	4,787	340	561	42%
Egypt	24,735	990	5,157	30%		Paraguay	7,877	486	1,155	38%
El Salvador	11,962	770	2,165	30%		Peru	26,206	2,041	5,776	27%
Fiji	4,230	321	728	33%		Philippines	37,888	3,670	8,640	22%
Finland	53,242	8,062	11,700	19%		Poland	47,418	4,609	12,273	20%
France	94,621	26,258	31,399	10%		Portugal	47,412	5,888	10,582	20%
Gabon	3,475	268	423	47%		Senegal	5,265	328	736	43%
Gambia	2,177	90	165	60%		Singapore	56,787	7,850	13,773	17%
Germany	98,516	33,488	37,793	8%		Spain	91,621	16,338	27,725	13%
Ghana	6,920	357	1,072	37%		Sri Lanka	19,874	1,412	4,093	26%
Greece	41,627	4,147	8,185	25%		Sweden	73,114	15,857	18,683	15%
Guatemela	15,140	1,023	2,915	29%		Switzerland	86,982	19,208	22,023	14%
Guinea	3,071	156	371	51%		Taiwan	80,006	15,004	22,945	13%
Guinea Biss	801	57	44	61%		Tanzania	5,957	421	804	39%
Honduras	9,863	580	1,597	35%		Thailand	55,175	5,117	16,844	16%
Hong Kong	75,135	11,348	17,780	17%		Togo	2,830	198	294	46%
Hungary	41,840	4,897	8,946	21%		Trinidad	10,425	605	1,687	32%
India	70,563	6,460	22,019	17%		Tunisia	14,904	992	2,971	29%
Indonesia	47,167	2,537	13,665	19%		Turkey	47,089	2,836	13,823	20%
Ireland	49,123	6,647	10,215	20%		Uganda	2,994	153	455	45%
Italy	94,265	23,945	32,598	10%		UK	99,662	30,219	32,580	10%
Jamaica	9,370	818	1,133	37%		Uruguay	19,412	1,317	3,587	31%
Japan	82,823	23,831	24,713	11%		USA	104,839	35,654	42,584	7%
Jordan	12,801	580	1,953	46%		Vietnam	23,636	451	8,284	21%
Kenya	11,820	962	1,653	36%		Zambia	3,231	223	307	48%
Korea	70,417	8,917	20,189	15%						
Madagascar	5,222	353	993	29%		Total	2,861,365	460,189	770,015	16%

Table 2: Descriptive Statistics: Importers										
Importer	**Number of Inflows**			**Annual Death Rate**		**Importer**	**Number of Inflows**			**Annual Death rate**
	Total	**1985**	**2005**				**Total**	**1985**	**2005**	
Argentina	48,109	4,818	12,480	17%		Italy	87,350	16,624	24,871	14%
Australia	61,116	13,538	20,241	12%		Jamaica	30,227	3,270	6,156	24%
Austria	61,412	10,872	18,136	13%		Japan	67,971	13,673	20,922	12%
Barbados	24,897	3,577	5,694	21%		Korea	62,738	8,509	18,040	15%
Belize	16,748	1,813	2,763	32%		Malaysia	68,802	12,417	18,124	15%
Bolivia	37,061	3,798	6,927	26%		Mexico	63,795	7,080	18,019	16%
Brazil	52,271	5,790	14,706	15%		Morocco	39,789	5,138	10,943	17%
Canada	66,046	12,613	22,572	12%		Netherlands	79,326	15,467	21,094	14%
Chile	48,149	6,972	13,237	15%		New Z'land	50,991	9,828	15,661	13%
Colombia	46,396	5,288	12,533	18%		Oman	41,857	2,227	7,340	30%
Costa Rica	42,112	3,692	10,029	21%		Paraguay	29,796	2,990	5,165	25%
Cyprus	40,929	6,089	9,487	17%		Peru	46,162	6,015	10,920	20%
Denmark	57,356	12,296	15,885	14%		Philippines	54,205	6,183	13,699	18%
Ecuador	41,398	4,505	9,267	23%		Portugal	49,422	8,410	13,708	14%
Egypt	52,934	6,038	10,367	24%		Saint Lucia	16,955	2,127	2,968	24%
Finland	48,730	10,755	15,109	12%		Singapore	68,251	13,786	19,315	14%
France	90,409	17,981	26,599	13%		Spain	74,525	12,306	23,038	13%
Germany	91,504	20,974	28,382	12%		Sweden	61,033	13,081	17,129	13%
Greece	52,702	9,592	14,513	15%		Thailand	58,513	8,831	17,358	14%
Guatemala	45,868	4,253	10,727	23%		Trinidad	31,951	4,936	6,767	24%
Honduras	34,140	2,821	7,439	27%		Tunisia	38,141	4,948	9,508	18%
Hong Kong	57,885	11,698	16,910	13%		Turkey	55,883	6,382	15,913	16%
Iceland	32,760	5,896	9,964	14%		UK	101,387	21,106	26,681	14%
India	65,803	7,962	18,201	19%		Uruguay	33,191	4,177	7,756	18%
Indonesia	66,109	9,520	14,994	19%		USA	103,032	22,344	30,765	13%
Ireland	56,331	9,750	14,188	17%		Venezuela	54,486	7,075	11,941	21%
Israel	52,411	8,358	14,864	15%		Total	2,861,365	460,189	770,015	16%

