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On the role of vertical differentiation in enhancing the survival of export flows: evidence from a developing country

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Abstract
This paper analyzes the role of vertical differentiation linked with global production networks in increasing the chance of export survival using highly disaggregated machinery exports data from Turkey for the 1998–2013 period. Results obtained from the descriptive statistics analysis suggest that the duration of Turkey's machinery exports is remarkably short with a median duration of merely one year. In addition, the likelihood of the survival of exports varies widely across total machinery, finished and parts and components as well as across trade types (horizontally and vertically differentiated products). Based on discrete-time duration models, the empirical results demonstrate that vertical differentiation together with product and market diversification are associated with a higher export survival rate, particularly for parts and components. The evidence hence supports the hypothesis that global production sharing activities greatly increase the chances of survival in export markets.

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Keywords Export duration; survival analysis; vertical differentiation; global production networks

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1. Introduction

Increasing the survival chances of export relationships is essential for sustainable export growth, in particular for developing countries. Brenton, et al. (2009a) show that lower-income countries do fairly well in building new trade relationships, but experience much lower survival rates. New export relationships, however, contribute relatively little to export growth than do the existing linkages for developing countries (Besedes and Prusa, 2010). Then, it is important to understand the factors determining the duration of export flows in order to design appropriate policies for developing countries.

This paper is related to the literature investigating the factors playing a role in the duration of exports. A small number of empirical studies analyzing the determinants of trade duration can be divided into two groups based on the data sources used. The first group includes the studies that employ product-level data in a particular country or set of countries, while the second group includes the studies that instead exploit the firm-level data in a particular country.[1] The factors considered as a determinant of the hazard rate of trade flow include a range of variables from product/market characteristics and search costs to usual gravity model variables. The focus in this paper is on the linkage between the survival rate of exports and global production networks (GPN). Enlarged fragmentation of production and geographical dispersion have made GPN ever more complex, interdependent and stable.[2] That in turn, is expected to increase the survival probabilities of exports between countries. For instance, Obashi (2010) shows that trade in machinery parts and components (P&C) have a higher probability of survival compared to finished products, leading to successful and long-lasting trade relationships among East Asian countries. These results have also been confirmed in Corcoles et al. (2012) for Spain's machinery exports, Shao et al. (2012) for Chinese manufacturing exports, Corcoles et al. (2014) for world auto exports and Diaz-Mora et al. (2015) for exports of Spanish manufacturing firms. Esteve-Perez et al. (2007), by using firm level data, further prove the long-lived export relationship among firms engaging in intra-industry trade, although Gullstrand and Persson (2015) find no significant evidence

[1] The first group includes for instance Besedes and Prusa (2006a,b), Fugazza and Molina(2011), Besedes (2008), Nitsch (2009), Besedes and Prusa (2010), Brenton et al. (2010), Hess and Persson (2011b), while the second group includes Esteve-Perez et al. (2007), Alvarez and Lopez (2008), Volpe-Martincus and Carballo (2009), Ilmakunnas and Nurmi (2010), Esteve-Perez et al. (2013), Görg et al. (2012), Cadot et al. (2013), Stirbat et al. (2015), and Gullstrand and Persson (2015).

[2] There are different types and terms of product fragmentation used in theoretical and empirical literature. These are "outsourcing" by Feenstra and Hanson (1997), "disintegration of production" by Feenstra (1998), "international fragmentation of production" by Jones and Kierzkowski (2001), "vertical specialization" by Hummels et al. (1998), "international product sharing" by Yeats (2001), and "intra-product specialization by Arndt (1997). For more detailed information on the different terms for product fragmentation, see Sotomayor (2016).

supporting the prediction that vertical trade could affect the survival of export flows between upstream and downstream firms.

The aforementioned empirical studies point out the significance of P&C trade on the survival rate of trade relationships; however, they are unable to distinguish the nature of the linkage in the networks. [3] In other words, they fail to adequately address (1) the horizontal nature of trade in similar goods with differentiated varieties, (2) the vertical nature of trade in differentiated goods distinguished by quality and (3) the vertical specialization that involves the exchange of technologically linked goods (Jones et al., 2002; Ando, 2006). Using trade in P&C as the sole indicator of GPN in an empirical analysis may lead to overestimation of the role GPN plays in explaining the differences in survival rates across different product types.

Unlike previous empirical studies, the purpose of this study is to explore the ways that the emergence of GPN influences the export survival in a developing country. We introduce an indicator of vertical/horizontal differentiation as a proxy for GPN into the regression analysis. The indicator adopted from the intra-industry trade literature is based on a decomposition of trade into vertical and horizontal flows and is constructed as a ratio of the unit values of exports and imports. In this way, it becomes possible to examine the role vertical differentiation plays in the survival of exports.

The empirical analysis is carried out with discrete-time hazard models with proper control for unobserved heterogeneity, as suggested by Hess and Persson (2011b). The analysis is conducted using Turkish data on machinery and transportation products at the HS-6 digit level for the 1998-2013 period. Models are estimated separately for total machinery, machinery finished products and P&C exports to find out if GPN plays a different role in explaining export survival across different product types.

Investigating the Turkish case is important for several reasons. First, Turkey is a good representative of developing countries which experienced export growth almost fivefold from 26.9 billion US dollars to 151.8 billion US dollars from 1998 to 2013. Second, according to the Exporter Dynamics Database of the World Bank, the number of exporting firms increased from 30,000 to 48,000 and the number of exporters per export destination increased from 500 to 1,000 between 2002 and 2010. Meanwhile, the share of the top 10 markets in Turkey's total exports decreased from 62% in 2000 to 48% in 2010. Turkey's spectacular export performance is mainly attributed to the successfully diversified exports by products and destination markets but also to the increasing participation of Turkish firms in global value

[3] There is another line of the literature that studies the duration of trade survival empirically – including, but not limited to, Besedes and Prusa (2006a), Nitsch (2009), Brenton et al. (2010), Hess and Persson (2011b), Cadot et al. (2013), Stirbat et al. (2015).

chains in recent years (Kaminsky and Ng, 2006; Saygılı and Saygılı, 2011; Gros and Selçuki, 2013; Aldan and Çulha, 2013; Türkcan, 2014; World Bank, 2014). The OECD-WTO Trade in Value Added (TiVA) database suggests that Turkey's Global Value Chain participation index (percent share in total gross exports) in 2011 was around 41 percent, rising by 14 percentage points in the period from 1995 to 2011.

The rest of the paper is organized as follows. Section 2 describes the data and provides descriptive statistics on the duration of machinery exports and survivor functions for P&C and finished products. Section 3 discusses the econometric strategy and potential determinants of export duration, and reports the empirical results, including various robustness checks. The final section includes concluding remarks and policy recommendations.

2. Data and descriptive analysis

We use highly disaggregated data taken from BACI, an international trade database developed by CEPII.[4] The database constructed using the United Nations Commodity Trade Statistics (UN COMTRADE) original database contains bilateral values (in thousands of US Dollars at the current prices) and quantities of exports and imports at the 6-digit level according to the Harmonized System (HS, Revision 1996) products classification, for more than 200 countries from 1998 to 2013.[5]

The BACI database has several advantages over the UN COMTRADE. First, the BACI database reconciles mirror flows (for both values and quantities), which are reported by at least one of the partners, thus providing a more complete and refined geographical coverage. This ensures greater accuracy of the zeros (i.e. absence of trade) in the estimation of trade duration, which is particularly relevant in determining the duration of trade relationships (Fugazza and Molina, 2011). Secondly, unlike the UN COMTRADE database (where quantities are reported in different units of measure, such as meters, square meters, number of items, kilograms, liters, and such), the quantities in the BACI database are registered in the same unit (tons) so that unit values are comparable at both world and product levels (Gaulier and Zignago, 2010). Therefore, the BACI database is well suited to diligently computing the vertical differentiation indicator, as it directly provides comparable unit values at the product-level.[6]

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[4] The BACI database is available for researchers already subscribing to the United Nations COMTRADE database at: http://www.cepii.fr.

[5] The BACI database does not include flows below 1,000 US dollars.

[6] It would be ideal to use intra-firm trade statistics to investigate the role of vertical differentiation in the patterns of trade duration. Unfortunately, these data are not available at the detail needed.

At the 6-digit level of the HS 1996 product classification, there are more than 5,000 product lines covering all articles in trade. We identify product lines included in any of the headings of chapters 84-92: general machinery (HS 84), electric machinery (HS 85), transport equipment (HS 86-89), and precision machinery (HS 90-92). Following the procedures in Ando (2006) and Obashi (2010), out of 1124 product lines, about 729 are considered as finished machinery products and 445 are considered as machinery P&C. We examine exports of each product to 188 countries, accounting for over 90% of Turkey's exports. Table A1 in the appendix lists the countries included in the analysis, while Table A2 provides information on the definition and source of the data.

2.1 Duration of Turkey's machinery exports

Export duration is measured by the length of different spells of trade. Export spells refer to a realization of an export relationship in consecutive years, during which the export relationship is active between the partner countries. The length of the export spells is then calculated as the number of consecutive years that the export relationship takes place without interruption. An export relationship may stop and start several times over the study period, which in turn results in multiple spells within one export relationship. A greater number of spells means a shorter duration of export spells. This also means that the number of export spells exceeds the number of export relationships over the study period. In our analysis, the maximum number of spells possible for each importing country and product pair during 1998-2013 (16 years) is eight.

