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Die Another Day:
Duration in German Import Trade*

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Abstract
International trade patterns at the product level are surprisingly dynamic. The majority of trade relationships exist for just a few, often only one to three, years. In this paper, I examine empirically the duration in German import trade at the 8-digit product level from 1995 to 2005. I find that survival probabilities are affected by exporter characteristics, product type and market structure. Specifically, I show that the duration of exporting a product to Germany is longer for products obtained from countries that are economically large and geographically close to Germany; for products with large trade value and a low elasticity of substitution; and for trade pairs that command a large share of the German import market and are characterized by two-way trade.

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1. Introduction

In 2004, Germany reported positive imports in 9,756 product categories, according to the most detailed (8-digit) product level classification in European trade statistics. The products were obtained from virtually all over the world, with official statistics listing 236 supplying countries and territories. Since most products were imported from more than one supplier, there were, in total, 206,727 product-country pairs (or 'varieties'). Interestingly, this number has been relatively stable over time; for other years, numbers of similar magnitude are observed. For instance, there were 202,604 trade pairs in 2003 (with imports of 9,976 products from 236 countries) and 200,706 trade pairs in 2005 (with imports of 9,697 from 239 countries). In combination with other evidence on the (short-run) persistence in international trade (e.g., the empirical success of the gravity model of trade, the role of networks in trade), the small variation in the total number of product-level trade relationships may be just another indication that trade patterns are relatively stable over time.[1]

Contrary to this belief, however, Besedeš and Prusa (2006a, 2006b) have recently argued in a series of papers that trade relationships are often very short-lived. Examining the duration of U.S. imports, they find that the U.S. pattern of foreign sourcing is surprisingly dynamic; the median duration of importing a product from a foreign supplier in their sample is just one year. As a result, the stability of aggregate trade patterns may mask considerable turnover at the product level, with a large fraction of suppliers entering and exiting the market each year.

Data for German import trade generally confirm Besedeš and Prusa's (2006a) findings. Of the 206,727 product-country pairs in 2004, 49,621 (~24%) pairs were non-existent a year earlier, while 49,928 (~24%) pairs died in the following year; a subset of 27,824 (~13%) pair-wise trade relationships was observed in 2004 (i.e., in one year) only. However, there is also considerable heterogeneity across products and countries. Most notably, some products were repeatedly imported from a particular country over a relatively long period of time; about one-tenth of all trade relationships in 2004 have been in existence for at least a decade.

This paper examines the duration of trade relationships in more detail. In particular, I aim to identify relationship-specific characteristics that help to explain the observed differences in the duration of trade. Besedeš and Prusa (2006b) find, based on a matching

[1] The gravity model of trade is highly successful in explaining bilateral trade flows between two countries with their economic mass and the distance between them – measures that change (at best) only slowly over time. The network view of trade emphasizes that search for a trading partner is costly and therefore may be completed at some point in time (even before the best match is achieved).

model, that survival rates are higher for differentiated products than for homogeneous products; they also show that duration increases with initial trade size. In this paper, I take a much broader view. In particular, I ask: Do country characteristics, such as proximity or common language, matter for survival? Are there any product characteristics, such as product sophistication, that affect the duration of trade? And to what extent do market characteristics play a role, such as market entry of a foreign competitor?

To analyze these questions, I examine a new data set of German import trade from 1995 to 2005. The data set comprises trade values and quantities at the 8-digit Combined Nomenclature (CN) level which is the most detailed product classification to designate goods and merchandise in European Union trade statistics; the CN-8 level contains about 13,000 product codes. Based on this data, I use various techniques, including a Cox hazard model, to explore the survival time of importing a product from a particular country.

I find that the duration of a trade relationship is indeed strongly and significantly associated with characteristics of the supplier country, specific features of the imported product, as well as the structure of the (import) market. Specifically, I find that country pair-specific features that are typically identified to increase bilateral trade in gravity models are also beneficial for the duration of trade. Further, trade relationships tend to last longer for differentiated products, for products with a low elasticity of substitution, and for products with high contract intensity. Finally, large transaction values as well as German exports of a particular product (i.e., two-way trade) increase the probability of survival.

The remainder of the paper is organized as follows. Section 2 briefly reviews the relevant literature. Section 3 describes the data. Sections 4 and 5 are the main parts of the paper; they present the empirical results. Section 6 provides a short conclusion.

2. Literature

In standard models of international trade, the duration of trade is typically ignored. Some models appear to imply that trade patterns are highly static and persistent. In these models, a trade relationship, once established, will almost last forever. For instance, according to the factor proportions theory, trade is based on differences in (relative) factor endowments. To the extent that such differences remain in place (as they often do between countries over time), a trade relationship remains undissolved.

Other models focus (more explicitly) on the dynamics of trade, but rarely discuss exits from export markets. These models typically cover trade dynamics by considering market entry of new exporters. The implications (of this growing trade diversity) for existing exporters, however, are often less clear; initial trade patterns may be reinforced or reversed, depending on circumstances.[2] Still, it is interesting to note that also in these models patterns of specialization change at best only gradually. Shifts in the pattern of specialization may be associated with, for instance, the life cycle of a product, the diffusion of technology or differences in factor accumulation; see, for instance, Vernon (1966), Grossman and Helpman (1991). None of these reasons, however, helps explain the very short episodes (that are observed in the data) when a product is exported for just a few years.

It is even more striking that (the few) models that explicitly consider the duration of trade especially emphasize the stability of international trade patterns. Examples include models of hysteresis in trade, such as Baldwin and Krugman (1989). In these models, based on the existence of sunk market-entry costs, firms tend to serve an export market over relatively long periods of time. For instance, an exchange rate overvaluation may lead to (additional) entry by foreign firms which then do not exit after the exchange rate shock has passed. In similar fashion, search-cost models of trade view the connection between buyers and sellers as a search process that, because of its costliness, is terminated at some 'reservation match'; that is, at some point in time , firms stop searching for alternative partners even if they have not yet found the perfect partner. As Rauch (2001, p. 1179) emphasizes, networks help to reduce such partner-related search costs because network members have thorough knowledge of each others' characteristics and, more importantly, "their members are engaged in repeated exchange that helps sustain cooperation/collusion". To further illustrate this point, Rauch (2001, p. 1179) quotes Egan and Mody (1992) who state that "Most U.S. buyers interviewed for this study preferred long-term, stable and direct relationships with both developed and developing country suppliers".

Empirical studies on trade dynamics have mainly focused on changes in the pattern and composition of international trade. Feenstra and Rose (2000), for instance, examine the ordering when countries begin to export a particular product to the United States. Redding (2002) documents the evolution in the pattern of specialization across OECD countries. While these studies often emphasize the mobility in trade patterns, the duration of trade has

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[2] Evenett and Venables (2002) find, for a sample of 23 developing countries, that the number of zeros in bilateral trade matrices has fallen considerably over time; their estimates imply that the increase in the number of trading partners (what they call "geographic spread of trade") accounts for about one third of developing economies' export growth since 1970. Kehoe and Ruhl (2003) argue along similar lines; they study six episodes of major trade liberalization and find that the decrease in trade barriers has mainly benefited trade in goods that were not traded before. For a contrasting view, see Helpman, Melitz and Rubinstein (2007).

previously been analyzed only by Besedeš and Prusa (2006a, 2006b). There is also a recent related literature that studies the duration of prices. Gopinath and Rigobon (2006), for instance, examine the stickiness of U.S. import prices.

3. Data

Any estimate of the duration of trade is highly sensitive to the analyzed level of product classification. Periods of continued trade tend to become longer for more aggregate industries because the wider the range of products that is covered by an industry classification, the higher is the probability that at least one product of this category is traded in a given year. At a very detailed level of product description, in contrast, even a minor change of product specifications may lead to a reclassification of an otherwise identical product, thereby resulting in a recorded failure of a trade relationship. Also, (regular) modifications of product codes may affect the results for individual products more strongly than for broad product groups or industries.

In this paper, I make use of a new and previously unexplored data set of product-level trade for Germany. Trade values and quantities are reported at the 8-digit Combined Nomenclature (CN) level, which is the most detailed product classification in European Union trade statistics. The data are provided by Eurostat and are available online at http://ec.europa.eu/eurostat.

According to the European Commission, the CN is comprised of the (widely used and often better known) Harmonized System (HS) nomenclature, which is run by the World Customs Organization, with further Community subdivisions. With about 13,000 product codes, however, the CN-8 classification covers a smaller number of products than the 10-digit HS scheme which is used to classify U.S. trade. To illustrate the level of product detail, Table 1 lists the five product codes with the smallest and largest import values for Germany in 2004. As shown, there is enormous variation in the importance of individual products. The smallest import value that is recorded in this year is 500 euro, which is actually below the smallest statistical threshold level for reporting trade (to reduce the burden from statistical formalities on businesses).[3] The product categories with the largest import values are, as expected, natural resources, passenger cars, and airplanes.

