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

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On the Role of Vertical Differentiation in Enhancing 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 descriptive statistics analysis suggest that duration of Turkey's machinery exports is remarkably short with the median duration of merely one year. In addition, the likelihood of the survival of exports widely varies across product types (total machinery products, finished machinery products and machinery parts and components) and across trade types (horizontally differentiated products and vertically differentiated products). Based on discrete-time duration models, the empirical results demonstrate that vertical differentiation as well as product and market diversification are associated with a higher export survival rate, particularly for parts and components linked with global production networks. The evidence hence supports the hypothesis that global production sharing activities greatly increases the chances of survival in export markets.

Keywords: Export duration, Survival analysis, Vertical Differentiation, Global production networks

JEL Classification: F10, F14, C41

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1.Introduction

For most developing countries, improving the survival chances of export relationships is a necessary requirement for successful export growth, as suggested by the seminal work of Besedes and Prusa (2006a). Brenton, et al. (2009a) show that lower-income countries do fairly well in building new trade relationships, but experience much lower survival rates, compared to the developed countries. More recently, Besedes and Prusa (2010) find that new export relationships contributes relatively little to export growth than does the existing trade relationships, especially for developing countries. Therefore, understanding the factors that may explain low export survival rate in developing countries is important, as it facilitates the identification of the major constraints to export growth in developing countries and the policy options to overcome these constraints.

There is a small but growing literature that tries to identify the determinants 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). But these studies ignore one important determinant, that is the influence of global production activities on the survival of trade flows. Increased fragmentation of production and geographical dispersion have made global production networks ever more complex and more interdependent, and in turn, more stable. In this more sophisticated and complex networks, the buyer-supplier relationships tends to become stronger due to fact that trading partners incurs fixed costs to join global production networks. The firms in such relationships that involve repeat transactions and the development of trust between the partners have found it increasingly difficult to terminate them, as argued by Obashi (2010). These features of trade in intermediate goods within the global production networks, therefore, are expected to increase the survival probabilities of exports. In East Asia, Obashi (2010) showed that trade in machinery parts and components has a higher probability of survival compared to finished products and concluded that the presence of global production networks is a key factor leading to successful and long-lasting trade relationships among East Asian countries over the last couple of decades. The prevalence of longer relation in parts and components trade, especially those linked to global production networks, has been also found in a few studies including 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.

However, many of the aforementioned empirical studies suffer from the same problem of being unable to distinguish between vertically linked transactions of intermediate goods and other unrelated party transactions. These studies evaluate the role of global production networks on export survival by looking at the items classified as components and parts within the machinery and transport equipment group of the Harmonised System (HS). The major disadvantage of this approach is that many parts related to above groups come under different headings. In addition, different types of trade are captured in measurements of trade in parts and components: horizontal trade in similar goods with differentiated varieties; trade in vertically differentiated goods distinguished by quality; and vertical specialization that involves the exchange of technologically linked goods (Jones et al., 2002; Ando, 2006). Clearly, the nature of trade in intermediate products is partly related to the global production sharing that requires back-and-forth transactions in vertically fragmented production networks in the same commodity heading. Hence, assuming all trade in parts and components is indicative of global production sharing may lead to overestimation of the role of the global production sharing in explaining the differences in survival rates across product types.

Unlike previous empirical studies, which use trade in parts and components as a proxy for participation in global production networks, the purpose of this study is to more deeply explore the ways that the emergence of global production sharing influences the export survival in a developing country, introducing an indicator of vertical differentiation built from unit prices as an explanatory variable, an issue that has not been adequately addressed in the trade duration literature. More precisely, this indicator borrowed from the empirical studies on intra-industry trade is based on a decomposition of the 6-digit trade flows into vertical and horizontal flows derived from the ratio of the unit values of exports and unit value of imports. If this ratio is outside a particular range, the trade flow is defined as a flow of vertical differentiation which can be considered an adequate proxy for participation in global production activities at the product-level. This decomposition will enable us to demonstrate the increasingly important role vertical specialization within a global production network plays in the survival of developing countries' exports. Thus, this study investigates the hypothesis that higher survival rates of exports will be positively related to participation in production networks, as in Obashi (2010), Corcoles et al. (2012, 2014).

Hence, given the growing role of global production networks in trade flows and lack of reliable empirical evidence, this paper aims to fill this gap in the literature by analyzing the role of vertical differentiation linked with global production networks and other underlying factors in explaining export survival using product level data –in particular, machinery and transportation products-at the HS-6 digit level from Turkey for the 1998-2013 period. Turkey is chosen for several reasons to investigate the role of vertical differentiation in enhancing survival of export flows. First of all, Turkey as a developing country could be used to represent other developing countries. Moreover, from 1998 to 2013, Turkey's exports have increased almost fivefold from 26.9 billion US dollars to 151.8 billion US dollars. With respect to the extensive margin, the Exporter Dynamics Database of the World Bank shows that 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. In addition to all these points, share of top 10 markets in Turkey's total exports decreased from 62 % in 2000 to 48 % in 2010.[1] Finally, it is observed that Turkey's spectacular export performance is mainly driven by the increasing participation of Turkish firms into global value chains in recent years (Kaminsky and Ng, 2006; Saygılı and Saygılı, 2011; and Gros and Selçuki, 2013). Overall, Turkey is particularly suitable country for studying duration of exports linked to global production networks not only because of the increase in its ties with global production chains but also because of the diversification patterns of its exports over the study period.

For this purpose, the analysis is carried out with a discrete-time hazard models with proper control for unobserved heterogeneity, as suggested by Hess and Persson (2011b). In addition to estimating the effect of vertical differentiation on the survival of total machinery exports, these models are also re-estimated separately for machinery finished products and machinery parts and components. A separate estimate of the two product types will enable us to determine whether vertical differentiation linked with global production networks plays a key role in explaining differences in export survival across product types.

The rest of the paper is organized as follows. Section 2 briefly reviews the theoretical and empirical wok related to trade duration. Section 3 describes the data and provides descriptive analysis of the duration of Turkey's machinery exports as well as computes the Kaplan-Meier estimates of the survivor functions and compares the shapes of survival curves across different product groups. Section 4 discusses the econometric strategy and potential determinants of export duration, and reports the empirical results, including various robustness checks. A final section gives concluding remarks as well as policy recommendations.

2. Related literature

A small but growing literature examines the duration of trade relationships. A common problem identified in all the existing research literature is that there is no theoretical

[1] For instance, Aldan and Çulha (2013) and Türkcan (2014) provided evidence that Turkey has successfully diversified its exports by products and destination markets in the 2000s.

framework that is specifically designed for investigating the duration of trade relationships (Fugazza and Molina, 2011; Hess and Persson, 2011b). Theoretical developments, such as the sunk-cost models developed by Baldwin (1988), Baldwin and Krugman (1989) and Dixit (1989) and the search-cost theory proposed by Rauch and Watson (2003) might present reasonable explanations, at least to some extent, for the observed short-lived trade relationships. The sunk-cost models highlight the importance of sunk costs on a firm's export decisions in uncertain environments. In the presence of sunk costs to exporting, these models show that prior export experience is important for the current decision to export. Specifically, once the firm has incurred a sunk entry cost to enter foreign market, it might prefer to maintain a presence in the foreign market even when it incurs temporary losses from exporting resulting from transitory changes in trade policy or macro shocks, such as large currency devaluation. This leads to hysteresis, i.e. persistence, in the exporting flows. Consistent with the theoretical predictions, empirical findings presented by Roberts and Tybout (1997), Bernard and Jensen (2004) show that the sunk costs are large and a significant source of export persistence. However, these models fail to explain the frequently observed the short duration of trade flows (Besedes and Prusa (2006a; Nitsch, 2009; Hess and Persson, 2011b).

The search-cost theory proposed by Rauch and Watson (2003) also presents some theoretical insights on the dynamics of trade duration. They show that search costs matter and play an important role in initiating and maintaining stable trade relationships. They argue that buyers in developed countries are required to pay search costs in order to find suppliers in developing countries and may be uncertain about the supplier's ability to fulfill large orders to the buyer's specifications. Consequently, the model predicts that the buyer in a developed country is more likely to start a relationship with an exporter with small trial order when they incur higher search costs and when they are uncertain about the supplier's ability to fulfill the buyer's specifications. This suggests a lower survival rates for trade relationships with small initial values. On the other hand, buyers tend to place a larger order when they face less uncertainty about the supplier's ability, which translates to higher survival rates of trade flows. The model also predicts that differentiated products have lower initial trade volumes and longer lasting trade relationships than homogenous products, based on the fact that search costs are generally higher for differentiated products relative to homogeneous products.

While these theoretical studies have difficulty accounting fully the observation that many trade relationships are short-lived, the empirical studies might provide theoretical perspectives and insights for developing a theoretical framework for the study of the trade duration. A small number of empirical studies have analyzed the determinants of trade duration. These studies undertaken so far 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 and the second group includes the studies that instead exploit the firm-level data in a particular country.

The first group of studies includes Besedes and Prusa (2006a, 2006b, and 2010), Besedes (2008), Nitsch (2009), Brenton et al. (2010), Fugazza and Molina (2011), and Hess and Persson (2011b). The first study to employ product-level data is Besedes and Prusa (2006a), who examined the duration of trading relationships using the data on imports from the United States at the 7-digit Tariff Schedule of the United States from 1972-1988 and at the 10-digit Harmonized System (HS) from 1989-2001. Based on Kaplan-Meier estimates of survival functions, the authors show that the duration of US imports is very short, with the median being 2-4 years. Their results also suggest that there is negative duration dependence, meaning that the hazard rate decreases over time. In a follow up paper (Besedes and Prusa, 2006b), using the same US import data, the authors further investigate the duration of trade by applying the search-cost model developed by Rauch and Watson (2003). Their results obtained under the Cox proportional hazards model indicate that homogenous products have higher hazard rate than differentiated products and trade relationships with a smaller initial transaction size have a higher hazard rates than those with larger initial transactions, for both product types, in line with the search-cost model of Rauch and Watson (2003). In related work, Besedes (2008) also test the main implications of the model by Rauch and Watson (2003) by applying the Cox proportional hazards model to the same data set as in Besedes and Prusa (2006a). The results are once again are consistent with a search model that higher reliability and lower search costs lead to larger initial purchases and longer relationships. In addition, Besedes (2008) show that intermediate products face a 10% higher hazard than final products, suggesting that higher degree of input substitutability is most likely to increase the hazard rate.

These early findings are generally confirmed by more recent evidence. For instance, Nitsch (2009) examines the duration of German imports at the 8-digit product level for 1995-2005 using a stratified Cox proportional hazards model. The author finds that the vast majority of the trade relationships in German import trade are remarkably short-lived, consistent with findings of Besedes and Prusa (2006a). In addition, factors associated with exporter characteristics, product characteristics, as well market characteristics strongly and significantly affect the duration of a trade relationship. Further, the hazard rates are found to be lower for differentiated products, and for products with a low elasticity of substitution and as well as for products with a large transaction value. Finally, the results suggest that hazard rates are lower for trade partners that hold large shares of the German import market and have a large share of two-way trade (intra-industry trade) in total trade.

Besedes and Prusa (2010) investigate the role of intensive and extensive margins in export growth. Using disaggregated bilateral manufacturing exports of 46 countries to 181 importers for 1975-2003, they decompose a country's export growth into three distinct components: establishing new partners and markets; having existing relationships survive or persist; and having existing relationships deepen. The first component represents the extensive margin, whereas the last two components represent the intensive margin. Their results indicate that most export relationships are very short-lived, with the median being 1-2 years and export growth mainly occurs through survival and deepening of existing trade relationships rather than the creation of new trade relationships, i.e. the extensive margin.

Brenton et al. (2010) examines the duration of export flows using the 5-digit level of the Standard International Trade Classification (SITC) data from 82 exporting countries to 53 importers for the period of 1985 to 2005. Using a discrete-time complementary log-log model (Prentice and Gloeckler, 1978), the authors first show that the initial size of an export flow, cultural and geographic ties between trading partners as well as economic size of both trading partners play significant role in export survival. Additionally, experience with exporting the same product to other markets or different products to the same product is found to significantly reduce the hazard of exporting of developing countries. The results also suggest that export experience is product rather than market specific, particularly for developing country exporters. Consistent with the findings from previous empirical studies, they also confirm that variables designed to capture search costs as well as cultural and geographical ties between trading partners seem to matter more to differentiated products than homogenous products.

Using an extended version of the semi-parametric Cox survival model and a Probit model with random effects, Fugazza and Molina (2011) investigate the patterns and determinants of trade duration for a set of 96 countries over the 1995-2004 period. First, their descriptive analysis show that export survival seemed to increase with the level of economic development. Second, their econometric results indicate that initial export size is positively related to the export survival, which is in line with Besedes and Prusa (2006b). Their results further suggest that the hazard rate is lower for differentiated products than for homogenous products, yielding results that are qualitatively similar to those found in Besedes and Prusa

(2006b). The authors offer possible explanations for this result: exporters producing homogenous products are likely to face more competition in global markets, which probably increases the hazard rates of export flows. Finally, they also found that fixed costs have a positive effect on the duration of trade relationships but that effect diminishes with the length of the trade relationship.

Hess and Persson (2011b) use discrete-time duration models rather than continuous-time hazard models, i.e. the Cox model, to analyze the import duration of European Imports (EU) for 1992-2006 and find that EU imports from the rest of the world are very short-lived. Besides finding significant impact of the traditional gravity variables such as distance, common language and income levels, on the duration of trading relationships, they also show that the export diversification, in the sense of number of products exported as well as number of markets served with the given product, has a negative impact on the hazard rate of trade flows.

The second group of studies such as 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) examines the determinants of firm’s duration in export markets for a particular country. Among the first study of this kind is Esteve-Perez et al. (2007), who investigate the determinants of persistence of firms in export markets using a sample of Spanish manufacturing firms for the period 1990-2000 and report that the mean and median duration of export spells are 6 and 5 years, respectively. Furthermore, by employing a discrete-time complementary log-log model, they found strong evidence supporting the hypothesis of negative duration dependence, thus giving support for the theory of active learning after entry in a new market. Their results further suggest that firms exporting to closer markets generally last longer in these exporting markets than firms exporting to more unknown and uncertain markets. Finally, other firm characteristics such as size, productivity, export and R&D intensities and final consumption products (differentiated product) have been found to be important determinants of export survival of Spanish firms. In a follow up paper, Esteve-Perez (2013) confirmed these results using more recent and comprehensive firm-level data for Spain covering 1997-2006. In addition to the usual variables used in the work of Esteve-Perez et al. (2007), they also explore the role of intra-industry trade, employed as an indicator of the degree of product differentiation, for the firms’ survival in export markets and find evidence that firms selling products for which Spain engages in intra-industry trade export for longer periods.

Based on Tobit model with industry dummies, Alverez and Lopez (2008) employ plant-level data for manufacturing industries in Chile between 1990 and 1999 to explore the industry-level determinants of entry and exit in export markets. They found that within-industry heterogeneity, measured by differences in total factor productivity, is the most important variable that explains firm turnover in and out of exporting. In contrast, trade costs, factor intensities, and the real exchange rate were found to be somewhat less relevant for firm's entry and exit decisions into exporting.