Tables 1-3 show that there are a good number of annual bilateral export observations over the 16-year period for all product types. The total number of export spells has been consistently higher than that of export relationships. The average (median) length of an export relationship is remarkably short with a mean of 3.25 (1.93) years in total machinery, 2.96 (1.95) years in finished products and 3.66 (1.9) years in P&C. These findings suggest that the duration of Turkey's machinery exports are often short-lived, which is in line with the findings of Obashi (2010) and Corcoles et al. (2012, 2014). Survival rates are higher for P&C than finished products, confirming the Corcoles et al. (2014) findings for world auto exports. These results support the hypothesis that GPN may increase the likelihood of exports' survival in a developing country.

However, compared to the results in Obashi (2010), which states that the mean (median) duration of export spells is 5 (2) years for machinery, 6.1 (3) years for P&C and 4.3 (2) years for finished products in East Asia, the findings in the Turkish case are considerably lower. The Turkish results are also lower than the results in Corcoles et al. (2014) (on average

4.2 years for P&C and 3.4 for final products). One of the explanations for these results may hinge on the high share of exported products with low-tech intensity.[7] If the demand for low-tech products with many close substitutes is elastic enough, then buyers will base their purchase decision on price rather than any concept of brand loyalty (Klemperer, 1995). Consequently, it is reasonable to expect that the hazard rate of low-tech products is higher than that of high-tech products, resulting in shorter export duration. Hence, the findings suggest that Turkish machinery exports consisting of low-tech products have higher hazard rates compared to competitors no matter what type of product.

Figure 1a-c indicates that nearly 53% of total machinery export spells fail within the first year. The hazard rate for finished products (55%) in the first year is higher than that of P&C (50%). The survival rate of P&C exports throughout the study period is 9%, but just 3% for finished products. Moreover, the Kaplan-Meier estimator of the survival functions in Figure 2 proves that the probability of surviving is highest for P&C and the gap increases with time. These results are in line with the literature but our rates are lower than the rates provided in Corcoles et. al. (2012), highlighting the fragility of the Turkish export duration.

The descriptive analysis so far suggests that Turkey's machinery export flows are short-lived and the rates are lower that the findings in the literature. We also checked the consistency of the results for alternative measures of export spells (i.e. first spell, single spell, gap-adjusted spell, etc.) and different levels of data aggregation (4-digit HS and 2-digit HS).[8] Table 1 indicates that our findings are quite robust across different samples. Furthermore, Figures A1-A3, in the appendix, confirm the results in Figure 2.

2.2. Vertical Differentiation and Duration of Turkey's Machinery Exports

The use of P&C (within the machinery and transport equipment) trade in evaluating the role of GPN on export survival, a common approach in the literature, has severe problems. First of all, P&C covers many parts that are recorded under different headings. For instance, the transport equipment group does not include parts such as automotive tires, electronics, instruments, glass parts, or rubber parts, which are recorded under different headings. In addition, different types of trade arrangements may be captured in measurements of trade in P&C: horizontal trade in similar products with differentiated varieties; trade in vertically differentiated products distinguished by quality; and vertical specialization that involves the

[7] Kaminski and Ng (2006) report that the share of medium- and high tech products in Turkish exports to the EU-25 moved up from 13.3 percent in 1995 to 37.3 percent in 2004, whereas the share of low-tech labor intensive products dropped from 69.6 percent to 46.5 percent in the same period. However, Gros and Selçuki (2013) state that low-tech products continued to play a major role in Turkish exports and Emirhan (2015) shows that medium quality industries have the highest share in Turkey's exports to the EU on average.

[8] Besedes and Prusa, 2006a; Nitsch, 2009; Hess and Persson, 2011b.

exchange of technologically linked products (Jones et al., 2002; Ando, 2006). Hence, using trade in P&C as an indicative of GPN may lead to overestimation of the role GPN plays in explaining the differences in survival rates across product types.

This study employs commonly used method in the intra-industry trade (IIT) literature to measure vertical differentiation in different types of machinery products. Vertical IIT can reflect multi-stage trade as a result of back-and forth transactions in vertically fragmented production networks in the same commodity heading. Vertical specialization generates unit value differences across technologically related exported and imported intermediates that can be used not only for quality differences but also as an indicator of GPN within the same product category (Türkcan, 2011; Ando, 2006; Wakasugi, 2007). [9,10]

Accordingly, Abd-el-Rahman (1991) and Greenaway et al. (1994, 1995) note that unit value information can be used to disentangle total IIT by a particular dispersion factor α satisfying the condition $1-\alpha \leq \frac{P_{ikt}^{X}}{P_{ikt}^{M}} \leq 1+\alpha$, where P_{ikt}^{X} and P_{ikt}^{M} represent the unit value of the exports and imports, respectively; and indices i refer to the product and k the partner country in year t. [11] If the unit value ratio lies outside of the range then IIT is called vertical, otherwise it is horizontal. In Greenaway et. al (1995) α=0.15 or α=0.25.

Unit values at the 6-digit product level of the HS are computed by dividing imports' and exports' values of each product by the corresponding quantities. We choose α=0.25 due to Türkcan (2011), who notes that when considering GPN, a 15% threshold could be too wide and a 25% threshold would be more appropriate. The 15% threshold is generally appropriate when the unit value differences reflect differences in quality only.

Out of 562,041 bilateral trade observations over the period from 1998 to 2013, about 29% of Turkey's total machinery exports are classified as vertically differentiated export flows. In the case of finished machinery exports, around 25% of 304,250 bilateral trade observations are considered to be vertically differentiated. With regard to the P&C, a total of 169,720 observations are classified as horizontally differentiated export flows, whereas 88,062 observations are vertically differentiated export flows (about 34% of the total observations).

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[9] Horizontal IIT through fragmentation would also be present if imported P&C were exported with the small unit price differentials embodied in the local market. However, this kind of trade does not seem to be important in intermediate products trade.

[10] Trade flows classified as vertically differentiated products could also include trade in intermediate products of different qualities.

[11] For a more detailed discussion on vertical IIT and fragmentation, see Türkcan and Ates (2011).

Figure 3 plots the Kaplan-Meier estimates of survival functions for horizontally and vertically differentiated products for each product type. All survival curves report that around 50% of export relationships fail in the first year. However, there are some important differences in survival patterns across the product types. First, horizontally differentiated products have slightly higher survival rates beginning with the second year, which implies that horizontal differentiation plays a greater role in the duration of total machinery exports in the long-term. This dominance of horizontal differentiation is dictated by the trend in the survival rates of finished products. This finding is consistent with the view that horizontally differentiated products are more difficult to substitute if they have more specific and highly desired attributes for the importer, thus increasing the degree of buyer's attachment to the specific brand or product over time.[12]

Considering P&C, the survival curves of horizontally differentiated products are almost identical to those of vertically differentiated products except for a couple of years following the first year. In contrast to finished products, the survival rates of vertically differentiated P&C are higher than for horizontally differentiated P&Cs. These results are consistent with the findings in Obashi (2010), Corcoles et al. (2012) and Corcoles et al. (2014).

In sum, there are four main conclusions to be drawn from the analysis of the raw data. First, the duration of Turkey's machinery exports is rather short-lived, regardless of the product type. Second, Turkey's machinery products exhibit higher survivability in export markets when the export relationship lasts for about five years. Third, survival rates for P&C are significantly higher than those of all machinery products and finished products, and their rates remain high throughout the whole period. Four, horizontally differentiated finished products have a higher chance of survival than vertically differentiated finished products. In contrast, survival rates are higher for vertically differentiated P&C than for horizontally differentiated P&C. Overall, the descriptive results support the claim that an increase in participation in GPN leads to a higher probability of survival in export markets, particularly for P&C in Turkey.

3. Empirical Analysis

3.1. Empirical strategy

Descriptive analysis is quite useful for establishing the stylizing facts regarding the duration of exports. However, a regression analysis is needed to assess the impact of vertical

[12] Nitsch (2009) found that survival rates are higher for differentiated products as well as products that exhibit a lower elasticity of substitution. Broda and Weinstein (2006) found that sectors related to machinery industries, for instance motor cars and other motor vehicles, have a low elasticity of substitution.

differentiation (as an indicator for international fragmentation of the production process within GPN) on the average duration of exports. The Cox proportional hazard model, originally proposed by Cox (1972), is the most widely used model to study the determinants of trade duration (e.g. Besedes and Prusa, 2006b, Nitsch, 2009; Obashi, 2010). The purpose of the model is to estimate the effects of several covariates influencing the time-to-failure of a system (i.e. the hazard rate). However, recent papers have identified three reasons why the Cox proportional hazard model is not appropriate for analyzing determinants of trade durations (Hess and Persson, 2011a and 2011b; Fugazza and Molina, 2011; Corcoles et al., 2014). First, the Cox model implies a continuous-time specification whereas trade flows are observed for discrete-time intervals. As a result, the observation of ties, i.e. spells of trade with exactly the same duration, is unavoidable. However, the partial likelihood estimation procedure of the Cox model requires chronologically ordered duration times. As discussed in Hess and Persson (2011a), the presence of many tied duration times therefore results in biased coefficients and standard errors. Second, the Cox model has no explicit controls for unobserved heterogeneity (or frailty) between trade partners. Individual heterogeneity cannot be ignored as its presence may lead to parameter bias and bias in the estimated survivor function. In the Cox model, accounting for unmeasured heterogeneity, however, requires the incorporation of random effects, which is computationally difficult, especially when working with large trade data sets. Third, one of the key assumptions of the Cox model is the proportional hazards function assumption, which is, questionable in trade duration analysis. When the underlying proportional hazards assumption is violated (i.e. the hazard ratio is not constant over time), then the Cox model should not be used since it may lead to bias in the estimated explanatory variable effects.