[3] Eurostat notes a transaction threshold of 1,000 EUR or 1,000 kg in extra-EU trade statistics; see http://europa.eu.int/estatref/info/sdds/en/text/ext_sm.htm. The OECD reports thresholds for intra-EU trade ranging from 30,000 EUR to as much as over 600,000 EUR while the recommended threshold for extra-EU trade is 800 EUR; see http://www.oecd.org/dataoecd/55/11/2539563.pdf.

The trade data are available for the eleven-year period from 1995 to 2005. For each year, I observe, at the product level, the value of German imports from a given country. That is, the total number of trade observations for all possible combinations of products, countries and years is about 33 million (≈13,000 products × 235 countries × 11 years). However, most of these potential trade relationships are non-existent; the number of observations with positive trade is about 2.2 million (≈6 percent of the sample). Moreover, the majority of these non-zero trade observations are small in value. About 30 percent of Germany's imports by product-country pair have a value of less than 10,000 euro; about 60 percent have a value of less than 100,000 euro. Figure 1 provides a histogram of trade observations by size groups of factor 10.[4]

Based on this data, I compute some additional statistics that help to characterize a pair-wise trade relationship. For instance, as noted before, it is possible to observe the total size of the German import market for a given product (see Table 1); dividing then pair-wise shipments by Germany's total imports of a product gives a country's market share in supplying this product to Germany. Similarly, the number of countries from which Germany has imported a product in a given year is easily identified. The upper part of Table 2 indicates that Germany typically obtains a product from various sources. The median number of suppliers is 17; less than 5 percent of the products are imported from just one (unique) supplying country.[5] Also, the degree of geographic concentration in the German import market is observed. Summing the number of products (with positive imports) by country gives an indication of product diversity in a country-pair relationship. As shown in the lower part of Table 2, distance to the German market appears to be an important determinant of product diversity in the bilateral trade relationship. This observation confirms recent findings by Baldwin and Harrigan (2007) on the incidence of non-zero trade in U.S. product-level trade statistics; Broda and Weinstein (2006) find that the U.S. imports the largest number of goods from Canada.

For each product and country, I also compute the Herfindahl index as a measure of trade concentration. The Herfindahl index is the sum of the squared shares of individual product-country pair import values in Germany's total imports either for a specific product or

[4] Given the statistical thresholds for reporting transactions, the share of small-value trade observations can be expected to be even larger. Still, the minimum reported trade value in the sample is 69 euro (for imports under CN code 04MMM000 from Malta in 2005).

[5] This result does not necessarily contradict the finding in Haveman and Hummels (2004) that importers buy from very few of available exporters. Based on four-digit SITC data, Broda and Weinstein (2004) report that Germany has, on average, imported a product from 38 suppliers in 1997.

from a particular country.[6] That is, the higher the value of the Herfindahl index, the less diversified geographically are Germany's imports of a particular product (for products) and the more specialized is a country in shipping a particular product to Germany (for countries). Table 3 lists the upper and lower bounds of the index as well as the median and mean values.[7] Not surprisingly, selected sorts of specialty food (which is actually defined by the region of origin) are imported almost exclusively from one supplying nation, while imports of various textile products are the least concentrated on a particular source country. In similar fashion, shipments to Germany from (economically) small countries are often dominated by a single commodity, while large and/or nearby countries tend to deliver a highly diversified range of products.

In addition, it is possible to derive from this data, similar to Besedeš and Prusa (2006a), the length of time that a country has continuously shipped a product to Germany. Focusing on the frequency of changes in the German import structure, this approach essentially ignores the actual size of imports, but goes beyond the simple zero-one question of when a country is on or off the German import market. Figure 2 graphically illustrates the procedures to construct the relevant variables for an exemplary product category, peanut butter (CN code 20081110). As shown, Germany has imported peanut butter from a total of 25 countries over the sample period from 1995 to 2005. However, not all of these countries have shipped the product to Germany in each and every year; circles denote years of an active trade relationship (with positive German import values of peanut butter from a particular country). Lines then mark episodes of a country continuously servicing the German market. These episodes are commonly referred to as 'spells'; that is, the maximum length of a spell in my sample is 11 years. An event when a country stops exporting to Germany is labeled as 'failure'; spells that fail during the sample period are shown in bold. At the extreme, a country exports a product to Germany every other year so that there are, for a given product-country pair, a maximum number of six spells and five failures in my sample.

Calculating duration then appears to be straightforward: it is simply the time (measured in years) that a trade relationship has been in existence (without interruption). Alternatively, applying statistical techniques from survival analysis, duration can be modeled

[6] Specifically, the Herfindahl index is defined for products as $H_t^p = \sum_c (x_{ct}^p / X_t^p)^2$, $c=1 \ldots C$, and for countries as $H_t^c = \sum_p (x_{ct}^p / X_{ct})^2$, $p=1 \ldots P$, where x_{ct}^p denotes German imports of product p from country c in year t, and X^p and X_c denote total German imports of p and from c, respectively.

[7] Only products imported from at least four suppliers and only countries shipping at least four products are reported. The results refer to 2004; aggregate figures for other years are identical.

as a sequence of conditional probabilities that a trade relationship continues after *t* periods given that it has already survived for *t* periods.[8] Specifically, let *T* be a random variable that denotes the length of a spell. Then, in discrete time, the survivor function is defined as

$$S(t)=Pr(T\geq t).$$

In similar fashion, the hazard function is the probability that the trade relationship dies after *t* periods given that it has survived up to that point; that is,

$$\lambda(t)=Pr(T=t|T\geq t).$$

In practice, the survivor and hazard functions are estimated (in a non-parametric way) by computing the number of spells that survive (end) as a fraction of the total number of spells that are at risk after *t* periods.[9]

An important issue for the analysis of duration data is censoring. Spells may begin before or end after the period under observation so that the observed spell length is shorter than the true length of the spell. For illustration, consider a trade relationship that is dissolved in 1995, the first year in my sample. Such a trade relationship is effectively observed as a (short) one-year spell, although it might have been in existence for decades. Another type of censoring is introduced by the frequent revision of product descriptions. In each year, some product definitions are modified, often accompanied by the introduction of new product codes and the deletion of other product codes, so that a product may be reclassified from one code to another. As a result, for a reclassified product, the observed duration of a trade relationship is shorter than the true length of the partnership. Although Eurostat allows, in principle, to track changes in product codes, it is not possible to identify, based on this data, a continuous, uninterrupted trade relationship.[10] Therefore, using a conservative approach to correct for reclassifications, I classify spells that begin when a new product code is created or that end when an existing product code is deleted as being censored.

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[8] Kiefer (1988) provides a more detailed description of duration analysis.

[9] More specifically, the Kaplan-Meier estimator of the hazard function is the fraction of spells that fail after *t* periods of all spells that have survived *t* periods. If the fraction of failures gets smaller for longer periods of time, trade relationships become more likely to be continued the longer they have been in existence, and the hazard function is downward sloping. Correspondingly, the estimator of the survivor function is the share of spells that survives at time *t*, but this time cumulative about all preceding time intervals. That is, if all spells survive and the ratio is one, the survivor function is flat at this interval; otherwise the function is stepwise declining.

Formally, $\hat{\lambda}(t)=d_t/N_t$ and $\hat{S}(t)=\prod_{t_{(i)}\leq t}(n_i-d_i)/n_i$, where d_t denotes the number of spells that die after *t* periods and N_t is the total number of spells that have survived up to that point.

[10] For a description of changes in product codes, see Eurostat's Update of CN codes.

Changes in product classification affect about 10 percent of the sample. As shown in the upper panel of Figure 3, about 500 new products are added to the statistics each year, while about the same number of product codes becomes obsolete, with large differences across years. Overall, the number of deleted product codes marginally exceeds the number of newly created codes so that the total number of product codes at the 8-digit CN level slightly decreases over time from about 10,500 in 1995 to about 10,000 codes at the end of the sample period.

Table 4 describes the data on German import trade in more detail. Uncorrected for censoring, the data set consists of 465,922 product-country pairs for which at least one year of (non-zero) exports to Germany is reported over the sample period from 1995 to 2005. For the majority of these bilateral pairs, trade takes place over a single span of consecutive years; the median number of spells per pair is one. However, some trade relationships were also dissolved and later re-established during the sample period so that the total number of spells in the sample amounts to 661,447. These episodes of uninterrupted trade ('spells') are the primary unit of analysis. Their maximum length in the full sample is 11 years when (non-zero) trade is recorded in every year from 1995 to 2005. In practice, however, the average trade relationship lasts only about 3 years; the median duration is 2 years. That is, the vast majority of the trade relationships in German import trade appear to be very short-lived, confirming similar findings for the United States by Besedeš and Prusa (2006a).

