A Search Cost Perspective on Formation and Duration of Trade

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Abstract

More than half of all US import relationships begin with less than $10,000 annually. The median relationship is observed to last just one year. The incidence and duration of these relationships are consistent with a search model of international trade. The preponderance of small starting relationships reveals uncertainty present in formation of trade relationships. Initial size, reliability, and search costs matter and play an important role. Larger initial purchase results in longer relationships. Higher reliability and lower search costs lead to larger initial purchases and longer relationships.

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1 Introduction

This paper investigates formation and duration of trade relationships at the product level. It builds on the analysis of Besedeš and Prusa (2006a) who first investigated duration of US import trade by showing that the preponderance of short spells is consistent with a search model. In addition, I discuss a new trade fact – in addition to being short, most trade relationships are of low value – and show it too is consistent with a search model. My investigation is motivated by Rauch and Watson (2003). They model a developed country buyer who searches for an appropriate supplier from a developing country. Given the uncertainty present in international markets their model shows buyers elect to start some relationships with small orders to test the supplier, while reliable suppliers receive large orders immediately. Relationships that start with large orders are more likely to be long lasting.

The empirical analysis proceeds in several steps. I initially examine only relationships that most closely match the model, those between the United States and developing countries. I then perform several robustness exercises. Finally, I study whether US import relationships with developed countries are consistent with the model. Three conclusions emerge.

First, data are consistent with a search model. A great majority of US import relationships commence with very small annual purchases with a median value below \$10,000.[1] More than ninety percent of US import relationships start under \$1,000,000. There is a considerable amount of uncertainty in formation of trade relationships. Most buyers choose to test suppliers via small orders and upgrade them to large orders if they prove capable. The smaller the initial purchase the shorter the relationship.

[1] All trade values are in 1987 US dollars.

Almost a half of the smallest relationships, those starting under $10,000, last only one year. Only three percent of the largest relationships, those starting over $1,000,000, fail after one year. Duration increases the more reliable the supplier and the smaller the search costs.

Second, implications of a search model are more widely applicable to all trade relationships. All US import relationships have similar characteristics – the majority start with small purchases and duration increases with initial purchase and reliability, while it decreases with search costs. Third, the paper highlights an unexplored fact of international trade. The majority of trade relationships start with small values and are of short length. Long lasting relationships with large values are a minority.

This paper contributes to a large body of literature on product level trade. Schott (2004) finds international competition in product markets has increased over time. Hummels and Lugovskyy (2006) show aggregating data from product level to industry level distorts measures of transportation costs. Broda and Weinstein (2006) estimate elasticities of substitution and investigate gains from increases in variety of traded products. Hallak and Schott (2005) estimate cross-country differences in product quality revealing trends not apparent in export prices alone.

A number of researchers have used plant and firm level data to investigate export dynamics. Roberts and Tybout (1997) and Bernard and Jensen (2004) analyze factors which determine firm/plant participation in international markets. While related to this literature, this paper differs fundamentally by studying imports rather than exports. While I cannot capture capture cross-firm heterogeneity with product level data, I will argue firm-product level data would only make the results stronger. In addition, product level data highlight the significant dynamics which are glanced over

when using firm level data. Besedeš and Prusa (2006a) contain an extensive discussion of differences between the use of product level import and firm level export data.

This paper makes a contribution to the literature on duration of trade. Besedeš and Prusa (2006a, b) investigate duration of US import trade. They find product level trade to be very volatile, with median duration of just four years. They find differentiated products exhibit much longer median duration than do homogeneous products, five versus two years. Nitsch (2007) finds similar results for German imports.

2 Motivation for Empirics

2.1 A Model of Costly Search and Unknown Match Quality

Rauch and Watson (2003) study how developed country buyers search for suppliers from less developed countries. While the original model is presented at the firm level, data constraints me to recast the model at the product level. The US is the buyer searching for a product supplier among developing countries.

The buyer's goal is to find a developing country supplier successful in fulfilling a large order. Suppliers differ in per-period production costs, which is revealed when a match is made. The buyer pays a search cost whenever a search is undertaken. The supplier's success in fulfilling a large order is unknown. In order to supply a large order, the supplier must be trained by the buyer. The training investment immediately reveals whether the supplier will be successful.

Once matched the buyer has three options: place a large order, place a small order, or reject the supplier and search anew. With a large order the buyer pays the training investment, learns the supplier's ability, and positive profit results if the supplier is

successful. While a small order results in zero profit, a series of small orders reveals whether the supplier can successfully supply a large order. If the supplier is revealed to be successful the buyer will pay the training investment and place a large order. If at any point the supplier is rejected the buyer returns to the pool and searches again. A successful relationship with a supplier gives the buyer access to a network of potential suppliers, which costlessly introduces the buyer to a new supplier. If the buyer decides to switch, it again must decide whether to start small or large.

In equilibrium buyers place large orders with low cost suppliers. Intermediate cost suppliers are tested with small orders. High cost suppliers will be immediately rejected. Rauch and Watson demonstrate two key characteristics of the equilibrium. First, relationships starting with large orders will be of longer duration. Second, a decrease in search costs and an increase in reliability each increase both the likelihood of a large start and duration.

2.2 Relating the Model to Data

Five key variables — supplier's production cost, search cost, and reliability, training investment, and re-match probability — are all supplier or product characteristics. I could directly estimate the model by collecting buyer-supplier firm level import data. Unfortunately, no such data are readily available. I use extremely disaggregated US import data from 1972 to 2001. I study only differentiated products since according to Rauch (1999) search costs do not play a large role in trade of nondifferentiated goods. Detailed product level trade data allow the identification of buyer-supplier relationships at the country level. While such data provide no information about individual firms involved, product and supplying country characteristics can be used

to determine whether data are consistent with the model.

US import data are recorded annually using the 7-digit Tariff Schedule of the United States (TS) between 1972 and 1988 and using the 10-digit Harmonized System (HS) since 1989.[2] Differentiated goods are defined using Rauch (1999). Spells of service are created from annual data. If product i is imported from country c between 1976 and 1980, then the ci^{th} *trade relationship* has a spell length of five. The TS dataset contains 17,818 differentiated goods and 548,692 spells of service, while the HS dataset has 15,218 differentiated goods and 701,615 spells. Concordance problems between TS and HS data make it impossible to construct a product level database covering the entire 1972–2001 period. I use HS data as a natural robustness check.