As an alternative, Hess and Persson (2011a) recommended the use of discrete-time duration models, such as logit and probit models, which can efficiently account for unobserved heterogeneity between trading pairs, handle ties without introducing bias in parameter estimates and relax the proportional hazards assumption so that the effects of explanatory variables vary over time. Calculation takes considerable less time, another rationale for preferring the discrete-time models, especially when dealing with large trade data sets.

Following Hess and Persson (2011a), this study utilizes logit, probit and cloglog models with random effects in the empirical analysis. Since they may lead to bias in the estimated hazard rates all left-censoring spells (i.e. those export flows that are already active in the first year of the sample, namely 1998) are omitted from the econometric analysis, reflecting common practice for handling the left-censoring data (Obashi, 2010; Hess and Persson, 2011b; Fugazza and Molina, 2011). As a result, approximately 11% of the observed spells are excluded due to left-censoring.[13] In order to deal with the problem of the existence of multiple spells following Hess and Persson (2011b), the duration analysis is also carried out separately for the case of single-spell data and the case of first-spell data as robustness checks. The impact of the kind of measurement error associated with trade data is accounted for by using one-year gap adjusted samples as robustness checks. The one-year gap adjustment generated 122,470 spells (around 24% less than the benchmark data shown in Table 1).

4.2. Determinants of export survival

The discrete-time hazards model is estimated separately for machinery products and for two subsamples (finished products and P&C) to check if the model estimates differ across the product types. Following the literature such as Besedes and Prusa (2006b), Nitsch (2009), Hess and Persson (2011b) and Corcoles et al. (2012), several explanatory variables are accounted for in the regression analysis. In contrast to, existing studies, this study includes dummy variables representing vertical differentiation in the regressions to assess the role of GPN in the duration of exports. The definitions and sources of each explanatory variable are provided in Table A2.

4.2.1. Country-specific variables

According to the gravity literature, trade costs (or service-link costs) are likely to be lower for countries that have a common border or language or are closer geographically. Lower trade costs are likely to increase trade relationships and therefore decrease the probability of failure. To account for these factors, a logarithm of the distance between trade partners' capitals, a common language dummy and a common border dummy are included.

Another variable that is likely to affect the survival of export flows is the importers' GDP, which serves as a proxy for market thickness. Brenton et al. (2010) argue that export relationships involving economically large importers are more likely to last longer. In addition, the trading partner's market size increases the opportunities of fragmentation in trade and lowers the export hazard (Grossman and Helpman, 2005; Jones and Kierzkowski, 2001).

Hess and Persson (2011b) states that countries with similar levels of per capita income have similar preferences and tastes and thus produce and exchange the same kinds of products more intensely with one another (IIT). Hence, we included differences in per capita GDP as a

[13] From Table 1, it can be seen that the left-censoring data spells represent around 11% of all spells, whereas the right-censoring spells account for about 30% of all spells.

measure of differences in economic development between Turkey and its trading partners. The difference in per capita GDP may also capture the differences in the quality of economic institutions. Well-functioning transport, logistics, finance, communications, and other business services are crucial to the survival of newly established export relationships in export markets.[14] Thus, a positive relationship is expected between the bilateral inequality in per capita GDP and the hazard rates of an export relationship.

With regard to the P&C, there is no clear consensus on the impact of bilateral inequality in per capita GDP on the duration of exports. Obashi (2010) predicts that wage (income) differentials enhance the fragmentation of production and trade within GPN, which in turn results in longer export relationships.[15] In contrast, Corcoles et al. (2012, 2014) predicts that a greater divergence in the level of economic development of two countries creates location disadvantages such as weak transportation and communication infrastructures, yielding a higher risk of failure of export relationship. Therefore, the relationship between the duration of P&C exports and the differences in per capita GDP could be either positive or negative depending on which effect dominates.

This analysis also uses two other country-specific variables. The first one is European Union (EU) membership. The EU had become the major export partner of Turkey after the Customs Union agreement was signed in 1995; therefore, a dummy variable is included to capture the effect of trade agreements on the duration of Turkey's exports to the EU. Trade agreements not only decrease trade costs between the parties not only directly through reductions in import duties and the costs of customs, regularity and administrative procedures at the border but also through the indirect effects of facing less competition from the rest of the world. Regardless of product types, this implies a reduction in the hazard rates for Turkey's export relationship with the EU (Hess and Persson, 2011b; Corcoles, et al., 2012).

Finally, following Besedes and Prusa (2006b) and Hess and Persson (2011b), the change in the relative real exchange rate (RER) is included in the model to capture the effects of exchange rate changes on the hazard. The rationale for including RER is that changes in exchange rates may influence a firm's decision to enter or exit export markets.[16] Traditionally,

[14] Following Corcoles et. al (2012), this study also includes the Rule of Law Index as a proxy for institutional quality in the export markets. However, as suggested in Hess and Persson (2011b), this variable was dropped from the final estimates because of the fact that it has a considerable amount of missing data. In addition, it seems that there is no need for additional covariates to specifically capture the institutional quality of trading partners, as it is closely correlated with the level of economic development as measured by the per capita GDP.

[15] Likewise, previous studies such as Egger and Egger (2005) and Kimura et al. (2007) have used per capita income differences to measure the effect of the differences in factor endowments on fragmentation.

[16] Bilateral nominal exchange rates (i.e. Turkish Lira per importer currency) are computed by using bilateral nominal exchange rates (i.e. foreign currency per US dollar) taken from the World Bank. Note that an increase

it is expected that a depreciation of the exporter's currency relative to the currencies of importers will boost exports and lower the hazard (Besedes and Prusa, 2006b).[17] However, there is evidence of fading linkage between RER and trade, in particular intermediate goods due to the GPN (Arndt and Huemer, 2005; Thorbecke, 2008; Obashi, 2010; Saygılı and Saygılı 2011; Türkcan, 2011). As a result, one cannot make a definitive assessment of the effect of RER changes on the duration of exports. Nonetheless, a possible negative coefficient would indicate a drop in the hazard rate due to depreciation in the exporter's currency.

4.2.2. Product-specific variables

Product differentiation, meanwhile, may influence the duration of trade in several ways. Rauch and Watson (2003) argues that trade in differentiated products requires higher search costs and stronger supplier-specific investments, making it difficult to switch to a new supplier. In addition, the formation of trade networks may reduce supplier-related search costs and lead to larger initial transactions and longer duration (Rauch, 2001). Besedes and Prusa (2006b) found that trade relationships involving homogenous products consistently start with considerably larger transactions than those involving differentiated products and differentiated products have the longest duration, followed by reference priced products, and then homogenous products. Several recent studies have drawn similar conclusions that trade duration varies across the type of products and increases with the size of transactions (Nitsch, 2009; Hess and Persson, 2011b; Fugazza and Molina, 2011).

This paper creates bilateral disaggregated data dummy variables to identify each trade flow as either horizontally or vertically differentiated using the method outlined in section 2.2. A dummy variable for vertical differentiation (VD) is created so that VD is equal to one if the export to import price ratio lies outside of the range indicated in section 2.2 and zero otherwise. In addition, two product type dummies are created for finished products and P&C in line with Kimura and Obashi (2010). Product type dummies are then multiplied by VD to generate interaction dummies. Interaction terms attempt to single out the effects of fragmentation induced by intermediate products trade from those of vertical trade in finished products. This refers to differences in product quality, not to differences in stage of production. The first interaction term is a binary variable that equals one if the product is

reflects a depreciation of the Turkish Lira against the importer currency. In the second step, bilateral real exchange rates between Turkey and its trading partners are constructed by deflating nominal rates using national consumer price indices (CPI) available from the World Bank. Bilateral real exchange rates were normalized by the average real exchange rates before computing annual percentage changes in relative real exchange rates (in logarithmic terms).

[17] Besedes and Prusa (2006b) make no distinction between final products and intermediate products in assessing the impacts of exchange rates.

classified as finished machinery products and the trade flow is vertical but zero otherwise, while the second interaction term is a dummy equal to one if the product is classified as P&C and the trade flows is vertical but zero otherwise.

When we estimate the discrete-time hazard model for total manufacturing exports, both interaction terms are included. The interaction term between P&C and the vertically differentiated product dummy is used to proxy GPN activities between the trading partners. In contrast, an interaction term between the finished products dummy and the vertically differentiated dummy address the impact of product quality on the duration of machinery exports. Since vertically differentiated finished products tend to have more quality attributes, those types of products may require complex and long-lasting export relationships (Besedes and Prusa, 2006b). Both interaction terms are expected to reduce the hazard rate. However, when the discrete-time hazards models are estimated separately for finished products and P&C, the vertical differentiation dummy is included instead of these interaction terms, though their effects and interpretation remain exactly the same.

The logarithm of the initial value of exports at the start of export spells is used to proxy the initial level of confidence that an exporter or an importer has for its trading partners in matters of reliability and integrity to fulfill their contractual obligations and commitments to the partnership (Besedes and Prusa, 2006b; Brenton, et al, 2010; Nitsch, 2009; Hess and Persson, 2011b; Fugazza and Molina, 2011). An export relationship with a larger initial transaction size reflects the existence of ex ante trust between trading partners, which is expected to lower export hazard rates across all product types (Rauch and Watson, 2003).

Exporters with past experience in a particular foreign market are more likely to start exporting the same product to the old market or new markets or different product to the old markets because they will be more likely to face lower sunk costs when entering old or new markets (Das et al., 2007, Alvaraez et al., 2013; Stirbat et al., 2015). Accordingly, two explanatory variables are included to assess the impact of the previous export experience on the hazard rate: the lagged duration (i.e. the number of years that a previous export spell lasted) and the total value of the exports of a given product. Hence, experience in exports of a specific product is expected to be negatively associated with the hazard rate.