Using firm-level data for the whole population of Peruvian new exporters over the period 2000-2006, Volpe-Martincus and Carballo (2009) show that the median duration of a Peruvian firm export spell is just one year. They also document the importance of geographical and product diversification of exports in enhancing the probability of firms surviving in export markets, but geographical diversification contributes more than product diversification. Furthermore, it is found that larger firms are more likely to stay longer in export markets.

Ilmakunnas and Nurmi (2010) investigate firm exit and entry from export markets using a simple discrete-time complementary log-log model applied to data from Finnish manufacturing plants for the period 1974-2005. The authors found that firms that are large, young, highly productive, and highly capital-intensive tend to enter foreign markets and survive longer in export markets. Their results further suggest that foreign ownership increases the probability of starting to export and staying in the export markets, especially for the smaller plants. Lastly, their results show a strong productivity growth resulting from entry into the export market, suggesting learning-by exporting effects.

Görg et al. (2012) identify factors that influence the survival of a given product in a firm's export mix using a Hungarian firm-product-destination data from 1992 to 2003. In doing so, they consider a number of explanatory variables that capture characteristics of firm/industry and product. Based on the complementary log-log estimations, the authors find that the firm- as well as the firm-product characteristics are important determinants of the survival of products in the exporting mix, which is broadly in line with theoretical predictions of Bernard et al. (2006). In addition, foreign firms were found to have a more stable product mix, suggesting that these firms have established links with foreign partners but also a greater level of export experience. Unexpectedly, they find that the relative unit value of a product as a proxy for product quality has a significant positive effect on the hazard rate. Related to this, their results also indicate that more differentiated products interacted with the relative unit values face higher hazard than less differentiated products, in contrast with the theoretical arguments. Finally, they classify products into consumer, capital and intermediate products in order to see whether the end-use of a product is relevant for export success. They show that consumer products have the longest probability of survival, whereas intermediate products are the most likely to be dropped by the firms. In addition, the relative unit values were found to exert stronger effects on survival when consumer products are considered, implying that the product quality matters a lot for the survival of consumer products (finished products).

Cadot et al. (2013), using transactions level export data obtained from the Customs authorities of four African countries (Malawi, Mali, Senegal and Tanzania), found that new export relationships hardly survive the beyond the first year for a given firm-product-destination triplet, suggesting that these African firms experiment substantially on export markets, at a low scale and with low survival rates. This evidence indicates a weak contribution of the intensive margin over the extensive margin. They however also find that once a firm's product manages to survive a given destination market beyond its first year, it grows significantly over time, consistent with the findings of negative duration dependence in Besedes and Prusa (2006a). Apart from these stylized facts, they empirically show that more companies from the same country selling the same product in the same destination together raise each other's survival probability. This finding suggests that exporters of similar products to the same destination lead to a positive externality on new entrants. Finally, they also find that both product and geographical diversification significantly improve the probability of surviving in the export market beyond the first year, but the geographic diversification matters more for survival than product diversification.

The study of Stirbat et al. (2015) explores the role of experience and network on the firms' survival in export markets by employing monthly firm-level customs records from Laos over the period 2005-2010. Focusing on a random effects discrete-time logit model, their regression results indicate that the different types of firm experience, such as prior experience or familiarity with the product or destination, experience with importing and using Thailand (culturally close developed neighbor) as a launch market, have a strong positive influence on the survival of exports for a given firm-product-destination triplet, implying learning-by-exporting effects. Their results further show that having already exported to the product or exporting it to several markets results in larger increase in the survival rate than destination experience and familiarity. At last, they find support for the hypothesis that exporter networks enhance the probability of firms' survival in export markets via the diffusion of information.

Gullstrand and Persson (2015) develop a theoretical framework that captures the importance of sunk costs of exporting, which include investments in marketing and/or distribution networks, as well as future returns from exporting in explaining the differences in survival rates across core and peripheral countries. They argue that the importance of sunk costs of exporting as well as future returns matter a lot in core markets, implying that once exporting has begun, it will last a longer time in those markets. Using firm-product-destination specific export data for all firms in the Swedish food chain over the period 1997-2007, they do find evidence supporting the hypothesis that firms tend to stay longer in their core markets, while they exit more easily from peripheral markets. To see whether this result holds across different product categories, they also decompose export flows into consumer products export flows and intermediate products export flows. Using this decomposition, the authors did not find any significant evidence to support the prediction that the vertical trade, i.e. the exchange of products between upstream and downstream firms, may lead to costly contracts or relationship-specific investment that give rise to a hold-up problem, which in turn could affect the survival of export flows.

In recent years, a more limited strand of literature has focused on the role of global production activities on the survival of trade flows, an issue that is directly relevant to this paper. A distinctive feature of present globalization is the development of global production sharing activities, i.e. production fragmentation.[2] As world markets have become increasingly integrated in the last few decades due to developments in transportation and communication technologies, the degree of product fragmentation has increased across countries, leading to a sharp increase in the share of intermediate products in world trade (Türkcan, 2011). This growth in intermediate products trade indicates the growing importance of global production networks in the world economy because a significant portion of international transactions of intermediate products (parts and components), which involves the relocation of parts of the production process into various stages or tasks across international borders, frequently takes place within the global production networks. However, despite the growing importance of production fragmentation in international trade within production networks, only limited evidence is available on the link between the survival of trade flows and global production networks (Obashi, 2010; Shao et al., 2012; Corcoles et al., 2012, 2014; Diaz-Mora, 2015).[3]

[2] Product fragmentation can be defined as division of production processes into different locations across different countries. There are different types and terms of product fragmentation used in the 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 (2001). For more detailed information on the different terms for product fragmentation, see Sotomayor (2016).

[3] There is also much older literature on the relationship between firms' entry-exit patterns and global commitments. For instance, Kimura and Fujii (2003) analyzed the exit pattern of firms in the Japanese

Obashi (2010) examine this issue for intra-East Asian machinery trade using bilateral import data at the 6-digit level of HS from 1993 to 2006. Kaplan-Meier estimates reveal significant differences in the probability of the survival of trade relationships between parts and components and finished products in intra-East Asian machinery trade. Specifically, it is found that both survival curves are downward sloping with a decreasing slope. This finding immediately implies that there is negative duration dependence. In addition, parts and components have higher survival rates than finished products and the gap between them is widening. The Cox proportional hazard estimates also proved the difference in the probability of the survival of trade relationships by product type. According to Obashi (2010), this is at least partially due to the relation-specific nature of the transactions of the intermediate products in production networks compared with the other transactions in East-Asia. To set up the production networks, a firm has to pay substantial service link costs as well as sunk costs. Hence, once the production networks are formed, transactions in parts and components become relation-specific and thereby stable.

The role of production fragmentation on export duration was also explored by Shao et al. (2012) using disaggregated 6-digit level HS export data from China for the period 1995-2007. They found that the coefficient of finished products has no significant effect on the hazard rate of exporting under the Cox proportional hazards model, but the coefficient of parts and components has a significant negative effect on the hazard rate, thereby suggesting that parts and components trade is more stable than trade in finished products, consistent with conclusions of Obashi (2010). The authors conclude that by participating more effectively in the global labor division, China achieved not only remarkable export growth over the past several decades, but also more stable export relationships.

A series of studies by Corcoles et al. (2012, 2014) and Diaz-Mora et al. (2015) also highlight the importance of the global production activities on the survival of trade flows. Likewise Obashi (2010), Corcoles et al. (2012) employs the data for Spain's exports of machinery and transport equipment to 90 destination countries at the 6-digit level of the HS to assess the duration of trade linked to cross-border production systems. Kaplan-Meier estimates at the product-level confirm the prediction that parts and components have higher survival rates compared to final products, consistent with the findings of Obashi (2010). The results further indicate that the risk of ending an export relationship gradually declines over time, but the decline appears to be smaller for trade associated with production networks.

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manufacturing sector and reported that different forms of global commitments, such as the foreign sales ratio, the foreign outsourcing dummy, and the owning foreign affiliates dummy, significantly improves Japanese firms' probability of survival when firms are small, but loses their significance as firm size increases.

Focusing on the discrete-time complementary log-log models with frailty, they also confirm the hypothesis that sunk entry costs and need for trust and reliability play a crucial role in enhancing the stability of exports linked to international production networks.

A more recent paper by Corcoles et al. (2014) analyze the role of product sophistication on the stability of trade flows that take place within global production networks using the data on auto exports from 60 countries at the 6-digit level of the HS over the period from 1996 to 2009. They start by decomposing auto exports into parts and components and final products to explore whether duration of export relationships vary across product types and find that the average number of years of uninterrupted trade ties in parts and components is 3.0 compared to 2.4 in final products. Furthermore, they show that product sophistication encourages stability of trade relationships using discrete-time logit model with random effects at the product-level, indicating that countries that produce and export more sophisticated products tend to stay longer in the global production networks. Finally, their results indicate that deeper integration in the global value chains proxied by product and market diversification reduces the risk of interruption of export relationships. Again, the results were similar to those given by Obashi (2010).

Using a sample of Spanish manufacturing firms for the period 2006-2010, Diaz-Mora et al. (2015) aim to identify the relation between being a vertically specialized firm, i.e. simultaneously an exporter of intermediate products and importer, and the probability of ceasing to export.[4] In particular, they argue that firms that engage in vertical specialization-based trade in intermediate products are likely to be larger, more productive, more foreign ownership, more skill intensive and have much higher FDI outward flows. Firms that possess these types of characteristics have an advantage over others which don't since such characteristics permit them to handle any uncertainties about their overseas business. This, in turn, reduces the probability of exiting export market. Their descriptive results show that the exit rate was 10% for firms involved in vertical specialization and 17% for firms that only export. In line with the descriptive results, the estimation of a random effects probit model also support the prediction that being a vertically specialized firm-which is closely related to global production networks-reduces the risk of ceasing to export, particularly for small-sized firms.

While the study of duration of trade relationships pioneered by the seminal work of Besedes and Prusa (2006a) has recently become a hot topic in the trade literature, a large body

[4] Related literature (e.g. Wagner, 2013) also highlights the positive relation between firm dynamics (exit and entry) and two-way trade.

of empirical evidence is restricted to developed countries and may have limited applicability in a developing country. It is recognized that factors affecting survival of trade relationships may well differ from developed countries to developing countries (Brenton et al., 2010). Hence, the current paper aims to produce reliable and rigorous evidence from the perspective a developing country that can help policy makers about the factors affecting export survival within the local contexts and needs.

3. Data and descriptive analysis

In order to examine the duration of Turkey's machinery exports, this paper uses highly disaggregated 6-digit product level data from 1998 to 2013 taken from BACI, an international trade database developed by CEPII.[5] The database, constructed using the United Nations Commodity Trade Statistics original database (UN COMTRADE), 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.[6] There are more than 5,000 headings at the six-digit level of the HS 1996.

As compared to the original database (UN COMTRADE), working with the BACI database has several advantages. First, the BACI database reconciles mirror flows (for both values and quantities), which is 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 for Turkey's machinery exports, which is particularly relevant in determining duration of trading 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 like), the quantities in the BACI database are registered in the same unit (tons) so that unit values are comparable at the world and product level (Gaulier and Zignago, 2010). Therefore, the BACI database is well suited to address the role of vertical differentiation on the duration of trade, as it directly provides consistent unit values at the product-level.[7]

The main purpose of this paper is to assess the effect of vertical differentiation on the duration of machinery exports at the product level. At the six-digit level of the HS 1996 product classification, there are more than 5,000 product lines covering all articles in trade

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

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

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

(HS chapters 1-92).[8] Following Kimura and Obashi (2010) and Obashi (2010), this study identifies product lines included in any of the headings of chapters 84-92 of the HS 1996 as machinery products: general machinery (HS 84), electric machinery (HS 85), transport equipment (HS 86-89), and precision machinery (HS 90-92). Furthermore, following the same procedure as in Ando (2006) and Obashi (2010), about 729 product lines are considered as finished machinery products and 445 product lines are considered as machinery parts and components out of 1124 product lines from the 6-digit level of HS 1996. Table A1 in the appendix lists the HS-6 codes relevant to machinery parts and components industry.

The selection of the sample countries was dictated by the availability of data on bilateral trade flows as well as on explanatory variables. Some countries could not be included if they had not have any export relationship with Turkey over the 1998-2013 time period. Others had to be excluded due to the lack of the data on explanatory variables over the sample period. To ensure that our results are not driven by the changes in political boundaries, some of countries were also excluded from the sample. With these restrictions, the sample of the current paper is limited to 188 countries out of the 244 countries included in the BACI trade database, accounting for over 90% of Turkey's exports. Table A2 in the appendix provides a detailed list of all 188 destinations countries included in the analysis. Thus, data on machinery exports by Turkey to 188 destination countries over the period 1998 to 2013, comprising of 1124 items at the 6-digit level of the HS 1996 was used in the analysis.[9]

Prior to carrying out the empirical analysis, the paper starts by providing a through descriptive analysis in order to investigate the patterns and differences in machinery exports duration across different spells of trade and different product groups. The central question in this section is how to calculate the duration of exports for each export relationship. Following Besedes and Prusa (2006a), an export relationship refers to the exchange of a certain product between exporting and importing country at the 6-digit level in a given year. Export spell, on the other hand, refers to a realization of an export relationship in consecutive years, during which the export relationship is active between exporting and importing country. For each importing country and product pair (export relationship), the duration or length of these export spells is then calculated as the number of consecutive years that the export relationship

[8] At the 2-digit level of HS1996, the products are organized into 97 chapters: HS 1-24: food; HS 25-27: mineral products; HS 28- 38: chemical products; HS 39-40: plastics and rubber; HS 41-43: hides and skins; HS 44-46: wood and wood products; HS 47-49: wood pulp products; HS 50-63: textiles and textile articles; HS 64-67: footwear; HS 68-70: articles of stone, plaster, and cement; HS 71: pearls and precious stones; HS 72-83: base metals; HS 84: general machinery; HS 85: electric machinery; HS 86-87: vehicles and railway; HS 88-89: aircraft and ships; HS 90-92: precision machinery, others: others, and not classified elsewhere (Ando, 2006).

[9] In the BACI database, Belgium and Luxembourg are a single entity.

takes place without interruption. An export relationship may stop and start several times over the study period, which in turn result in multiple spells within one export relationship. The greater number of spells means a shorter duration of export spells for each importing country and product pair. This also means that the number of export spells exceeds the number of export relationship over the study period. The maximum number of spells possible for each importing country and product pair during 1998-2013 (16 years) is eighth.

Duration of Turkey's machinery exports

The basic statistics on the duration of Turkey's machinery exports, finished machinery exports, as well as for machinery parts and components exports are presented in the first row of Table 1, Table 2 and Table 3.[10] As shown in Table 1, there are 562,041 annual bilateral export observations over 16-year period. Moreover, as shown in the first row of Table 1, there are 89,801 observed export relationships between Turkey and its destination countries. There exists 173,152 observed spells of export for all machinery exports during the sample period. It is important to note that the total number of export spell in the sample has been consistently higher than that of export relationship because multiple spells are treated as independent in the current study.

The results show that the average length of an export relationship in Turkey's machinery exports is remarkably short with the mean of 3.25 years. Moreover, as shown in Table 1, the median duration of export spells is just one year long in the benchmark sample, which means at least half of the relationships did not last longer than one year during the sample period. Additionally, the results in the first row of Table 1 indicate that the mean number of export spells per importing country and product pair is 1.93, whereas the median number of spells is 2. These findings suggest that 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). These findings also imply that Turkish companies do not afraid of entering into new and unfamiliar markets with new products.