Two issues necessitate a discussion of censoring. For some spells it is impossible to accurately observe either the beginning or ending date. Since trade relationships before 1972 are not observed, it is not clear whether those observed in 1972 actually start in 1972. Similarly, it is not clear whether relationships observed in 1988 truly end in 1988. All such relationships are treated as censored. For example, a spell observed from 1972 to 1976 is treated as censored and is of length of at least five years. In HS data spells observed in 1989 and/or 2001 are treated as censored. In addition, US Customs revises product codes on an annual basis. Old codes are discontinued, while new ones are required to better record trade. Since a concordance between new and old codes is unavailable, all such cases are treated as censored.[3] Besedeš and Prusa (2006a, b) discuss censoring issues at length.

A shortcoming of product level data is that even as disaggregated as they are (e.g.,

[2]Data were compiled by Feenstra (1996) and then extended by Feenstra et al. (2002). Data are available from the Center for International Data at UC Davis (http://cid.econ.ucdavis.edu).

[3]Reclassified codes are defined as those observed for the first time after 1972 (1989) and for the last time before 1988 (2001).

more than 30 different types of ball bearings) there is no information on individual buyers or sellers. In some cases one might expect observed data to be a result of multiple buyer-seller relationships at the firm level. A growing body of literature uses firm level export data (Roberts and Tybout, 1997; Bernard and Jensen, 2004), but those datasets typically identify only the total exports of a firm and provide no information on buyers of those exports nor exact products sold. There are several reasons why the bias introduced by using country-product data is small.

First, a great majority of relationships at the country-product level are observed for at most a year. The average observed duration is barely 3 years. Given data are reported annually the shortest time one could observe a buyer-seller relationship is one year. Second, most relationships are observed to start with surprisingly low values, less than $10,000 at the median. Firm level data would reveal even smaller initial values in cases of multiple buyer-supplier relationships at the firm-product level. Third, assuming most firms produce different products within the same industry, one would expect both initial purchases and duration to increase with aggregation. However, results with industry level data do not differ significantly from those at the product level. Data disaggregated to the country-firm-product level would result in even shorter duration and smaller initial purchase.

It is possible some shipments are miscalssified at the point of entry. Most data are constructed from forms filed with US Customs. While some effort goes into catching errors for large shipments, it is more liekely errors for small shipments will remain. Recording requirements are less stringent for small shipments, which may go unrecorded. This can have two effects on the results. Relationships with small regular shipments may be completely overlooked, understating duration. Certain

relationships may appear to have more than one spell because an unrecorded small shipment may break the observed continuity of the relationship.

While difficult to deal with, none of these issues are debilitating. If small initial purchases exposed in the paper are a result of filing errors, more than half of all relationships would have to be mistakenly recorded. For short duration to be a result of overlooking long but small relationships, there would have to be a large number of those as well. Given the need to collect accurate import data for duty collection purposes, it is unlikely there are so many recording errors to significantly affect the results. For an unrecorded shipment to result in a break in a relationship, there would have to be only one small shipment in a year or every shipment during the year is below the Cutoms radar. While possible, it is unlikely that in a long relationship there will be a year when every shipment is below the Customs radar. One robustness exercise assumes that every one year gap is a result of such an error. Even with such a drastic assumption, results do not change signfiicantly.

2.3 Verifiable Implications

The Rauch and Watson model can account for both small starting and short-lived relationships, as well as why duration may vary across suppliers and how starting size and duration are related. It implies some suppliers are rejected before any transactions takes place. These rejections are unobservable as only data on realized relationships are available.[4] Five verifiable implications can be identified.

Implication 1 *Some trade relationships will start small and others large. Large*

[4]There is no information on potential suppliers who were rejected by US buyers or even if non-active countries have the ability to supply a particular product.

starts should be of longer duration.

Since small is undefined, different definitions will be used for robustness. Lower hazard rates should be observed for relationships with large initial purchases.

Implication 2 *The more reliable the supplier, the larger the initial order and the longer the duration.*

Since a direct measure of reliability is unavailable, supplier's per capita GDP is used as a proxy. Higher per capita GDP suppliers should have longer duration.

Implication 3 *The lower the search cost, the larger the initial order and the longer the duration.*

Country and product characteristics will be used to proxy for search costs.

Implication 4 *The chance of a trade relationship ending will be the highest during the learning stage.*

Empirically, hazard rates should be high early in a relationship's life.

Implication 5 *A small fraction of successful relationships will end with a buyer switching to a new supplier.*

The risk of failure should decline the longer the relationship. It need not go to zero as a buyer could switch to a different supplier. The switch is less likely the lower the cost of the current supplier.

3 Results

The main focus of discussion is on TS data. All HS results are remarkably similar and available on request. I first investigate whether the implications of the model hold for developing countries, defined as non-OECD members in 1988.

3.1 A First Pass

I first evaluate implications #1, #4, and #5 nonparametrically. Implications #2 and #3 can only be evaluated by estimating a hazard model.

3.1.1 Starting small and starting large – Implication #1

Table 1 reports several percentiles of the distribution of first-year trade values. There is a great number of small starting relationships. The median starting value is just \$7,941. More than three quarters of relationships start below \$50,000. The few relationships that are large, are *very* large. The average starting value is \$432,151, which corresponds to the 94^{th} percentile. The majority of US import relationships start very small, while a few start very large.

Implication #1 also states that the size of a trade relationship in the first year affects its duration. I estimate survival functions for relationships divided in five groups according to their starting size: (i) below \$10,000 (53% of relationships), (ii) between \$10,000 and \$50,000 (24%), (iii) between \$50,000 and \$100,000 (7%), (iv) between \$100,000 and \$1,000,000 (12%), and (v) above \$1,000,000 (4%). Estimated survival functions in Figure 1 are consistent with the model: the smaller the initial purchase, the lower the probability of survival and the shorter the duration.