Table 3: Survival Rates for Income Groups and Selected Exporters									
Year	High Income	Middle Income	Low Income	USA	Hong Kong	Argentina	Egypt	Burkina Faso	Zambia
1	59%	51%	39%	70%	55%	52%	44%	27%	30%
2	46%	37%	25%	59%	41%	38%	29%	15%	18%
3	39%	31%	20%	53%	33%	31%	23%	10%	12%
4	35%	27%	17%	50%	29%	26%	19%	8%	9%
5	32%	25%	15%	47%	27%	24%	17%	7%	7%
6	30%	23%	13%	45%	25%	22%	15%	6%	6%
7	29%	22%	12%	43%	23%	20%	14%	5%	5%
8	28%	21%	12%	42%	22%	19%	13%	5%	4%
9	27%	20%	11%	42%	21%	18%	13%	4%	4%
10	26%	19%	11%	41%	20%	17%	12%	4%	3%
11	25%	19%	10%	40%	19%	17%	12%	4%	3%
12	25%	19%	10%	40%	19%	16%	11%	3%	3%
13	25%	18%	10%	39%	18%	16%	11%	3%	3%
14	24%	18%	9%	39%	18%	15%	10%	3%	3%
15	24%	18%	9%	38%	18%	15%	10%	3%	3%
16	24%	17%	9%	38%	17%	14%	10%	3%	2%
17	23%	17%	9%	38%	17%	14%	10%	3%	2%
18	23%	17%	8%	38%	17%	14%	10%	3%	2%
19	23%	17%	8%	37%	17%	14%	10%	3%	2%
20	23%	17%	8%	37%	16%	14%	10%	3%	2%
21	23%	17%	8%	37%	16%	14%	10%	3%	2%

Table 4: Survival Rates for Different World Regions							
Year	East Asia and Pacific	Europe and Central Asia	Latin America and Caribbean	Middle East and North Africa	OECD	South Asia	Sub Saharan Africa
1	56%	53%	48%	42%	59%	50%	33%
2	43%	39%	34%	28%	46%	36%	20%
3	36%	32%	27%	22%	40%	30%	15%
4	33%	28%	23%	18%	36%	27%	12%
5	30%	26%	21%	16%	33%	24%	10%
6	29%	24%	19%	15%	31%	23%	9%
7	27%	22%	17%	13%	30%	22%	8%
8	26%	21%	16%	13%	29%	21%	7%
9	26%	20%	16%	12%	28%	20%	6%
10	25%	19%	15%	11%	27%	20%	6%
11	25%	19%	14%	11%	26%	19%	6%
12	24%	18%	14%	11%	26%	19%	5%
13	24%	18%	13%	10%	25%	19%	5%
14	23%	17%	13%	10%	25%	18%	5%
15	23%	17%	13%	10%	25%	18%	5%
16	23%	17%	12%	10%	24%	18%	5%
17	22%	16%	12%	9%	24%	18%	4%
18	22%	16%	12%	9%	24%	18%	4%
19	22%	16%	12%	9%	24%	18%	4%
20	22%	15%	12%	9%	23%	17%	4%
21	22%	15%	12%	9%	23%	17%	4%