4.2.3. Export diversification-specific variables

A number of empirical studies have shown that export diversification contributes positively to higher survival of export flows (Volpe-Martincus and Carballo, 2009; Brenton et al., 2010; Hess and Persson, 2011b; Corcoles et al., 2012; Fugazza and McLaren, 2014; Corcoles et al., 2014; Stirbat et al., 2015). For instance, Volpe-Martincus and Carballo (2009) found that both product and market diversification have positive effects on the probability of the firm's survival in foreign markets, but the impact is higher in the former case. Expansion in GPN has not only increased trade in P&C, but has also contributed to export diversification in terms of destination markets and products. Following Hess and Persson (2011b) and Corcoles et al. (2012, 2014), the effects of export diversification on export duration in this study are captured by the total number of products exported to a specific market and the total number of markets to which one specific product is shipped. The estimated coefficients for both variables are expected to be negative and significant.

4.2.4. Other control variables

The presence of unobserved heterogeneity in the hazard functions may create biases in the estimated parameters. As Hess and Persson (2011b) noted, a discrete-time probit model with random effects can control for all the unobserved heterogeneity (or frailty) that remains constant at the importer-product pair level. However, the inclusion of those random effects will not eliminate the heterogeneity entirely since there could be different types of heterogeneities. These problems can be addressed by including a large set of dummy variables in the discrete-time hazard models, as suggested by Hess and Persson (2011b). Hence, in addition to random effects which are product and importer specific, this paper includes duration, time and spell dummies: duration dummies mark the current length of the spell for each export relationship that can be used to account for duration dependence in a regression; spell dummies count the number of previous spells for any export relationship; time dummies control the time-varying common latent (or unmeasured) variables that influence the duration of exports whether these variables are known or unknown to the researcher.

4.3. Benchmark results

The results of the econometric estimates are reported in Tables 4-6.[18] Note that there is broad similarity of the coefficient estimates in sign and statistical significance across the baseline hazard functions. Nonetheless, Tables 4 and 5 indicate that the logit model attains the highest log-likelihood closely followed by the probit models for total machinery products and finished products respectively. In contrast, the log-likelihood of the probit model slightly outperforms the logit model in the case of P&C (Table 6). Hence, the remainder of this section discusses the results of the preferred specification: the logit model for total machinery products and finished products and the probit model for P&C. The likelihood-ratio tests (the

[18] Recall that the number of spells used in the regression analysis is significantly lower than those shown in Tables 1-3, since spells with missing values of the explanatory variables any time during the spell are dropped from the estimations.

rho parameter) clearly rejects the null hypothesis of unobserved heterogeneity for all model specifications, confirming that unobserved heterogeneity plays a significant role in all specifications. This in turn implies that the discrete-time models are appropriate for the analysis at hand (as in Hess and Persson, 2011b). Finally, it is important to recall that a positive coefficient on an explanatory variable implies that the explanatory variable increases the hazard rate or, equivalently, the explanatory variable reduces the duration of export flows.

The effects of the country-specific variables from the selected models are similar in direction but dissimilar in magnitude by product type. Coefficients are relatively higher in absolute terms for finished products, except for the coefficient of RER. That implies in general the probability that the survival export relationship of P&C would be less affected by the level of trading costs. This conclusion is consistent with Obashi (2010). However, contrary to the findings in Obashi (2010), Tables 5 and 6 report that the probability of the survival of export flows of P&C are influenced significantly and negatively by the increase in RER, although the hazard rate for finished products remains intact. This outcome also contradicts the prediction of Auer and Chaney’s (2009) model that lower quality products are more sensitive to RER fluctuations than higher quality products.

Considering the effects of product-specific variables on the hazard rates of export relationships, all variables have the expected negative signs and are statistically significant. The absolute sizes of the initial export value, lagged duration and total export value are larger for P&C indicating that trust, reliability, knowledge and experience matter more for the stability of trade relationship. Similar findings also emerge in Besedes and Prusa (2006b), Hess and Persson (2011b) and Corcoles et al. (2014).

As noted in the introduction, our key variables of interest in this paper are the interaction terms between product types (finished machinery products and machinery parts and components) and the binary variable of vertically differentiated products. These interaction terms have been incorporated in the estimation models to isolate the impact of vertical differentiation induced by production sharing activities on the survival of export flows. In Table 4 the estimates show that the interaction coefficient for P&C is negative and statistically significant, whereas the interaction coefficient for finished products is positive but not statistically significant. Recall that the interaction term for P&C, a proxy for participation in GPN, is different from the interaction term for finished products, which is used as a proxy for quality differentiated trade. It is, therefore, not meaningful to compare the magnitudes of estimates between equations using the finished products data and equations using P&C data. Although Table 4 notes an insignificant influence of vertical differentiation of finished goods on overall machinery export hazard rates, Table 5 shows that the impact is negative and significant on finished goods export hazards. Noting that, the negative and statistical significance of vertical differentiation variables are in line with expectations. When products are vertically differentiated, those importers who like a particular brand's qualities and attributes are more likely to continue to purchase that brand even after its price increases by a small amount, leading to long-lasting export relationships (Görg et al., 2012).

Finally, both product and market diversifications are statistically significant and have negative effects on hazard rates for Turkey's exports of all types of machinery products, in line with Volpe-Martincus and Carballo (2009). However, results further indicate that product diversification has a much greater impact than market diversification on Turkey's export survival (although both in the same direction), which is in contrast with the findings of Volpe-Martincus and Carballo (2009), Corcoles et al. (2012) and Corcoles et al. (2014). Although the coefficients of product diversification are higher in magnitude compared to market diversification in both product types, product diversification contributes more to the falling hazard rate in P&C compared to finished products.

4.4 Robustness analysis

The results based on the benchmark sample demonstrate that vertical differentiation is an important factor in explaining differences in the hazard of exporting across product types. Following the approach in Hess and Persson (2011b), several additional analyses are conducted to check for the robustness of the findings. As discussed in the descriptive analysis, one robustness check is to restrict our sample to include export relationships with just one spell. In the second robustness check, the estimation of the duration models is carried out using the first spell of multi-spell relationships. Another robustness check is based on the modified sample that was created by merging all spells with a one-year gap into a single longer spell.

The patterns of the effect of the vertical differentiation remain negative and robust throughout different definitions of the export spells (Table 7-9). The only difference in Table 7 is that the estimate of the interaction term for finished products becomes negative and statistically significant using single spell and gap-adjusted samples. These results provide reassuring evidence that vertical differentiation is an important factor in enhancing the likelihood of survival of export flows. Moreover, the results for finished products and P&C are robust to the alternative definitions of export spells, as seen in Tables 8 and 9. The coefficients of vertical differentiation remain negative and statistically significant, but their magnitudes are much larger than the benchmark case.

As for the other independent variables, most of the effects appear relatively resilient to the different definitions of export spells and samples. Comparison with the benchmark results shows that the common language dummy loses its significance in cases where the sample is limited to single spell and first spell. The coefficients for the RER gain positive and significant values in the overall manufacturing and finished products using the single-spell and gap-adjusted samples. The main change is observed with the estimated RER coefficients in the P&C: coefficients either lose significance or become positive.

As a final robustness check, the benchmark data is re-estimated using a logit estimator with fixed effects, which also controls for unobserved heterogeneity.[19] As shown in Tables 7-9, the coefficient of interest is still negative, but no longer significant, except that the vertical differentiation variable for P&C preserves its negative and statistically significant effect. In summary, the robustness analysis does not alter the central finding that vertical differentiation plays an important role in explaining differences in the survival of export flows across product types.

5. Concluding remarks

The current paper seeks to build upon recent empirical findings that emphasize the importance of GPN in increasing the probability of export survival. It does this by introducing vertical differentiation indicators representing the extent of GPN in the regression analysis of the export survival of different types of machinery products. In this manner, the paper decomposes Turkey's machinery exports at the HS-6 digit level to 188 importing countries over the 1998-2013 period into finished products and P&C export flows. This decomposition enables us to determine whether or not vertical differentiation linked with GPN plays a key role in explaining differences in export survival across product types.

From the descriptive analysis, we determine that: the duration of Turkey's machinery exports is rather short-lived; survivability in export markets increases when the export relationship lasts for a certain period of time and survival rates for P&C are significantly higher than those of finished products; horizontally (vertically) differentiated finished products (P&C) have higher chances of survival than vertically (horizontally) differentiated finished products (P&C).

[19] There are several reasons to prefer a random effects logit model over a fixed-effects logit model. First, a random effect model is generally preferred if the outcome is binary or dichotomous. Second, a random effect model can estimate time-invariant variables, such as distance or the regional integration dummy, which are dropped in a fixed effects model. After obtaining the coefficient estimates from both models, a Hausman specification test is performed to see whether the coefficient estimates of the two models are systematically different. Given the above considerations and the test results (not reported here for the sake of brevity, but available upon request) suggest that the discrete-time logit model with a random effect is appropriate in our case.

The regression analyses show that vertical differentiation in P&C has a strong negative influence on the hazard rates of Turkey's overall machinery export flows, whereas vertical differentiation in finished products does not significantly affect the hazard rates. A separate regression analysis for both product types indicates that vertical differentiation which is a proxy for product quality reduces the hazard rate for finished products. Similarly, vertical differentiation that serves as a proxy for participation in GPN presents a significant negative effect on the hazard rate for P&C exports. These results confirm the importance of vertical differentiation linked with GPN in explaining the differences in hazard rates across product types.