3.1.2 Hazard rates – Implications #4 and #5

Early stages of relationships should be characterized by higher hazard rates as buyers determine whether suppliers can successfully deliver the order. Beyond the initial learning stage there should be a small number of failures stemming from re-matching. Both hypotheses are borne out by data. As reported in Table 2 the hazard rate is highest at its outset. More than a third of relationships fail in their first year. Beyond the first year hazard declines rapidly. About 25–35% of relationships fail in the next two years. Thereafter, there is little attrition. Between years five and ten no more than 10% of relationships fail. Once relationships last more than ten years, the hazard in each subsequent year is around or below one percent. Even when suppliers prove to be reliable and relationships are long, some buyers switch to a different supplier.

Relationships with larger initial transactions should experience lower hazard rates at every point. This implication is supported by data as seen in Figure 1. Hazard rates never decline to zero as buyers switch from successful suppliers to a new ones.

3.2 Hazard Model Estimation

To evaluate the interplay of all factors affecting the size-duration relationship, I 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. Explanatory variables capture search costs, supplier reliability, relative costs of trading, and initial purchase size. The baseline hazard, $h_{s0}(t)$, characterizes how hazard changes

as a function of time and is different for each strata, s. Estimation is stratified by regions and 1-digit SITC industries.

Distance, common language, contiguity, and the number of potential suppliers are used to capture search costs. Shorter distance, common language, and contiguity should make for an easier search by easing travel and communication difficulties.[5] The number of potential suppliers captures the ease with which a buyer can find a good match. This variable is a product level count of the cumulative number of observed suppliers. For instance, suppose Canada and France supply a product in 1972 and Canada, Germany, and Brazil supply it in 1973. There are two potential suppliers in 1972 and four in 1973.

Two measures of supplier reliability are used. It is assumed a supplier's reliability will be closely related to its level of development as proxied by per capita GDP.[6] The other measure, multiple spells, is more indirect and requires some explanation. Some trade relationships are observed for a period of consecutive years (spell 1), followed by a period of no trade, followed by another service spell (spell 2).[7] If failure is at least partially related to country characteristics then the first failure makes the second one more likely indicating lower reliability.[8] Multiple spells are treated as independent by using a dummy variable for higher order spells. Alternative approaches toward multiple spells are considered in robustness exercises.

Suppliers from larger economies are able to commence their relationships with US

[5]These three variables were obtained from Jon Haveman's website, http://www.freit.org.

[6]I considered other development indicators, but their coverage is far from complete.

[7]A quarter of relationships have multiple spells and two-thirds of those have just two spells. Less than one percent of relationships have more than three spells.

[8]Multiple spells are not a perfect measure of reliability. A buyer could find another supplier in the same country before switching countries. Unavailability of firm level make it impossible to deal with this issue. This problem is less relevant the longer the duration of the first spell, since the buyer has several years to be rematched with another supplier in that country.

buyers with larger values due to larger production capacities. Such suppliers should have longer relationships. I use GDP of the supplier country to control for this effect.[9]

I use percentage change in the relative real exchange rate and ad-valorem transportation costs to capture relative costs of trading. The change in the relative real exchange rate is constructed to measure how each currency relative to its competitors. Each country's exchange rate is normalized by the average real exchange rate of all currencies against the US dollar. An increase in the measure reflects a country's currency has weakened relatively more than its competitors', making its products cheaper and less likely its relationships will be discontinued.[10]

Transportation costs are measured as the cif/fob ratio for US imports as reported in Feenstra (1996) and Feenstra et al. (2002). According to Hummels and Lugovskyy (2006) this is a reasonable measure of transportation costs when calculated at the product level. Following Hummels and Lugovskyy I drop a handful of observations with transportation costs are more than the value of the traded product.

An agricultural goods dummy controls for their high susceptability to temporary shocks such as weather which may increase the variability in initial size and duration. An intermediate goods dummy controls for potential peculiarities related to intermediate goods but not final goods.[11] For example, some firms buy intermediate goods only from approved suppliers. The approval process may be very costly at the margin relative to the value of the part. In such cases, firms may be forced to buy from a single approved supplier, even though there are other capable suppliers. Other firms may have more liberty when buying intermediate goods which can lead to higher

[9]Both GDP and per capita GDP are measured in 1995 US dollars and were obtained from World Bank data sources.

[10]Exchange rate data were obtained from the US Department of Agriculture.

[11]Schott (2004) identifies intermediate products in US trade data.

variability in duration and greater turnover of suppliers.

I use two controls for the initial size of a trade relationship. In addition to the dollar value of imports in the first year, I use dummies representing the five groups in Figure 1 due to the skewness in the distribution of initial purchase.

3.2.1 Benchmark estimates

Table 3 contains benchmark results. All estimates are expressed in terms of hazard ratios. A hazard ratio greater than 1 indicates an increase in hazard and shorter duration. The two specifications presented differ only in size variables. Both contain the actual starting value, while the Column 2 adds size group dummies. Column 2 is the preferred and discussed specification.

Higher distance from the US increases hazard by a small amount, 0.015% per one thousand kilometers. Indonesian suppliers have a 14% higher hazard than suppliers form the average country which in turn have a 10% higher hazard than Mexican suppliers due to distance. Suppliers from English speaking countries face a 3% lower hazard. Mexico has a 28% lower hazard due to its common border with the US. A one standard deviation increase in the number of potential suppliers, 16 additional suppliers, lowers the hazard by about 9%. These findings are consistent with the Rauch-Watson model: the easier it is to search the lower the hazard rate.

Both variables measuring reliability are consistent with the model. More reliable suppliers have a lower hazard and longer duration. Suppliers from countries with a $1,000 higher per capita GDP face a 1.7% lower hazard. Relative to the average supplier with per capita GDP of $3,133 in 1980, the least reliable supplier faces a 5% higher hazard, while the most reliable supplier faces a 15% lower hazard. Multiple

spells are an indicator of lower reliability as expected resulting in a 31% higher hazard.