About one-third of the spells in the sample exist until the end of the reporting period (either because the product code is deleted or the sample period ends) so that the true length of the trade relationship is unknown. In the benchmark sample, these spells (that do not experience a failure during the sample period) are dropped to correct for right-censoring. This procedure implies that, by definition, spells of maximum length are excluded, thereby lowering observed trade duration. With this modification, the average length of a trade relationship in German imports is less than 2 years, with a median duration of just 1 year. Figure 4 provides a histogram for the observed duration of German imports for both the full and the benchmark samples. For both samples, the figure illustrates the rapidly decreasing frequency of trade spells for longer periods; that is, most German import trade is highly dynamic. Still, a sizable share of about 10 percent of the spells survives the full sample period of 11 years and thus is remarkably long-lived.

Other sub-samples show basically identical results. For instance, I have additionally dropped all left-truncated spells for which the start date is effectively unknown ("modified censoring"). Also, to deal with possible measurement errors in the statistics (where a trade relationship may be temporarily interrupted or end due to misreporting), I have considered, for each product-country pair, only the first reported spell in my sample ("first spell"), and I have also examined separately product-country pairs without multiple spells ("one spell only"). While the average trade duration slightly varies between 1.5 and 2 years across these sub-samples, the majority of the examined spells lasts just 1 year in all of these cases. Finally, part of the explanation for the short duration of trade appears to be the small value of many trade transactions. Therefore, I have dropped spells with initial trade values below various threshold levels, and I also considered trade at more aggregate levels of industry classification. As expected, trade duration increases with trade value. However, sample size decreases rapidly for these modifications. More importantly, the finding of relatively short-lived trade relations remains unchanged.

For the empirical analysis, I supplement the import values data with two other sorts of data. First, I obtain some additional trade information from Eurostat. For instance, Eurostat also reports, at the product-country level, import quantities (which allows computing import unit values) as well as the (corresponding bilateral) value of German exports (allowing to identify the extent of two-way trade in a similar product, i.e., 'intra-product' trade).

Second, I match this product-level trade data set with other recent product features which I borrow from the recent trade literature. Rauch (1999), for instances, groups products into three categories (homogeneous products that are traded at organized exchanges, products that have a reference price, and differentiated products) and shows that patterns of international trade differ across these product groups. Broda and Weinstein (2006) provide product-level estimates of elasticities of substitution between varieties of foreign imports. Finally, Nunn (2007) identifies the degree to which the production of goods requires advanced intermediate inputs. Since the production of customized inputs may require more relationship-specific investment, Nunn (2007) argues that trade patterns are affected by a country's institutional (that is, contract enforcement) environment. In the following, I examine whether these product characteristics help explain the observed differences in the duration of trade.

4. Length of Trade Relationships

A first attempt to explain the large amount of heterogeneity in the stability of German import patterns focuses on the plain duration of trade spells. More specifically, I observe for each spell in my sample the length of the (uninterrupted) trade relationship (in years). This variable is regressed on a set of country and product specific characteristics. That is, I run regressions of the form:

$$Length_i = \alpha + \beta X^c + \gamma Z^p + \varepsilon_i ,$$

where $Length_i$ is the duration of spell i, X^c is a set of country-specific covariates, Z^p is a set of product-specific covariates, and ε is a well-behaved residual. In my baseline specification, I estimate this equation with conventional OLS; this regression includes, besides the variable(s) of interest, a comprehensive set of either country-specific and/or product-specific fixed effects. In addition, since the number of years that a trade relationship has been in existence is a limited dependent variable, I also report coefficient estimates derived from an ordered probit model. Finally, I replace spell length as dependent variable with a binary dummy variable that takes the value of one if a spell survives the full eleven-year sample period; this (logit) specification allows making (proper) use of right-censored observations that are previously excluded from the regression (in the benchmark sample).

I begin with a discussion of possible country-specific determinants of trade duration. In choosing variables that might affect the duration of trade, it seems reasonable to include, as a starting point, the standard determinants of bilateral trade volumes as typically used in the gravity model. Gravity variables are highly successful in explaining patterns of trade; they may also be relevant for the duration of trade. In addition, I have compiled a variable that captures the number of products Germany has imported from a particular country; this variable may proxy for trust or any other unobserved linkages that potentially affect bilateral information costs (with a broader range of products shipped possibly indicating a preferred supplier of Germany). Finally, I add the yearly difference in the log of the nominal exchange rate as a measure of exchange rate stability. When exchange rate changes have the potential to terminate a trade relationship, switching of suppliers might be an explanation for the low observed exchange-rate pass-through on domestic prices; see Campa and Goldberg (2005).

Table 5 presents the results. The first column reports the coefficient estimates for the standard gravity variables based on the benchmark sample. As shown, the key gravity variables do not only affect the magnitude of trade but also matter for trade duration: larger economic size is positively associated with the length of a trade relationship, while trade with more distant partners is on average more short-lived. For other variables (that are typically used in the gravity framework), the picture is more mixed. A common land border with Germany lengthens trade spells, while common language, membership in the European Union

(EU-15) and EMU membership (EMU-12) are all uncorrelated with trade duration.[11] In the next two columns, I use the same (benchmark) sample but sequentially include the other two country-specific regressors mentioned above that might affect trade duration. Of these measures, product diversity turns out to be relevant: there is a strong and significant positive association between the length of trade spells and the number of imported products. Moreover, while part of this effect comes, not surprisingly, at the expense of the standard gravity variables (size and distance are associated with various aspects of bilateral trade intensity), the variable also appears to pick up a previously uncaptured country-specific component of trade duration. The coefficient on the exchange rate variable, in contrast, is statistically indistinguishable from zero.[12] Next, I report results for two other samples of data: I drop spells with (initial) trade smaller than 10,000 euro, and I present results for the full sample (that includes left- and right-censored observations).[13] Despite large differences in sample size, the key results remain basically unchanged: German import trade is more durable for imports from large and close export countries. Finally, for further sensitivity analysis, I modify the estimation method. One potential issue is that the length of trade spells is an ordered categorical variable that takes on discrete values (between 1 and 10 in the benchmark sample). To take account of this specific feature of the dependent variable, I use ordered probit estimation, without much effect on the results. Another potential concern is that spells that do not end during the sample period are excluded from the analysis. Therefore, I change the dependent variable and use logit estimation to identify the determinants of highly-persistent trade relationships; the binary dependent variable takes the value of one for trade spells that last the full eleven-year period and zero otherwise. Similar to the OLS results, the coefficient estimates derived from the full sample are, if anything, even more supportive for gravity-based determinants of durability in trade. In addition to size and distance, also the estimated coefficients on common language and per capita income are statistically highly significant in this specification. Interestingly, the results suggest that, holding GDP constant, imports from richer countries are on average more short-lived (perhaps because of greater substitutability among suppliers or more narrowly defined product groups).

[11] Note that the two countries sharing a common language with Germany (Austria and Switzerland) also share a common border with Germany.
[12] It should be noted, however, that the coefficient takes on the expected (positive) sign indicating that trade relations are rarely terminated after a depreciation of the foreign exchange rate; for some (unreported) specifications, the coefficient just misses statistical significance at conventional levels.
[13] Full sample results are reported mainly for comparison with the results from other models which make (partly) use of these observations.

Table 6 explores the effect of various product-specific and relationship-specific characteristics. In my baseline regression, I include three variables that may help describe a bilateral trade relationship apart from the features of the product-supplying country (which are captured by a comprehensive set of country-specific fixed effects): the (log) initial transaction value, the (log) bilateral unit value, and the (product-specific) elasticity of substitution.[14] Again, I begin reporting results for the benchmark sample, with the rest of Table 6 providing extensive sensitivity checks. Overall, the results strongly confirm intuition. The positive coefficient on the (log) initial import value suggests that duration increases with transaction size; that is, major bilateral trade linkages often remain in existence for longer periods of time. Also, the (log) unit value enters the regression positively, possibly capturing the effect of product sophistication on trade duration. Finally, the negative coefficient on the elasticity of substitution indicates that products which are not easily replaced by others tend to be imported from a particular partner for several years. In the next columns, I add two other variables to the baseline specification that capture product features but are only available for a much smaller sample. Similar to Besedeš and Prusa's (2006b) findings for the United States, trade in differentiated products, as defined by Rauch's (1999) classification, turns out to be relatively durable. Since differentiated products are characterized by non-standardized features, these products may require closer, more long-living trade relationships. Moreover, with this variable included, the estimated coefficient on the (log) unit value falls in magnitude and significance. Similar results are obtained for contract intensity, a measure of product sophistication that has been recently proposed by Nunn (2007); the higher a product's share of differentiated inputs the longer is on average the trade spell.[15] As before, I also report coefficient estimates for other samples and estimation methods. Again, I find the main results to be reasonably robust.

In Table 7, I provide estimation results for a third set of variables; these variables aim to describe the structure of the German import market. For instance, market size may matter for trade duration, with a larger market perhaps allowing exporters to accommodate temporary fluctuations in demand more easily. In practice, I use two measures of market size and find that the estimated coefficients on these variables are indeed positive and significant.

