Is Trade in Differentiated Goods Different?*

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Abstract

We examine the extent to which product differentiation affects the duration of US import trade relationships. Applying nonparametric and semiparametric techniques to highly disaggregated product level data we estimate the hazard rate is at least 25 percent higher for homogenous goods than for differentiated products. The results are not only highly robust but often are strengthened under alternative specifications. For instance, if we define trade relationships using industry level rather than product level data we find that the hazard rate is 46–56 percent higher for homogenous goods than for differentiated products. The survival ranking across product types holds across individual industries. We show that dropping the smallest trade relationships further accentuates the differences among product types. We also control for the possible measurement error in measuring spell lengths and the role of multiple spell relationships and find that in all cases the differences among products types are greater than in our benchmark analysis.

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1 Introduction

The influence of the pioneering work of Krugman (1979, 1980, 1981) and Helpman and Krugman (1985) has been so profound nearly all discussions of prominent trade issues such as inter- and intra-industry trade, the home market effect, and imperfect competition involve the implicit assumption that trade involving homogeneous and differentiated goods is different. While trade economists agree that the motivations underlying trade may differ depending upon the type of product, there is little understanding of how product type characteristics reveal themselves in trade patterns.[1]

In this paper we take a first step in addressing this shortcoming. We identify one important dimension in which product type clearly affects trade, namely duration of trade relationships. Using highly disaggregated data on US imports for the 1972–1988 period we find duration depends significantly on the extent of product differentiation. All else equal, countries tend to export differentiated goods far longer than homogenous goods. As far as we know this is the first direct empirical evidence that product type significantly affects trade. Moreover, it is consistent with a number of widely used models of trade.

One might expect relationships involving homogeneous goods to be quite fragile. For products such as corn, wheat, and oil one can imagine a "world market" where all foreign suppliers ship and all buyers purchase their products and the lowest price rules the day. Trade relationships might be very short; relationship-specific factors

[1] Trade in differentiated and homogeneous goods can be explained within a single hybrid model incorporating both monopolistic competition and factor proportions theory (Helpman and Krugman, 1985).

may not matter and source country may be irrelevant. By contrast, there are a number of explanations why differentiated products may exhibit long duration. The seminal work of Dixit and Stiglitz (1977) and Helpman and Krugman (1985) asserts each variety of differentiated products should be desired by consumers; hence trade relationships for differentiated goods should be very long-lived (i.e., source country matters). Rauch and Watson (2003) argue search costs combined with uncertainty about supplier reliability can create fragile relationships. To the extent search costs differ for differentiated and homogenous goods, duration will also differ. Sunk costs and relationship-specific investments can also explain differences in duration. If differentiated goods require larger initial investments, models such as Baldwin (1988) and Melitz (2003) suggest once relationships are established they will tend to be robust.

Other researchers have examined the extent to which neoclassical and monopolistic competition models find support in bilateral trade patterns (Helpman, 1987; Hummels and Levinsohn, 1995; Evenett and Keller, 2002; Debaere, 2003). Evenett and Keller (2002) neatly summarize much of this discussion and conclude product differentiation is more important in explaining North-North trade while factor abundance is more important for North-South trade. While such a characterization is valuable, it glances over an important "micro" feature that we exploit — namely, the role of product type. Our focus on duration offers an entirely new perspective on the question of what role, if any, product differentiation plays in trade.

More closely related to our work is that of Rauch who has spent the better part of the past decade wrestling with the question of how product type influences trade. His work emphasizes most homogeneous goods, but few differentiated goods, are traded on organized exchanges. This finding underlies his view that network or search theory is important for understanding trade in differentiated products (Rauch, 1996, 1999, 2001; Casella and Rauch, 2003; Rauch and Trindade, 2002).[2]

Using Rauch's (1999) classification scheme we are able to characterize how product type affects duration. Specifically, Rauch's scheme classifies products into one of three types — differentiated, reference priced, and homogeneous. Our empirical findings provide strong support for the view that trade in differentiated and homogeneous goods does differ. Differentiated products tend to have the longest duration, followed by reference priced products, and then homogeneous goods. Said differently, as compared with differentiated products, the hazard rate for reference priced products is 18 percent higher and for homogeneous goods 25 percent higher.

The results are highly robust to a large number of alterations to the benchmark data. For instance, we examine whether they are solely a function of the benchmark 1972–1988 period. When we conduct the analysis using product level data for the 1989–2001 period the differences between product types persist though are somewhat muted. Likewise the results are not driven by the highly disaggregated nature of the data. Aggregating from product level to industry level data results in no appreciable changes in the estimated differences in survival among product types. The industry level results are a striking confirmation of the product level results and are remarkably reassuring given the potential for misclassification that exists in a product level trade dataset constructed from literally millions of U.S. Customs declaration forms.

[2]More recently, Dalgin, Mitra and Trindade (2003) examine if product type helps explain inequality and trade.

We also examine whether differences in the value of trade across product types explain the estimated differences. It seems reasonable to expect trade relationships with large initial values of trade to be longer lived, perhaps reflecting the beach-head effect discussed in Baldwin (1988). As shown in Besedeš and Prusa (2003), relationships with large trade values do indeed have longer duration. Yet, we find rather than weakening the results, controlling for size increases the role of product type. As the smallest trade relationships are dropped, the differences among product types increase significantly. Limiting the analysis to relationships with trade in the first year greater than \$100,000 (\$1,000,000) the hazard rate for reference priced products is 61 percent (167 percent) higher and for homogeneous goods 76 percent (203 percent) higher than for differentiated goods. Size does matter and it serves to intensify, not diminish, the importance of product type.