Trading costs have a sensible impact. Transportation costs have a small effect: a one standard deviation increase, about 12%, increases the hazard rate by 1.3%. The relative real exchange rate has a larger effect. A 10% depreciation of supplier's currenty lowers its hazard rate by 5%; a one standard deviation depreciation, about 26%, lowers the hazard rate by 22%. Agricultural goods face an almost 10% lower hazard, while intermediate goods face a 10% higher hazard than final goods.

Initial purchase plays an important role. Relationships with starting value in the second smallest group face a 36% lower hazard relative to the smallest relationships. As the starting value increases the hazard decreases: by 50% for the middle group, 70% for the second largest, and 93% for the largest group. The actual value of the initial purchase does not have a statistically signifcant effect.

Columns (5) and (6) present corresponding results using HS data. The effect of search costs increases, while that of reliability and trading costs declines. Larger economies have a smaller advantage. The effect of size variables is almost identical. The only significant change is the reversal in sign for intermediate goods and agricultural goods are no longer different from final goods. Results in Table 3 offer strong support for the model: reliability and search costs matter, and size has a tremendously large effect on duration of relationships.

3.2.2 A more flexible alternative

Since the size of the initial purchase has a nonlinear effect, it is possible other exogenous variables have a size specific effect. The initial purchase effect may be mismeasured or overstated by not allowing a size specific effect of every variable. The top

panel of Table 4 presents results from estimating

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

where D_i denotes the i^{th} size dummy corresponding to the five initial size groups. The reference category are final products with initial purchase below \$10,000. Reading across the columns one can compare the effect for each variable as initial size increases.

Effects of explanatory variables generally do vary by size. The positive effect of distance is the strongest for the smallest starting relationships — hazard increases by almost 2% for each 1,000 kilometers. The effect is smaller for the next two groups and it reverses in sign for the largest two groups. This may signify that the buyer does not commit to far away suppliers (expensive search) unless they will be successful.

The role of search costs and reliability increases with initial size. Except for the smallest starting relationships, the effect of common language increases with size, up to 45% lower hazard. Mexico's border with the US lowers its hazard by 17% to 82%. Larger starting relationships benefit more from a higher number of potential suppliers with up to 3.3% lower hazard. The effect GDP per capita increases with size, but does not have an effect for the largest relationships. Multiple spells become more detrimental as starting value increases.

Larger economies face from 9% to 11% lower hazard the larger the initial transaction. The effect of the change in the relative real exchange rate increases with size from 4% to 10%, with no effect for the largest relationships. Ad-valorem transportation costs have a statistically significant effect only for the smallest and largest relationships. The largest relationships are particularly sensitive facing an 18% higher hazard for every 10% increase in transportation costs.

Even after controlling for the size specific effect of every explanatory variable relationships starting with smallest transactions still face the largest risk. Relative to the smallest relationships involving final goods, the largest relationships enjoy a 61% lower hazard. Larger relationships enjoy an inherent advantage over smaller ones.

3.3 Robustness

Several issues might bias the results: (i) measurement errors regarding the end of a spell, (ii) inability to observe the exact starting date for relationships that are active at the beginning of the sample, (iii) definition of size, and (iv) aggregation concerns. All robustness results are presented in Table 5.

3.3.1 Measurement errors and Multiple spells

There are two issues related to multiple spells. The first involves the possibility of mismeasuring the end of the preceding spell. The second involves the assumption of independence of multiple spells.

A short gap between two spells could be a result of a recording error or transactions too small to be recorded. If time between two spells is sufficiently short, then they may be more appropriately interpreted as one spell. I assume a one year gap between two spells is a result of a recording error and merge the spells creating one longer spell. Gaps longer than a year are assumed to accurately reflect failure. To illustrate suppose a country supplies a product from 1981–1983 and then again from 1985–1987. The benchmark approach treats this as two independent spells, each three years long. The gap-adjusted approach interprets this as one 7-year spell. The gap-adjusted

estimates which are very similar to benchmark estimates.[12]

Two alternatives are estimated to investigate the independence assumption. Analysis is limited to the first spell of each relationship eliminating every higher order spell. A more restrictive approach analyzing only single spell relationships is also considered. Results are reported in columns 3 and 4. While some estimated coefficients change in magnitude, results do not change qualitatively.

3.3.2 Starting dates

For relationships active in 1972 it is impossible to ascertain the exact starting date. Benchmark analysis interprets all such spells censored. I estimate the model excluding all spells observed in 1972. Results very similar to benchmark are reported in column 5.

3.3.3 Defining size

One difficulty in empirically investigating the Rauch-Watson model is the appropriate notion of initial size. Due to product heterogeneity it may be more appropriate to use market share instead of dollar value to define size. For some products \$15,000 may be big and for others \$1 million could be small. I calculate market share for each supplier in their first year and divide relationships into five groups so approximately the same fraction of observations fall into each group as under dollar value cutoffs. The chosen market share cutoffs are: 0.4%, 5%, 20%, and 50%.

Estimates presented in column 6 are qualitatively similar to benchmark estimates. The effect of size is muted, especially for the largest two groups. The hazard rate for

[12]Transportation cost for the gap year is the average of the two adjoining years. There are fewer subjects due to merging of spells, while there are more observations as the gap year is added.

the largest group is 44% lower than for the smallest group. By contrast, the largest group has an 86% lower hazard in the benchmark case.

Two comments are in order. First, even when using the relative size concept larger initial transactions have lower hazard. Second, results suggest the absolute size of a transaction has a more pronounced effect on hazard. A supplier may be relatively big even though it may have only a few thousand dollars of sales. All else equal, this supplier is worse off than a relatively small supplier with a million dollars of sales.

3.3.4 Aggregation

In the preceding analysis trade relationships were defined using product level data. The product level might be an overly fine parsing of data. A supplier may sell a variety of products that all fall within the same industry. Product level data would reveal the supplier has very short duration as its sales shift from one product to another. At the industry level, however, one would observe the supplier experiences a long duration. The highly disaggregated nature of trade data might bias results toward short duration. Spells of service at the SITC 5- and 4-digit levels were computed using industry level data compiled by Feenstra (1996) and Feenstra et al. (2002). Industry level estimates are reported in columns 7 and 8. Following Hummmels and Lugovskyy (2003) I exclude transportation costs as the reliability of cif/fob ratios declines with aggregation.