[14] The elasticities are taken from Broda and Weinstein (2006) and graciously made available online by Christian Broda at http://faculty.chicagogsb.edu/christian.broda/website/research/unrestricted/TradeElasticities/TradeElasticities.html. I use concordance tables from Eurostat to match SITC Rev.3 5-digit codes to CN-8 codes.

[15] Contract intensity measures the proportion of intermediate inputs that require relationship-specific investments in the production process.

Trade relations are more durable when the German import market is relatively large, after controlling for average market size. Similarly, market share as measured by the fraction of bilateral trade in total German imports of a given product is strongly and positively associated with the length of a trade spell; major suppliers tend to serve the German market over longer periods of time. Another market characteristic is the number of countries supplying a particular product to Germany. Interestingly, the number of competitors has no measurable effect on trade duration; the estimated coefficient, though negative, is statistically indifferent from zero. Finally, I make use of German export data. The value of German exports of a particular product to a country turns out to affect corresponding imports positively; two-way trade lengthens trade, perhaps because of greater trust or reciprocity in trade policies.

In sum, I have identified, using conventional regression analysis, a number of factors that help explain observed differences in the length of Germany import trade relationships. It is also well known, however, that the analysis of duration data involves various conceptual problems for which standard regression techniques may not be completely appropriate; see, for instance, Kiefer (1988). Therefore, as a further robustness check, I apply a set of statistical methods that were particularly developed for analyzing survival data.

5. Duration Analysis

I perform the duration analysis in two steps. In a first step, I use a simple graphical approach to examine differences in exit rates across product-country pairs. Specifically, I estimate survival functions for trade relationships, divided along various lines, using the Kaplan-Meier product limit estimator. To categorize product-country pairs, I use the same set of variables as before; the effect of these variables on survival rates is analyzed in univariate fashion. In a second step, I examine the interplay of potential factors affecting trade duration, estimating a stratified Cox proportional hazard model.

Figure 5 presents a series of graphs where Kaplan-Meier curves are plotted for different variables. Each line represents the survival function for a group of product-country pairs that exhibits a particular characteristic. In the top-left graph, for instance, pairs are grouped by the economic size of the exporting country (as measured by the country's GDP). Confirming earlier regression results, the graph shows that country size clearly affects duration; exit rates are significantly higher for imports from (economically) smaller countries.[16] Similar encouraging results are obtained for all other standard gravity variables.

[16] The 95 percent confidence interval of the estimate is (in all cases) extremely tight and therefore not shown.

Unconditional survival probabilities are higher for import trade relationships with countries that have a high per capita income, are geographically close to Germany, and share similar institutions (such as language or membership in the European Union). Exchange rate movements, in contrast, have no measurable linear effect on exit rates; exit rates appear to be low for particularly stable exchange rates.

Analogous graphs are presented for the group of product- and relationship-specific measures as well as for market-specific variables. The results, though slightly more mixed, are again broadly supportive for the findings from regression analysis. Most notably, there is strong evidence that exit rates differ significantly by transaction size, with spells of larger initial trade value, in larger import markets, and commanding a greater share of the import market having higher estimated probabilities of survival.

In sum, this exploratory exercise confirms that the length of trade relationships differs along various lines. Interestingly, an almost identical set of factors as before is identified to be associated with differences in exit rates. However, since the definition of bins for continuous variables is rather arbitrary, I do not intend to interpret the results too literally. Consequently, I use Cox proportional hazard regression to examine the effect of potential factors on trade duration.

Following Besedeš (2006), I estimate a stratified proportional hazards model. In the (standard) Cox model, the hazard function h is parameterized as:

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

where t denotes survival time, x is a set of explanatory variables, and β is a vector of coefficients to be estimated. In this model, there is a common unspecified baseline hazard function, $h_0(t)$, which characterizes how the hazard function changes as a function of survival time, while the function $e^{x\beta}$ characterizes how the hazard function changes as a function of subject covariates. In the stratified version of this model, I allow the baseline hazard function to vary; that is, the baseline hazard function becomes stratum-specific. In the actual implementation, I use (World Bank) regions and 1-digit industries as stratification variables.

The results are reported in Table 8. In my default regression, I fully correct for censoring. Also, to keep the sample as large as possible, I begin with the same set of (benchmark) variables as before. Reassuringly, the key findings turn out to be reasonably robust. In particular, the estimation results are not only (qualitatively) quite similar to those of Tables 5-7, but the results are statistically even stronger. All coefficients (except for the European Union dummy) take on the expected sign and are statistically highly significant. For instance, estimated hazard rates are lower for trade with partners from large and nearby countries as well as for major bilateral trade pairs (as proxied by trade value and market share).

The next two columns augment the default specification by adding other explanatory variables; for these variables much fewer observations are available so that sample size is reduced drastically. Again, the estimation results strongly confirm previous findings. A foreign appreciation (i.e., a decrease in the foreign country's real exchange rate) is associated with higher hazard rates (as foreign goods become cheaper). Moreover, products that exhibit a lower elasticity of substitution and differentiated products are characterized by lower hazards, while all other results remain basically unchanged.

I have also examined different samples. Column 4 presents coefficient estimates derived from the full sample (that includes left-censored observations); column 5 reports results for particularly large trade flows with initial transactions above a threshold of 10,000 euro. For both samples, I find results similar to the default regression.

Finally, I have changed the estimation strategy. The last column of the table reports estimates for a Cox model without stratification. Again, this perturbation has little effect on the results.

In sum, it turns out that the estimates are remarkably robust across different samples and estimation methods.[17]

6. Conclusion

International trade patterns at the product level are surprisingly dynamic. Products are typically obtained from various international sources; many trade transactions are small in value. Accordingly, the majority of bilateral trade relationships exist for just a few, often only one to three, years.

In this paper, I examine empirically the duration in German import trade at the 8-digit product level from 1995 to 2005. Not surprisingly, there are large differences in the duration of trade: while many trade transactions are short-lived, a sizable fraction of bilateral trade pairs also appears to survive for more than a decade. Given these discrepancies, I explore a wide range of potential determinants of trade duration. Using various techniques, I find that survival probabilities are indeed affected by exporter characteristics, product type features and market structure. In particular, I show that the standard 'gravity' determinants of trade do not only affect trade values but also trade duration. In addition, the duration of exporting a

[17] This finding also includes all the other sub-samples described in Table 4 for which results are unreported to economize on space.

product to Germany is longer for trade relationships with a large initial transaction size and for products with a low elasticity of substitution. Finally, trade pairs that command a large share of the German import market and trade pairs characterized by two-way trade have on average lower exit rates.

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Table 1: German imports at the product level by import value, 2004

Product code	Product description	Import value, €
27090090	PETROLEUM OILS AND OILS OBTAINED FROM BITUMINOUS MINERALS, CRUDE (EXCL. NATURAL GAS CONDENSATES)	24,991,366,847
27112100	NATURAL GAS, GASEOUS	13,134,110,032
87032319	MOTOR CARS/STATION WAGONS/RACING CARS FOR TRANSPORT OF PERSONS, OTTO CYCLE, CYLINDER CAPACITY > 1.500-3.000 CC, NEW (EXCL. CARAVANS/FOR >= 10 PERSONS)	9,599,081,747
88024010	AEROPLANES AND OTHER POWERED AIRCRAFT OF AN OF AN UNLADEN WEIGHT > 15.000 KG, FOR CIVIL USE (EXCL. HELICOPTERS AND DIRIGIBLES)	8,822,268,329
87033219	MOTOR CARS/STATION WAGONS/RACING CARS FOR TRANSPORT OF PERSONS, DIESEL/SEMI-DIESEL, CAPACITY > 1.500-2.500 CC, NEW (EXCL. CARAVANS/FOR >= 10 PERSONS)	8,352,035,423
	Mean	58,979,216
	Median	7,518,391
43018030	RAW FURSKINS OF MARMOTS, WHOLE, WITH OR WITHOUT HEADS, TAILS OR PAWS	511
29251930	N,N'-ETHYLENEBIS"4,5-DIBROMOHEXAHYDRO-3,6-METHANOPHTHALIMIDE"	509
29242400	ETHINAMATE (INN)	508
02109959	EDIBLE OFFAL OF BOVINE ANIMALS, SALTED, IN BRINE, DRIED OR SMOKED (EXCL. THICK SKIRT AND THIN SKIRT)	503
01019030	LIVE ASSES	500

Notes: Total number of products with positive imports is 9,756.