In addition, we have found that the presence of sunk entry costs in export markets and the existence of trust and experience as well as knowledge acquired via exporting tend to reduce the probability of ceasing export activity for trade partners in GPN, having a negative effect on the hazard rates of all product types.

These results may assist policymakers in identifying the key elements that affect the duration of export flows of developing countries, in particular. First, policies should be implemented to promote and facilitate the integration of local firms in the GPN. Enhancing the competitiveness should be based on not only shifting exports towards higher quality and technologically sophisticated products, but also improving infrastructures, such as communications technology, transportation and logistics, port facilities and energy. Efficient infrastructures reduce the cost per transaction while enabling local firms to ship products on time and in good condition, which are crucial elements for full integration into the GPN (Athukorala and Yamashita, 2006). Furthermore, building a strong institutional capacity (including good governance, the rule of law, contract enforcement and intellectual property rights) can facilitate the integration of firms into the GPN.

The implementation of trade facilitation measures such as the simplification of trade documents, the streamlining of border procedures and the automation of the border processes could help participation in the GPN by reducing trade costs, increasing speed and removing uncertainties. Meanwhile, bilateral free trade agreements like FTAs can facilitate participation in the GPN and support FDI inflows by further easing cross-border barriers.

Policy-makers should use industrial and investment policies to gain a competitive advantage in sectors which provide the country with the potential to compete in foreign markets. Policy instruments include taxes and direct credit incentives, selective export subsidies, special tax privileges to attract FDI into non-traditional sectors and local content requirements. Investments in higher-value-added export sectors, such as chemicals, pharmaceuticals, consumer electronics, motor vehicles, machinery and equipment should be encouraged. Such a move towards higher-technology activities will improve export competitiveness and foster export diversification, thereby reducing vulnerability to external shocks.

Export promotion agencies should be used more effectively in order to encourage domestic firms to penetrate a wide range of markets. By providing local firms with a broad range of services, such as counseling and export assistance and by sponsoring their participation in international trade missions and fairs, export promotion agencies may remove any information asymmetries that have hindered the diversification of exports (Brenton et al., 2009b). Export promotion agencies should also help local companies to gain information about the technical norms and standards of the target market in order to access new markets.

The results in this paper leave several issues for future research. The link between GPN and hazard rates of vertically differentiated exports flows has not been fully established. The trade data used in this paper provides information only on the trade values of a given product at country-product-level. Hence, with the currently available trade data, it is difficult to track a P&C once it is imported. The exported P&C could be used primarily for the production of final goods by local companies other than by firms operating in a GPN. Therefore, it may be worthwhile to investigate this link in more detail using firm-level data in a future study to confirm whether the finding that a strong negative relationship between GPN and the hazard rates of P&C exports truly reflects outsourcing activities of firms operating in a GPN.

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Appendix

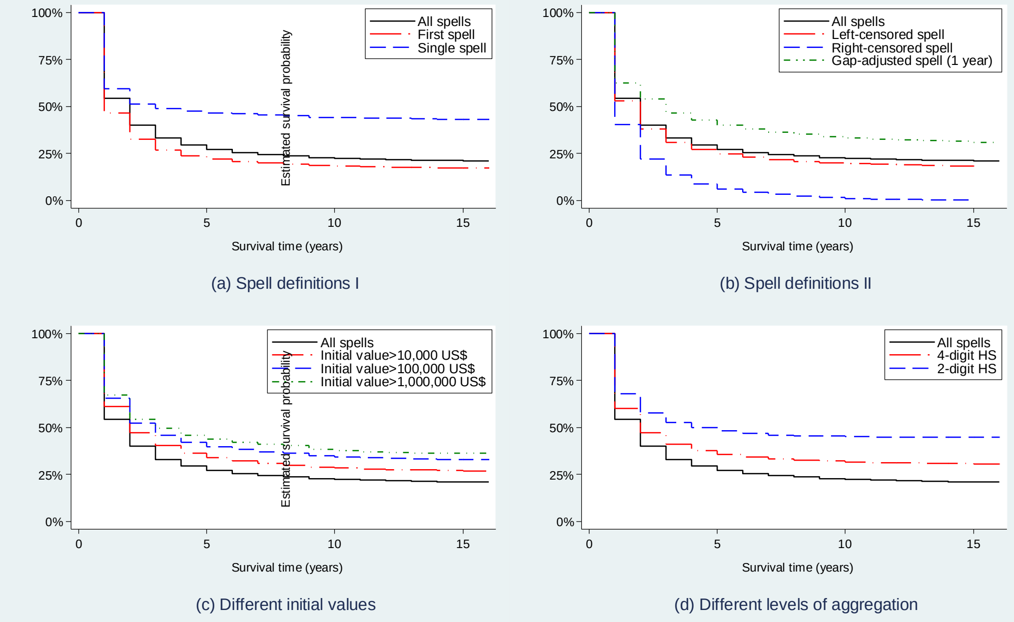
Table A1: List of countries

Afghanistan	Djibouti	Kyrgyzstan	Rwanda
Albania	Dominica	Lao PDR	St. Kitts&Nevis
Algeria	Dominican Republic	Latvia	St. Lucia
Andorra	East Timor	Lebanon	St. Vincent&Grenadines
Angola	Ecuador	Liberia	Samoa
Antigua&Barbuda	Egypt	Libya	San Marino
Argentina	El Salvador	Lithuania	Sao Tome&Principe
Armenia	Equatorial Guinea	China, Macau	Saudi Arabia
Aruba	Eritrea	Madagascar	Senegal
Australia	Estonia	Malawi	Serbia
Austria	Ethiopia	Malaysia	Seychelles
Azerbaijan	Fiji	Maldives	Sierra Leone
Bahamas	Finland	Mali	Singapore
Bahrain	France	Malta	Slovakia
Bangladesh	French Polynesia	Marshall Islands	Slovenia
Barbados	Gabon	Mauritania	Solomon Islands
Belarus	Gambia	Mauritius	South Africa
Belgium-Luxembourg	Georgia	Mexico	Spain
Belize	Germany	Micronesia	Sri Lanka
Benin	Ghana	Moldova	Suriname
Bermuda	Greece	Mongolia	Sweden
Bhutan	Greenland	Montenegro	Switzerland
Bolivia	Grenada	Morocco	Syria
Bosnia&Herzegovina	Guatemala	Mozambique	Tajikistan
Brunei Darussalam	Guinea	Myanmar	Tanzania
Bulgaria	Guinea-Bissau	Nepal	Thailand
Burkina Faso	Guyana	Netherlands	TFYR of Macedonia
Burundi	Haiti	New Caledonia	Togo
Cambodia	Honduras	New Zealand	Tonga
Cameroon	China, Hong Kong	Nicaragua	Trinidad&Tobago
Canada	Hungary	Niger	Tunisia
Cape Verde	Iceland	Nigeria	Turkey
Central African Republic	India	Northern Mariana Islands	Turkmenistan
Chad	Indonesia	Norway	Tuvalu
Chile	Iran	Oman	Uganda
China	Iraq	Pakistan	Ukraine
Colombia	Ireland	Palau	United Arab Emirates
Comoros	Israel	Panama	United Kingdom
Congo (Rep.)	Italy	Papua New Guinea	USA
Congo (Dem. Rep.)	Jamaica	Paraguay	Uruguay
Costa Rica	Japan	Peru	Uzbekistan
Côte d'Ivoire	Jordan	Philippines	Vanuatu
Croatia	Kazakhstan	Poland	Venezuela
Cuba	Kenya	Portugal	Viet Nam
Cyprus	Kiribati	Qatar	Yemen
Czech Republic	Korea (Rep.)	Romania	Zambia
Denmark	Kuwait	Russia	Zimbabwe