Results are qualitatively similar to the benchmark. Contiguity has a much stronger effect than at the product level, while the effect of multiple spells is reduced significantly. Intermediate goods are no longer different, largely due to imperfect matching of product level characteristics to industries. An industry might contain final and

intermediate goods. In such cases the industry was assigned the characteristic of the majority of products within it. General insights that search costs, reliability, and initial transaction size all matter for duration find strong support in industry level estimates. This result should not be surprising given the recent work of Bernard, Redding, and Schott (2006) which shows firms frequently alter their product mix measured at the industry level.

Overall robustness exercises show benchmark results are robust to a series of alternative treatments. Relationships starting with lower purchases have higher hazard and shorter duration.

4 What About Developed Countries?

When developed country buyers search for suppliers from developing countries they tend to commence the majority of their relationships with small orders resulting in short relationships. Lower search costs and greater supplier reliability result in larger initial orders and longer duration. Are any of these characteristics present when developed country buyers search for suppliers from developed countries? Although Rauch and Watson (2003) did not have those relationships in mind, it is worthwhile to compare the two environments.

Figure 1 and Tables 1 through 4 contain results for developed country relationships equivalent to those already discussed for developing countries. All results are qualitatively similar and only major differences are discussed here. Developed countries have a higher survival and a lower hazard than developing countries, but still display the same size-duration relationship. Developed countries have relationships

that start with smaller purchases. However, they dominate developing countries in the size of the largest relationships by a factor of two.

Table 3 replicates the benchmark estimation for developed countries. Results are qualitatively similar to those for developing countries. Distance actually lowers hazard. Japan and several European countries have longer duration than Canada, the closest country to the US, causing the reversal of the sign. Common language, multiple spells, and transportation costs play a larger role, while the impact of GDP and GDP per capita is smaller for developed countries. Exchange rates have a much larger effect in the earlier period, but have almost no impact in the latter period. Except for the largest relationships, the size of the initial purchase reduces hazard more for developed countries. Estimates from the more flexible specification in Table 4 reveal qualitatively similar results to those for developing countries. Larger relationships have lower hazard rates. Robustness exercises (available on request) again show the relationship between the size of the initial purchase and duration is robust.

5 Conclusion

This paper examines formation of trade relationships through the lens of a search model. US import data are used to examine a number of implications of the Rauch-Watson model of searching for a foreign supplier from a developing country. There are three main contributions.

First, there is strong support for all implications. Not only do many trade relationships start small but they are also of shorter duration. Relationships that start large are a clear minority with a distinct advantage in expected duration. More re-

liable suppliers have longer lasting relationships. The ease with which a buyer can find a supplier increases duration. Relationships are more likely to end in their early phase if the supplier is reveled to be unreliable. A small fraction of relationships end even after the supplier has proven to be successful.

Second, results indicate the role of search costs is potentially broader than Rauch and Watson suggest. They motivate their model by describing a number of case studies of a developed country establishing a relationship with suppliers from less developed countries. They point out it is common for these relationships to begin with small orders and are gradually deepened if the buyer is satisfied with the supplier. Not only does this paper go well beyond case study anecdotes, it demonstrates such behavior is not limited to less developed country suppliers. There is overwhelming evidence US buyers start a great majority of relationships with foreign suppliers with small orders whether they are from developed or developing countries. However, one should be careful in directly extending the Racuh-Watson model to developed country suppliers as the those relationships may not commence in the same way as those with developing country suppliers. However, both types of relationships have similar characterstics.

Third, results highlight an important phenomenon — many trade relationships begin with small initial values and are often very short lived. Future research should explore implications of this finding for international trade both theoretically and empirically. Almost all empirical work uses more aggregated data and as a result does not observe much of the underlying dynamics unearthed here. Results using aggregated data will be driven by the relatively few, but very large observations. While these trade weighted studies accurately measure general patterns and relationships,

there is a lot of economic activity they do not capture.