Table 5: Estimates of the Cox (1972) PH Model

Variable	Exp(b)	P-Value
Initial Value	0.908	0.000
Distance	1.074	0.000
Border	0.831	0.000
Common Language	0.895	0.000
Colony	0.988	0.001
GDP Product	0.979	0.000
Total Exports	0.989	0.000
Industry Exports	0.997	0.000
Product Exports	0.942	0.000
Product Imports	0.984	0.000
Bilateral Trade	0.965	0.000
Neighbour	0.881	0.000
Previous Spell	0.842	0.000
FX Volatility	1.007	0.000
FX Misalignment	1.000	0.160
PTA	0.999	0.599
Stratification by Product		
Log Likelihood		13,149,695
No. of Spells		2,356,910
No. of failures		1,836,375

Table 6: Schoenfeld (1982) Test of PH Assumption

Variable	chi2	P-Value
Initial Value	513.75	0.000
Distance	691.09	0.000
Border	248.71	0.000
Common Language	149.33	0.000
Colony	1.41	0.200
GDP Product	4451.92	0.000
Total Exports	4634.23	0.000
Industry Exports	167.37	0.000
Product Exports	628.62	0.000
Product Imports	240.02	0.000
Bilateral Trade	266.56	0.000
Neighbour	124.87	0.000
Previous Spell	436.64	0.000
FX Volatility	0.000	0.900
FX Misalignment	865.75	0.000
PTA	11.54	0.000
Global	14551.38	0.000

Table 7: Prentice-Gloeckler Model with and without Unobserved Individual Heterogeneity

Model	Prentice-Gloeckler		Prentice-Gloeckler		Prentice-Gloeckler		Prentice-Gloeckler	
Unobserved Heterogeneity	No		Yes		Yes		Yes	
Distribution			Gamma		Gamma		Normal	
Variable	Exp(b)	P-Value			Exp(b)	P-Value	Exp(b)	P-Value
logt	0.767	0.001			1.053	0.003	0.997	0.218
Initial Value	0.962	0.001	0.959	0.000	0.960	0.001	0.960	0.000
Distance	1.323	0.002	1.424	0.000	1.444	0.003	1.424	0.000
Border	0.681	0.004	0.617	0.000	0.608	0.005	0.619	0.000
Common Language	0.721	0.003	0.664	0.000	0.657	0.003	0.666	0.000
Colony	0.945	0.005	0.958	0.000	0.956	0.007	0.950	0.000
GDP Product	0.897	0.001	0.865	0.000	0.860	0.001	0.866	0.000
Total Exports	0.977	0.000	0.974	0.000	0.973	0.000	0.973	0.000
Industry Exports	0.989	0.000	0.978	0.000	0.976	0.001	0.980	0.000
Product Exports	0.857	0.000	0.834	0.000	0.830	0.001	0.832	0.000
Product Imports	0.946	0.000	0.929	0.000	0.926	0.001	0.930	0.000
Bilateral Trade	0.991	0.001	0.995	0.000	0.997	0.001	0.995	0.000
Neighbour	0.723	0.002	0.679	0.000	0.672	0.002	0.681	0.000
Previous Spell	0.488	0.001	0.417	0.000	0.410	0.001	0.430	0.000
FX Volatility	0.964	0.001	0.958	0.000	0.958	0.001	0.959	0.000
FX Misalignment	0.992	0.000	0.993	0.000	0.993	0.000	0.992	0.000
PTA	1.163	0.003	1.205	0.000	1.217	0.004	1.207	0.000
LogL		-2,197,242		-2,183,236		-2,184,015		-2,187,563
No. of Observations		7,234,950		7,234,950		7,234,950		7,234,950
Gamma Variance								
Exp(b)				0.474		0.539		0.723
P-Value				0.000		0.000		0.000
LR Test								
chi2				66871.8		26455.1		19000
P-Value				0.000		0.000		0.000