Figure 1a plots the histogram of the frequency of export spells on annual basis within the time period of 1998-2013. The figure clearly indicated that short spells were most dominant, with the frequency decreasing as the length of the spell was increased. As the histogram in Figure 1a shows, nearly 53% of export spells fail within the first year. Almost 81% of Turkey's export relationships fail within the first 4 years. Only 4% of the export spells exist until the end of the reporting period, implying that Turkish exporters tend to have lower

[10] SAS program was used for manipulating data and generating Table 1, 2 and 3.

survival rates, especially in the early years of exporting, confirming similar results obtained by Nitsch (2009) for German imports.

To further investigate the patterns of the survival of Turkey's machinery exports, we also estimate the survival functions using the Kaplan-Meier method. Figure 2 presents the Kaplan-Meier estimator of the survival functions for Turkey's machinery exports indicating the probability of an export relationships surviving through their first year, their second year and so on.[11] The survival function depicted as a solid line in Figure 2 is downward sloping with a decreasing slope, implying that the probability of survival decreases as the duration of export spells increases. In particular, the figure illustrates that the probability of surviving the first year is about 55% and maintaining a relationship for more than five years is around 30%. The probability of an export relationship surviving throughout the entire period is only 25%, suggesting how short-lived Turkey's export relationships are. The decreasing slope of the survival function also implies that the probability of export survival is increasing as Turkish firms stay in export markets for longer periods. There is a negative duration dependence as in Besedes and Prusa (2006a). These results lead to conclusion that survival rates of Turkey's machinery export flows is low during the early years, but after 5 years the survival rates remain nearly constant.

Overall, the descriptive analysis so far suggests that most of Turkey's machinery export flows are short-lived. However, this result may be driven by measurement errors associated with misreporting or misrecording or temporary interruption of trading relationship. To ensure that measurement error in export statistics does not drive the results, a broad set of alternative measures of export spell (i.e. first spell, single spell, gap-adjusted spell, etc.) and different levels of data aggregation (4-digit HS and 2-digit HS) were applied in computing the duration of Turkey's machinery exports. In their seminal work on export survival, Besedes and Prusa (2006a) argue that the existence of multiple spells that may arise from measurement errors in the trade statistics could cause bias calculating the duration of export flows. Besedes and Prusa (2006a) applied three different approaches to deal with the issue of multiple spells.[12] They first restrict their analysis to the first spell of export relationships with multiple spells and the single spell, i.e. export relationships with just one spell. In addition, Besedes and Prusa (2006a) pointed out that the existence of multiple spells may result in the underestimation of the duration of export spells. This is especially true when the interval between spells is quite short and the gap may be simply due to recording error at

[11] In this paper, graphs, histograms as well as Kaplan Meier survival curves are created using Stata version 13.

[12] Many studies including Nitsch (2009), Fugazza and Molina (2011) and Hess and Persson (2011b), have applied the same approach to take into account multiple spells of service.

customs. Thus, they suggested correcting this measurement error by merging all spells with a one-year gap into a single longer spell.

Thus, following Prusa and Besedes (2006a), three alternative approaches (first spell, single spell and gap-adjusted spell) have been implemented in order to assess the robustness of the benchmark findings and the findings are also reported in Table 1. In the benchmark sample, roughly 75% of export relationships experience multiple spells of service. When considering the first spell of each export relationship, the numbers of observations and export spells are significantly dropped, suggesting that a very large fraction of Turkey's export relationship fail and then reoccur over the sample period, as can be seen from Table 1.[13] Moreover, as shown in Table 1, the mean and median lengths of the first spell sample are 3.52 years and 1 year, respectively. When compared to the mean lengths obtained with the benchmark sample, the mean lengths of the first spell sample is slightly longer, implying that the greater proportion of export relationships in the first-spell sample has longer relationship.

In a similar manner, focusing on single spell relationships further increases the mean and median duration of exports, with mean and median duration being 5.54 and 2 years, respectively. The results indicate that single spell export relationships tend to have longer lives than in the benchmark sample. When examining the gap-adjusted sample, it was found that the mean duration of exports is 4.55 years while the median duration is now 2 years, meaning that the gap-adjusted spell sample have longer export relationship than in the benchmark results. The longer duration of gap-adjusted sample has been also obtained by Nitsch (2009) and Hess and Persson (2011b).

In addition to the issue of multiple spells, data censoring is crucial issue in duration analysis. The censoring problem arises from the fact many countries fail to report trade flows in some years, creating left- and right- censoring in the middle of the sample period that must be dealt with efficiently. Specifically, left-censoring occurs when an export relationship can have been established before the sample period starts. Consider the sampling period of 1998-2013, if an export relationship was observed in 1998, it is difficult to know whether this relationship begun in 1998 or sometime before. Right-censoring, on the other hand, occurs when an export relationship exists until the end of the sample period. It is also difficult to know whether an export relationship that is last observed in 2013 was truly ended in 2013 or continued after it. Ignoring the problem of left- and right censoring will likely to lead to an overestimation of actual spell durations (Nitsch, 2009).

[13] The first spell of an export relationship includes relationships with just a single spell and the first spell in a multi-spell relationship.

Following Nitsch (2009), the averages of duration of export without the left- and right-censored observations are calculated in order to highlight the severity of censoring problem in the current sample. After correcting for left-censoring, the average spell duration in Turkey's machinery exports is less than 3 years, with the median duration of just 1 year, confirming similar findings of Nitsch (2009) for left-censoring sample. In a similar manner, with a correction for right-censoring, the mean and median lengths of export spells were drastically declined to 1.83 and 1 year. As seen in Table 1, among all spells the left- and right-censored spells tend to be shorter while the non-censored spells are longer on average, which shows upward bias that would be introduced if only non-censored spells would be analyzed.

As argued by Rauch and Watson (2003), new exporters begin by exporting small amounts when they are uncertain about their profitability in new markets, and are more likely to exit the export market in their first few years. This suggests a lower survival rates for export flows with small initial values. On the other hand, exporters tend to place a larger order when they face less uncertainty in their activity abroad, which translates to higher survival rates of export flows. Following Nitsch (2009) and Hess and Persson (2011b), this paper also explore whether initial export value plays a significant role on the duration of Turkey's machinery exports by dropping spells with initial export value less than 10,000 dollars (100,000 or 1,000,000 dollars). The results presented in Table 1 show that using different cut-off levels increase the average and median duration of export flows, that is spell that starts with higher initial export value lasts longer than those starting with small initial export values, consistent with the results of previous findings in the literature (see, for instance, Besedes and Prusa, 2006a; Nitsch, 2009; Hess and Persson, 2011b). Although results vary slightly across different samples, the same pattern remains: Turkey's machinery exports is very short-lived.

Besedes and Prusa (2006a) argue that the duration analysis can be sensitive to the level of data aggregation. As expected, export duration increases with higher levels of aggregation because higher levels of data aggregation decrease the number of product categories, which in turn increases the probability that at least one product is traded in that category for a given year. However, higher-level of aggregation comes with a trade-off, the loss of product-level information. Given these considerations, this paper also computes export duration at more aggregate levels of industry classification (HS-4 and HS-2 digit levels). The results presented in Table 1 clearly illustrate that higher levels of data aggregation leads to an increase in the average and median duration of Turkey's machinery export flows, as predicted. It is clear that the average duration of export flows is affected by the level of aggregation but effects of data aggregation on the analysis results appear to be limited since even at a highly aggregated level, export flows is still short-lived, particularly at 2-digit levels of HS where only nine product categories exist. Observed short duration in Turkey's machinery exports is thus not merely a product of the use of more highly disaggregated trade data, in line with the findings of previous studies (Besedes and Prusa, 2006a; Nitsch, 2009; Hess and Persson, 2011b).

As a robustness check, survival functions are re-estimated using subsamples of the export data on the basis of different definition of spells, different cut-off levels and different levels of data aggregation. Figure 3 shows the estimates of survivor functions of different samples. The shape of the estimated survival curves for different samples looks similar compared to those of the benchmark sample. Specifically, the survival curves across all samples are downward sloping with a decreasing rate, indicating that hazard rate for export flows gradually declines over time. The results of the survival analyses for different samples thus clearly indicate that Turkey's machinery export flows on average have very low survival rates and their survival rates remains fairly constant after 5 years.

Duration of Turkey's finished machinery exports

Following Obashi (2010), Corcoles et al. (2012, 2014), the descriptive analysis is also carried out for two product types, namely finished machinery products and machinery parts and components, in order to highlight the role of product characteristics in explaining the observed differences in the duration of Turkey's machinery exports. The averages and median duration of Turkey's finished machinery exports as well as other relevant summary statistics are reported in Table 2. The results show the duration of finished machinery exports is only slightly shorter than that of total machinery exports. In particular, Table 2 indicates that the mean (median) length of spells is 2.96 (1) years for finished products and 3.25 (1) years for all machinery products over the sample period. This result confirms the previous finding that finished products have lower survival rates than all products, which includes both finished as well as parts and components (see for instance, Obashi, 2010 for machinery industry and Corcoles et al., 2014 for automotive industry).[14] This finding is not surprising given the fact Turkey is mainly exporting low or medium quality products. [15] It has been observed that low-quality products tend to have more close substitutes in global markets, which makes

[14] In contrast, Besedes (2008) find evidence that trading relationships involving intermediate goods have a higher hazard than those in finished goods.

[15] For instance, Emirhan (2015), based the data on Turkey's exports to the EU countries from 2008q1 to 2009q4, showed that the medium quality industries have the highest share in Turkey's exports to the EU countries on average. Likewise, 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. In contrast, the share of low-tech labour intensive products dropped from 69.6 percent to 46.5 percent over the same period. Despite the changing pattern of exports, the low-tech products continued to play a major role in Turkish exports to Europe (Gros and Selçuki, 2013).

competition more intense. When there are more close substitutes in the global markets, the demand becomes more elastic since buyers find it easy to switch, thereby reducing search and switching costs. With an abundant global supply of low quality products, buyers usually purchase products based on price rather than any concept of brand loyalty (Klemperer, 1995). In contrast, higher search costs and switching costs can increase companies' market power and eventually lead to brand loyalty. In particular, consumers facing high search and switching costs will tend to purchase the brand that he already knows (Klemperer, 1995). Consequently, it is reasonable to expect that the hazard rate of low-quality products is higher than that of high-quality products, thereby having shorter export duration. Hence, the results suggest that the low quality content of Turkey's finished machinery exports leads to a reduction in competitiveness and to increase in hazard rate.

The relative frequency histogram presented in Figure 1b shows that spells with longer duration represent a low share of export spells. About 55% of all export relationships for finished machinery products fail within the first year, and 85% of export relationships exit the market within the first five years. Only around 3% of all export relationships survive throughout the study period, implying that Turkey's finished machinery exports are, in general, very short-lived. The results suggest that Turkey's finished machinery exports tend to be traded over a relatively short period of time compared with other product types. The Kaplan-Meier survival function estimates for finished sample reported in Figure 2 give a similar picture. In particular, the figure indicates that hazard rate is decreasing in duration time. A possible explanation for this finding is that as the export relationships deepen, buyer's increase their expertise in the firm's product line and Turkey and develop increased search and switching costs. This, in turn, contributes to longer export relationships between Turkey and its trade partner.

Descriptive statistics on the duration of finished machinery products across different samples are reported in Table 2. Although there appears to be few differences, the average spell length for finished machinery products across subsamples is consistently lower than those for those all machinery products, once again confirming the finding that export relationships of finished machinery products clearly have shorter duration than all machinery products. Likewise, Figure 4 depicts the result of the same Kaplan-Meier survival function estimates for finished machinery products across different subsamples. Results show that survivor curves exhibit similar patterns across all subsamples, implying that export spells that survive the first five-year period tend to have a higher probability of surviving in the future.

Taken together, these results so far suggest that short duration of the export relationship have constrained Turkey's export growth in finished machinery products over the sample period.

Duration of Turkey's machinery parts and components

Survival analysis is also carried out in this study by using the export flows of machinery parts and components in order to identify the growing role of the end-use characteristics of the product in building a long-term established relationship. As illustrated in Table 3, from 1998 to 2013 the mean duration of the export spell is 3.66 years and the mean duration is 2 years for the entire sample, which were much higher than those of all machinery products and finished machinery products. This finding is similar to the finding of Obashi (2010), who reports that, for machinery industry, the mean (median) duration of export spells is 6.1 (3) years for parts and components and 4.3 (2) years for finished products. Similarly, focusing on world auto exports, Corcoles et al. (2014) also show that survival rates are considerably higher for parts and components than finished products. This evidence hence supports the hypothesis that global production sharing may increase the likelihood of exports' survival in Turkey.

In Figure 1c, the frequency distribution of Turkey's export spells for machinery parts and components are illustrated for the 16-year period from 1998 to 2013. Results showed that a high percentage of spells have short duration. The share of one-year export spells is around 50% and the share of two-year export spells is 17%. On the other hand, export spells that survived throughout the entire sample period represent only 6% of the spells, which is considerably greater than those of finished machinery products. This result reinforces the hypothesis that parts and components are traded through longer-lived and more stable relationships than finished products due to the relation specific nature of transactions (Obashi, 2010).

Likewise, Figure 2 indicates that machinery parts and components exhibit higher probabilities of survival than other product types. In addition, survival curves are downward sloping with a decreasing slope indicating that export relationships become more stable as they mature. Specifically, the figure shows that survival rate for parts and components decreases sharply at the beginning of the study period, particularly in the first year, and then remained relatively stable beyond 5 years. The probability of an export relationship surviving the first year is about 58%, and maintaining a relationship beyond five years is around 33%. Around 30% of export flows survive throughout the whole period. As shown in the gap between the survival curves at the end of the period, parts and components export flows are significantly more stable than those of other product types. The steep decline in the survival rate in the early periods suggests that Turkish firms continuously experiment their products in one market before deciding whether to enter into the global value chains or not (Cadot et al., 2013). On the other hand, the relatively stable hazard rate after 5 years may reflect the fact that participation in global value chains restrict the flexibility of the firm due to the resulting network and sunk costs, which need to be incurred in the beginning and cannot always easily recovered later (Obashi, 2010; Corcoles et al., 2014). Moreover, firms engaging in production sharing exhibit a lower elasticity of substitution between inputs sold in global markets relative to other firms because within global production networks, production stages located in different countries perform specific tasks which are not easily substituted elsewhere. When the parts and components are less substitutable, a price or cost change is less likely to induce the finished products producers in the trading partners to switch to an alternate.[16] This implies a higher survival rates for machinery parts and components than finished machinery products.

As seen in Table 3, these findings are quite consistent across different samples. Compared to other product types, machinery parts and components have a higher mean and median duration of the export spell across different samples, with few exceptions. By employing the Kaplan-Meier method, this study has also found evidence of more stable export relationship of machinery parts and components across different samples, as shown in Figure 5. Therefore, the descriptive evidence shows that machinery parts and components have higher survival rates and much more stable export relationship as compared to the other product types and this evidence is quite robust across different samples. Off course, these results reflect the fact that parts and components are usually traded within complex global supply networks, based on long-term contractual arrangements, which lead to longer survival of the export spells.