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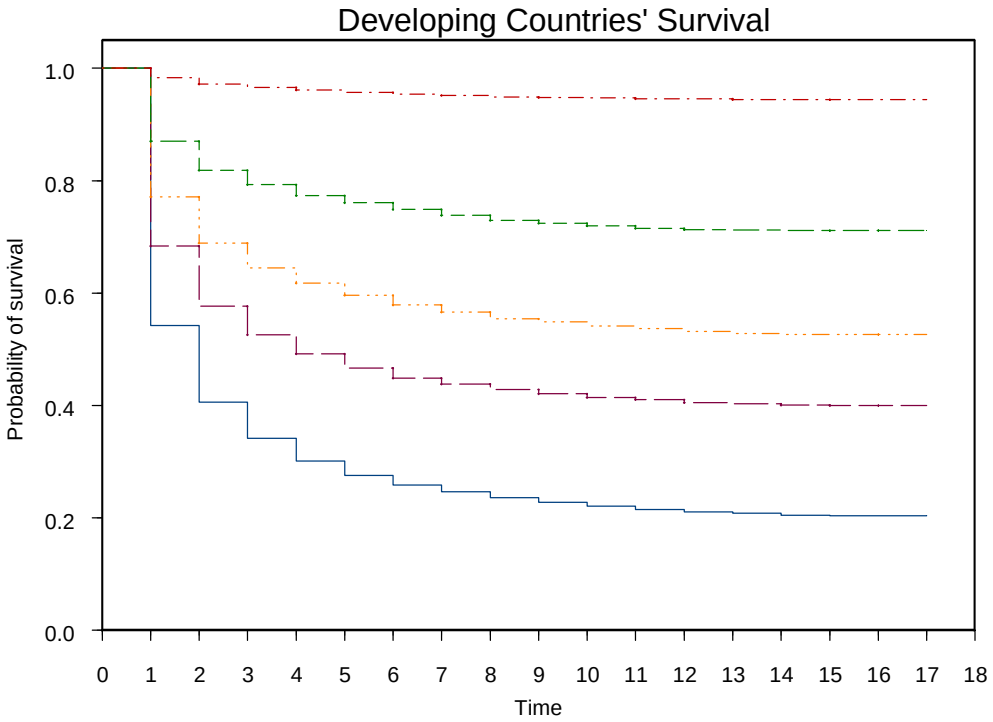
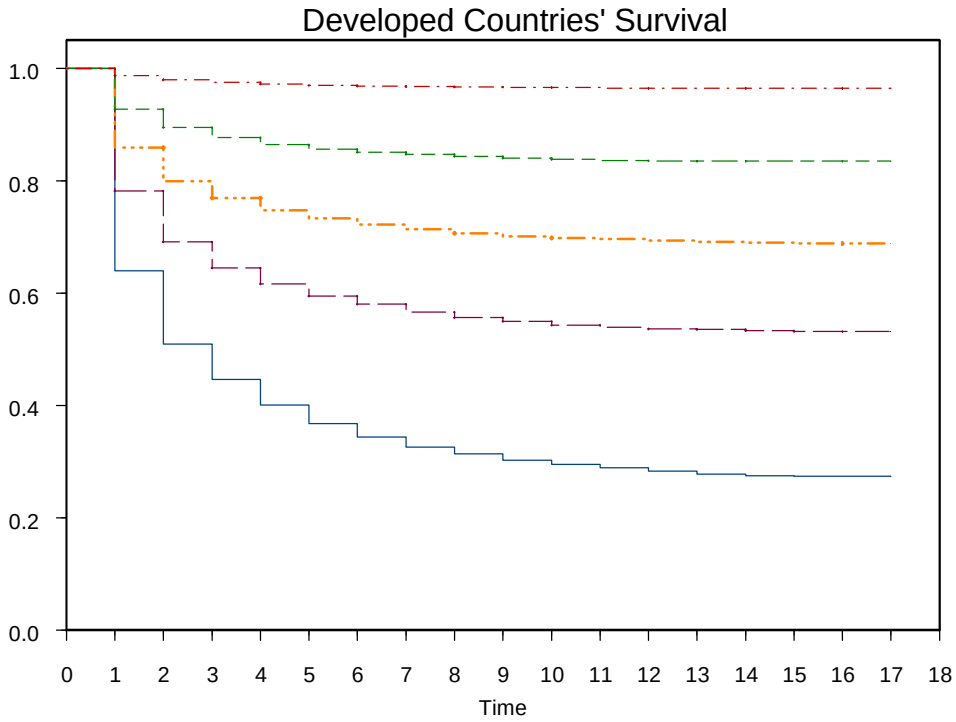
A Data Appendix

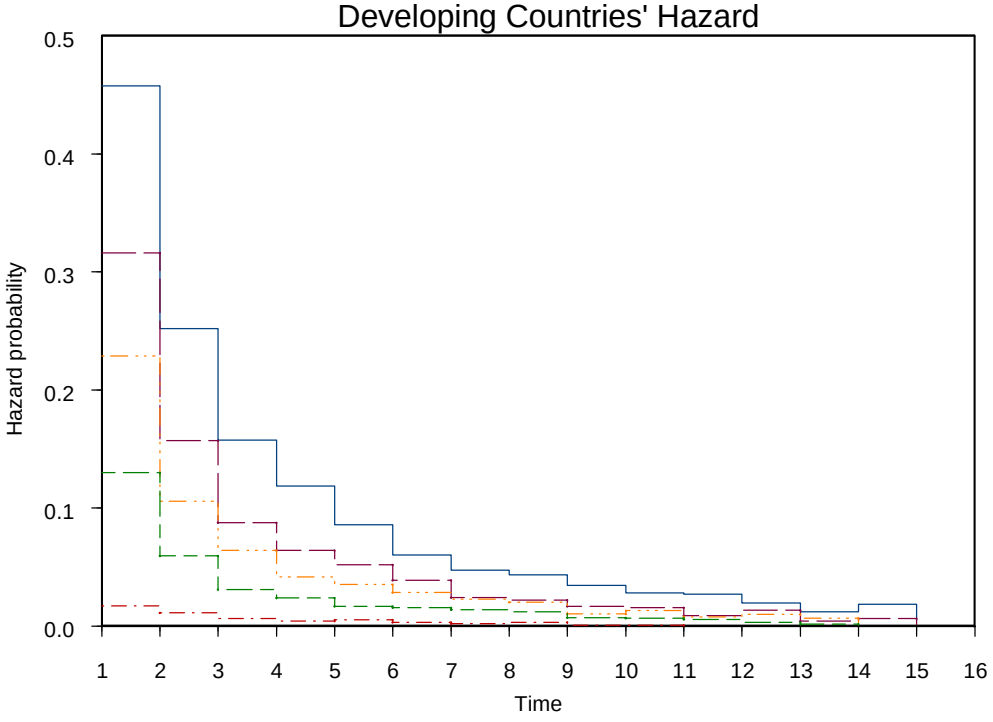
All data are available from public sources.

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/
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/
Real Exchange Rates	US Department of Agriculture's Economic Research Service at http://www.ers.usda.gov/Data/exchangerates/
Ad Valorem Transportation Costs	Calculated from the product level import data from http://data.econ.ucdavis.edu/international/
GDP and GDP per capita	World Bank