Table A2: Variable definitions and data sources

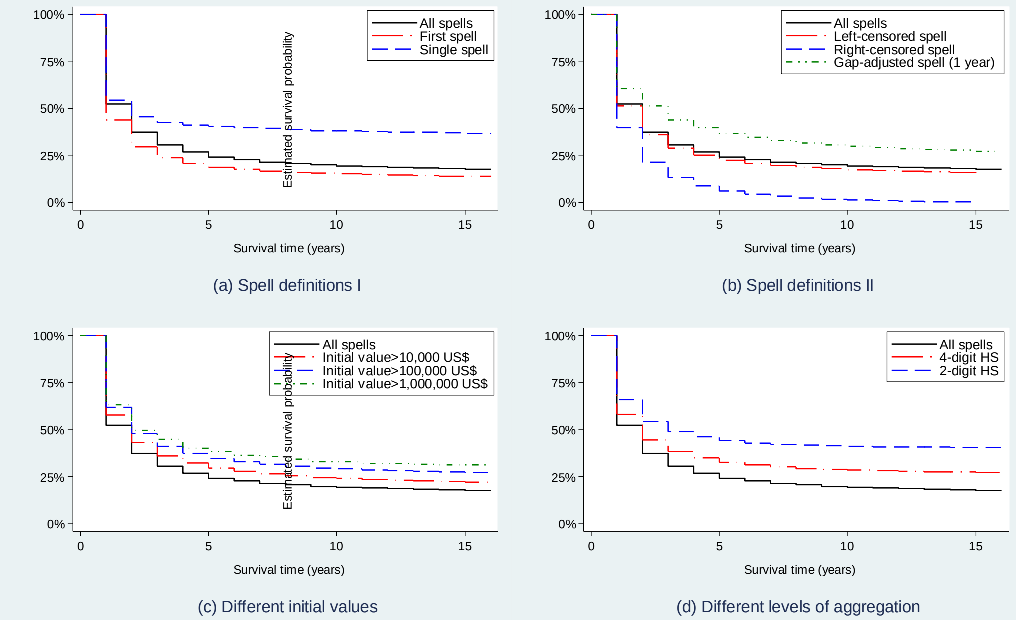
Variable	Definition	Data source
Log distance	Log of the distance in kilometers between Turkey's capital and its trading partner's capital	CEPII's GeoDist database: http://www.cepii.fr
Common language	Takes the value of one if Turkey and its trading partner have a common language, zero otherwise	CEPII's GeoDist database:: http://www.cepii.fr
Common border	Takes the value of one if Turkey and its trading partner have a common border, zero otherwise	CEPII's GeoDist database:: http://www.cepii.fr
Log GDP (importer)	Log of importer's GDP, measured in nominal US dollars	World Bank's World Development Indicators (WDI)
Log abs. difference in PCGDP	Log of the absolute difference in per capita GDPs of Turkey and its trading partner, measured in US dollars	World Bank's World Development Indicators (WDI)
EU membership	Takes the value of one if the trading partner belongs to the European Union in the given calendar year, zero otherwise	
% change in log relative RER	Yearly percent change in the log of the relative real exchange rate between Turkey and its trading partner	World Bank's World Development Indicators (WDI) and US Department of Agriculture's Exchange Rate Data Set
VD for P&C	Takes the value of one if the 6-digit parts and components flow shows evidence of vertical differentiation in the given calendar year, zero otherwise.	CEPII's BACI database: http://www.cepii.fr
VD for finished products	Takes the value of one if the 6-digit finished products flow shows evidence of vertical differentiation in the given calendar year, zero otherwise.	CEPII's BACI database: http://www.cepii.fr
Log initial export value	Log of the value of exports at the start of the spell, measured in US dollars	CEPII's BACI database: http://www.cepii.fr
Lagged duration	Number of years that the previous spell of the same export relationship lasted	CEPII's BACI database: http://www.cepii.fr
Log total export value	Log of the total value of the exports of a given product to all the partners, measured in US dollars	CEPII's BACI database: http://www.cepii.fr
Log number of export products	Log of the total number of products exported to a specific market	CEPII's BACI database: http://www.cepii.fr
Number of export markets	Total number of markets to which one specific product is shipped	CEPII's BACI database: http://www.cepii.fr

Figure A1: Kaplan-Meier estimates of survival functions for all machinery products



Source: Authors' own calculations based on CEPII's BACI database

Figure A2: Kaplan-Meier estimates of survival functions for finished machinery products



(a) Spell definitions I

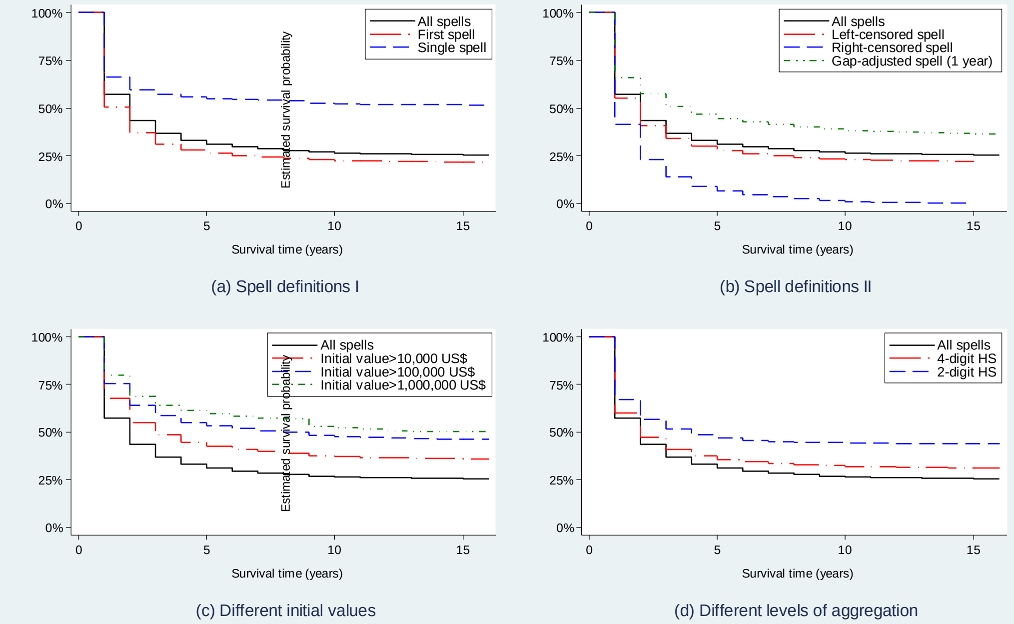
(b) Spell definitions II

(c) Different initial values

(d) Different levels of aggregation

Source: Authors' own calculations based on CEPII's BACI database

Figure A3: Kaplan-Meier estimates of survival functions for machinery parts & components



Source: Authors' own calculations based on CEPII's BACI database

Table 1: Description of Turkey's exports of all machinery products with different samples, 1998-2013

	No. of product-country pairs	No. of spells	No. of observations	Observed spell length in years		No. of spells per product-country pair		No. of product codes
				Mean	Median	Mean	Median	
All spells	89,801	173,152	562,041	3.25	1	1.93	2	1,174
First spell	89,801	89,801	316,235	3.52	1	1	1	1,174
Single spell	40,644	40,644	224,968	5.54	2	1	1	1,174
Left-censored spell	81,822	154,406	421,316	2.73	1	1.89	2	1,174
Right-censored spell	70,912	122,470	224,062	1.83	1	1.73	1	1,174
Gap-adjusted spell (1 year)	89,801	132,444	602,749	4.55	2	1.47	1	1,174
Initial value>10,000 US$	52,167	74,676	291,436	3.9	2	1.43	1	1,174
Initial value>100,000 US$	14,744	17,558	80,340	4.58	2	1.19	1	1,174
Initial value>1,000,000 US$	2,138	2,432	12,916	5.31	2	1.14	1	1,174
4-digit HS	24,255	45,756	195,851	4.28	2	1.89	2	227
2-digit HS	1,349	2,302	14,500	6.3	3	1.71	1	9

Notes: Only non-zero export flows are used in the calculation of each sample.
Source: Authors' own calculations based on CEPII's BACI database

Table 2: Description of Turkey's exports of finished machinery products with different samples, 1998-2013

	No. of product-country pairs	No. of spells	No. of observations	Observed spell length in years		No. of spells per product-country pair		No. of product codes
				Mean	Median	Mean	Median	
All spells	52,716	102,801	304,250	2.96	1	1.95	2	729
First spell	52,716	52,716	164,594	3.12	1	1	1	729
Single spell	23,503	23,503	110,585	4.71	1	1	1	729
Left-censored spell	49,144	93,091	240,142	2.58	1	1.89	2	729
Right-censored spell	43,112	75,053	135,826	1.81	1	1.74	1	729
Gap-adjusted spell (1 year)	52,716	78,556	328,495	4.18	2	1.49	1	729
Initial value>10,000 US$	33,354	50,189	171,089	3.41	2	1.5	1	729
Initial value>100,000 US$	10,461	12,809	49,349	3.85	2	1.22	1	729
Initial value>1,000,000 US$	1,567	1,827	8,091	4.43	2	1.17	1	729
4-digit HS	16,494	31,636	123,229	3.9	2	1.92	2	162
2-digit HS	1,299	2,295	13,241	5.77	2	1.77	1	9

Notes: Only non-zero export flows are used in the calculation of each sample.
Source: Authors' own calculations based on CEPII's BACI database

Table 3: Description of Turkey's exports of machinery parts and components with different samples, 1998-2013

	No. of product-country pairs	No. of spells	No. of observations	Observed spell length in years		No. of spells per product-country pair		No. of product codes
				Mean	Median	Mean	Median	
All spells	37,085	70,351	257,791	3.66	2	1.9	2	445
First spell	37,085	37,085	151,641	4.09	1	1	1	445
Single spell	17,141	17,141	114,383	6.67	2	1	1	445
Left-censored spell	32,678	61,315	181,174	2.95	1	1.88	2	445
Right-censored spell	27,800	47,417	88,236	1.86	1	1.71	1	445
Gap-adjusted spell (1 year)	37,085	53,888	274,254	5.09	2	1.45	1	445
Initial value>10,000 US$	18,813	24,487	120,347	4.91	2	1.3	1	445
Initial value>100,000 US$	4,283	4,749	30,991	6.53	3	1.11	1	445
Initial value>1,000,000 US$	571	605	4,825	7.98	5	1.06	1	445
4-digit HS	13,972	26,295	111,709	4.25	2	1.88	2	138
2-digit HS	1,023	1,714	10,459	6.1	3	1.68	1	8

Notes: Only non-zero export flows are used in the calculation of each sample.
Source: Authors' own calculations based on CEPII's BACI database