Possible incorrect inferences about the end of trade relationships are another potential source of bias in the results. Some relationships experience multiple spells of service and if the time between spells is short, it is possible the gap of non-service and duration are erroneously measured. The two short spells (separated by a gap) might really be one longer spell. We control for this potential measurement error and find little impact on the results. Finally, we examine whether the results holds for each of the ten industries as defined by the SITC classification. Differentiated products have a lower hazard rate than homogenous goods in six of seven industries with all three product types.

2 Data

The analysis is based on US import statistics as compiled by Feenstra (1996) and extended by Feenstra, Romalis, and Schott (2002).[3] We provide a brief description of the data and refer the interested reader to Besedeš and Prusa (2002) where we provide a detailed description of the data and all the relevant issues when applying survival analysis methods. The data record annual US imports of products between 1972 and 2001 from virtually every trading partner and includes the value of trade, quantity, customs collected, and other relevant information.[4] The data set can be divided in two periods based on the nature of the product classification scheme used by US Customs.

From 1972 to 1988 products were classified according to the 7-digit Tariff Schedule of the United State (TS). There is a total of some 23,000 different products imported from about 160 countries. On average, each year some 10,000 products are imported. From 1989 on products are classified according to the 10-digit Harmonized System (HS). Some 23,000 different product are observed since 1989 with an average of 15,000 imported every single year from some 180 countries.

Annual data for each country-product pair are used to create spells of service indicating continuous service of the US market. If the US imports product i from country c continuously from 1980 to 1985 then it is classified as a spell of six years. Such transformation of data results in 495,763 observed trade relationships between

[3] Details on the sources of our data are included in the appendix.

[4] The coverage of some variables is not complete. For example, some observations have missing values for quantity and duties.

the US and a source country for the 1972-1988 period and 620,177 for the latter period. A number of trade relationships experience a dormant phase at some point — the relationship is alive and the US imports a product for a number of years, then stops for at least a year and then starts importing the same product from that same country again. For both periods under study the number of spells of service exceeds the number of trade relationships. There are 693,963 spells of service between 1972 and 1988 and 918,236 in the latter period.

One of the most subtle issues in survival analysis is treatment of censored observations. Censoring appears in three flavors. Relationships observed in 1972 and 1989[5] have an uncertain starting date as those are the first years under observation — they may have commenced in 1972 (1989) or before. Similarly, relationships observed in 1988 and 2001 may have truly ended in those years or at a later unobserved time. Both types of censoring are common in duration analysis.

The third flavor is unique to the data used. US Customs revises product codes on an annual basis. Some codes deemed to represent products incorrectly, either obsolete or too broad, are discontinued and new codes are introduced. Reclassification may split a single code into several new ones or several codes could be merged into a new one. We are not aware of any US Customs documentation of reclassifications and given the multitude of changes we are unable to create our own reclassification mapping. As a result, trade relationships in reclassified codes, either discontinued ones or new ones, are all treated as censored since the most that can be said about

[5]Frequent merging of several TS codes into a single HS and splitting of a single TS code into several HS codes make it impossible to establish a concordance between TS and HS codes.

them is they last for at least the number of observed years.[6] All censored spells in the data have the interpretation of being observed for at least x years.

The benchmark analysis is based on the 7-digit TS product level data. We use the 10-digit HS product level data as a natural robustness check. We also use industry level data as an additional robustness exercise. It is possible the product level data are too disaggregated and will lead us to observe excessive entry and exit and hence result in overly short spells of service. Trade relationships might be better measured using industry level data. We also report results using the 5- and 4-digit SITC industry level data to define relationships. An additional benefit of performing the analysis with industry level data is that there is no reclassification of industry codes during the two periods under study. The only censoring remaining stems from the start and end of the observation period. Industry level data then serve as a check for the treatment of reclassified products as censored.

The next major task involves characterizing the extent of product differentiation for each product. We follow Rauch (1999) and classify commodities into three categories: homogeneous, reference priced, and differentiated. Rauch classified products traded on an organized exchange as homogeneous goods. Products not sold on exchanges but whose benchmark prices exist were classified as reference priced; all other products were deemed differentiated.

Although coarser than one would like, Rauch's classification scheme has several virtues. First and foremost, it is the only classification scheme we know of that exists

[6] In Besedeš and Prusa (2003) we discuss in great detail the impact of censoring and examine alternative treatments of reclassified product codes.

at a highly disaggregated level. Rauch classifies products at the 4-digit SITC level and we mapped his codes to the product level codes using the concordance found in Feenstra (1996). Rauch's scheme is broad as seven of the ten SITC industries are represented by products from each of the three product types.

Second, Rauch's scheme makes intuitive sense since it broadly captures what economists mean by product substitutability. Products sold on organized exchanges (like corn, oil, wheat, etc.) are exactly those products typically cited as being homogeneous. Consumers may neither know nor care about the source of the product they are purchasing. Products like many types of steel and chemicals whose prices are listed in industry guides and trade journals will likely have some unique attributes (e.g., quality may vary by source country) but are essentially substitutable. Consumers will know the source country, but it may only have a small impact on their purchasing decision.

In the final category are differentiated products. Products with many characteristics that vary across suppliers and may even be specifically tailored to the end-user's needs. Automobiles are perhaps the most often cited example of such a good; in fact, most consumer goods (e.g., toys, apparel, cookware) are classified as differentiated.

Third, Rauch's classification scheme is quite comprehensive, covering about 98 percent of all US import relationships.