Figure 1 - Survival and Hazard by Initial Purchase, 7-digit TS data







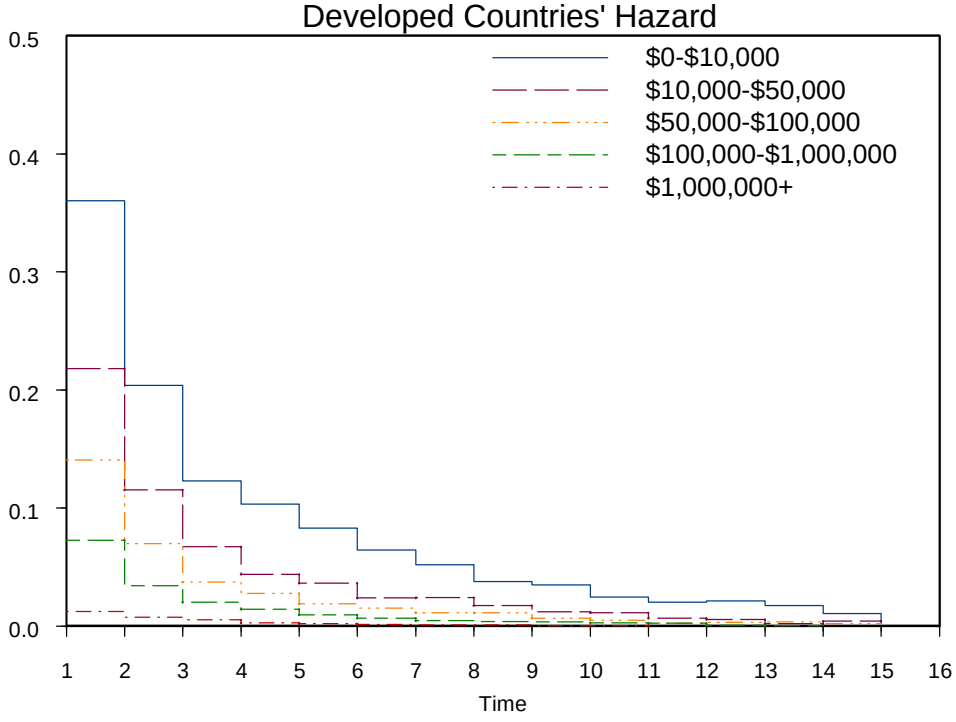


Table 1 - Distribution of First-Year Trade Values ($1987)

		Developing Countries	Developed Countries	All Countries
7-digit TSUSA data, 1972-1988	Relationships	294,075	254,617	548,692
	Mean	$432,151	$1,020,295	$705,076
	5th percentile	$503	$469	$487
	25th precentile	$1,818	$1,634	$1,729
	Median	$7,941	$6,752	$7,376
	75th percentile	$42,100	$44,456	$43,076
	95th percentile	$710,457	$1,335,901	$970,647
10-digit HS data, 1989-2001	Relationships	402,400	299,215	701,615
	Mean	$603,754	$1,232,676	$871,967
	5th percentile	$382	$357	$369
	25th precentile	$2,118	$1,939	$2,041
	Median	$8,384	$8,129	$8,281
	75th percentile	$42,348	$57,282	$47,413
	95th percentile	$823,324	$1,672,886	$1,162,163

Table 2 - Estimated Hazard Rates

	7-digit TS data, 1972-1988			10-digit HS data, 1989-2001		
Year	Developing Countries	Developed Countries	All Countries	Developing Countries	Developed Countries	All Countries
1	0.352	0.264	0.311	0.372	0.287	0.336
2	0.160	0.124	0.141	0.176	0.138	0.158
3	0.088	0.067	0.076	0.098	0.077	0.087
4	0.062	0.047	0.053	0.059	0.045	0.052
5	0.048	0.034	0.039	0.038	0.030	0.034
6	0.034	0.024	0.028	0.027	0.019	0.023
7	0.026	0.020	0.022	0.018	0.014	0.016
8	0.023	0.014	0.017	0.015	0.010	0.012
9	0.016	0.011	0.013	0.009	0.007	0.008
10	0.015	0.008	0.010	0.006	0.004	0.005
11	0.012	0.006	0.008	0.002	0.002	0.002

Note: Hazard rates for only the first 11 years are presented

Table 3 - Cox Proportional Hazard Estimates

	7-digit TSUSA data, 1972-1988				10-digit HS data, 1989-2001			
	Developing Countries		Developed Countries		Developing Countries		Developed Countries	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Distance	1.01484	1.01544	0.96687	0.96387	1.01950	1.02217	0.98615	0.99295
(unit = 1,000 kilometers)								0.077
Language dummy	0.98883	0.97041	0.81755	0.81075	0.95094	0.93572	0.88705	0.89014
	0.110							
Contiguous with USA	0.72116	0.71854			0.65827	0.66416		
Number of potential product suppliers	0.99430	0.99420	0.98457	0.98596	0.99411	0.99386	0.98904	0.98948
GDP per capita	0.98090	0.98314	0.99377	0.99237	0.99853	0.99823	0.99961	0.99883
(1995 US$, unit = $1000)							0.177	
Multiple spell dummy	1.37014	1.31431	1.98109	1.84074	1.36521	1.30997	2.01939	1.79162
GDP	0.90147	0.91068	0.94943	0.95277	0.95113	0.95422	0.96389	0.96727
(1995$, unit = $100bil)								
%Δ relative real exchange rate	0.95083	0.95176	0.83247	0.82894	0.97989	0.97943	0.99179	0.98958
(unit = 10%)							0.021	
Ad-valorem transportation cost	1.03860	1.01082	1.06793	1.03786	1.03351	1.00584	1.06532	1.02835
(unit = 10%)								
Intermediate goods	1.14115	1.10819	0.99325	1.00052	0.96659	0.95213	0.82990	0.84273
			0.522	0.961				
Agricultural goods	0.91297	0.89516	1.03370	1.03001	1.01288	1.02064	1.10605	1.12119
			0.154	0.213	0.528	0.315		
First year imports	0.21691	0.94332	0.32716	0.96885	0.14758	0.85773	0.25480	0.93436
(millions $1987)		0.153		0.090				0.022
First year imports between $10,000 and $50,000		0.69239		0.63645		0.70188		0.59061
First year imports between $50,000 and $100,000		0.51279		0.44359		0.50203		0.39555
First year imports between $100,000 and $1,000,000		0.29219		0.26740		0.27685		0.23145
First year imports above $1,000,000		0.07808		0.08064		0.09009		0.08351
Observations	440,852	440,852	705,022	705,022	839,119	839,119	1,076,172	1,076,172
No. Subjects	193,855	193,855	230,382	230,382	286,709	286,709	293,380	293,380