Table 8: Preferred Specification for Different Types of Goods

	Diversified		Reference Priced		Homogeneous	
Variable	Exp(b)	P-Value	Exp(b)	P-Value	Exp(b)	P-Value
Initial Value	0.933	0.000	0.925	0.000	0.958	0.000
Distance	1.497	0.000	1.471	0.000	1.380	0.000
Border	0.586	0.000	0.623	0.000	0.657	0.000
Common Language	0.639	0.000	0.664	0.000	0.740	0.000
Colony	0.914	0.000	1.004	0.794	0.971	0.287
GDP Product	0.832	0.000	0.875	0.000	0.905	0.000
Total Exports	0.969	0.000	0.983	0.000	0.992	0.000
Industry Exports	1.000	0.618	0.966	0.000	0.994	0.017
Product Exports	0.797	0.000	0.851	0.000	0.873	0.000
Product Imports	0.930	0.000	0.945	0.000	0.966	0.000
Bilateral Trade	0.978	0.000	0.993	0.002	0.973	0.000
Neighbour	0.693	0.000	0.678	0.000	0.682	0.000
Previous Spell	0.424	0.000	0.347	0.000	0.318	0.000
FX Volatility	0.953	0.000	0.968	0.000	0.990	0.037
FX Misalignment	0.992	0.000	0.992	0.000	0.985	0.000
PTA	1.266	0.000	1.201	0.000	1.178	0.000
LogL		-1346111		-527676		-117807.7
No. of Observations		4745333		1707599		347020
Gamma Variance						
Exp(b)		0.564218		0.488039		0.51164
P-Value		0.000		0.000		0.000
LR Test						
chi2		17640.4		6982.31		1784.19
P-Value		0.000		0.000		0.000

Prentice-Gloeckler Model with a Gamma Distribution Summarizing Unobserved Heterogeneity

Table 9: Preferred Specification for Exporters Belonging to Different Income Groups

	High income		Middle income		Low income	
Variable	Exp(b)	P-Value	Exp(b)	P-Value	Exp(b)	P-Value
Initial Value	0.953	0.000	0.960	0.000	1.011	0.000
Distance	1.344	0.000	1.542	0.000	1.368	0.000
Border	0.648	0.000	0.664	0.000	0.939	0.153
Common Language	0.669	0.000	0.686	0.000	0.840	0.000
Colony	0.961	0.000	0.964	0.004	0.733	0.000
GDP Product	0.861	0.000	0.856	0.000	0.896	0.000
Total Exports	0.964	0.000	0.968	0.000	0.982	0.000
Industry Exports	0.977	0.000	0.985	0.000	0.971	0.000
Product Exports	0.830	0.000	0.836	0.000	0.838	0.000
Product Imports	0.930	0.000	0.924	0.000	0.942	0.000
Bilateral Trade	0.990	0.000	0.999	0.737	0.988	0.000
Neighbour	0.709	0.000	0.650	0.000	0.610	0.000
Previous Spell	0.452	0.000	0.382	0.000	0.325	0.000
FX Volatility	0.941	0.000	0.980	0.000	0.980	0.000
FX Misalignment	0.978	0.000	1.012	0.000	1.003	0.216
PTA	1.074	0.000	1.260	0.000	1.308	0.000
LogL	-1196643		-787801		-133132	
No. of Observations	4094474		2596781		317203	
Gamma Variance						
Exp(b)	0.367819		0.583		0.458	
P-Value	0.000		0.000		0.000	
LR Test						
chi2	20249.8		34636.2		7516.7	
P-Value	0.000		0.000		0.000	

Prentice-Gloeckler Model with a Gamma Distribution Summarizing Unobserved Heterogeneity

Table 10: Preferred Specification: Robustness

	Excluding Repeated Spells		Excluding Flows < 55000 (initially)	
Variable	Exp(b)	P-Value	Exp(b)	P-Value
Initial Value	0.972	0.000	1.146	0.000
Distance	1.671	0.000	1.459	0.000
Border	0.551	0.000	0.537	0.000
Common Language	0.601	0.000	0.642	0.000
Colony	0.938	0.000	1.072	0.000
GDP Product	0.798	0.000	0.862	0.000
Total Exports	0.972	0.000	0.968	0.000
Industry Exports	0.970	0.000	0.956	0.000
Product Exports	0.802	0.000	0.799	0.000
Product Imports	0.915	0.000	0.920	0.000
Bilateral Trade	1.020	0.000	0.984	0.000
Neighbour	0.563	0.000	0.605	0.000
Previous Spell		0.000	0.409	0.000
FX Volatility	0.927	0.000	0.965	0.000
FX Misalignment	0.991	0.000	0.989	0.000
PTA	1.358	0.000	1.185	0.000
LogL	-1013563		-407224	
No. of Observations	2702156		1762595	
Gamma Variance				
Exp(b)	1.692		1.03	
P-Value	0.000		0.000	
LR Test				
chi2	168473		19069.3	
P-Value	0.000		0.000	

Prentice-Gloeckler Model with a Gamma Distribution Summarizing Unobserved Heterogeneity