3 Empirical Approach

Since we are interested in investigating how likely a country is to cease exporting a product to the United States, it is only natural we approach this issue by using duration analysis. We first estimate survival functions across product types by using the nonparametric Kaplan-Meier product limit estimator, and then proceed to model the hazard of US import trade using the Cox proportional hazard model. The goal of the exercise is to investigate whether differences across product types are robust once we include factors we think affect duration of trade.

The survival function, $S(t)$, is usually estimated nonparametrically using the Kaplan-Meier product limit estimator. Derivation is as follows. Assume a sample contains n independent observations denoted $(t_i; c_i)$, $i = 1, 2, \ldots, n$, where t_i is the survival time, while c_i is the censoring indicator variable C (taking on a value of 1 if failure occurred, 0 otherwise) of observation i. Assume there are $m < n$ recorded times of failure. Denote the rank-ordered survival times as $t(1) < t(2) < \cdots < t(m)$. Let n_j denote the number of subjects at risk of failing at $t(j)$ and let d_j denote the number of observed failures. The Kaplan-Meier estimator of the survival function is then

$$\hat{S}(t) = \prod_{t(i)<t} \frac{n_j - d_j}{n_j},$$

with the convention that $\hat{S}(t) = 1$ if $t < t(1)$. Given many observations are censored, we note the Kaplan-Meier estimator is robust to censoring and uses information from both censored and non-censored observations.

In the discrete case, the hazard function can be estimated by

$$\widehat{h}(t_j) = \frac{d_j}{n_j}.$$

We choose to estimate the hazard function only at the observed failure times.

We will also estimate a stratified Cox proportional hazard model

$$h_s(t, \boldsymbol{x}, \boldsymbol{\beta}) = h_{s0}(t) \exp(\boldsymbol{x}'\boldsymbol{\beta}),$$

where $\boldsymbol{x}$ denotes a vector of explanatory variables and $\boldsymbol{\beta}$ is to be estimated. The baseline hazard, $h_{s0}(t)$, characterizes how the hazard function changes as a function of time and is different for each strata, s. A particular advantage of the Cox model is that the baseline hazard is left unspecified and is not estimated. It allows us to account for unobserved heterogeneity in a more tractable approach than the Kaplan-Meier estimator and a less restrictive approach than a fully parametric model.

4 Empirical Findings — Benchmark Product level Data

4.1 Nonparametric Results

The Kaplan-Meier survival function, $\hat{S}(t)$, for the 7-digit TS data is graphed in the upper-left panel of Figure 1 for each of the three product types. The median survival times are extraordinarily short: only five years for differentiated products and just two years for reference priced products and homogeneous goods. Half of the trade relationships involving reference priced and homogeneous goods fail during the first two years.

Survival rates for years 1, 4, and 12 are reported in Table 1. Survival functions across product types are similar in that each is downward sloping with a decreasing slope. The survival rate in the first year is remarkably low, 55 percent for homogeneous goods, 59 percent for reference priced products, and 69 percent for differentiated products. By year 4 the survival rates range from 33 to 52 percent. Between years 4 and 12 the survival rates are fairly stable, declining by just 7 percentage points.

In terms of the main research issue differences in the survival functions across product types are notable. At each point the survival function for differentiated products is above the survival function for reference priced products, which in turn is above the survival function for homogeneous goods. Given the large number of observations in the sample, the differences between the Kaplan-Meier survival functions are statistically significant.[7]

For comparison we also calculate survival rates for the 1989–2001 period using the 10-digit HS data and graph them in the upper-right panel of Figure 2. While differences between product types are not as large as in the earlier period, they are still present and statistically significant. Differentiated goods exhibit similar survival rates in both periods: in the first year during the 1972–1988 period it is 69 percent while it is 66 percent for the later period. The biggest differences stem from the

[7] The standard errors are in the range 0.001 to 0.02.

higher survival experience of reference priced and homogeneous goods during the later period.

As discussed in Besedeš and Prusa (2003) trade relationships face a high hazard in their first few years and the risk declines quite markedly once trade relationships last for 4–5 years. These results show negative duration dependence holds for each product type. For 1972–1988 the hazard rates in the first year of a relationship are remarkably high, ranging from 45 percent for homogeneous goods, 41 percent for reference priced products, to 31 percent for differentiated products. Over the next three years the hazard rates range from 25 percent for differentiated products to 40 percent for homogenous products. For the rest of the sample there is little additional hazard. This does not mean there are few exits; rather, most exits observed in later years are classified as censored as opposed to failures, resulting in low hazard rates.

4.2 Semiparametric Results

Table 2 contains the Cox proportional hazard estimates using the benchmark data for the 1972–1988 period. The basic estimation model includes the standard regressors appearing in the gravity equation literature (GDP, language, contiguity, distance). While we do not offer a theoretical model of how these variables affect survival, we believe it is reasonable to include the gravity equation variables in the empirical model.[8] The gravity equation states the bilateral trade between two countries is directly pro-

[8] Several models that could generate the type of behavior we investigate are sketched in the working paper version of this paper (Besedeš and Prusa 2004).

portional to the product of the countries' GDPs and therefore larger countries will tend to trade more with each other. Given the gravity equation's remarkable job of predicting bilateral trade, we view the gravity-motivated regressors as an exogenous control for the propensity for source countries to supply the US market.

We include an ad-valorem measure of transportation costs which we compute as the cif/fob ratio for US imports as reported in Feenstra (1994) and Feenstra et al. (2002). When calculated at the product level this ratio is a reasonable measure for transportation costs (Hummels and Lugovskyy, 2003). Following Hummels and Lugovskyy we drop a handful of observations with unrealistically large transportation costs (i.e., those more than double the value of the product being traded).