Vertical Differentiation and Duration of Turkey's Machinery Exports

Finally, to gain a better understanding of how product characteristics affect export duration, this paper further decompose Turkey's machinery exports into horizontally differentiated and vertically differentiated products using the method suggested by Abd-el-Rahman (1991) and Greenaway et al. (1994,1995). The first component for machinery industry represents trade among products that are similar in terms of quality but differing in terms characteristics or attributes, while the second once is referred to trade in products that differ only in the quality. Following Türkcan (2003, 2011), Ando (2006), and Wakasugi (2007), however, this paper argues that trade in vertically differentiated products in the machinery industry, particularly

[16] Obashi (2010) found that trade in parts and components are less sensitive to trade costs (e.g. distance or exchange-rate fluctuations).

for parts and components, reflect only quality differences but also international fragmentation at the same level of statistical disaggregation of 6 digit HS. This empirical approach is clearly supported by the recent findings by Jones et al. (2002) and Ando (2006) that rapid increase in vertical intra-industry trade was mainly originated from the vertical linkages in production rather than trade in quality differentiated products.[17]

Assuming that price differentials between export prices and import prices outside a certain range reflect vertical differentiation, trade in machinery industry is considered to be horizontal if the export and import values differ by less than 25% and to be vertical when the ratio of unit values falls outside following range:[18]

$$\frac{1}{1.25} \leq \frac{P_{ijkt}^{X}}{P_{ijkt}^{M}} \leq 1.25 \qquad (1)$$

where P_{ijkt}^{X} and P_{ijkt}^{M} represent the unit value of the Turkey's exports and imports, respectively; and indices i refer to the product, j the industry, k the partner country in year t.[19]

When Turkey's total machinery exports are divided into two categories, a total of 397,940 annual bilateral observations of export flows over the period 1998-2013 are classified as horizontally differentiated while 164,101 annual observations as vertically differentiated export flows (where vertical export flows is about 29% of total export flows). Considering only finished machinery exports, the sample contains approximately 228,211 annual observations for horizontally differentiated products and 76,039 observations for vertically differentiated products (around 25% of the total observations). With regard to the machinery parts and components, the decomposition of export flows into two product types has resulted in a total of 169,720 observations being classified as horizontally differentiated export flows whereas 88,062 observations as vertically differentiated export flows (about %34 of the total observations).

Figure 6 plot the Kaplan-Meier estimates of survival functions by trade type (horizontally versus vertically differentiated products) for each product type (total machinery products, finished machinery products and machinery parts and components). The figure shows that, all survival curves are downward sloping with a decreasing rate, with around 50%

[17] For a more detailed discussion of fragmentation, see Türkcan and Ates (2011).
[18] The choice of 25% is arbitrary. In trade literature, two common values are often employed, 15% and 25%. The 15% threshold is generally used and considered to be appropriate when the unit value differences reflect only differences in quality. However, in case of global production sharing the 15% threshold could be too wide and 25% threshold is considered to be more appropriate. Taking these considerations into account, this paper uses a rather narrower measure of vertical differentiation in intermediate goods to more accurately identify whether trade flows relate to the global production networks (Türkcan, 2011).
[19] Unit values at the six digit product level of the HS are constructed as the value of imports and exports of the product divided by the corresponding quantities.

of export relationships fail in the first year, regardless of sample type. While the survival curves across product types are qualitatively similar in shape, there are some important differences in survival patterns. As seen in Figure 6, for the whole sample, which includes both finished machinery products as well as machinery parts and components, the shapes of survival curves of the two groups largely overlapped within the first 5 or 6 years and after that the survival rates in the horizontally differentiated products became slightly higher than that in the vertically differentiated products. A very small survival rate difference between the two groups in later periods may indicate that at the beginning factors affecting the length of export duration are common to all product types. However, horizontal differentiation plays greater role in the duration of total machinery exports in the long-term. 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.[20] It seems that an exporter offers a particular mix of product attributes to create a brand that appeals to certain buyers are more likely to see their export flows survive for longer periods of time.

The slight dominance of horizontally differentiated products over the vertically differentiated products has become much more apparent in the case of finished machinery products, as seen in Figure 6. Survival curves for both trade types mostly overlapped for the first 2 years, but thereafter it seems that horizontally differentiated products exhibit higher survival rates. This behaviour suggests that horizontally differentiated products in Turkey's machinery industry are traded longer since they are subject to a low elasticity of substitution (high differentiation), a feature which had already been confirmed for the duration in German import data (Nitsch, 2009).[21]

Considering machinery parts and components, the survival curves of horizontally differentiated products are almost identical to those of vertically differentiated products but then they diverge with separation until year 5 but thereafter once again both curves overlap until the end of the study period. Contrary to finished machinery products, the results of machinery parts and components also indicate that survival rates are higher for vertically differentiated products than for horizontally differentiated products. A possible explanation for this finding is that service link costs play a critical role in explaining longer duration of export relationship in Turkey's machinery parts and components. The result is consistent with

[20] 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.
[21] Nitsch (2009) find evidence that survival rates are higher for differentiated products as well as products that exhibit a lower elasticity of substitution.

the findings of previous studies (e.g., Obashi, 2010; Corcoles et al., 2012 and Corcoles et al., 2014) which reported that parts and components trade exhibit much longer mean duration of trade due to networks and structural integration in global value chains. It thus appears that Turkey's increasing participation into global value chains in recent years leads to more stable export earnings in machinery parts and components exports (Türkcan, 2014).

In sum, there are four main observations which are suggested by the raw data before proceeding to the formal econometric analysis. First, duration of Turkey's machinery exports is rather short-lived, regardless of the product types. Second, the survival curves are downward sloping with a decreasing slope suggesting that Turkey's machinery products exhibit higher survivability in export markets as the export relationship lasts for a certain period of time (usually five years). Third, survival rates for machinery parts and components are significantly higher than those of all machinery products and finished machinery products and their rates remain high throughout the whole period. Last but not the least, horizontally differentiated finished products have higher chance of survival than vertically differentiated products. In contrast, survival rates are higher for vertically differentiated parts and components than for horizontally differentiated parts and components. Overall, the descriptive results support the claim that engaging trade within global production networks increases the probability of survival in export markets.

4. Empirical strategy and results

4.1 Empirical strategy

Although the descriptive analysis is quite useful to establish the stylizing facts regarding the duration of Turkey's machinery exports, a more complete econometric analysis is needed to assess the role of vertical differentiation 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 explanatory variables or covariates influencing the times-to failure of a system (i.e. hazard rate). The dependent variable in the model is the hazard function that consists of two parts in multiplicative form: a baseline hazard function and a function of explanatory variables, which is written as follows:

$$h(t, x, \beta) = h_0(t) e^{x\beta} \quad (2)$$

where $h_0(t)$ is the baseline hazard function, t denotes survival time, x is the vector of explanatory variables, β is a vector of coefficients to be estimated. In simple words, the hazard function, $h(t, x, \beta)$, gives the probability that a subject will experience an event (for example, ceasing an export relationship) at a particular time t, conditional on the assumption that the event has not occurred yet. It can therefore be interpreted as the risk of an event occurring at time t.

The baseline hazard function, $h_0(t)$, analogous to the intercept term in a multiple regression or logistic regression model, is a function of time only but not a function of the explanatory variables. Moreover, the functional form of the baseline function is left unspecified and is not estimated (Besedes and Prusa, 2006b). Thus, the model is semi-parametric approach, i.e. it does not explicitly express the relationship between explanatory variables and the hazard function in parametric form, therefore quite flexible in practice. The second part of the hazard function, $e^{x\beta}$, i.e. the function of the explanatory variables, describes the functional relationship between the model explanatory variables and the hazard function. Additionally, the explanatory variables do not change over time, that is, they are time-independent. This is another reason for the wide use of Cox's proportional hazard model since the relative risk or hazard ratio, which is the ratio of hazard at time t to the baseline hazard, depends only on explanatory variables and not on time t. This is called as proportional hazards assumption. The coefficients of the explanatory variables, β, can be estimated using the method of partial likelihood without explicit specification of the baseline hazard function. The resulting coefficients show the relationship between the explanatory variables and the hazard function (i.e. the risk of ending an export relationship).

Despite its unique advantages, recent papers identify three problems why the Cox proportional hazard model, which is designed for estimating continuous proportional hazard model, is not appropriate in 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 are 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, of course questionable in the studies of 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.

Due to the above limitations of the Standard Cox Proportional Hazard Model, Hess and Persson (2011a) recommended the use of discrete-time models, such as logit and probit models, that 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. In addition, the calculation takes considerable less time with the discrete-time models than with the Cox model. This provides another rationale for preferring the discrete-time models, especially important when dealing with large trade data sets.

Following the recommendations of Hess and Persson (2011a), this study employs a discrete-time hazard models to analyze the determinants of the duration of Turkey's machinery exports. Discrete-time hazard models can be specified in terms of conditional probabilities of termination of a particular trade relation in a given time interval. Using the same notation as in Hess and Persson (2011a), define T_i as continuous, non-negative random variable measuring the survival time of a particular trade relation. The hazard probability is then defined as the probability of terminating a trade relation within specified time interval $[t_k, t_{k+1}), k = 1,2, \dots, k^{max}$ and $t_{1=0}$, given that failure has not occurred prior to the starting time of the interval and the explanatory variables are added to the regression model. This conditional probability can be expressed as a discrete-time hazard rate:

$$h_{ik} = P(T_i < t_{k+1} | T_i \geq t_k, x_{ik}) = F\left(x_{ik}^{'}\beta + \gamma_k\right) \tag{3}$$

where x_{ik} is a vector of time-varying covariates that are assumed to effect the hazard rate, β is a vector of coefficients to be estimated. A positive (negative) sign of coefficients means higher (lower) likelihood of terminating an export relationship and consequently lower (higher) probability of surviving in the export market. γ_k is a function of (interval) time that allows the hazard rate to vary across periods, and $F(.)$ is an appropriate distribution function ensuring that $0 \leq h_{ik} \leq 1$ for all i , k. In this study, i denotes separate export spells for any given importer-product combination. In addition, since the underlying baseline hazard is unknown in practice, γ_k is included into the regression model as a set of dummy variables marking the length of each spell.

The discrete-time proportional hazards model can be estimated by maximizing the following log-likelihood function:

$$ln\,\mathcal{L} = \sum_{i=1}^{n}\sum_{k=1}^{k_i}[y_{ik}ln(h_{ik}) + (1 - y_{ik})ln(1 - h_{ik})] \quad (4)$$

where k_i refers to terminal time period, the subscript i indicates that it may vary with the spell. y_{ik} is a binary variable and takes the value of one if spell i is observed to cease during the kth time interval, and zero otherwise. Hence, with this specification, discrete-time hazard models can be regarded as a sequence of binary dependent variable models. This is convenient because any standard model for binary dependent variables (such as logit, probit or cloglog) can be applied to estimate discrete-time hazard models.

Consequently, this specification of the log-likelihood function requires underlying export database to be changed in the following way. If the spell of the ith subject is completed, then the binary dependent variable assumes the unit value for the last time point (T_i) while it is zero for the rest of time points $(1,2, \ldots T_i - 1)$ of the time interval. For example, consider that Turkey exports a given product to a particular destination country from 2000 to 2004. Such an export relationship is regarded as having a spell length of four years. With this information about the spell length, the binary dependent variable takes the value of zero from 2000 to 2003 and one for the fourth year. The advantage of this approach is that it allows the inclusion of time-varying explanatory variables into the regression model (Esteve-Perez et. al., 2007).

In order to estimate the parameters of equation (4), it is necessary to determine the functional form of hazard rate, h_{ik}. As discussed in Hess and Persson (2011a), logit, probit and complementary log-log (cloglog) specifications are the most common function specifications for estimation of models with binary dependent variables. The cloglog model is the discrete-time counterpart of the continuous-time Cox proportional hazards model. In contrast, both logit and probit models provides a non-proportional hazard assumption. Furthermore, Hess and Persson (2011a) argued that the inclusion of random effects into the binary choice model framework is satisfactory approach because parameter estimates are less affected by the choice of heterogeneity distribution and this approach is convenient from a computational point of view. Therefore, following Hess and Persson (2011a) this study utilizes xtlogit, xtprobit and xtcloglog commands in STATA, respectively, to estimate the logit, probit and cloglog models with random effects.

Before proceeding to the model specifications and econometric analysis, several issues involving bilateral trade data should be addressed properly. First, as already discussed in the descriptive analysis, left- and/or right-censoring data typically bias the results in survival analysis models. Although the right-censoring data can be easily handled by standard techniques of survival analysis, the left-censoring data should be treated differently.

Therefore, this study omits all left-censoring spells (i.e. those export flows that are already active at the first year of the sample, namely 1998) from the econometric analysis, reflecting common practice of the handling the left-censoring data (Obashi, 2010; Hess and Persson, 2011b; Fugazza and Molina, 2011). Approximately 11% observed spells are excluded due to left-censoring.[22] The second data problem frequently encountered in the trade data is multiple spells, that is, an export relationship may be initiated, stopped and started again over the sample period. As seen in Table 1, in the benchmark sample, roughly 75 % of export relationships experience multiple spells of service. To account for this issue, following Hess and Persson (2011b), the duration analysis in this paper is also carried out separately for the case of single-spell data and the case of first-spell data as robustness checks. Finally, there is the issue of measurement error associated with trade data. The measurement error can cause a false beginning or end for an export relationship, which in turn leads to the rising incidence of multiple spells. As pointed out by Besedes and Prusa (2006a), small gaps between two spells could be due to misreporting. To control for the possible measurement error in computing spell lengths, this study combines one-year gap between spells to form longer spells and then estimates equation (4) using the one-year gap adjusted sample as robustness checks. The one-year gap adjustment results in 122,470 spells which is around 24 % percent less than with the benchmark data, as shown in Table 1.

4.2 Determinants of export survival

To examine duration of Turkey's machinery exports, this paper considers a number of country, product and export diversification-specific variables suggested in the previous duration literature (Besedes and Prusa, 2006b; Nitsch, 2009; Hess and Persson, 2011b; Corcoles et al., 2012). Apart from those used in previous studies, this study also includes a dummy variable for vertical differentiation in the regressions to assess the role of global production networks in the duration of exports. The discrete-time hazards model is estimated over the whole sample (all machinery products), and then over two subsamples (finished machinery products and machinery parts and components) in order to check whether the hazard estimates differ for both product types. Moreover, restricting our attention to these subsamples enables us to identify the role played by global production networks in duration patterns with certainty (Obashi, 2010). The definitions and sources of each explanatory variable are provided in Table A3.

[22] From the 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 percent of all spells.

The explanatory variables analysed in this study can be divided into four categories: (i) country-specific variables, (ii) product-specific variables, (iii) export diversification-specific variables and (iv) other control variables.

(i) Country-specific variables

Several country-specific variables suggested by the duration literature (Besedes and Prusa, 2006b; Brenton et al., 2010; Hess and Persson, 2011b; Corcoles et al., 2012) that is commonly included in gravity models of international trade flows are used as explanatory variables. Trade costs (or service-link costs) are important factor determining the volume of trade between countries, especially in the fragmentation trade because of multiple border-crossing involved in the global production networks (Türkcan, 2011). However, measures of service-link costs are not widely available. Service-link costs consist of transport costs, telecommunication costs, coordination costs, and others. Among various components of service-link costs, transportation costs between production sites are the most visible portion of service link costs, and transportation costs are typically assumed to be a linear function of geographical distance. For instance, Kimura et al. (2007) claim that geographical distance between countries can be viewed as indicative of service-link costs, particularly the transportation and telecommunication costs. Further, these costs are likely to be lower for countries that share common border or common language.