Table 2: Description of German imports, 2004

Number of countries from which a product is imported

Product code	Product description	Number of countries
84733010	ELECTRONIC ASSEMBLIES OF AUTOMATIC DATA-PROCESSING MACHINES OR FOR OTHER MACHINES OF 8471, NES.	115
61091000	T-SHIRTS, SINGLETS, TANK TOPS AND SIMILAR GARMENTS OF COTTON, KNITTED OR CROCHETED	112
97040000	POSTAGE OR REVENUE STAMPS, STAMP-POSTMARKS, FIRST-DAY COVERS, POSTAL STATIONARY (STAMPED) ETC., USED, OR IF UNUSED NOT OF CURRENT OR NEW ISSUE	108
49019900	PRINTED BOOKS, BROCHURES, LEAFLETS AND SIMILAR PRINTED MATTER, NES.	107
85179082	ELECTRONIC ASSEMBLIES FOR ELECTRICAL APPARATUS FOR LINE TELEPHONY/TELEGRAPHY AND VIDEOPHONES (EXCL. TELEPH./TELEGRAPHIC CARRIER-CURRENT LINE SYSTEMS)	105
	Mean	21.19
	Median	17
	308 products	1

Number of products imported from a country

Exporter	Number of products
Netherlands	8,008
France	7,830
Italy	7,364
Switzerland	7,013
Belgium	6,911
Mean	875.96
Median	88
4 countries	1

Table 3: Further description of German imports, 2004

Supplier concentration in the German import market (excl. products imported from less than 4 countries)

Product code	**Product description**	**Herfindahl index**
29215910	M-PHENYLENEBIS"METHYLAMINE"	1.000
75012000	NICKEL OXIDE SINTERS AND OTHER INTERMEDIATE PRODUCTS OF NICKEL METALLURGY	0.998
22042126	QUALITY WHITE WINES PRODUCED IN TOSCANA [TUSCANY], CONTAINERS <= 2 L, ACTUAL ALCOHOLIC STRENGTH <= 13% VOL (EXCL. SPARKLING/SEMI-SPARKLING WINE)	0.997
22042128	QUALITY WHITE WINES PRODUCED IN VENETO, CONTAINERS <= 2 L, ACTUAL ALCOHOLIC STRENGTH <= 13% VOL (EXCL. SPARKLING/SEMI-SPARKLING WINE)	0.996
22042167	QUALITY WINES PRODUCED TRENTINO/ALTO ADIGE, CONTAINERS <= 2 L, ALCOHOLIC STRENGTH <= 13% VOL (EXCL. SPARKLING/SEMI-SPARKLING WINE/GENERAL WHITE WINE)	0.996
	Mean	0.369
	Median	0.295
61044300	WOMEN'S OR GIRLS' DRESSES OF SYNTHETIC FIBERS, KNITTED OR CROCHETED	0.057
62052000	MEN'S OR BOYS' SHIRTS OF COTTON, NOT KNITTED OR CROCHETED	0.056
62046318	WOMEN'S/GIRLS' TROUSERS AND BREECHES, OF SYNTHETIC FIBRES, NOT KNITTED/CROCHETED (EXCL. NOT OF CUT CORDUROY, DENIM, INDUSTRIAL/OCCUPATIONAL CLOTHING	0.053
71129200	WASTE AND SCRAP OF PLATINUM, INCL. METAL CLAD WITH PLATINUM BUT EXCL. SWEEPINGS CONTAINING OTHER PRECIOUS METALS	0.053
12119097	PLANTS AND PARTS FOR PERFUMERY, PHARMACY OR INSECTICIDAL OR SIM. PURPOSES, FRESH OR DRIED (EXCL. LIQUORICE, GINSENG, COCA LEAF, POPPY STRAW, TONQUIN)	0.049

Product specialization by exporter (excl. countries from which Germany imported less than 4 products)

Exporter	**Herfindahl index**
Antigua & Barbuda	0.995
Bermuda	0.993
Kiribati	0.990
Marshall Islands	0.985
Liberia	0.983
Mean	0.339
Median	0.228
India	0.007
Czech Republic	0.006
Netherlands	0.006
Italy	0.006
Switzerland	0.003

Table 4: Description of German imports, 1995-2004

	Number of product-country pairs	**Number of spells**	**Number of observat's**	**Number of spells per product-country pair**		**Number of observations per spell (observed spell length in years)**		**Estimated KM survival rate**	
				Mean	Median	Mean	Median	1 year	4 years
Full sample	465,922	661,447	2,199,552	1.39	1	3.33	2	–	–
Benchmark	280,921	402,038	754,428	1.37	1	1.88	1	0.61	0.39
Modified censoring	182,159	303,276	480,561	1.50	1	1.58	1	0.50	0.22
First spell	280,921	280,921	555,569	1	1	1.98	1	0.62	0.42
One spell only	139,096	139,096	259,743	1	1	1.87	1	0.69	0.58
Initial trade >10,000	103,268	142,419	333,627	1.34	1	2.34	1	0.76	0.58
Initial trade >100,000	26,647	34,331	104,083	1.27	1	3.03	2	0.90	0.79
Initial trade >1,000,000	4,417	5,343	19,096	1.22	1	3.57	3	0.97	0.92
6-digit CN level	180,873	265,084	519,903	1.40	1	1.96	1	0.58	0.37
4-digit CN level	56,810	85,299	167,068	1.42	1	1.96	1	0.62	0.42
2-digit CN level	7,543	11,430	22,496	1.44	1	1.97	1	0.66	0.48

Note: Data refer to non-zero trade. The benchmark sample excludes spells that were active at the end of the sample period. A similar restriction applies to all other reported (sub-)samples.

Table 5: Duration and country characteristics

Sample	Benchmark			Initial trade >10,000	Full sample	Bench-mark	Full sample
Log GDP	0.187** (0.039)	0.059# (0.027)	0.218** (0.047)	0.235** (0.049)	0.798* (0.261)	0.094** (0.038)	0.496** (0.028)
Log per capita income	0.004 (0.006)	0.007 (0.006)	0.004 (0.012)	0.048** (0.008)	-0.140* (0.058)	0.007 (0.004)	-0.132** (0.020)
Log distance	-0.262** (0.078)	-0.107# (0.050)	-0.278** (0.073)	-0.338* (0.109)	-0.824** (0.251)	-0.146** (0.032)	-0.515** (0.026)
Common border	0.250** (0.072)	0.274** (0.079)	0.249* (0.080)	0.341** (0.079)	0.787** (0.090)	0.052** (0.019)	0.176** (0.016)
German lang. dummy	-0.109 (0.118)	-0.114 (0.118)	-0.101 (0.111)	-0.150 (0.135)	0.529* (0.184)	-0.080 (0.056)	0.279** (0.046)
EU-15 dummy	-0.028 (0.099)	0.055 (0.084)	-0.073 (0.092)	-0.179 (0.140)	-0.016 (0.068)	-0.040 (0.053)	-0.168** (0.027)
EMU-12 dummy	-0.044 (0.039)	-0.069 (0.040)	-0.036 (0.037)	-0.065 (0.037)	0.007 (0.037)	-0.011 (0.021)	0.026 (0.037)
Log number of products		0.246* (0.043)					
Change in log real exch. rate			0.131 (0.394)				
Product-specif. fixed effects	Yes	Yes	Yes	Yes	Yes	No	No
Estimation	OLS	OLS	OLS	OLS	OLS	Probit	Logit
Number observations	362,713	362,713	258,711	128,426	604,511	362,713	604,511
Adj. R^2	0.10	0.11	0.11	0.19	0.29		
Pseudo R^2						0.01	0.10

Notes: Dependent variable is observed spell length. Standard errors robust to clustering by year recorded in parentheses. **, *, and # denote significant at the 1, 5, and 10 percent level, respectively.

Table 6: Duration and product characteristics

Sample	Benchmark			Initial trade >10,000	Full sample	Bench-mark	Full sample
Log initial import value	0.197** (0.037)	0.215** (0.040)	0.181** (0.032)	0.364** (0.062)	0.662** (0.081)	0.130** (0.010)	0.552** (0.104)
Log unit value	0.035** (0.009)	0.033* (0.010)	0.022 (0.013)	0.005 (0.011)	0.171* (0.059)	0.025** (0.003)	0.098** (0.006)
Elasticity of substitution	-0.009** (0.002)	-0.010** (0.003)	-0.006** (0.002)	-0.013* (0.004)	-0.032** (0.006)	-0.005** (0.001)	-0.028** (0.005)
Differentiated prod't dummy		0.158* (0.049)					
Contract intensity			0.145* (0.061)				
Country-specif. fixed effects	Yes	Yes	Yes	Yes	Yes	No	No
Estimation	OLS	OLS	OLS	OLS	OLS	Probit	Logit
Number observations	205,093	59,936	114,798	91,502	340,077	205,093	340,077
Adj. R^2	0.09	0.10	0.08	0.10	0.34		
Pseudo R^2						0.02	0.26

Notes: Dependent variable is observed spell length. Standard errors robust to clustering by year recorded in parentheses. **, *, and # denote significant at the 1, 5, and 10 percent level, respectively.