We also include several variables that capture relative cost and competitiveness issues. The industry level tariff rate, calculated at the 4-digit SITC level, controls for the ease with which foreign firms can enter the market. Whether higher tariffs increase or decrease the hazard depends largely on whether time series or cross-section variation dominates. For a given product, an increase in the tariff should lead to some foreign firms exiting because higher tariffs raise the costs of servicing the US market. It follows time series variation in tariffs should lead us to find higher tariffs raise the hazard. Looking across industries higher tariffs mean less competition for those firms currently in the market. Both domestic and foreign firms servicing the US market face less risk and a lower hazard. Cross section variation in tariffs should lead to higher tariffs lowering the hazard. Given the relative absence of time series variation we expect the cross section effect to dominate, which means higher tariffs should lower the hazard.

The change in the relative real exchange rate should capture the impact of cost changes on the hazard. To construct it we began by defining each country's exchange rate so that an increase corresponds to a real depreciation (i.e., foreign currency per US dollar). In each year we normalize by the average real exchange rate of all countries relative to the US dollar and then calculated annual percentage changes. It gives us a measure of how each country's exchange rate changed relative to its competitors. An increase in the measure reflects a country's currency has weakened relatively more than its competitors. If one country's currency depreciates relative to other countries' currencies, its firms should become more competitive vis-à-vis other foreign and domestic firms and less likely to exit.

Schott (2001) argues even with data as disaggregated as the product level import data, some products are more broadly defined than one would like. The coefficient of variation of unit values for each TS (or HS) product in each year controls for diversity of products within each product code. We expect the smaller the coefficient of variation the more standardized is the product and the greater the hazard.

Finally, there is the issue of multiple spells — trade relationships with multiple periods of service separated by a period with no service. Some trade relationships are observed for a period of consecutive years (spell 1), then are followed by a period of no trade, and then again observed for another service spell (spell 2).[9] We believe the first failure makes a second failure more likely (higher hazard). On the other hand, it is also possible the return of the foreign supplier to the market is a positive

[9] About one-quarter (one-third) of trade relationships experience multiple spells of service at the TS (HS) level and about two-thirds of those experience just two spells. Less than ten percent of trade relationships have more than three spells.

sign making a second failure less likely. In either case the hazard rate will depend on whether we are observing a second spell and should be controlled for. We treat multiple spells as independent and use a dummy to control for any impact of higher order spells.[10]

In the first column of Table 2 we report the benchmark estimates based on the 1972-1988 period.[11] Throughout we present results in terms of hazard ratios. An estimated hazard rate coefficient less than (greater than) (equal to) 1 is interpreted as implying the variable lowers (raises) (has no impact on) the hazard rate.

We begin by looking at variables motivated by the gravity equation. The effect of distance is small. Common language lowers the hazard, but again the effect is fairly small, about 5 percent. Countries contiguous with the US (Canada and Mexico) face significantly lower hazard rates — on the order of almost 30 percent. Larger countries (as measured by GDP) face a lower hazard. Given the variance in GDP across countries, the size of the effect depends significantly on country size. Thinking either in terms of differences across time or countries the estimates imply a $100 billion increase in GDP lowers the hazard rate by about 2 percent; a $1 trillion increase in GDP lowers the hazard rate by about 20 percent.

Transportation costs have a sizeable impact. A 10% increase in transportation costs raises hazard by 7%. Industries with higher tariffs face a lower hazard. A 1 percentage point higher tariff lowers the hazard by approximately 2 percent. Changes in the relative real exchange rate have a large impact on the hazard rate. A 10 percent

[10]We considered alternative methods for addressing multiple spells and found no significant changes in the results. Results are available upon request.

[11]In all estimations we stratify by region.

depreciation in the real exchange rate (relative to other suppliers) lowers the hazard by about 10 percent. As a country's currency becomes cheaper, its products become more competitive and survive in the US market longer.

Products with higher variation in unit values face a significantly lower hazard rate which suggests high and low prices for the same product increase duration. The result confirms Schott's (2001) contention that products within a single product code may not be identical. For instance, the "cotton T-shirt" product might include commodity grade products from China and Bangladesh and also fashion designer products from Italy. It would be surprising if the effect were common for all three product types. As we will show below, the effect differs across product types.

We are primarily interested in the product type estimates. Letting differentiated products be the benchmark, reference priced products have an 18 percent higher hazard and homogeneous goods a 25 percent higher hazard. The estimates strongly support what Figure 1 suggested: namely, product type matters.

We ran a similar regression for the 1989–2001 HS data as a robustness check. This result, along with those from other robustness checks, are presented in Table 4. In the interest of brevity and since we are primarily interested in the effect of product type we only report those estimates.[12] As was the case with the TS data, product type matters, albeit somewhat less. Reference price products face 5 percent higher hazard and homogeneous goods face 9 percent higher hazard.

In Table 3 we report the results when we consider a more flexible specification

[12] All other regression coefficients are qualitatively similar to those in the benchmark case. Complete regression results are available upon request.

where we allow the coefficients on all variables to vary by product type. That is, we estimate

$$h_s(t, \boldsymbol{x}, \boldsymbol{\beta}) = h_{s0}(t) \exp\left(\sum_i D_i \boldsymbol{x}' \boldsymbol{\beta}\right),$$

where D_i denotes the ith dummy corresponding to product type. To conserve space we present the results in a somewhat nonstandard form. All of the results come from one large specification where each variable is interacted with product type dummies. However, the number of estimated parameters is awkward to report in a single column. To get around this difficulty, we report the product type-interacted estimates across a series of columns. Reading across the columns one can compare the effect for each variable as product type changes.