As discussed in Hess and Persson (2011b), the service-link costs also matter for the duration of trade too. Accordingly, the distance is expected to increase the likelihood of failure (or reduce the likelihood of survival), but sharing a common language and common border is predicted to lower the hazard. To account for these factors, the logarithm of the distance between trade partners' capitals, a common language dummy and a common border dummy are included. However, it should be noted that the impact of the service-link costs on the hazard rate could be larger for machinery parts and components than for finished machinery products.

Another variable that is likely to affect the survival of export flows is the importers' GDP that serves a proxy for market thickness. Brenton et al. (2010) argues that there are likely to be larger number of buyers in bigger markets, thus increasing the chance of the exporter finding and maintaining a suitable match. Therefore, it is expected that export relationships involving economically large importers are more likely to last longer than otherwise. In addition, Grossman and Helpman (2005) show that a trading partner's market size encourages greater degrees of fragmentation between two countries. Firms are more likely to find a trading partner with the appropriate skills that match their needs in large host markets. Similarly, Jones and Kierzkowski (2001) argue that a greater level of market size promotes and facilitates the formation of business linkages between local firms and foreign firms within the global production networks due to increasing returns to scale in service-link activities. Thus, the larger the trading partner's market size the larger the opportunities of fragmentation trade and the lower export hazard (i.e. higher export survival).

Our empirical model also includes differences in per capita GDP as a measure of differences in economic development between Turkey and its trading partners. 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 (intra-industry trade). On the other hand, 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.[23] Thus, an expected positive relationship exists between bilateral inequality in per capita GDP and hazard rates of an export relationship, particularly in finished products.

With regard to the parts and components, there is no clear consensus on the sign of bilateral inequality in per capita GDP on the duration of exports. Obashi (2010) considers differences in per capita income as differences in wages between trading partners. Consequently, Obashi (2010) predicts that wage differentials enhance the fragmentation of production and trade within global production networks, which in turn results in longer export relationships.[24] In contrast, Corcoles et al. (2012, 2014) emphasized the role of economic development (proxied by absolute differences in per capita GDP) in their studies of the determinants of duration and argued that location advantages, such as the existence of well-established transportation and communication infrastructures, make the host countries profitable locations for production. As a result, they predict that a greater divergence in the level of economic development of two countries yields a higher risk of failure of export relationship. Therefore, the relationship between the duration of parts and components exports

[23] Corcoles, et al. (2012) found a positive impact of institutional quality, proxied by the "Rule of Law Index", on the stability of trade flows. Following Corcoles et. al (2012), in experimental runs this study also includes the Rule of Law Index as a proxy for the institutional quality in the export markets. This variable was dropped from the final estimates because of the fact that it has a large amount of missing data and dealing with missing observations of covariates is always problematic in models with binary dependent variable. For example, in carrying out the estimations of the discrete-time hazards model, Hess and Persson (2011b) dropped all spells with missing at any time during the spell, leading to a substantial decline in the number of spells used in the estimations. In addition, it seems that there is no need for additional covariates specifically to 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.

[24] 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.

and the differences in per capita GDP could be either positive or negative depending on which effect dominates.

The analysis also uses two other country-specific variables. European Union (EU) is the major export partner of Turkey with a significant share in total export flows (around 42% in 2011) (Türkcan, 2014). In consequence, a dummy variable for trade agreement with reference to Customs Union agreement between Turkey and the European Union signed in 1995 is included to capture the effect of trade agreements on the duration of Turkey's exports. Trade agreements was expected to affect export flows not only through the direct effects of reductions in trade costs (such as reductions in import duties and in the costs of customs, regularity and administrative procedures at the border) on demand, 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 is included in the model to capture the effects of exchange rate changes on the hazard because changes in exchange rates may influence firm's decision to enter and exit export markets. In order to construct it, bilateral nominal exchange rates (i.e. Turkish Lira per importer currency) have been computed in the first step using nominal exchange rates (i.e. foreign currency per US dollar) taken from the World Bank's WDI.[25] In terms of this definition, an increase in this measure reflects a depreciation of the Turkish Lira against the importer currency. The second step was the computation of bilateral real exchange rates between Turkey and its trading partner. National consumer price indices (CPI) available from the World Bank's WDI were used for this purpose. In the next step, each importing country's bilateral real exchange rate was normalized by the average real exchange rates of all importing countries against the exporting country (Turkey). The final step was the computation of annual percentage changes in relative real exchange rate (in logarithmic terms), which is a relative measure that indicates the changes in Turkey's currency relative to importer's currency. Accordingly, an increase in the relative real exchange rate weakens Turkey's currency relative to importer currency, which makes exports more competitive and reduces the risk of failure in export markets. Traditionally, it is expected that a depreciation of the exporter's currency relative to the currencies of importers boosts exports and lower the

[25] Whenever nominal exchange rate series are not available, nominal exchange rates obtained from United States Department of Agriculture's Exchange Rate Data Set are used to supplement the missing data.

hazard (Besedes and Prusa, 2006b).[26] There is some evidence, however, that the global production networks has weakened the relationship between exchange rates and trade in intermediate products (Arndt and Huemer, 2005; Thorbecke, 2008; Türkcan, 2011). In particular, the global production networks tends to reduce the link between the cost of production and export competitiveness due to the fact that any changes in the exchange rates are, for instance, quickly offset by the reduction in costs that occurs as the price of imported inputs fall (Obashi, 2010). As a result, one cannot make a definitive assessment of the effect of exchange rate changes on the duration of exports. Regardless of the product types under study, a possible negative relationship in the empirical results, however, implies that an increase in the relative real exchange rate will indicate a negative effect on the hazard rate.

(i) Product-specific variables

According to the facts presented in the descriptive analysis, vertical differentiation could be another factor which influences the duration Turkey's machinery exports. As argued by Rauch and Watson (2003), trade in differentiated products requires higher search costs and stronger supplier-specific investments, making it difficult to switch 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). Using Rauch and Watson's (2003) matching model, 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 type of products and increases with the size of transactions (Nitsch, 2009; Hess and Persson, 2011b; Fugazza and Molina, 2011).

These papers, however, do not explicitly consider the role of trade networks induced by global production sharing in survival in the exports market. Increased fragmentation of production and geographical dispersion has made global production networks ever more complex and more interdependent, and in turn, more stable. In this more sophisticated and complex networks, the buyer-supplier relationships tends to become stronger due to fact that trading partners incurs fixed costs to join global production networks. The firms in such relationships that involve repeat transactions and the development of trust between the partners have found it increasingly difficult to terminate them, as argued by Obashi (2010).

[26] For assessing the impacts of exchange rate fluctuations on the duration of US imports, Besedes and Prusa (2006b) make no distinction between final products and intermediate products.

These features of trade in intermediate products within the global production, therefore, are expected to increase the survival probabilities of exports.

As discussed in the introduction, existing studies on the topic suffer from one common problem: the difficulty of effectively disentangling effects of global production sharing on the survival of exports from other factors. These studies evaluates the role of global production networks on export survival by looking at the items classified as components and parts within the machinery and transport equipment group of the Harmonised System (HS). The major disadvantage of this approach is that many parts related to above groups come under different headings.[27] In addition, different types of trade are captured in measurements of trade in parts and components: horizontal trade in similar products with differentiated varieties; trade in vertically differentiated products distinguished by quality; and vertical specialization that involves the exchange of technologically linked products (Jones et al., 2002; Ando, 2006). Clearly, the nature of trade in intermediate products is partly related to the global production sharing that requires back-and-forth transactions in vertically fragmented production networks in the same commodity heading. Hence, assuming all trade in parts and components is indicative of global production sharing may lead to overestimation of the role of the global production sharing in explaining the differences in survival rates across product types.

Unlike previous empirical studies, which use trade in parts and components as a proxy for participation in global production networks, this study employs another method that is commonly used in the intra-industry trade literature to measure the degree of vertical specialization in intermediate products trade. In the trade literature, it is common to divide total intra-industry trade (IIT) into two parts: IIT in horizontally differentiated products and IIT in vertically differentiated products by comparing unit values of exports relative to imports because the determinants of both types of IIT appear to be quite different and need to be assessed. In a similar way to final products, this method has also been adopted by several recent papers including Ando (2006), Wakasugi (2007), and Türkcan (2011) to distinguish horizontal IIT from horizontal IIT in intermediate products. In this context, intra-industry trade is classified as horizontal IIT when the unit value of exports relative to unit value of imports lies within a specified range. Conversely, if the relative unit values lay outside this range, IIT is defined as vertical, which may capture not only trade in intermediate products with different quality, but also trade in technologically linked intermediate products. Vertical IIT can reflect multi-stage trade as a result of back-and forth transactions in vertically

[27] For instance, transport equipment group does not include parts such as automotive tires, electronics, instruments, glass parts, or rubber parts, which are recorded under different headings.

fragmented production networks in the same commodity heading because vertical specialization definitely generates unit value differences across technologically related exported and imported intermediates. Therefore, vertical differentiation could be used as an indicator of international production sharing within the same product category.[28]

In accordance with the same line of thought, this study also use unit–price differentials between exported and imported intermediate products as a criterion for distinguishing trade in horizontally differentiated intermediate products from trade in vertically differentiated intermediate products, resulting from global production sharing activities. However, it should be kept in mind that trade flows classified as vertically differentiated products could also include trade in intermediate products of different quality.[29]

Then, given the unavailability of proxies for global production sharing, this paper creates bilateral disaggregated data dummy variables to identify every and each trade flows as either horizontally differentiated or vertically differentiated by using the method outlined in the previous section. These dummies have been used to detect differences in stability between vertically linked transactions of intermediate goods and other unrelated party transactions. The first step in creating bilateral disaggregated data dummy variables to decompose trade in machinery industry into finished and parts and components trade. Bilateral trade flows employed in this paper are classified at the 6-digit level of the HS, which are used to create dummy variables indicating product differentiation for each importing-product pair. Once these trade flows are divided into two trade types, the second step is to decompose trade flows into horizontally differentiated and vertically differentiated products using the method suggested by Abd-el-Rahman (1991) and Greenaway et al. (1994, 1995). Assuming that price differentials between export prices and import prices outside a certain range reflect vertical differentiation, trade flows is considered to be horizontally differentiated if the export and import values differ by less than 25% and to be vertical when the ratio of unit values falls outside that range, using equation (1) at the 6-digit level of HS items.

After we identify whether trade flows of a specific product is horizontally or vertically differentiated, a dummy variable for vertical differentiation was thus created: VD is a dummy, being one if the 6-digit flow is classified as vertically differentiated and zero otherwise. In addition, I created two dummy variables for types of products, that is for the exports of finished machinery products and for the exports of machinery parts and components, defined

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

[29] In the empirical trade literature, unit value is generally regarded as proxy for product quality.

as in Kimura and Obashi (2010). Finally, to create the interaction terms, these product type dummies are then multiplied by the vertically differentiated dummy. These interaction terms attempt to single out the effects from fragmentation-induced intermediate products trade from those of vertical trade in finished products that refers to differences in product quality, not to differences in stages of production. The first interaction term is a binary variable that equals to one if the product is classified as finished machinery products and trade flows is vertical, and zero otherwise while the second interaction term is a dummy equal to one if the product is classified as parts and components and trade flows is vertical, and zero otherwise.

Hence, the interaction of the parts and components dummy with the vertically differentiated product dummy is included in the regressions to proxy for global production sharing activities between trading partners. In contrast, an interaction term between finished products dummy and vertically differentiated product dummy is introduced to address the impacts of product quality on the duration of machinery exports. Since vertically differentiated finished products tend to have more quality attributes, these of types of products may have require more complex and long-lasting export relationships (Besedes and Prusa, 2006b). These interaction terms, thus, allow testing whether the growing importance of global production sharing truly enhance the continuity of export flows. Given that vertically differentiated finished products have higher qualities and attributes and vertically differentiated parts and components are within global production networks, both interaction terms are expected to reduce the hazard rate. The influence of the vertical differentiation, however, should be more significant for parts and components that are subject to global production sharing than finished products that are not part of the global production networks. When the discrete-time hazards models are estimated separately for finished products and parts and components, vertical differentiation dummy is included instead of these interaction terms, though their effects and interpretation remain exactly the same.

The next product-specific variable included in the discrete-time hazards model regressions is the logarithm of initial value of exports at the start of export spells, which is proxy for 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). As argued by Rauch and Watson (2003), when buyers have low confidence or little knowledge about their trading partners, they place a small trial order to see how well they live up to their contractual obligations and commitments in terms of the delivery schedule and product quality. If suppliers perform satisfactory on trial orders, the buyers are then place larger orders with their suppliers. Therefore, 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.

Exporters face various sunk costs associated with entering foreign markets that may arise from establishing marketing and distributional channels, learning foreign customs procedures, adjusting their products and packaging for foreign markets and complying with safety and quality requirements set in foreign markets (Das et al., 2007). With increasing export experience, exporters acquire more knowledge of the export markets, perceive less uncertainty, and become more confident in their ability to assess foreign markets. By implication, 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 of entering the old or new markets (Alvaraez et al., 2013; Stirbat et al., 2015). Based on these arguments, two explanatory variables are thus included to assess the impact of the previous export experience on the hazard rate: the lagged duration and the total value of exports of a given product. The lagged duration, i.e. the number of years that a previous export spell lasted, is expected to reduce the likelihood of failure because of the acquisition of knowledge of foreign markets and products through experience (Hess and Persson, 2011b; Corcoles et al., 2012; Corcoles et al., 2014; Stirbat et al., 2015). The total value of exports of a certain product has been also considered proxy for the firm's past export experience. Exporters that have greater overall experience in exporting the specific product overseas acquire more knowledge and expertise that can effectively lower the sunk costs associated with export entry activity into new markets. In addition, the overall export experience overseas tends to generate a lot of spillover effects that may help marginal firms to overcome sunk costs that are crucial to start exporting (Brenton et al., 2010). Hence, the total value of exports of a specific product is expected to be negatively associated with the hazard rate.

(iii) Export diversification-specific variables

A number of empirical studies have shown that export diversification is contributing 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, as discussed above, Volpe-Martincus and Carballo (2009), find 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 case of the former.

Product diversification refers to the inclusion of more and more products in export baskets and market diversification usually refers to the diversification of destination markets. Volpe-Martincus and Carballo (2009) point out two arguments for this finding: portfolio argument and efficiency argument. The portfolio argument suggests that firms trade many different products with many different countries achieve better stability in export sales, which would improve their chances for remaining active in export markets. The efficiency argument, on the other hand, indicates that firms that engage in international trade are naturally the most productive than their domestic counterparts since exporting involves sunk costs (Melitz, 2003; Bernard and Jensen, 2004). Consequently, more productive and efficient firms are also more likely to find it easier to increase the variety of their export basket and expand into new markets as they are able to bear the sunk costs and stay in export markets longer. In addition, these internationally diversified firms have better access to the resources (such as internal and external sources of capital) necessary to avoid the negative impact of a closure in a market or product on the surviving business. Additionally, the firms that trade with many markets and with different products gain more experience in export markets and acquire more market-related information, which in turn would encourage these firms to diversify their export baskets and, whenever possible, to enter new markets and thus survival (Hess and Persson, 2011b).