Table 7: Duration and market characteristics

Sample	Bench-mark	Initial trade >10,000	Full sample	Bench-mark	Full sample
Log total import value	0.084** (0.006)	-0.038# (0.019)	0.367** (0.084)	-0.024** (0.006)	0.370** (0.020)
Import product market share	1.588** (0.224)	0.705** (0.186)	6.786** (0.968)	0.540** (0.045)	1.584** (0.192)
Log number of exporters	-0.063 (0.239)	-0.185 (0.270)	-0.072 (0.475)	0.076** (0.013)	0.573** (0.078)
Log German export value	0.016** (0.003)	0.014* (0.004)	0.046** (0.008)	0.027** (0.003)	0.101** (0.021)
Product-specific fixed effects	Yes	Yes	Yes	No	No
Country-specific fixed effects	Yes	Yes	Yes	No	No
Estimation	OLS	OLS	OLS	Probit	Logit
Number observations	402,038	142,419	661,447	402,038	452,953
Adj. R^2	0.12	0.20	0.36		
Pseudo R^2				0.03	0.22

Notes: Dependent variable is observed spell length. Standard errors robust to clustering by year recorded in parentheses. **, *, and # denote significant at the 1, 5, and 10 percent level, respectively.

Table 8: Cox hazard analysis

Sample	Modified censoring	Modified censoring	Modified censoring	Full sample	Initial trade >10,000	Modified censoring
Log GDP	-0.013** (0.003)	-0.013** (0.003)	-0.041** (0.008)	-0.148** (0.002)	-0.207** (0.005)	-0.010** (0.002)
Log per capita income	0.040** (0.002)	0.032** (0.002)	0.034** (0.006)	0.023** (0.002)	0.027** (0.004)	0.034** (0.002)
Log distance	0.085** (0.006)	0.015** (0.004)	0.103** (0.018)	0.125** (0.004)	0.375** (0.010)	0.017** (0.004)
Common border	-0.072** (0.009)	-0.129** (0.008)	-0.106** (0.026)	-0.271** (0.007)	-0.159** (0.013)	-0.127** (0.007)
German lang. dummy	-0.093** (0.012)	-0.091** (0.013)	-0.099** (0.037)	-0.231** (0.011)	-0.297** (0.018)	-0.098** (0.012)
EU-15 dummy	0.003 (0.010)	-0.002 (0.010)	-0.014 (0.030)	0.017# (0.009)	0.118** (0.015)	-0.005 (0.009)
EMU-12 dummy	-0.041** (0.009)	-0.044** (0.009)	-0.042 (0.028)	0.002 (0.009)	-0.002 (0.013)	-0.038** (0.009)
Log number of products	-0.211** (0.004)	-0.240** (0.005)	-0.161** (0.011)	-0.236** (0.004)	-0.205** (0.009)	-0.224** (0.003)
Change in log real exch. rate		-0.095** (0.028)				
Log initial import value	-0.013** (0.001)	-0.005** (0.001)	-0.016** (0.003)	-0.185** (0.001)	-0.310** (0.003)	-0.010** (0.001)
Log unit value	-0.026** (0.001)	-0.019** (0.001)	-0.019** (0.004)	-0.013** (0.001)	-0.011** (0.002)	-0.018** (0.001)
Elasticity of substitution			0.003** (0.001)			
Differentiated prod't dummy			-0.078** (0.021)			
Contract intensity			-0.022 (0.042)			
Log total import value	-0.021** (0.002)	-0.032** (0.002)	-0.016** (0.004)	-0.003 (0.002)	0.032** (0.003)	-0.026** (0.002)
Import product market share	-1.768** (0.044)	-1.684** (0.044)	-2.096** (0.168)	-3.306** (0.072)	-2.762** (0.069)	-1.770** (0.044)
Log number of exporters	-0.393** (0.005)	-0.351** (0.005)	-0.398** (0.015)	-0.807** (0.005)	-1.116** (0.009)	-0.365** (0.005)
Log German export value	-0.038** (0.001)	-0.036** (0.001)	-0.041** (0.003)	-0.041** (0.001)	-0.058** (0.002)	-0.034** (0.001)
Stratification variables	Region, industry	Region, industry	Region, industry	Region, industry	Region, industry	No
Number observations	397,464	308,489	45,596	1,242,102	944,743	397,464
Number subjects	225,830	172,504	25,276	336,090	200,595	225,830

Notes: Standard errors are in parentheses. **, *, and # denote significant at the 1, 5, and 10 percent level, respectively.

Figure 1: Histogram of German import values by product-country pair

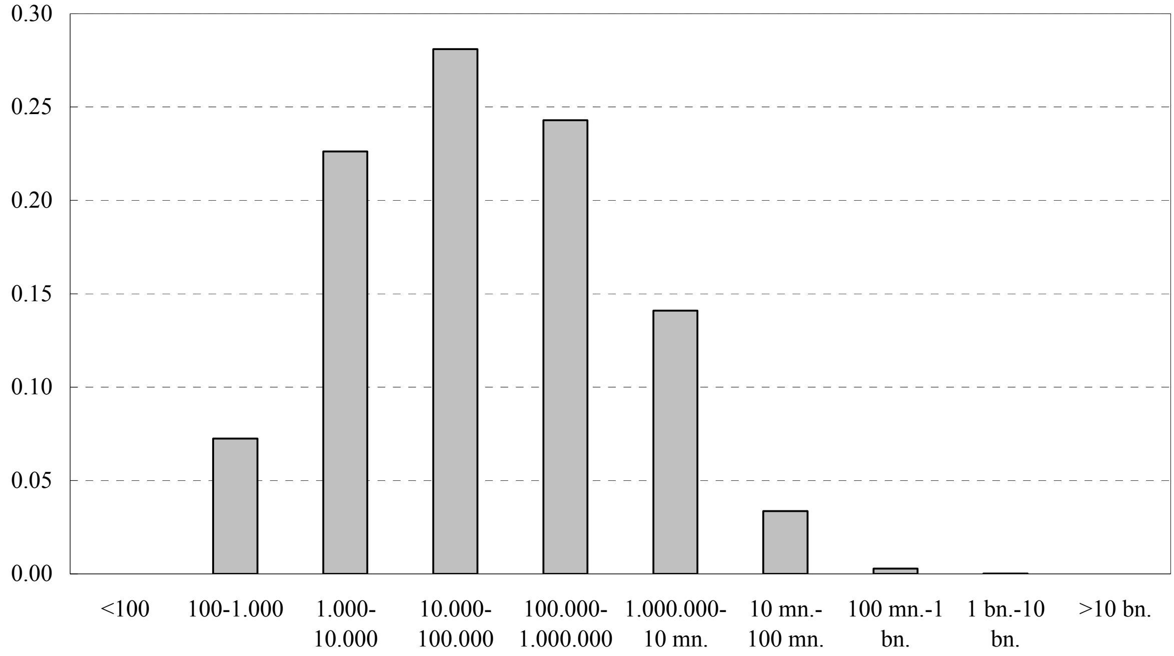
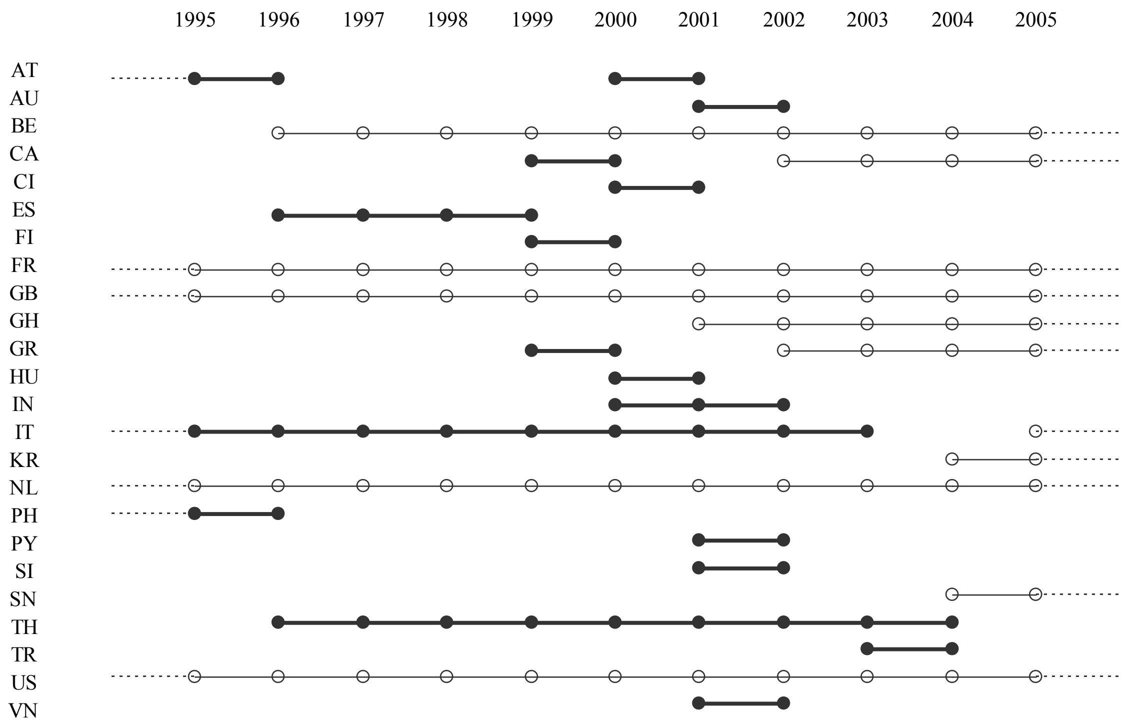