The estimates confirm what we learned from the basic specification. Namely, Canada and Mexico, common language, larger countries, high tariff products, and weaker currencies, all have lower hazard rates for each product type. Just as standard economic theory would predict, higher variation in unit values lowers the hazard for differentiated products, but increases it for homogeneous goods. In a homogeneous good market one would be surprised if high priced suppliers would have long lived spells of service; in a differentiated product market, high priced suppliers could easily have a long service spell if their high prices reflect quality differences.

Even after allowing for systematic differences across product types, reference priced products and homogeneous goods face a significantly higher hazard than differentiated products, on the order of 19 and 26 percent.

5 Robustness

We perform several exercises to investigate whether the differences between product types are robust. There are four concerns we explore. First, are the results driven by differences in the value of trade across product types? Second, are the results affected by a potential measurement error regarding the end of the spell? Third, are the same patterns found in industry level data? Fourth, are the differences across product types driven by the distribution of product types across industries?

5.1 Does size matter?

The results could be affected by differences in the value of trade across product markets. It seems reasonable to expect spells with large values of trade to be longer lived. All else equal, one might expect a relationship with $1 million of trade in the first year of the spell to survive longer than an observation with $100,000 of trade in the initial year.[13] The results might reflect (i) small valued spells are at greatest risk and (ii) homogeneous goods tend to involve small value spells. The estimates may merely be capturing differences in traded value rather than telling us something about the importance of product type.

Let us look at the support for each hypothesis separately. First, are small valued spells at greatest risk? To answer, we filter out small dollar-value observations: eliminate spells with trade in the first year below some minimum level. We then estimate the survival functions for each of the three product types after dropping the

[13] We use the CPI to convert the nominal trade values into real 1987 dollars.

small-valued observations (Figure 1). In Table 1 we report the survival rates based on dropping all observations where the value of trade in the first year of the spell was less than \$100,000 (\$1,000,000). Two important insights are gained. First, the survival functions shift up as we progressively drop observations. Spells that begin with small trade value are at greatest risk. Second — and most relevant for the discussion — the estimates provide no evidence differences among the product types are driven by small observations. In fact, the differences among product types grow as we progressively eliminate the smaller trade observations. For instance, when we restrict the sample to only those spells whose first year trade value exceeded \$1,000,000 the 1-year survival rate is 99 percent for differentiated and 75 percent for homogeneous goods which compare with 69 and 55 percent, respectively, for the benchmark.

Let us now look at the support for the second hypothesis. Do homogeneous goods tend to involve small value spells? If so, it is possible the differences in the survival functions only reflect size. If size were all that mattered, we should find differentiated products tend to involve larger trade values. Yet, the opposite is the case: differentiated products tend to involve the smallest trade values. On average in the first year of the spell homogeneous goods involve larger value transactions (\$4.5 million for TS, \$4.3 million for HS) than reference priced (\$730,000 for TS, \$620,000 for HS) or differentiated products (\$700,000 for TS, \$870,000 for HS).[14]

To get a numerical assessment of the impact of initial size, we re-estimate the Cox

[14] If we compare the average value over the entire spell we find the same ordering. In addition, we also compare trade values for groupings of countries such as OECD and non-OECD. No matter the grouping we always find differentiated products involve far smaller trade values than homogenous goods.

proportional hazard model filtering out the spells that start small. The estimates are reported in columns two and three of Tables 2 and 4. Comparing these estimates with the benchmark (column one), we find the impact of common language, contiguity, GDP, and tariff rates all increase. The impact of distance becomes statistically insignificant.

Most importantly, product type dummies indicate the results are not driven by small value spells. Compared to differentiated products, homogeneous goods face a 76 percent higher hazard rate at the $100,000 cutoff level, and a 203 percent higher hazard rate at the $1,000,000 cutoff level. Reference priced products face 61–167 percent higher hazard rates as we restrict the sample to larger trade value observations.

We use the same size cutoffs for the 1989–2001 HS data and report these results in Table 4. As was the case with the TS data, filtering out the small observations results in an increased impact of product type. Reference price products face 27–71 percent higher hazard and homogeneous goods face 44-124 percent higher hazard. These all exceed the benchmark HS estimates.

The bottom-line is size does matter. Rather than weakening the results, however, controlling for size strengthens them: product type is even more important than the benchmark results suggest.

5.2 Measurement error

We examine how the results are affected if we incorrectly infer the end of a trade relationship. The concern involves trade relationships with multiple spells. If the time between spells is short (what we refer to as the gap), it is possible the gap is mis-measured and interpreting the initial spell as "failing" is inappropriate. The two spells might be better thought of as one longer spell. If the measurement error is related to product type in that homogeneous goods are more likely to have short gaps, then the results will misrepresent the role of product type.

We address this issue by assuming a one-year gap between spells is an error, merge the individual spells, and adjust duration accordingly. Gaps of two or more years are assumed to be accurate and no merging is done. As an example, suppose the US imports a product from country c in 1973–74, 1976–77, and 1979–1980. Without any adjustment this trade pattern is interpreted as three distinct spells, each of length two years. Assuming all gaps of one year are errors, there is just one distinct spell with a length of eight years.

The survival functions for the product level data using the gap-adjustment modification are shown in the lower right panel of Figure 1 (and also in Table 1). The probability of survival for each product type increases at each point in time, yet the differences across product types remain. The same can be inferred from the estimation results reported in Table 4. The impact of product type increases slightly as compared with the benchmark runs. As compared with differentiated goods reference priced goods have a 20 percent higher hazard rate while homogeneous goods have a 28 percent higher hazard rate in the earlier period, and 7 and 11 percent higher hazard rates in the latter period.