The rise of global production networks resulting from globalisation over recent decades has not only promoted increased trade in parts and components, but also increased the level of export diversification in terms of destination markets and products. At the same time, the emergence of global production networks has deepened and broadened commercial ties with trading partners. As the relationship deepens, firms with network find it difficult and expensive to switch to an alternative manufacturing partner, leading to a stable and long lasting partnership with their existing production partners. Recent studies by Corcoles et al. (2012, 2014) show that both the number of destination markets and products, proxy for the degree of connectivity within the network, encourages stability of trade relationships. The arguments given above thus led to a prediction that the export diversification reduces the hazard rates of export flows of finished machinery products as well as machinery parts and components. 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.

(iv) Other control variables

As discussed above, the presence of unobserved heterogeneity in the hazard functions will create bias in the estimated parameters. As Hess and Persson (2011b) note, a discrete-time probit model with random effects can control for all 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 heterogeneity. 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 employs duration, time and spell dummies. First, duration dummies are introduced to mark the current length of the spell for each export relationship that can be used to account for duration dependence in a regression. Second, the discrete-time models also have spell dummies that count the number of previous spells for any export relationship. These spell dummies have been introduced because the underlying baseline hazard is unknown. Finally, in addition to all the previous dummy variables, time dummies are included to control for 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

In the following, benchmark estimates of different baseline hazard specifications for Turkey's machinery exports during the period of 1998-2013 are presented for alternative levels of aggregation. The baseline hazard specification models are estimated using discrete-time probit, logit and cloglog models. In order to detect the differences in the survival behaviors of different subsamples of Turkey's machinery exports, the discrete-time hazards model are re-estimated separately for machinery finished products and machinery parts and components. The dependent variable for these models is binary or dichotomous, which is equal to one if the observed export spell is ended and zero otherwise, and regressed on a set of country and product and export diversification-specific variables along with other control variables.[30] In addition to aforementioned explanatory variables (covariates), all models include random effects for every importer-product combinations. Benchmark results are shown in Table 4, Table 5 and Table 6.[31] Within tables, each column reports regression results from probit, logit and cloglog models. All left-censored observations are entirely excluded from the estimations.

[30] The coefficients on these additional control variables, which are available upon request, are not reported for brevity.

[31] Recall that the number of spells used in the regression analysis is significantly lower than those shown in Tables 1, 2 and 3, since spells with missing values of the explanatory variables any time during the spell are dropped from the estimations.

The interpretation of the results starts with an analysis for total machinery exports and then move on to more detailed product groups (finished machinery products and machinery parts and components). Before moving to a detailed interpretation of the coefficients, it is important to note that there is broad similarity of the coefficient estimates in sign and statistical significance across baseline hazard functions. Nonetheless, as a point of comparison, the log-likelihoods are computed for the different models. The results in Tables 4 and 5 show that the logit model attains the highest log-likelihood closely followed by the probit models for total machinery products and machinery finished products. In contrast, the log-likelihood of the probit model slightly outperforms the logit model in the case of machinery parts and components, as shown in Table 6. Hence, the remainder of this section discusses the results of the preferred specification: the logit model for total machinery products and machinery finished products and the probit model for machinery parts and components. Also, it is important to stress that the likelihood-ratio tests (the 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.

Results for Machinery Exports

Table 4 shows the estimation results of different types of discrete-time hazards models for Turkey's machinery exports to over 188 trading partners during the period of 1998-2013, where the dependent binary variables are based on total machinery exports. The results seem to be robust across different specifications of the hazards model. Focusing on the results of the logit model (column 2 of Table 4), the signs of coefficient estimates generally conform to a priori expectations and are consistent with those reported elsewhere (Obashi, 2010; Hess and Persson, 2011b; Corcoles et al., 2012; Corcoles et. al., 2014).

First of all, starting with the country-specific variables, the results show that the distance has a positive and significant effect on the hazard rate, while a common language and a common border significantly reduces the hazard rate. Hence, the results suggest that sharing a common border, speaking the same language and having a close proximity lower transaction costs and correspondingly enhance the continuity of export flows. In addition, the model estimates show that the importer's GDP is negatively and significantly associated with the hazard rate. A possible explanation is that the likelihood of finding a possible buyer increases with the size of the importer's GDP. This, in turn, facilities the stability of export relationships. The analysis also support the hypothesis that a greater divergence in the level of economic development between trading partners (proxied by the logarithm of the absolute difference in per capita income between trading partners) strongly increases the risk of failure of export relationship, suggesting that the level of economic development is a key factor in sustaining export relationships for the longer term.

Contrary to expectations, the EU membership variable, however, exert a positive and significant influence on the hazard rate. This finding may explained by the fact that the EU's share of Turkey's exports has steadily declined in the last decades, while the volume of exports to non-traditional markets, such as the Middle East, Asia, and Africa, increased substantially (Türkcan, 2014), so this big changes in the geographical composition of export flows may obscure the conventional negative effect of the regional integration on the hazard rates of export relationships. Finally, the results confirm the expectation that a depreciation of the Turkish Lira against the currency of an importer reduces the hazard rate for Turkey's machinery products. This finding is not surprising, given the fact that significant portion Turkey's exports are concentrated in low-quality products in which a firm's competitive advantage heavily depends on price. As a result, the depreciation of the Lira may improve the competitiveness of Turkish exports and therefore may help to reduce the hazard rates for Turkey's export relationships.

Consider now the effects of product-specific variables on the hazard rates of export relationships, all variables have expected signs and are statistically significant, with one important exception. As mentioned in the previous section, the key explanatory variables 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 multiplicative interaction terms have been incorporated in the estimation models to isolate the effect of vertical differentiation induced by production sharing activities on the survival of export flows. The results show that vertical differentiation plays a more decisive role in the survival pattern of machinery parts and components than of machinery finished products. In particular, the estimates show that the interaction term between vertical differentiation and machinery parts and components is negative and statistically significant, whereas the interaction coefficient for machinery finished products is positive but not statistically significant. Hence, the result is generally consistent with the prediction that the influence of vertical differentiation should be more significant for parts and components that are subject to global production sharing than finished products that are not part of the global production networks. The results also confirm previous studies which showed that firms within production networks incur high-cost of fixed investment (i.e. sunk costs), which makes it more difficult and costly for these firms to begin and end new export relationships, thereby having relatively longer export duration (Obashi, 2010; Shao et al., 2012; Corcoles et al., 2012; Corcoles et al., 2014).

Furthermore, the results imply that export relationships having a greater initial value have lower hazard rates. This outcome is consistent with previous studies that have provided empirical support for the models developed by Rauch and Watson's (2003) model, in which search costs and information asymmetries lead the buyers, i.e. importers to begin with small trial orders in order to test the credibility of an exporter, while the buyers tend to make large orders with reliable exporters (see, for instance, Besedes and Prusa, 2006b; Nitsch, 2009; Obashi, 2010; Hess and Persson, 2011b). Related to this, the lagged duration also presents a significant negative effect on the probability of export failure. Similar finding also emerge in Besedes and Prusa (2006b), Hess and Persson (2011b) and Corcoles et al. (2014). Thus, the result confirms the prediction that the expertise and knowledge of foreign markets and products gained through export experience increases the survival of export relationships. Lastly, the total value of exports of a specific product is found to be negatively and statistically significantly associated with the hazard rates of Turkey's machinery exports, verifying the hypothesis that firms with greater overall experience in the exporting the specific product overseas have higher chances of survival (Corcoles et al., 2012).

Along with various country and product-specific variables, export diversification-specific variables do matter for the hazard rates for Turkey's machinery products, as shown in Table 4. Specifically, both product diversification variable (proxied by the number of exported products) and market diversification variable (proxied by the number of export markets) have negative and statistically significant effect on the likelihood of failure of Turkey's machinery exports. Hence, this finding supports for the notion that diversification of export products and destinations helps in stabilizing export earnings in the longer run, which in turn decreases the probability to terminate an export relationship. This finding is consistent with Volpe-Martincus and Carballo (2009) who found that both product and market diversification have positive effects on the probability of the firm's survival in foreign markets. The results further show that product diversification had a much larger 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) who concluded that market diversification prevails over product diversification.

Results for Finished Machinery Exports

Based on data for Turkey's exports of machinery finished products, the results of estimations using the discrete-time hazard models are reported in Table 5. Most estimates are similar to those in Table 4, except for a few exceptions. First, note that the coefficient of the percent change in relative exchange rate has the expected sign but becomes insignificant. Given the relatively high share of low-quality products in Turkey's machinery exports, this outcome contradicts the prediction of Auer and Chaney's (2009) model that lower quality products are more sensitive to exchange rate fluctuations than higher quality products. The weak external demand due to depressed economies in developed markets coupled with the structural constraints in the Turkish economy may appear to attenuate the effects of currency depreciation on the export sales as well as on the hazard rates. Theoretically, a depreciation of the lira increases competitiveness of export products in foreign markets, which makes export relationships more stable. However, relatively weak external demand seems to dampen the beneficial effects of a weaker exchange rate. Perhaps the more important reason for the limited reaction of some exporters to the weaker exchange rate is the structural constraints in the Turkish economy (such as relatively low industrial productivity, limited capacity for innovation and production of high quality products, scarcity of trade finance, and etc.) that may limit the exporter's ability to reap the benefits from huge improvement in their external competitiveness.

The second notable difference between finished products and parts and components results is the coefficient of vertical differentiation, which becomes statistically significant with the expected negative sign, suggesting that vertical differentiation which has been used as proxy for product quality reduces the hazard rate for finished products, in line with the findings of Görg et al. (2012). This result is consistent with the low elasticities of substitution with vertically differentiated products relative to horizontally differentiated products. 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.

Results for machinery parts and components

Table 6 reports the preferred probit results for machinery parts and components. The results for machinery parts and components are qualitatively similar to those obtained for machinery finished products, though the magnitudes of the coefficients are generally larger for parts and components. This conclusion was also obtained by other studies including Obashi (2010) and Corcoles et. al., (2012). First, the results indicate that the country-specific variables (such as distance, importer's GDP, differences in per capita GDP, the change in relative exchange rate) play a more decisive role in the survival pattern of parts and components than of finished products. In particular, the positive impact of the distance variable, used as proxy for transportation costs, on the hazard rate becomes stronger for parts and components, perhaps because geographical proximity will tend to foster and facilitate the fragmentation of production, allowing parts and components to cross borders many times with relatively low transportation costs, thereby leading to a lower hazard rate for parts and components exports.

Moreover, the market size variable (importers' GDP) has exerted a stronger influence on the hazard rates of parts and components than of finished products. This result is not surprising given the fact the thickness of the market has a positive impact on the location of fragmentation since the costs of searching for an appropriate supplier of parts and components decreases as the size of a country increases (Grossman and Helpman, 2005). The thicker the market, the easier the business-to-business matching becomes and the more likely firms have stable relationships with their partners. This is in accord with the results of Obashi (2010) and Corcoles et al. (2012, 2014). On the other hand, differences in GDP per capita are shown to have a positive and significant effect on the hazard rates, and this effect is also larger for parts and components than for finished products. The evidence supports the view that differences in GDP per capita that serves as a proxy for location advantages (such as the existence of supporting industries, public infrastructure, favorable policy environment, skilled labor and industry agglomeration) tend to encourages the stability of trade relationships within global chains (Corcoles, et. al., 2012). However, this outcome contrasts with the predictions of Obashi (2010) who, as noted before, argued that differences in GDP per capita, which has been used as a proxy for wage differential, reduce the probability that the hazard occurs. Thus, the finding of a positive and significant of differences in per capita GDP implies that location advantages are most important in reducing the hazard rates of export relationships than labor cost differences.

Unlike finishing products, changes in the relative real exchange rate produce significant negative effects on the hazard rates of parts and components exports. The evidence suggests that a depreciation of the lira relative to the currencies of trading partners significantly improves the chances of export survival in Turkey (i.e. reduces the hazard rates). This finding contradicts recent claims that the rise of global value chains has weakened the relationship between exchange rates and trade in parts and components used as inputs into other economies' exports (Obashi, 2010; Corcoles et al., 2012). More generally, the insensitivity of parts and components to the exchange rate fluctuations finds little support in the data. The estimated links have not generally weakened over time despite the increasing participation of Turkish companies into the global value chains in recent years.

Turning now to the product-specific variables, the vertical differentiation has a significant negative effect on the hazard rate of Turkey's machinery parts and components. The influence of vertical differentiation on hazard rate is not greater for parts and components than for finished products. Bear in mind that the vertical differentiation variable for parts and components is a proxy for participation in global production activities and is defined as a dummy variable, which takes value one if the 6-digit flow shows the evidence of vertical differentiation. This is different from finished products equation, where vertical differentiation variable is used as a proxy for quality differentiated trade. It is therefore not meaningful to compare the magnitudes of estimates between equation using the finished products data and equation using parts and components data. Taking this into account, the negative and statistical significance of vertical differentiation variable is in line with the hypothesis that integrating firms into global value chains deepens interdependence between trading partners within networks since in an effort to become a partner in global value chains, exporting firms might incur specific sunk cost investments, making it more difficult for them to find an alternative purchaser (Obashi, 2010; Corcoles et al., 2012, 2014).

Another product-specific variable is the value of initial export, which is intended to capture the level of confidence that sellers or buyers have in partners' capabilities. The effect of the value of initial export on the hazard rate is found to be both negative and statistically significant, as expected. Furthermore, the impact is much larger in magnitude compared to the finished products, indicating that trust and reliability seems to matter more for stability of international production networks (Corcoles, et al., 2012). Moreover, the results indicate that the lagged duration variable as a proxy for exporting knowledge and experience shows, as expected, a negative and significant relationship with the hazard rates of parts and components. Once again, effect sizes were considerably greater for parts and components compared to finished products. Likewise, the estimated coefficient on the total value of exports, which is used as proxy for overall experience in exporting, is negative and statistically significant, and quantitatively larger in magnitude than those obtained using the sample of finished products. Taken together, these two results supports the notion that firms with greater knowledge and experience which have been accumulated through the active participation in global value chains and production, will face lower hazard rates (Obashi, 2010; Corcoles et al., 2012; Corcoles et al., 2014).

Finally, the results suggest that both the number of products exported (product diversification) and the number of exported markets (market diversification) are statistically significant and have negative effect on hazard rates for Turkey's exports of machinery parts and components. Although both types of diversification lead to a reduction in the level of terminating an export relationship, this effect is stronger in the case of product diversification, and smaller in the case of market diversification. This result is not in line with the evidence provided in Corcoles et al. (2012) and Corcoles et al. (2014) who showed that the market diversification prevails over product diversification. Overall, these results imply that increasing fragmentation of production across national borders and tasks, that is geographic dispersing of value chain's activities, has led to greater geographic diversification in parts and components, especially in the manufacturing sector. The increased geographical diversification accompanied by greater diversification of products for export, in turn, lead to increasing interconnections across countries and firms within the networks. In consequence, higher interconnection increases the likelihood of staying within the production network and therefore strengths the chance of survival in export markets (Corcoles et al., 2012; Corcoles et al., 2014). In addition, these findings suggests that the both types of diversification brought about by global value chains can generate greater experience and knowledge spillovers, which encourage domestic firms to engage and increase exports, and thus enhance domestic firms' ability to survive in the export markets (Cadot, et al., 2013). Hence, the empirical link between diversification and firms' survival in export markets has provided the economic rationale for policy measures to promote and facilitate local Turkish firms to join a global value chain.