Table 4: Estimation results for all machinery products

	Probit	Logit	Cloglog
Log distance	0.0565	0.0832	0.0734
	(0.000)	(0.000)	(0.000)
Common language	-0.2262	-0.3673	-0.2787
	(0.000)	(0.000)	(0.000)
Common border	-0.1510	-0.2428	-0.1930
	(0.000)	(0.000)	(0.000)
Log GDP (importer)	-0.0308	-0.0474	-0.0364
	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0441	0.0737	0.0549
	(0.000)	(0.000)	(0.000)
EU membership	0.0811	0.1338	0.1026
	(0.000)	(0.000)	(0.000)
% change in log relative RER	-0.0006	-0.0011	-0.0009
	(0.073)	(0.060)	(0.057)
VD for P&C	-0.1509	-0.2634	-0.2193
	(0.000)	(0.000)	(0.000)
VD for finished products	0.0072	0.0082	-0.0062
	(0.441)	(0.606)	(0.612)
Log initial export value	-0.0681	-0.1154	-0.0912
	(0.000)	(0.000)	(0.000)
Lagged duration	-0.0411	-0.0866	-0.0751
	(0.000)	(0.000)	(0.000)
Log total export value	-0.0157	-0.0217	-0.0138
	(0.000)	(0.000)	(0.000)
Log number of export products	-0.4425	-0.7353	-0.4699
	(0.000)	(0.000)	(0.000)
Number of export markets	-0.0178	-0.0297	-0.0216
	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
ρ	0.1052	0.0629	0.0658
	(0.000)	(0.000)	(0.000)
Observations	387,025	387,025	387,025
Spells	142,534	142,534	142,534
Export relations	76,851	76,851	76,851
Log likelihood	-169,087	-169,046	-169,528

Notes: All regressions include random effects on the importer-product level. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Table 5: Estimation results for finished machinery products

	Probit	Logit	Cloglog
Log distance	0.0515	0.0772	0.0624
	(0.000)	(0.000)	(0.000)
Common language	-0.2940	-0.4770	-0.3543
	(0.000)	(0.000)	(0.000)
Common border	-0.1785	-0.2880	-0.2222
	(0.000)	(0.000)	(0.000)
Log GDP (importer)	-0.0287	-0.0453	-0.0319
	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0403	0.0680	0.0491
	(0.000)	(0.000)	(0.000)
EU membership	0.1076	0.1781	0.1304
	(0.000)	(0.000)	(0.000)
% change in log relative RER	-0.0002	-0.0004	-0.0004
	(0.677)	(0.587)	(0.518)
Vertical differentiation	-0.0509	-0.0907	-0.0797
	(0.000)	(0.000)	(0.000)
Log initial export value	-0.0671	-0.1134	-0.0864
	(0.000)	(0.000)	(0.000)
Lagged duration	-0.0282	-0.0625	-0.0617
	(0.000)	(0.000)	(0.000)
Log total export value	-0.0167	-0.0234	-0.0144
	(0.000)	(0.000)	(0.000)
Log number of export products	-0.4345	-0.7225	-0.4619
	(0.000)	(0.000)	(0.000)
Number of export markets	-0.0186	-0.0312	-0.0223
	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
ρ	0.1371	0.0937	0.0827
	(0.000)	(0.000)	(0.000)
Observations	219,436	219,436	219,436
Spells	85,863	85,863	85,863
Export relations	46,105	46,105	46,105
Log likelihood	-100,766	-100,714	-100,911

Notes: All regressions include random effects on the importer-product level. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Table 6: Estimation results for machinery parts and components

	Probit	Logit	Cloglog
Log distance	0.0744	0.1117	0.1012
	(0.000)	(0.000)	(0.000)
Common language	-0.1178	-0.1963	-0.1500
	(0.007)	(0.005)	(0.009)
Common border	-0.1081	-0.1735	-0.1427
	(0.000)	(0.000)	(0.000)
Log GDP (importer)	-0.0401	-0.0623	-0.0527
	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0492	0.0824	0.0655
	(0.000)	(0.000)	(0.000)
EU membership	0.0437	0.0716	0.0577
	(0.000)	(0.001)	(0.001)
% change in log relative RER	-0.0012	-0.0021	-0.0015
	(0.023)	(0.023)	(0.037)
Vertical differentiation	-0.0481	-0.0871	-0.0833
	(0.000)	(0.000)	(0.000)
Log initial export value	-0.0787	-0.1356	-0.1144
	(0.000)	(0.000)	(0.000)
Lagged duration	-0.0556	-0.1132	-0.0892
	(0.000)	(0.000)	(0.000)
Log total export value	-0.0200	-0.0292	-0.0199
	(0.000)	(0.000)	(0.000)
Log number of export products	-0.4519	-0.7490	-0.4839
	(0.000)	(0.000)	(0.000)
Number of export markets	-0.0164	-0.0273	-0.0205
	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
ρ	0.0592	0.0220	0.0452
	(0.000)	(0.014)	(0.000)
Observations	167,589	167,589	167,589
Spells	56,671	56,671	56,671
Export relations	30,746	30,746	30,746
Log likelihood	-68,067	-68,081	-68,366

Notes: All regressions include random effects on the importer-product level. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Table 7: Robustness results for all machinery products

	Single spell	First spell	Gap-adjusted	FE logit
Log distance	0.1798	0.0894	0.1196	
	(0.000)	(0.000)	(0.000)	
Common language	-0.0203	0.0122	-0.4178	
	(0.885)	(0.866)	(0.000)	
Common border	-0.1048	-0.0554	-0.2488	
	(0.035)	(0.030)	(0.000)	
Log GDP (importer)	-0.0746	-0.0397	-0.0422	-0.5797
	(0.000)	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0864	0.0573	0.0703	-0.0743
	(0.000)	(0.000)	(0.000)	(0.000)
EU membership	0.4228	0.1445	0.2301	0.0444
	(0.000)	(0.000)	(0.000)	(0.362)
% change in log relative RER	0.0068	-0.0002	0.0021	-0.0012
	(0.000)	(0.794)	(0.002)	(0.198)
VD for P&C	-0.5059	-0.2241	-0.4328	-0.0645
	(0.000)	(0.000)	(0.000)	(0.044)
VD for finished products	-0.1969	-0.0340	-0.1787	-0.0123
	(0.000)	(0.150)	(0.000)	(0.654)
Log initial export value	-0.0454	-0.0961	-0.0717	-0.1625
	(0.000)	(0.000)	(0.000)	(0.000)
Lagged duration			-0.0774	0.4724
			(0.000)	(0.000)
Log total export value	-0.1802	-0.0518	-0.0521	-0.0664
	(0.000)	(0.000)	(0.000)	(0.000)
Log number of export products	-0.7030	-0.6052	-0.7082	-0.1502
	(0.000)	(0.000)	(0.000)	(0.000)
Number of export markets	-0.0351	-0.0331	-0.0275	-0.0502
	(0.000)	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	Yes
ρ	0.0000	0.0000	0.0442	
	(0.471)	(0.454)	(0.000)	
Observations	99,833	159,840	382,013	246,951
Spells	30,109	65,107	105,146	142,534
Export relations	30,109	65,107	73,228	76,851
Log likelihood	-28,900	-74,397	-138,387	-59,468

Notes: All regressions include random or fixed effects on the importer-product level. Unless otherwise stated, the preferred random-effects logit model is estimated. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Table 8: Robustness results for finished machinery products

	Single spell	First spell	Gap-adjusted	FE logit
Log distance	0.2020	0.1074	0.1162	
	(0.000)	(0.000)	(0.000)	
Common language	-0.0213	-0.0249	-0.5256	
	(0.906)	(0.786)	(0.000)	
Common border	-0.0971	-0.0887	-0.2953	
	(0.116)	(0.006)	(0.000)	
Log GDP (importer)	-0.0874	-0.0465	-0.0419	-0.5797
	(0.000)	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0880	0.0541	0.0707	-0.0804
	(0.000)	(0.000)	(0.000)	(0.001)
EU membership	0.4431	0.1641	0.2823	0.1172
	(0.000)	(0.000)	(0.000)	(0.063)
% change in log relative RER	0.0070	0.0010	0.0025	-0.0008
	(0.000)	(0.321)	(0.005)	(0.495)
Vertical differentiation	-0.3096	-0.1129	-0.2812	-0.0220
	(0.000)	(0.000)	(0.000)	(0.418)
Log initial export value	-0.0491	-0.0904	-0.0700	-0.1490
	(0.000)	(0.000)	(0.000)	(0.000)
Lagged duration			-0.0513	0.4725
			(0.000)	(0.000)
Log total export value	-0.1487	-0.0412	-0.0578	-0.0807
	(0.000)	(0.000)	(0.000)	(0.000)
Log number of export products	-0.6450	-0.5582	-0.7018	-0.2350
	(0.000)	(0.000)	(0.000)	(0.000)
Number of export markets	-0.0432	-0.0369	-0.0285	-0.0488
	(0.000)	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	Yes
ρ	0.0000	0.0000	0.0809	
	(0.477)	(0.460)	(0.000)	
Observations	54,838	90,611	218,129	143,135
Spells	18,328	39,350	63,604	85,863
Export relations	18,328	39,350	44,077	46,105
Log likelihood	-17,541	-43,760	-84,189	-35,482