5.3 Aggregation

We can define trade relationships using industry level data. In addition to mitigating the censoring problem, industry level analysis allows us to explore whether the differences across product types are due to the highly disaggregated nature of the data. The concern is the TS (HS) classification system is too fine and leads us to observe excessive entry and exit. Trade relationships might be better measured using the SITC industry classification.

We calculated spells of service using the 5- and 4-digit SITC industry data. We plot the Kaplan-Meier survival function for each of the three product types in the bottom-half of Figure 2 for the 5-digit SITC data for the 1972–1988 and 1989–2001 periods.[15] As with the benchmark data, in both periods the survival function for differentiated products is above the survival function for reference priced products, which in turn is above the survival function for homogeneous goods. The graphs suggest the differences among the product types are somewhat attenuated as compared to the benchmark data. The median survival time for all three product types is just two years. Nevertheless, the differences persist and are statistically significant.

In Table 4 we report the Cox proportional hazard estimates for both periods.[16] Interestingly, the differences among product types are about the same using industry data for the 1972–1988 period and are somewhat larger for the latter period.

[15] The Kaplan-Meier plots are similar for the 4-digit data and are available upon request.

[16] Not all of the variables are available at the SITC level. In particular, the regressions do not include the coefficient of variation of unit value because units vary across products within the same industry. Also, Hummels and Lugovskyy (2003) argue that the ad valorem transportation cost is unreliable at the industry level.

The industry level analysis confirms the main findings: differentiated products face a significantly lower hazard rate than reference price goods which in turn have a significantly lower hazard than homogeneous goods.

5.4 Industry by industry analysis

The final concern we investigate is whether the distribution of product types across industries drives the results. A vast majority of products in the data are classified as differentiated, while fairly few are classified as homogeneous. Furthermore, two industries, Machinery (SITC=7) and Miscellaneous Manufactures (SITC=8), are composed entirely of differentiated products.[17] Could the driving force behind the results be the distribution of product types across industries? Are the product type differences found when looking at individual industries or are they driven by variation across industry?

We define trade relationships at the 7-digit TS and 10-digit HS product level and re-estimate the benchmark specification for each 1-digit industry separately. We chose this approach rather than simply including industry dummies because the majority of products are in two industries (SITC=7 and 8) which contain only differentiated products.

The results are reported in Table 5. In the interest of brevity, we again only report the estimates for the product type dummies. In the top (lower) panel we report estimates for the benchmark 7-digit (10-digit) data. The results largely confirm

[17] A third industry, SITC=9, is composed of only differentiated and homogenous goods and is not presented.

the findings — for both periods differentiated products have lower hazard rates and involve longer-lived spells than homogenous goods for six of seven industries.

There are two important caveats. First, for "Animals and Vegetable Oils" (SITC=4) the difference between product types is not statistically significant. In the early period for three other industries — "Beverages and Tobacco" (SITC=1), "Crude Materials (SITC=2), and "Mineral Fuels" (SITC=3) — the difference between differentiated and reference price goods is not significant. In the later period all coefficients are significant except for SITC=4. Second, differentiated products have a higher hazard rate than reference priced or homogeneous goods for "Mineral Fuels" (SITC=3). We are not troubled by this result because (i) we do not know what it means for a mineral fuel to be differentiated and (ii) in this industry being differentiated may be undesirable.

All in all, these findings confirm the main result — the difference across product types — is not driven by the distribution of product types across industries.

6 Conclusion

This paper offers the first direct empirical evidence that trade in differentiated and homogenous products is different. We do so by focusing on duration of trade relationships. We show duration depends on the nature of the product being traded and the differences are systematic. The results indicate duration of trade depends on the type of the product being traded. Differentiated products have a median duration several years longer than either reference priced or homogeneous goods. The hazard rate for differentiated products is 18 percent lower than for reference priced products and 25 percent lower than for homogeneous goods.

We perform a number of robustness exercises which show differences in duration across product types are systematic. The results indicate lower transportation costs, common language, common border, higher GDP, higher tariffs, and depreciation of the source country's currency all lead to longer durations. Higher variation in unit values lowers the hazard for differentiated products and raises it for homogenous goods.

The analysis indicates the survival in US import markets will be longer if a differentiated good is traded. An open question we did not seek to answer in this paper is whether exporters should focus on differentiated products. In other words, future work could study whether a country's development experience is related to its movement from homogeneous to differentiated products.

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A Data Appendix

All of the data used in this paper are available from public sources.

Variable	**Source**
7-digit TS and 10-digit HS Import Data	Robert Feenstra's online data collection at http://data.econ.ucdavis.edu/international/
5- and 4-digit SITC Import Data	http://data.econ.ucdavis.edu/international/
Rauch Product Type Classification	James Rauch's website at http://weber.ucsd.edu/ jrauch/
GDP	World Development Indicators (World Bank Statistics)
Consumer Price Index	Bureau of Labor Statistics at http://www.bls.gov/cpi/
Language, Contiguity, Distance	Jon Haveman's online international trade data at http://www.haveman.org/
US Industry Level Tariffs	Calculated from Robert Feenstra's data collection at the 4-digit SITC level following Chris Magee's calculations for the 4-digit SIC industries
Real Exchange Rates	US Department of Agriculture's Economic Research Service at http://www.ers.usda.gov/Data/exchangerates/
Unit Values and Ad Valorem Transportation Costs	Calculated from the product level import data from http://data.econ.ucdavis.edu/international/