Figure 2: Description of trade spells

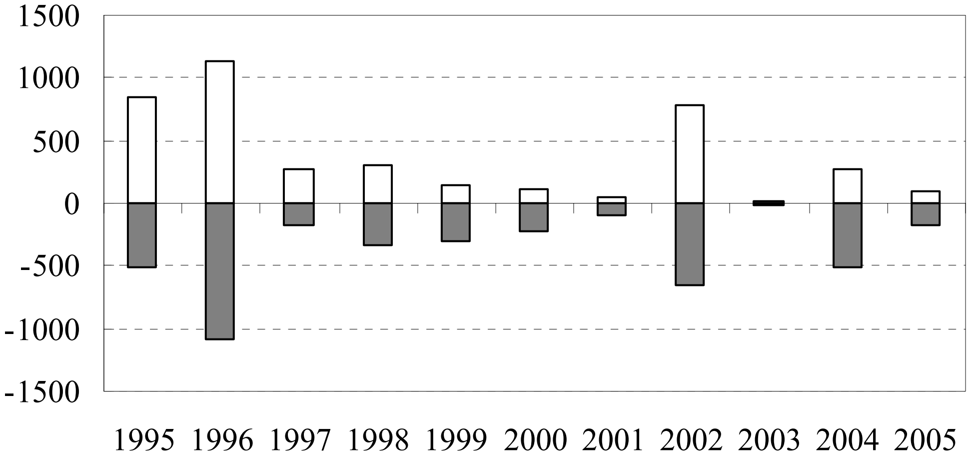
Product code: 20081110 (Peanut butter)



Notes: Circles mark a year of positive imports from a particular country; lines indicate spells of consecutive years of positive imports. Full circles (and thick lines) denote completed spells (i.e., spells that died during sample period) and thus are included in the benchmark sample.

Figure 3: Product codes at the CN-8 level

Entries and exits



Total number of codes

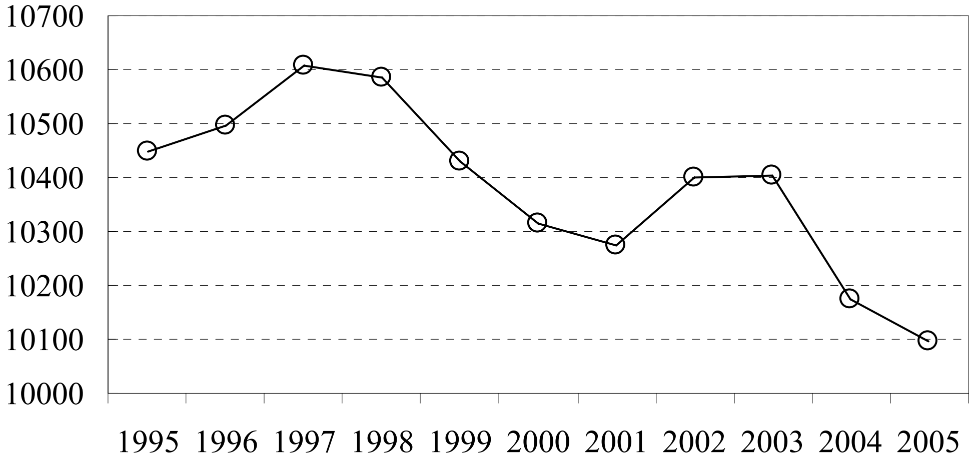
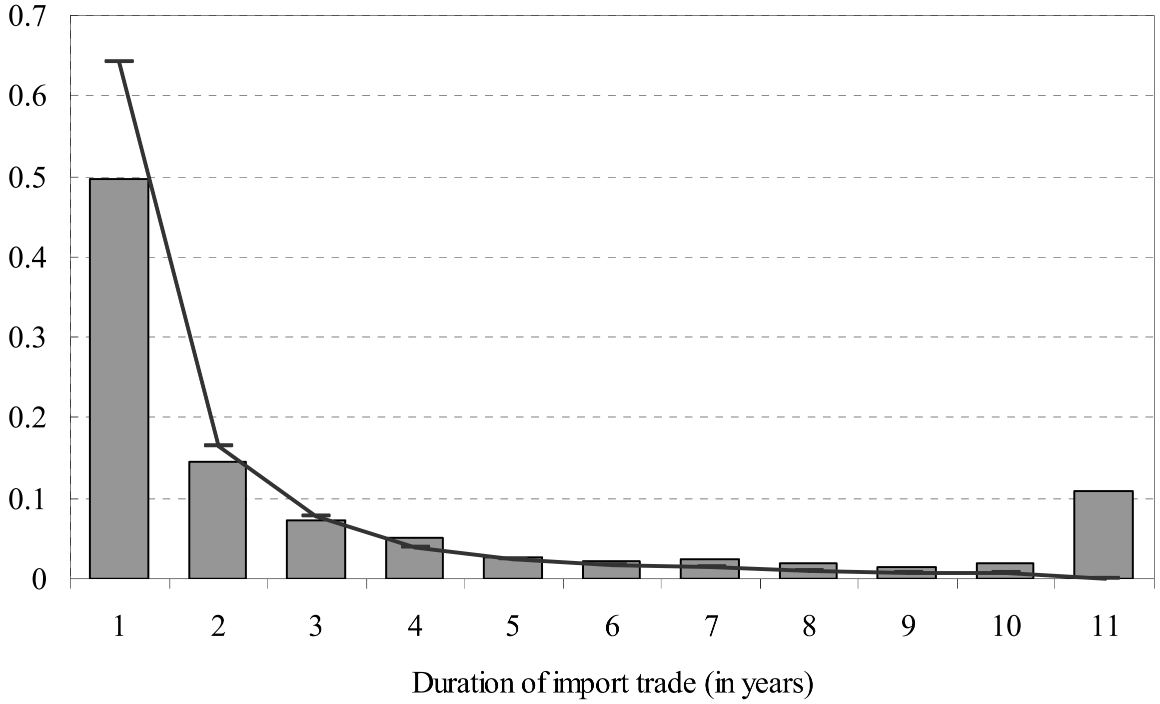
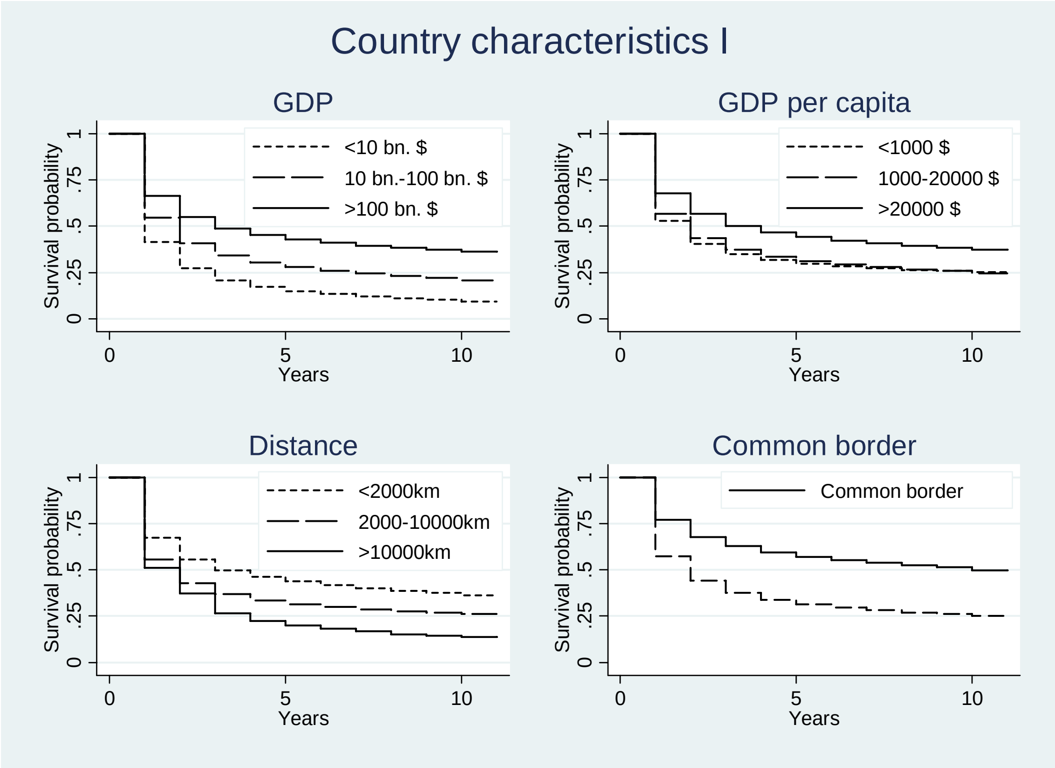