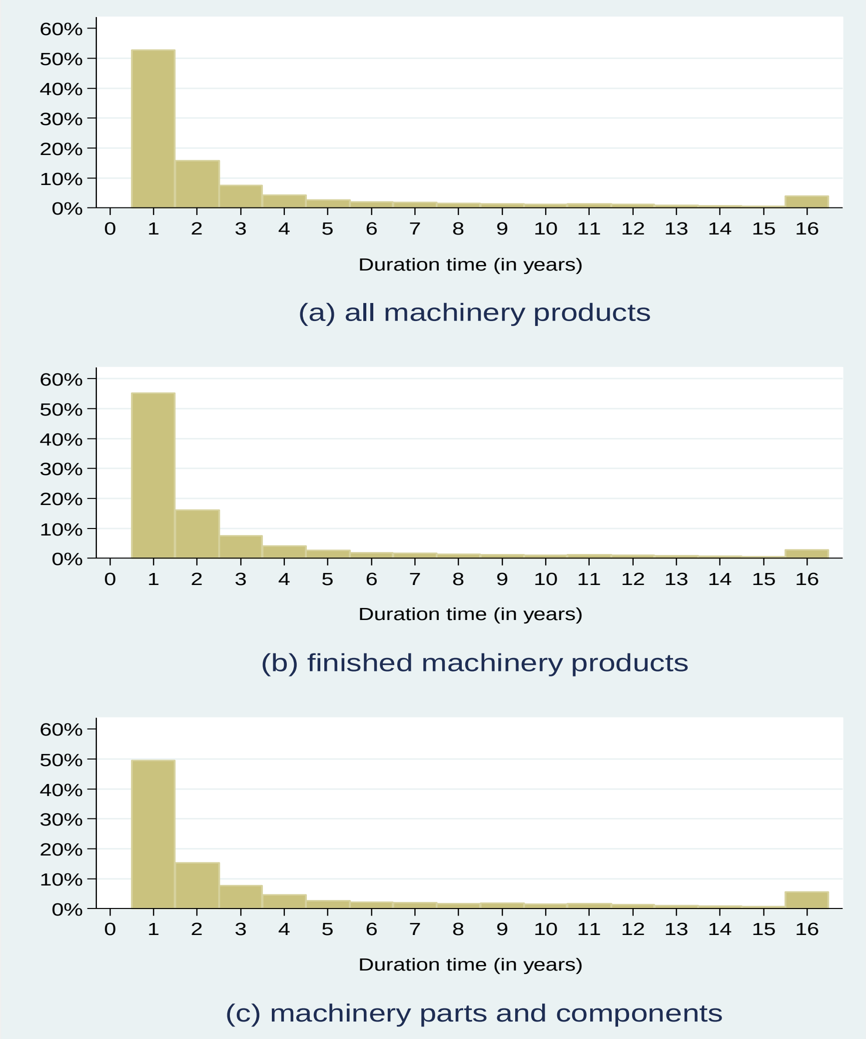
Notes: All regressions include random or fixed effects on the importer-product level. Unless otherwise stated, the preferred random-effects logit model is estimated. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Table 9: Robustness results for machinery parts and components

	Single spell	First spell	Gap-adjusted	FE logit
Log distance	0.1309	0.0683	0.0926	
	(0.000)	(0.000)	(0.000)	
Common language	-0.0132	0.0487	-0.1551	
	(0.914)	(0.483)	(0.001)	
Common border	-0.0755	-0.0084	-0.1053	
	(0.097)	(0.736)	(0.000)	
Log GDP (importer)	-0.0605	-0.0313	-0.0363	-0.5630
	(0.000)	(0.000)	(0.000)	(0.000)
Log abs. difference in PCGDP	0.0492	0.0386	0.0424	-0.0535
	(0.000)	(0.000)	(0.000)	(0.061)
EU membership	0.2070	0.0685	0.0905	-0.0738
	(0.000)	(0.000)	(0.000)	(0.339)
% change in log relative RER	0.0031	-0.0012	0.0008	-0.0016
	(0.013)	(0.095)	(0.182)	(0.264)
Vertical differentiation	-0.1356	-0.0465	-0.1363	-0.0409
	(0.000)	(0.007)	(0.000)	(0.208)
Log initial export value	-0.0400	-0.0718	-0.0497	-0.1859
	(0.000)	(0.000)	(0.000)	(0.000)
Lagged duration	0.0000	0.0000	-0.0510	0.4713
			(0.000)	(0.000)
Log total export value	-0.1297	-0.0421	-0.0318	-0.0532
	(0.000)	(0.000)	(0.000)	(0.003)
Log number of export products	-0.3990	-0.3758	-0.4326	-0.1325
	(0.000)	(0.000)	(0.000)	(0.009)
Number of export markets	-0.0143	-0.0169	-0.0153	-0.0497
	(0.000)	(0.000)	(0.000)	(0.000)
Duration dummies	Yes	Yes	Yes	Yes
Spell no. Dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	Yes	Yes
ρ	0.0000	0.0000	0.0479	
	(0.488)	(0.480)	(0.000)	
Observations	44,995	69,229	163,884	103,816
Spells	11,781	25,757	41,542	56,671
Export relations	11,781	25,757	29,151	30,746
Log likelihood	-11,293	-30,534	-53,939	-23,903

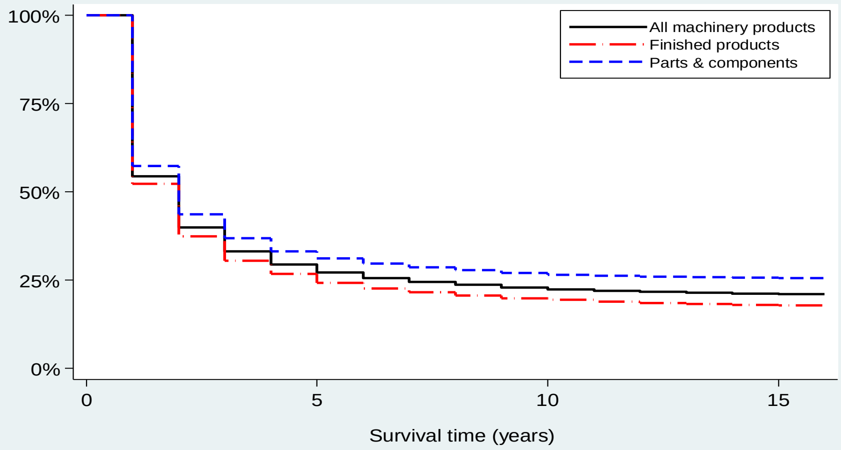
Notes: All regressions include random or fixed effects on the importer-product level. Unless otherwise stated, the preferred random-effects probit model is estimated. P-values are in parentheses. ρ is the fraction of error variance that is explained by a variation in the unobserved individual factors. The export relationship is defined as the importer-product combination. The number of observations is computed based on the total number of years with positive export flows for all machinery products. All left-censored observations are excluded from the data used in the estimations.

Figure 1: Histogram of duration of Turkey's exports of machinery products



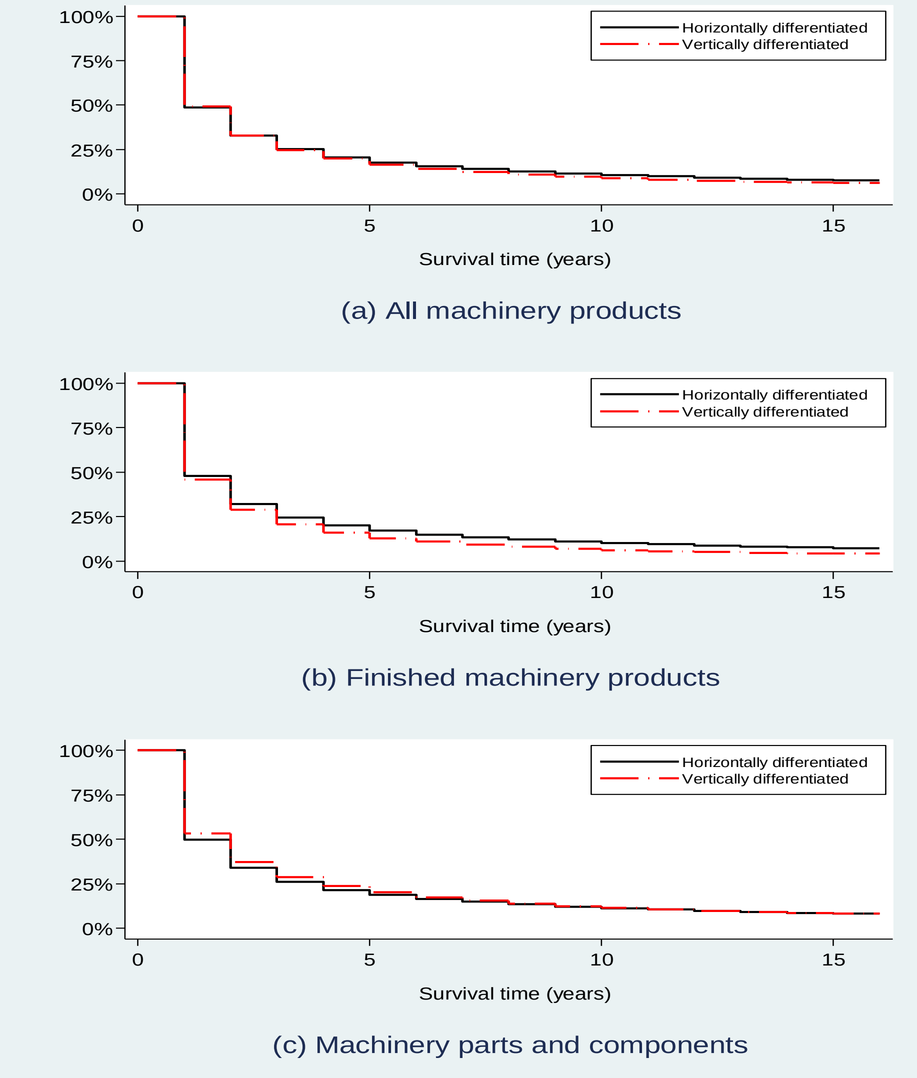
Source: Authors' own calculations based on CEPII's BACI database

Figure 2: Kaplan-Meier estimates of survival functions by product types



Source: Authors' own calculations based on CEPII's BACI database

Figure 3: Horizontallly versus verticallly differentiated products



(a) All machinery products

(b) Finished machinery products

(c) Machinery parts and components

Source: Authors' own calculations based on CEPII's BACI database