Table 1 - Kaplan-Meier Survival Rates

Period	Data		Differentiated Products Year 1	Differentiated Products Year 4	Differentiated Products Year 12	Reference Priced Products Year 1	Reference Priced Products Year 4	Reference Priced Products Year 12	Homogeneous Goods Year 1	Homogeneous Goods Year 4	Homogeneous Goods Year 12
1972-1988	7-digit TSUSA	Benchmark	0.69	0.52	0.45	0.59	0.38	0.31	0.55	0.33	0.25
		Obs>$100,000	0.92	0.86	0.83	0.80	0.66	0.60	0.69	0.49	0.41
		Obs>$1,000,000	0.99	0.97	0.96	0.90	0.80	0.76	0.75	0.59	0.52
		Gap-adjusted	0.74	0.61	0.52	0.65	0.47	0.38	0.61	0.42	0.32
	5-digit	SITC	0.58	0.38	0.32	0.56	0.34	0.28	0.55	0.31	0.24
	4-digit	SITC	0.59	0.39	0.34	0.58	0.36	0.31	0.56	0.34	0.27
1989-2001	10-digit HS	Benchmark	0.66	0.48	0.44	0.65	0.46	0.40	0.62	0.40	0.35
		Obs>$100,000	0.92	0.85	0.83	0.86	0.75	0.71	0.76	0.59	0.55
		Obs>$1,000,000	0.98	0.96	0.96	0.93	0.86	0.85	0.79	0.65	0.63
		Gap-adjusted	0.73	0.58	0.52	0.71	0.55	0.48	0.68	0.49	0.41
	5-digit	SITC	0.65	0.47	0.44	0.64	0.44	0.40	0.61	0.39	0.34
	4-digit	SITC	0.66	0.50	0.46	0.66	0.48	0.44	0.62	0.42	0.38

Note: The survival functions across the product types within each dataset are statistically significant at the 1% level using the logrank test

Table 2 - Cox Proportional Hazard Estimates for 1972-1988 7-digit TSUSA Data

	Benchmark	Obs>$100,000	Obs>$1,000,000	Gap-adjusted
Distance	0.99633	1.00042	0.98735	0.99808
(unit = 1,000 kilometers)	0.011	0.933	0.264	0.243
Ad-valorem transportation cost	1.07235	1.04495	1.05831	1.07665
(unit = 10%)	0.000	0.000	0.003	0.000
Language dummy	0.95648	0.75692	0.7633	0.94656
	0.000	0.000	0.000	0.000
Contiguous with USA	0.71109	0.43642	0.3841	0.6208
	0.000	0.000	0.000	0.000
GDP	0.98013	0.96052	0.95884	0.97415
(unit = $100bil)	0.000	0.000	0.000	0.000
Tariff rate, 4-digit SITC	0.97912	0.94392	0.87578	0.97566
(unit = 1%)	0.000	0.000	0.000	0.000
%Δ relative real exchange rate	0.90445	0.89577	0.94122	0.87579
(unit = 10%)	0.000	0.000	0.000	0.000
Coefficient of variation of unit values	0.93222	0.86829	0.92766	0.92315
	0.000	0.000	0.003	0.000
Multiple spell dummy	1.47864	2.23428	2.32668	1.47588
	0.000	0.000	0.000	0.000
Reference priced products	1.18069	1.61022	2.66944	1.20655
	0.000	0.000	0.000	0.000
Homogeneous goods	1.25201	1.76138	3.02695	1.28048
	0.000	0.000	0.000	0.000
Observations	1,140,896	356,141	128,871	1,140,945
No. Subjects	444,378	85,629	26,236	386,191

P-values are below the estimated hazard ratios
Stratified by regions

Table 3 - Product-type Specific Cox Proportional Hazard Estimates for 1972-1988 7-digit TSUSA Data

	Differentiated Products	Reference Priced Products	Homogeneous Goods
Distance	0.99263	1.00762	1.00001
	0.000	0.000	0.999
Ad-valorem transportation cost	1.08804	1.03595	1.04236
	0.000	0.000	0.000
Language dummy	0.96305	0.94774	0.92271
	0.000	0.000	0.005
Contiguous with USA	0.69781	0.75292	0.64288
	0.000	0.000	0.000
GDP	0.97598	0.98774	0.99993
	0.000	0.000	0.960
Tariff rate, 4-digit SITC	0.97959	0.97225	0.98955
	0.000	0.000	0.000
%Δ relative real exchange rate	0.8975	0.91908	0.92719
	0.000	0.000	0.000
Coefficient of variation of unit values	0.90778	0.99317	1.03717
	0.000	0.229	0.024
Multiple spell dummy	1.64925	1.13097	0.99554
	0.000	0.000	0.847
Reference priced products	1.19654		
	0.000		
Homogeneous goods	1.26182		
	0.000		
Observations	1,140,896		
No. Subjects	444,378		

P-values are below the estimated hazard ratios
Stratified by regions

Table 4 - Cox Proportional Hazard Estimates for Product Type Dummies Only

	Product Level				Industry Level	
7-digit TS Data 1972-1988	Benchmark	Obs> $100,000	Obs> $1,000,000	Gap-adjusted	5-digit SITC	4-digit SITC
Reference priced products	1.18069	1.61022	2.66944	1.20655	1.18781	1.1385
	0.000	0.000	0.000	0.000	0.000	0.000
Homogeneous goods	1.25201	1.76138	3.02695	1.28048	1.25019	1.27489
	0.000	0.000	0.000	0.000	0.000	0.000
10-digit HS Data 1989-2001						
Reference priced products	1.04847	1.26996	1.71571	1.07211	1.28121	1.20718
	0.000	0.000	0.000	0.000	0.000	0.000
Homogeneous goods	1.08621	1.44287	2.24237	1.11307	1.55706	1.45619
	0.000	0.000	0.000	0.000	0.000	0.000