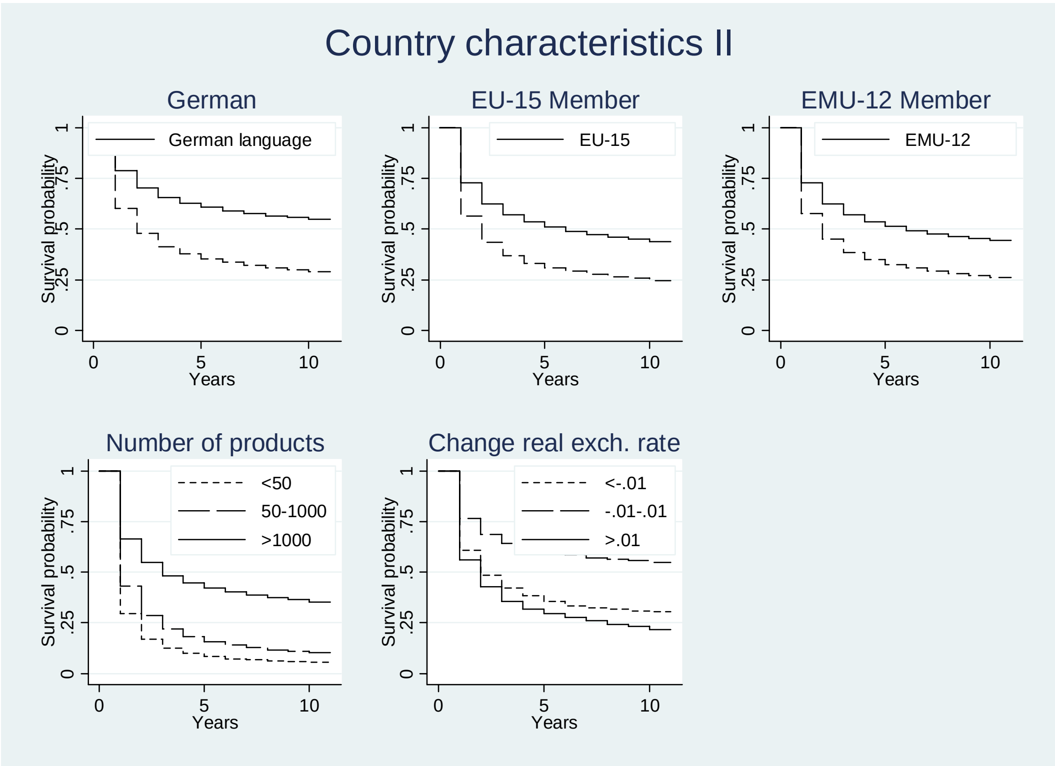
Figure 4: Trade duration

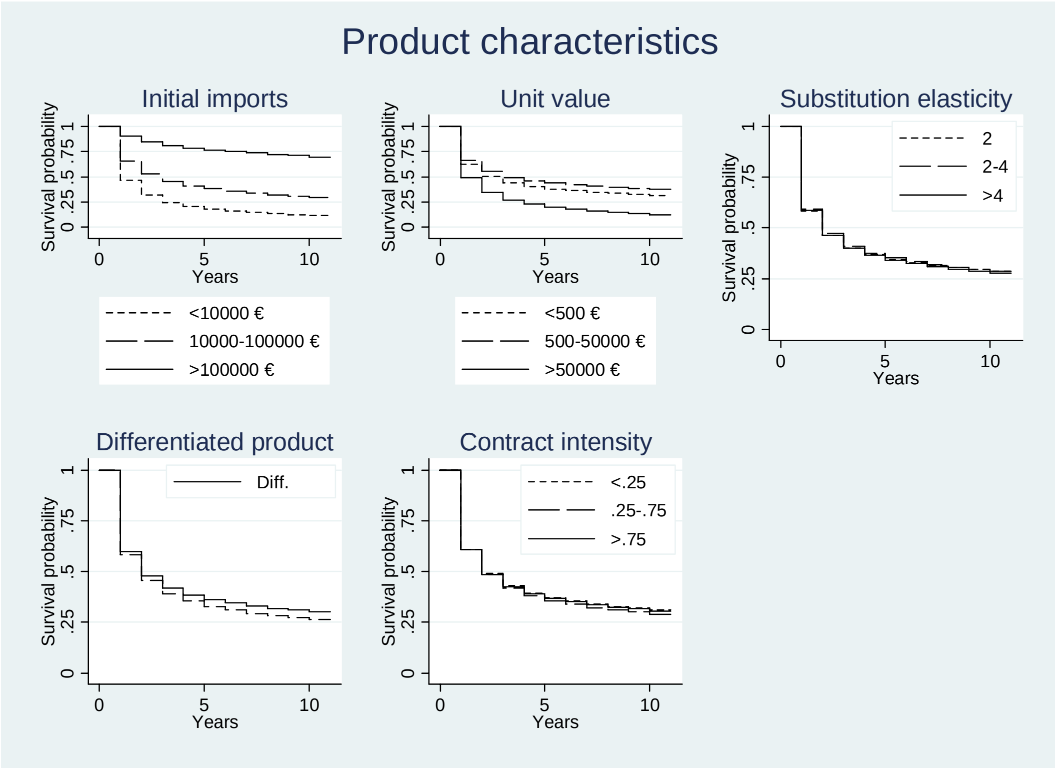


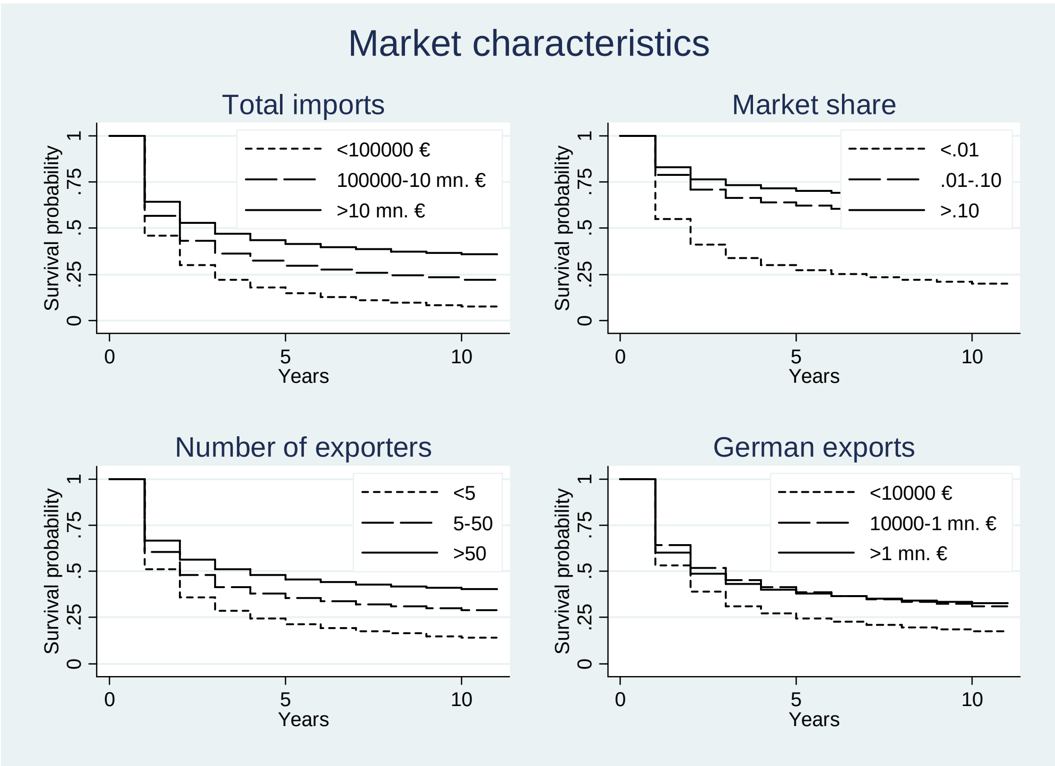
Notes: Columns (line) show the distribution of durations for the full (benchmark) sample.

Figure 5: Survival functions






Product characteristics
Initial imports
Survival probability
0 .25 .5 .75 1
0 5 10
Years
<10000 €
10000-100000 €
>100000 €
Unit value
<500 €
500-50000 €
>50000 €
Substitution elasticity
2
2-4
>4
Differentiated product
Diff.
Contract intensity
<.25
.25-.75
>.75


Market characteristics
Total imports
Survival probability
0 .25 .5 .75 1
0 5 10
Years
<100000 €
100000-10 mn. €
>10 mn. €
Market share
<.01
.01-.10
>.10
Number of exporters
<5
5-50
>50
German exports
<10000 €
10000-1 mn. €
>1 mn. €