Notes: Only p-values greater than 0.01 are reported below the estimated hazard ratios
Stratified by regions and 1-digit SITC industries

Table 4 - Cox Proportional Hazard Estimates with Group Varying Coefficients, 1972-1988 7-digit TSUSA data

Developing Countries	Relationships with first year trade value				
	<$10,000	≥$10,000 & <$50,000	≥$50,000 & <$100,000	≥$100,000 & <$1,000,000	≥$1,000,000
Distance	1.01996	1.00814	1.00914	0.97672	0.89148
			0.017		
Language dummy	1.00128	0.96393	0.90327	0.78559	0.55526
	0.870	0.014			
Contiguous with USA	0.82995	0.65311	0.54312	0.35141	0.17382
Number of potential product suppliers	0.99609	0.99260	0.98988	0.98560	0.96714
GDP	0.91530	0.90621	0.89643	0.88178	0.89446
Multiple spell dummy	1.19051	1.40432	1.62944	2.51149	7.16317
GDP per capita	0.98639	0.98219	0.97085	0.97242	1.00543
					0.766
%Δ relative real exchange rate	0.96294	0.92950	0.91061	0.90473	1.00129
					0.971
Ad-valorem transportation cost	1.01324	1.00617	0.97770	0.99684	1.18437
		0.277	0.189	0.878	0.016
Final goods	1	0.86629	0.73984	0.62082	0.38717
Intermediate goods	1.09610	1.15036	1.13328	1.15271	0.99122
					0.967
Agricultural goods	0.83314	0.98174	1.09429	1.14334	0.57067
		0.646	0.276	0.149	0.204
Observations			440,852		
No. Subjects			193,855		

Developed Countries	Relationships with first year trade value				
	<$10,000	≥$10,000 & <$50,000	≥$50,000 & <$100,000	≥$100,000 & <$1,000,000	≥$1,000,000
Distance	0.95803	0.98388	0.99091	1.01294	1.05951
			0.244	0.097	0.032
Language dummy	0.85154	0.77365	0.75184	0.67740	0.42651
Number of potential product suppliers	0.99021	0.98138	0.97529	0.96640	0.95287
GDP	0.95893	0.95056	0.93989	0.92541	0.90303
Multiple spell dummy	1.51883	2.32063	3.43892	5.82499	16.01357
GDP per capita	0.99310	0.99005	0.99098	0.99321	0.98688
					0.036
%Δ relative real exchange rate	0.84064	0.80976	0.79553	0.80125	0.80008
Ad-valorem transportation cost	1.03876	1.04728	1.05931	1.03151	1.08238
				0.126	0.250
Final goods	1	0.59582	0.41247	0.25087	0.08715
Intermediate goods	1.07519	0.99288	0.75588	0.71211	0.84386
		0.770			0.401
Agricultural goods	0.96366	1.04947	1.19565	1.39979	1.84693
	0.165	0.265	0.060		0.020
Observations			705,022		
No. Subjects			230,382		

Notes: Only p-values greater than 0.01 are reported below the estimated hazard ratios
Stratified by regions and 1-digit SITC industries

Table 5 - Robustness Regressions, 1972-1988, Developing Countries

	Product level data						Industry level data	
	(1) Benchmark	(2) Gap-Adjusted	(3) First Spell	(4) Single Spell	(5) No 1972 Spells	(6) Market Share	(7) 5-digit	(8) 4-digit
Distance	1.01544	1.01919	1.01329	1.01597	1.01540	1.01233	1.00840	1.00486
								0.035
Language dummy	0.97041	0.96759	0.94821	0.97796	0.98159	1.00235	0.96511	0.94616
				0.041		0.739		
Contiguous with USA	0.71854	0.63693	0.68162	0.57669	0.74733	0.66166	0.55076	0.49122
Number of potential product suppliers	0.99420	0.99384	0.99562	0.99417	0.99416	0.98948	0.99687	0.99738
GDP per capita	0.98314	0.98126	0.98146	0.97885	0.98231	0.97855	0.98591	0.98658
Multiple spell dummy	1.31431	1.31983			1.26992	1.47309	1.05268	1.07556
GDP	0.91068	0.89662	0.91470	0.88801	0.90697	0.89700	0.88558	0.83430
%Δ relative real exchange rate	0.95176	0.94587	0.95957	0.95263	0.95076	0.95209	0.97372	0.98072
Ad-valorem transportation cost	1.01082	1.00779	1.00792	1.00455	1.01288	1.04203		
				0.108				
Intermediate goods	1.10819	1.10201	1.14561	1.11214	1.11588	1.15110	0.99310	0.99185
							0.625	0.670
Agricultural goods	0.89516	0.90399	0.83758	0.86972	0.89285	0.93153	0.90755	0.89767
								0.011
First year value	0.94332	0.95315	0.88850	0.89608	0.94387	1.00168	0.98809	0.99011
	0.153	0.252	0.058	0.203	0.146	0.069	0.142	0.201
Group 2	0.69239	0.69678	0.67907	0.68159	0.69864	0.68523	0.73834	0.73231
Group 3	0.51279	0.51667	0.49503	0.49411	0.51900	0.53671	0.56854	0.56380
Group 4	0.29219	0.28690	0.26135	0.24631	0.29911	0.51470	0.40437	0.40071
Group 5	0.07808	0.07241	0.06993	0.05686	0.08064	0.56350	0.15299	0.14892
Observations	440,852	467,291	330,325	279,733	391,537	440,852	164,274	110,292
No. Subjects	193,855	170,863	142,371	113,404	186,341	193,855	47,810	29,271

Notes: Only p-values greater than 0.01 are reported below the estimated hazard ratios

Stratified by regions and 1-digit SITC industries

For specifications (1)-(5) and (7)-(8) 'First year value' denotes the dollar value of imports (millions) and Groups 2-5 are defined as in Table 4.

For specification (6) 'First year value' denotes import market share (%) and Groups 2-5 are defined as follows:

Group 2	First year market share between 0.4% and 5%
Group 3	First year market share between 5% and 20%
Group 4	First year market share between 20% and 50%
Group 5	First year market share above 50%