P-values are below the estimated hazard ratios
Stratified by regions

Table 5 - Cox Proportional Hazard Estimates for Product Type Dummies for 1-digit SITC Industries

7-digit TS Data 1972-1988	SITC=0	SITC=1	SITC=2	SITC=3	SITC=4	SITC=5	SITC=6
Reference priced good	1.1424	1.0282	1.0237	0.9224	1.0393	1.1073	1.0487
	0.000	0.701	0.230	0.334	0.738	0.000	0.000
Homogenous good	1.2140	1.6874	1.2083	0.8641	1.1274	1.2899	1.2070
	0.000	0.000	0.000	0.128	0.147	0.000	0.000
10-digit HS Data 1989-2001							
Reference priced good	1.1700	1.1733	1.1249	0.9571	1.2294	1.0508	1.0751
	0.000	0.008	0.000	0.590	0.047	0.000	0.000
Homogenous good	1.1936	1.2167	1.2632	0.8393	1.2431	1.1710	1.2578
	0.000	0.010	0.000	0.037	0.009	0.003	0.000

P-values are below the estimated hazard ratios
Stratified by regions

Figure 1 - Survival Function for Rauch's Product Classification

7-digit TSUSA

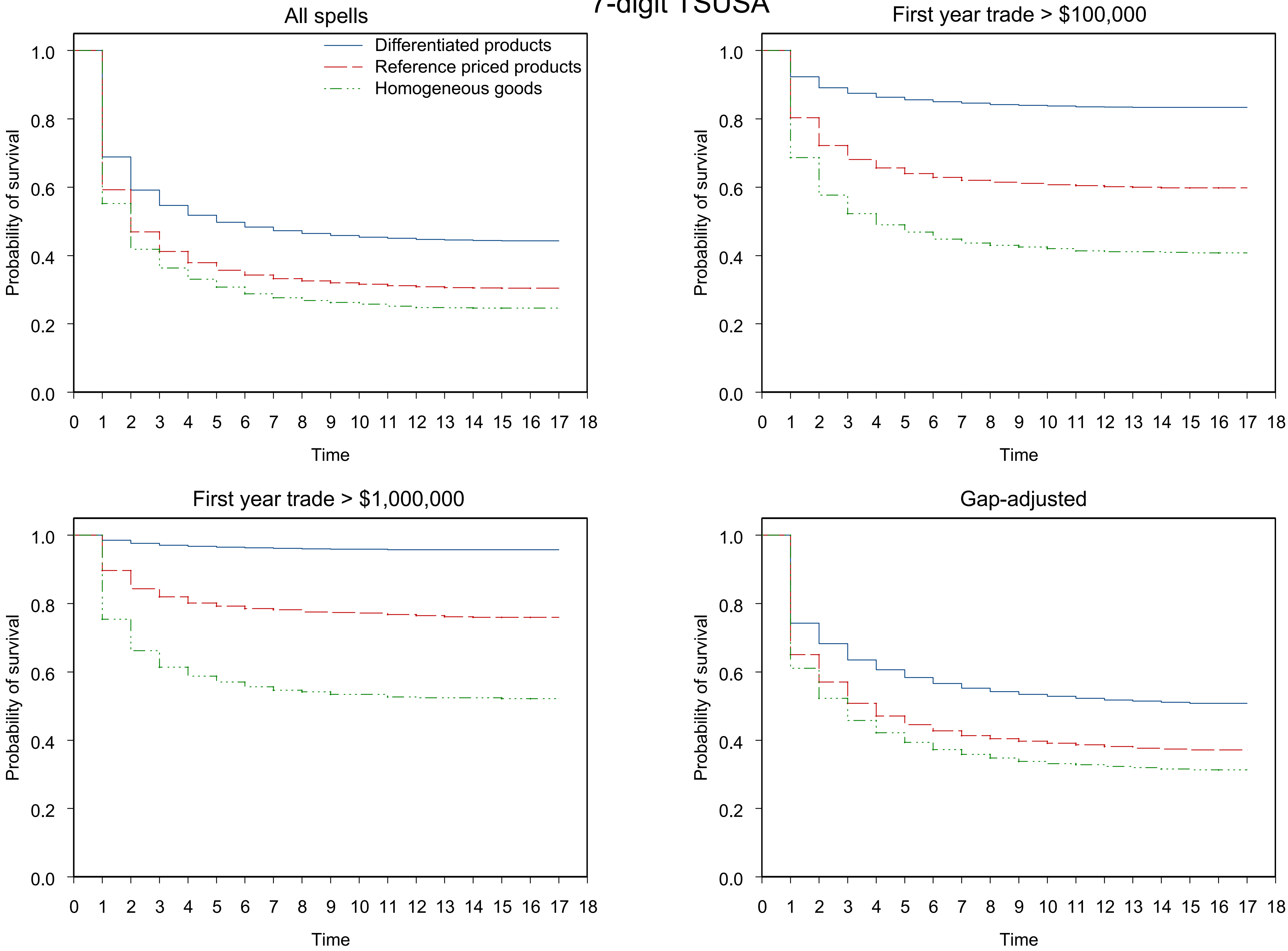

Figure 2 - Robustness Check Survival Functions