4.4 Robustness analysis

The results based on the benchmark sample demonstrate that vertical differentiation is an important factor in explaining differences in hazard of exporting across product types. It would be interesting to determine if this finding holds across different samples. Following the approach by Hess and Persson (2011b), several robustness checks are conducted, considering alternative samples.[32] 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.

[32] Note that the logit model is the preferred specification of a discrete-time hazards model for all machinery products and finished products sample, while the probit model for parts and components.

As shown in Table 7, the patterns of the main variables appear quite robust to the different definitions of the export spell. In particular, the effect of the vertical differentiation, the main empirical variable of interest, remains negative and robust throughout different definitions of the export spells. The only difference being that the estimate of the interaction term for finished products now becomes statistically significant using single spell and first spell samples. These results provide reassuring evidence that vertical differentiation is an important factor in enhancing the likelihood of survival of export flows (and hence reducing the probability of hazard) and the impact of vertical differentiation on hazard rates in parts and components is larger than that of finished products. Moreover, the results for finished products and parts and components are robust to the alternative definitions of export spells, as seen in Tables 8 and 9. The results show that the coefficient of interest remains negative and statistically significant, but its magnitude is much larger than in the benchmark case, confirming the distinctive role of vertical differentiation in explaining the differences in hazard rates among product types.

As for the other independent variables, most of the effects appear relatively resilient to the different definitions of export spells and samples. Comparison with to the previous benchmark results shows that common language dummy loses its significance in cases where the sample is limited to single spell and first spell, whereas the percentage change in the relative exchange rate variable becomes insignificant using the first spell. One potential explanation could be that in those samples obviously a large number of spells is dropped from estimations, which makes it harder to detect statistically significant effect.

As a final robustness check, the benchmark data is re-estimated using a logit estimator with fixed effects, which also control for unobserved heterogeneity.[33] As shown in Tables 7, 8 and 9, the coefficient of interest is still negative, but no longer significant, except that the vertical differentiation variable for parts and components retains its negative and statistically significant coefficient. This finding further support the prediction that vertical differentiation induced by international fragmentation of production seems to matter more for parts and components trade.

[33] The most commonly regression models that control for unobserved heterogeneity are fixed-effects model and random-effects model. 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 above considerations and the test results (not reported here for brevity, but available upon request) suggest that the discrete-time logit model with a random effect is appropriate in our case.

In summary, the results are robust to using alternative definitions of export spell and logit model with fixed effects. In all cases, the robustness analysis does not alter the central finding of the present paper that vertical differentiation plays an important role in explaining differences in survival of export flows across product types.

5. Concluding remarks

Survival of exporters' in international markets is very important to achieve growth and stability in export earnings and thereby stimulate economic growth. The current paper seeks to build upon and extend on recent empirical findings that highlight the importance of global production networks in increasing the chance of export survival (e.g., Obashi, 2010; Corcoles et al., 2012; Corcoles et al., 2014). Empirical contribution of the current paper lies mainly in elaborating the role of global production networks in export survival of machinery products by employing interaction terms between product types and the binary variable of vertically differentiated products. These multiplicative interaction terms have been incorporated in the estimation models to isolate the effects of vertical differentiation induced by production sharing activities within global production networks on the survival of export flows. In so doing, the current paper decomposes Turkey's machinery exports at the HS-6 digit level to 188 importing countries over the period of 1998-2013 into finished products export flows and parts and components export flows. This decomposition enables us to determine whether vertical differentiation linked with global value chains plays a key role in explaining differences in export survival across product types.

Some preliminary conclusions have been emerged from the descriptive analysis. First, duration of Turkey's machinery exports is rather short-lived, regardless of the product types. Second, the survival curves are downward sloping with a decreasing slope suggesting that Turkey's machinery products exhibit higher survivability in export markets as the export relationship lasts for a certain period of time. Third, survival rates for machinery parts and components are significantly higher than those of all machinery products and finished machinery products and their rates remain high throughout the whole period. Finally, horizontally differentiated finished products have higher chance of survival than vertically differentiated finished products. In contrast, survival rates are higher for vertically differentiated parts and components than for horizontally differentiated parts and components. Overall, the descriptive results support the claim that engaging trade within global production networks increases the probability of survival in export markets.

Beside descriptive analysis, discrete-time proportional hazard models were estimated to assess the role of vertical differentiation on the duration of machinery exports for alternative levels of aggregation (total machinery products, finished products, parts and components). The estimation results show that the interaction effect of vertical differentiation dummy and parts and components have strong negative influence on the hazard rates of Turkey's machinery export flows, whereas the interaction effect of vertical differentiation dummy and finished products did not significantly affect the hazard rates. Further, for each product type, the estimation is carried out separately for finished products and parts and components. A separate estimate of the two product types displays that vertical differentiation which has been proxy for product quality reduces the hazard rate for finished products. Similarly, vertical differentiation that serves as a proxy for participation in global production activities also presents a significant negative effect on the hazard rate for parts and components. These results confirm the importance of pay attention to the role of vertical differentiation linked with global value chains in explaining the differences in hazard rates across product types. Besides key predictor variables, variables, such as distance, the initial value of exports, lagged duration, market and product diversification, correlated strongly with the hazard rates of exports. Thus, findings appear to support the hypothesis that the presence of sunk entry costs in export markets and the existence of trust, experience as well as knowledge acquired via exporting tend to reduce the probability of ceasing export activity for firms integrated in global production activities, thereby having a negative effect on the hazard rates for parts and components.

The evidence here assists policymakers in identifying the key elements that affect the duration of Turkey's machinery exports. It also provides some policy options that will help Turkey to secure stable export growth. First, policies should be implemented to promote and facilitate the integration of local firms in global production networks. Competitiveness is the most important factor for successfully participating in global value networks. Although Turkey has clearly improved its international competitiveness due to the gradual shift in the quality and technological sophistication of its exports towards more sophisticated products over the past decade, it still lags behind the BRIC economies (Brazil, Russia, China and India). In order to enhance the competitiveness of Turkish firms and facilitate their participation in global production networks, Turkey must focus on improving its infrastructure, such as communications technology, transportation and logistics, port facilities and energy. Efficient infrastructure reduces the cost per transaction while enabling local firms to ship products on time and in good condition, which are crucial element for full integration into global value chains (Athukorala and Yamashita, 2006). Furthermore, building strong institutional capacity, including good governance, the rule of law, contract enforcement and intellectual property rights, can facilitate integration of firms into global value chains.

Moreover, FDI inflows effectively foster the integration of local firms with the global production networks, whereby leading firms engage in global production activities with local firms located in developing countries. Consequently, government should take necessary measures to generate favorable conditions for FDI flows into Turkey, which in turn could encourage spillovers and technological diffusion from foreign to local firms within global production networks. This could also facilitate technological upgrading of exports and domestic production generally. However, it is necessary to have certain qualified human capital stock to improve the abilities of local firms to absorb and use new technology effectively. While some progress has been made in this area, shortage of a skilled trained labor force is still a major constraint on the ability for Turkey to absorb technology transfer and export technologically sophisticated high-quality products. Skills shortages which reduce Turkey's ability to innovate new products, development or adaptation of the new technology and upgrade the quality of Turkey's exports can be addressed and resolved through better education, appropriate training and labor market policies (Lall, 2000).

Trade cost reduction policies have also important impacts on the participation in global production networks. Such policies include liberalization of trade in products as well as services and trade facilitation. While efforts to liberalize trade in products serves a good starting point for global production network participation, liberalizing services trade brings far greater benefits. In addition, making regulatory reforms to make the services sector, such as banking and insurance services as well as logistics services, more competitive is another key suggestion to enhance the competitiveness of products exports and help trade and business operations within global production networks. Another important factor contributing to the reductions in trade costs is trade facilitation measures, including simplification of trade documents, streamlining of border procedures and automation of the border process. Implementation of trade facilitation measures could help Turkish firms participate in global production networks by reducing trade costs, increasing speed and remove the uncertainty. In the meantime, Turkey should extensively engage in bilateral free trade agreements like FTAs with new emerging markets because FTAs can facilitate participation into global value chains and support FDI inflows through the further elimination of cross-border barriers. The implementation of the above-mentioned policies can help Turkish domestic firms more deeply integrate into global production networks and thus export more competitively, which in turn could promote their survival in the global markets.

The findings from this study also provide evidence on the importance of export diversification (both in terms of products and destinations) in Turkish firm's survival in export markets. Though Turkey has achieved remarkable export growth over the past decade, it is still far from its full potential in terms of export values and export diversification (Türkcan, 2014). Accordingly, Turkey should take the following measures in diversifying its product base and geographical scope, because concentration on a few markets or products cannot ensure long-term sustainable export growth and thereby economic growth. Policy-makers should use industrial and investment policies to gain a competitive advantage in sectors through which the country has the potential to compete in foreign markets. Policy instruments include tax and direct credit incentives, selective export subsidies, special tax privileges to attract FDI into non-traditional sectors, and local content requirements. Turkey should particularly focus policies on encouraging investments in higher-value-added export sectors, such as chemicals, pharmaceuticals, consumer electronics, motor vehicle and machinery, and equipment. Such a move towards higher-technology activities will improve Turkey's export competitiveness and foster export diversification, thereby reduce its vulnerability to external shocks.

Meanwhile, Turkey should aim to use export promotion agencies more effectively in order to enable Turkish firms to penetrate in a wide range of markets. By providing local firms with a broad range of services, such as, counseling, export assistance services and 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.

Several studies (e.g., Acar, 2009; Malueche, 2009; Demir, 2014; Türkcan, 2015; Türkcan and Avsar, 2016) clearly demonstrate the importance of a well-functioning financial markets and financial intermediaries in Turkey, because to operate in foreign markets, Turkish firms need better access to trade finance. Consequently, Turkey should develop and maintain an effective financial system in order to broaden the range of trade finance instruments and risk mitigation tools at lower costs for new and small exporters who might have the potential to develop new export lines. Such developments would help Turkish firms not only access the finance they need to export more and diversify its exports in terms of products and destinations, but eliminate the risk of a trade transaction. Meanwhile, Turkey should aim to use Turk Eximbank, the official state export credit agency, more effectively in order to enable Turkish firms to penetrate in a wide range of markets. By supporting Turkish exporters through a variety of credit, insurance and guarantee programs, Turk Eximbank may help companies, particularly new and small exporters, to enter new markets and mitigate the losses. Finally, Turkey should establish institutional structures to ensure the efficient regulation and enforcement of contracts between exporters and importers, because stricter enforcement of contracts enhances Turkish firms' ability to increase their exports or enter markets and improve the survival of newly established bilateral trade relationship. Overall, a combination of these policies would help Turkey to diversify its product range and geographic scope, improve the quality of its exports, foster export growth, stabilize its export earnings, and thereby leading to sustainable long-run economic growth.

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Appendix

Table A1: List of machinery parts and components

840140	841330	843141	846791	848390	852910	853922	854459	871491	901590
840290	841340	843142	846792	848410	852990	853929	854460	871492	901790
840390	841350	843143	846799	848420	853090	853931	854470	871493	902490
840490	841360	843149	846890	848490	853110	853932	854511	871494	902590
840590	841370	843290	847310	848510	853120	853939	854519	871495	902690
840610	841381	843390	847321	848590	853180	853941	854520	871496	902790
840681	841382	843490	847329	850300	853190	853949	854590	871499	902890
840682	841391	843590	847330	850490	853210	853990	854610	871690	902990
840690	841392	843691	847340	850511	853221	854011	854620	880310	903090
840710	841410	843699	847350	850519	853222	854012	854690	880320	903190
840721	841420	843790	847490	850520	853223	854020	854710	880330	903290
840729	841430	843890	847590	850530	853224	854040	854720	880390	903300
840731	841440	843991	847690	850590	853225	854050	854790	880510	910400
840732	841451	843999	847790	850690	853229	854060	854810	880520	911011
840733	841459	844090	847890	850710	853230	854071	854890	900110	911012
840734	841460	844190	847990	850720	853290	854072	860711	900120	911019
840790	841480	844240	848010	850730	853310	854079	860712	900130	911090
840810	841490	844250	848020	850740	853321	854081	860719	900140	911110
840820	841520	844390	848030	850780	853329	854089	860721	900150	911120
840890	841590	844811	848041	850790	853331	854091	860729	900190	911180
840910	841610	844819	848049	850890	853339	854099	860730	900211	911190
840991	841620	844820	848050	850990	853340	854110	860791	900219	911210
840999	841630	844831	848060	851090	853390	854121	860799	900220	911280
841011	841690	844832	848071	851110	853400	854129	870600	900290	911290
841012	841710	844833	848079	851120	853510	854130	870710	900311	911310
841013	841720	844839	848110	851130	853521	854140	870790	900319	911320
841090	841780	844841	848120	851140	853529	854150	870810	900390	911390
841111	841790	844842	848130	851150	853530	854160	870821	900590	911410
841112	841891	844849	848140	851180	853540	854190	870829	900691	911420
841121	841899	844851	848180	851190	853590	854212	870831	900699	911430
841122	841990	844859	848190	851210	853610	854213	870839	900791	911440
841181	842091	845090	848210	851220	853620	854214	870840	900792	911490
841182	842099	845190	848220	851230	853630	854219	870850	900890	920910
841191	842123	845240	848230	851240	853641	854230	870860	900990	920920
841199	842129	845290	848240	851290	853649	854240	870870	901090	920930
841210	842131	845390	848250	851390	853650	854250	870880	901190	920991
841221	842191	845490	848280	851490	853661	854290	870891	901290	920992
841229	842199	845590	848291	851590	853669	854390	870892	901310	920993
841231	842290	846610	848299	851690	853690	854411	870893	901320	920994
841239	842390	846620	848310	851790	853710	854419	870894	901380	920999
841280	842490	846630	848320	851840	853720	854420	870899	901390	
841290	843110	846691	848330	851850	853810	854430	870990	901410	
841311	843120	846692	848340	851890	853890	854441	871411	901420	
841319	843131	846693	848350	852210	853910	854449	871419	901480	
841320	843139	846694	848360	852290	853921	854451	871420	901490	

Notes: There are 1174 items for machinery products out of 5066 items from the six digit level of Harmonized System (HS) 1996. Following Kimura and Obashi (2010), 729 items are considered as finished machinery products and 445 items are considered as machinery parts and components.

Table A2: 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 A3: 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 one if Turkey and its trading partner share a common language, zero otherwise	CEPII's GeoDist database:: http://www.cepii.fr
Common border	Takes the value one if Turkey and its trading partner share 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 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 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 one if the 6-digit parts and components flow shows the 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 one if the 6-digit finished products flow shows the 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

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: Author's 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: Author's 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: Author's 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 variation in the unobserved individual factors. An export relation is defined as 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 variation in the unobserved individual factors. An export relation is defined as 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 variation in the unobserved individual factors. An export relation is defined as 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 variation in the unobserved individual factors. An export relation is defined as 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

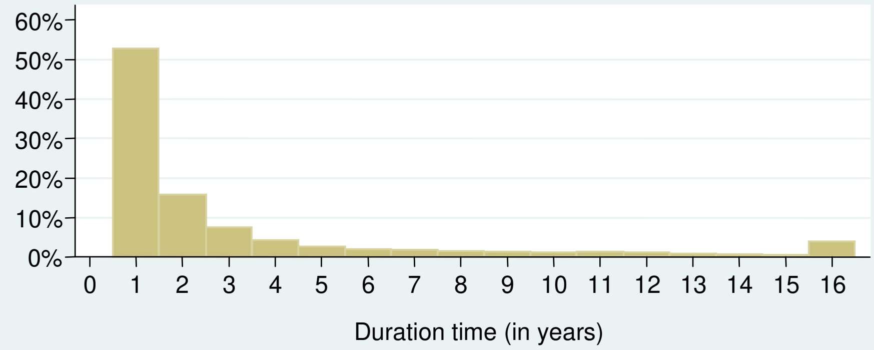
Notes: All regressions include random or fixed effects on the importer-product level. Unless otherwise stated the preferred random-effects logit model is estimated. P-values are in parentheses. ρ is the fraction of error variance that is explained by variation in the unobserved individual factors. An export relation is defined as 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

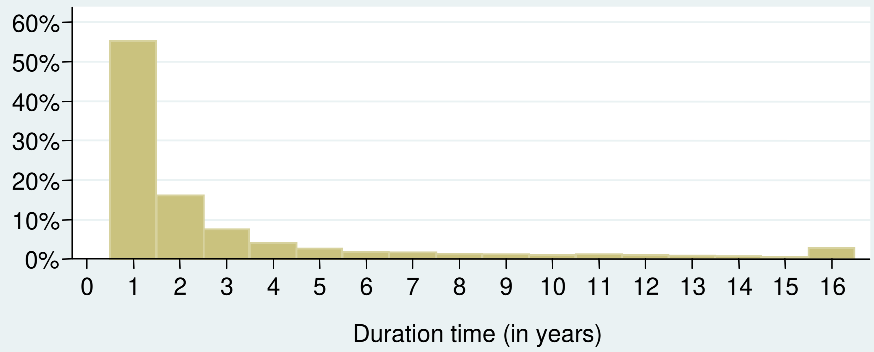
	Single spell	First spell	Gap-adjusted	FE logit
Log distance	0.1309	0.0683	0.0926	
	(0.000)	(0.000)	(0.000)	
Common language	-0.0132	0.0487	-0.1551	
	(0.914)	(0.483)	(0.001)	
Common border	-0.0755	-0.0084	-0.1053	
	(0.097)	(0.736)	(0.000)	
Log GDP (importer)	-0.0605	-0.0313	-0.0363	-0.5630
	(0.000)	(0.000)	(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 variation in the unobserved individual factors. An export relation is defined as 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.

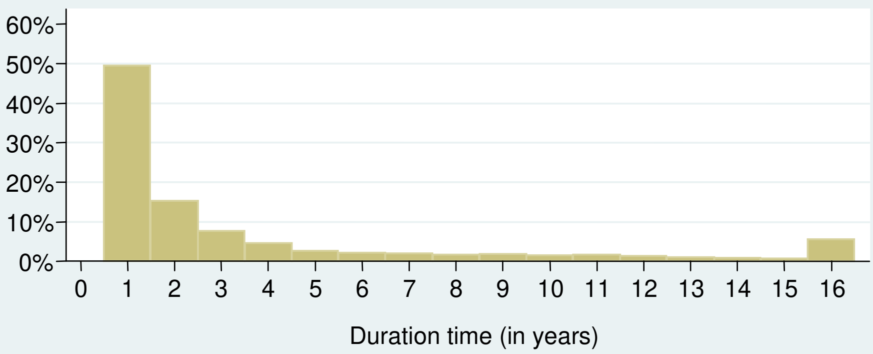
Figure 1: Histogram of duration of Turkey's exports of machinery products



(a) Duration of exports of all machinery products



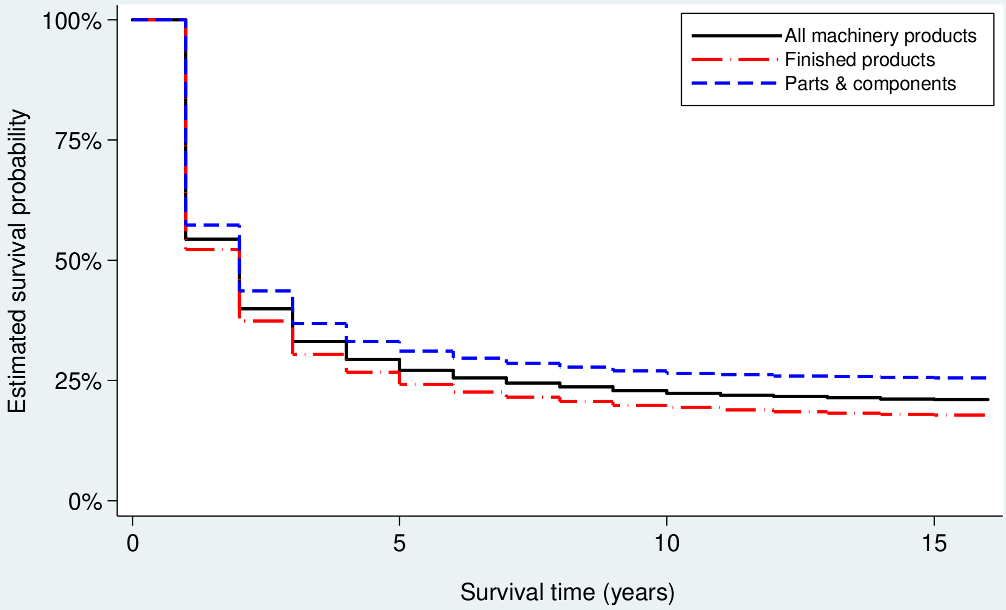
(b) Duration of exports of finished machinery products



(c) Duration of exports of machinery parts and components

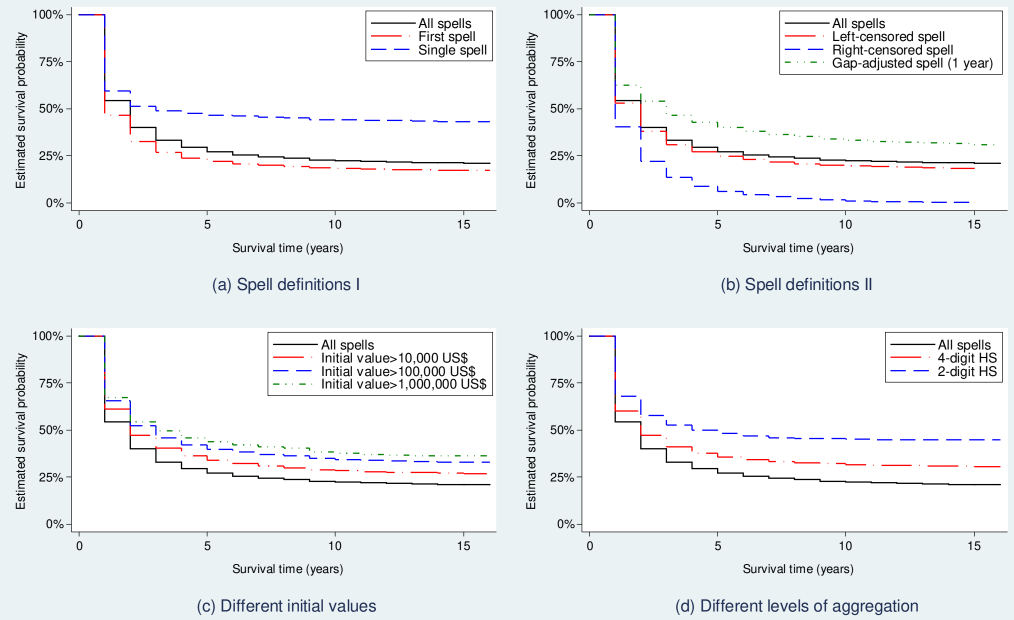
Source: Authors' own calculations based on CEPII's BACI database

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



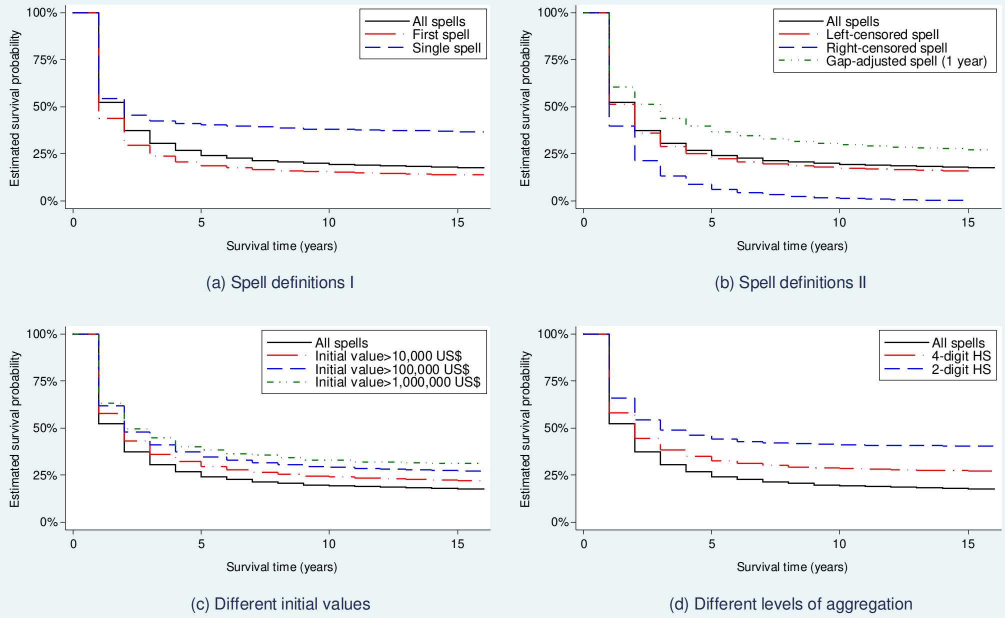
Source: Authors' own calculations based on CEPII's BACI database

Figure 3: Kaplan-Meier estimates of survival functions for all machinery products



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

Figure 4: Kaplan-Meier estimates of survival functions for finished machinery products



(a) Spell definitions I

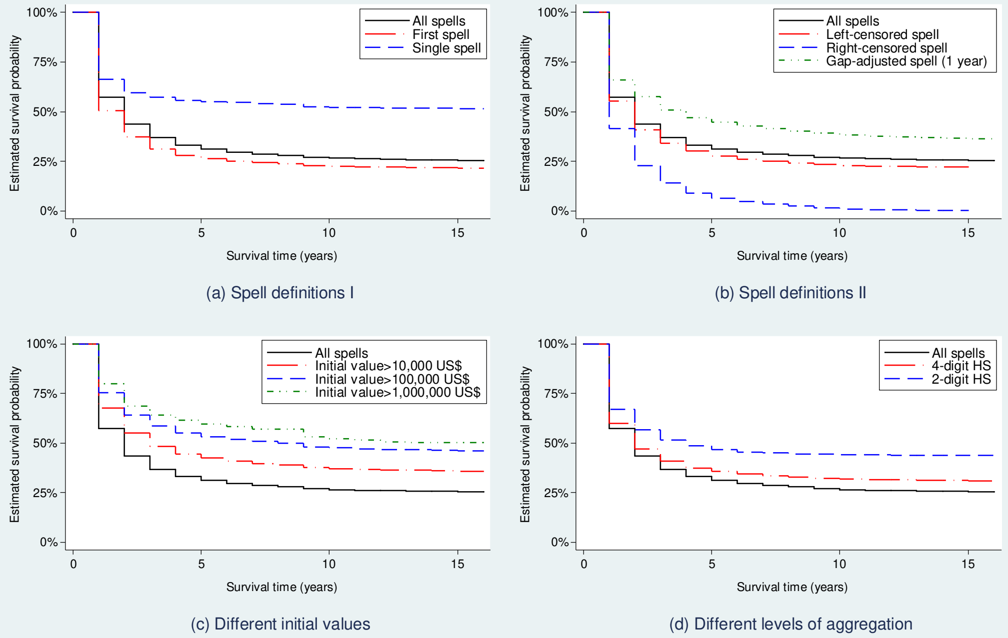
(b) Spell definitions II

(c) Different initial values

(d) Different levels of aggregation

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

Figure 5: Kaplan-Meier estimates of survival functions for machinery parts & components



(a) Spell definitions I

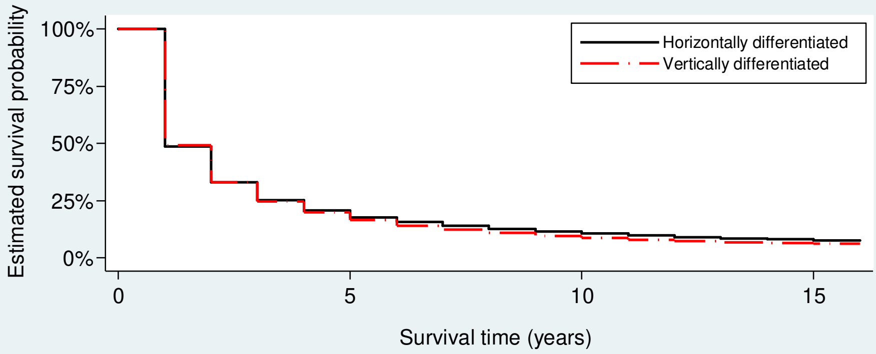
(b) Spell definitions II

(c) Different initial values

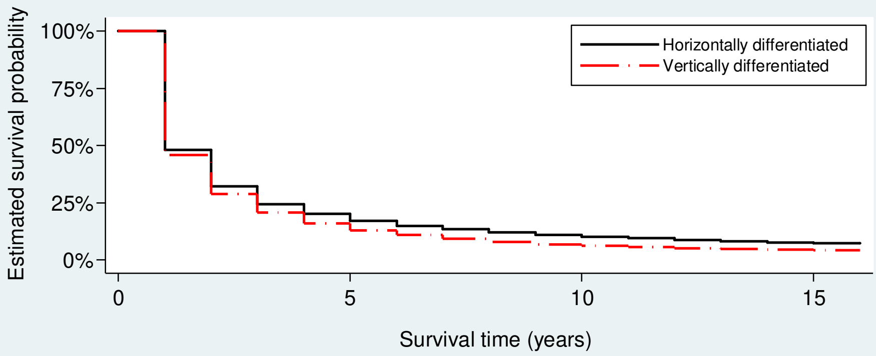
(d) Different levels of aggregation

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

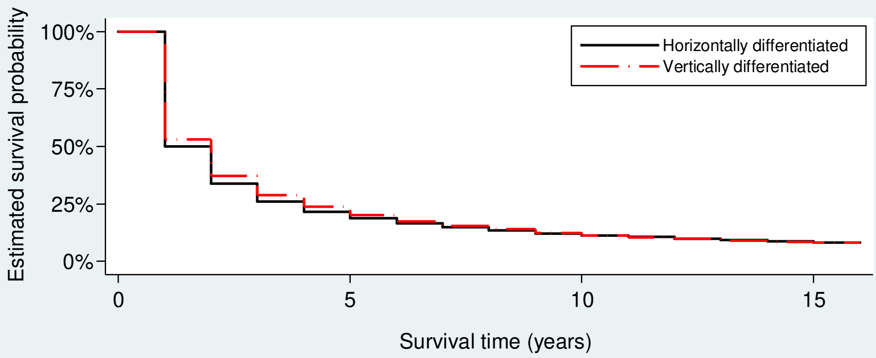
Figure 6: Horizontallly versus verticallly differentiated products



(a) All machinery products



(b) Finished machinery products



(c) Machinery parts and components

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