Toward a Geography of Trade Costs

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Abstract:

What are the barriers that separate nations? While recent work provides intriguing clues, we have remarkably little concrete evidence as to the nature, size, and shape of barriers. This paper offers direct and indirect evidence on trade barriers, moving us toward a comprehensive geography of trade costs. There are three main contributions.

One, we provide detailed data on freight rates for a number of importers. Rates vary substantially over exporters, and aggregate expenditures on freight are at the low end of the observed range. This suggests import choices are made so as to minimize transportation costs. Two, we estimate the technological relationship between freight rates and distance and use this to interpret the trade barriers equivalents of common trade barrier proxies taken from the literature. The calculation reveals implausibly large barriers. Three, we use a multi-sector model of trade to isolate channels through which trade barriers affect trade volumes. The model motivates an estimation technique that delivers direct estimates of substitution elasticities. This allows a complete characterization of the trade costs implied by trade flows and a partition of those costs into three components: explicitly measured costs (tariffs and freight), costs associated with common proxy variables, and costs that are implied but unmeasured.

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I. Introduction

Trade barriers play a central role in models of international specialization and trade. Much of the positive theory concerns the effects of barriers on trade, and trade costs figure prominently in recent work that extends our understanding of the nature of specialization. For example, the unique insights of economic geography models depend critically on the size of trade costs (Krugman (1991a)) and their distribution over goods (Davis (1998))[1]. Brainard (1998) and Markusen and Venables (1996) emphasize trade costs in examining substitution between trade and foreign investment, and Hummels, Ishii and Yi (1999) highlight trade costs in explaining the rise of vertical specialization.[2] Trade costs may also play a role in policy formation as the optimality of preferential trade arrangements depends on the size and shape of "natural" trade barriers (Krugman (1991b)). Of course, empirical evaluation of any model of international specialization and trade must ultimately confront trade costs. For example, Trefler (1995) and Davis and Weinstein (1998a) propose trade costs as a primary explanation for the celebrated absence of factor content in trade. Indeed, a better understanding of trade costs may provide insights into a broad range of questions about international integration.

What then are the barriers that separate nations? How large are they? How much do they vary across partner countries? While recent work provides intriguing clues, we have remarkably little concrete evidence as to the nature, size, and shape of barriers. This paper argues that progress toward a more nuanced understanding of these three issues rests on careful measurement, and on starting that measurement in obvious places.

One can imagine a long list of barriers that plausibly affect international integration. Beginning with tariffs, and proceeding to transportation costs, time, information, or more esoteric explanations, it is not difficult to construct credible stories for any number of important trade costs. The difficulty lies in directly measuring the purported cost and so researchers rely primarily on indirect methods: positing a model of bilateral trade flows and correlating flows with proxy variables meant to represent trade barriers. It is well known that the volume of bilateral trade diminishes sharply with the distance between trading partners, and that a shared language and adjacency corresponds to greater trade flows. Several recent papers (McCallum (1995), Helliwell (1996, 1997), and Wei (1996)) show that trade flows imply significant "home

[1] These are only two of the large number of papers on geography and trade. In these models, geography effects are generated by the interaction between increasing returns in production and trade costs.

[2] Vertical specialization is simply trade in stages of production rather than final goods, and is also known as "slicing up the value chain" or "fragmentation".

bias" in consumption. Thus, indirect methods suggest, language matters, borders matter, relative location matters.[3]

While intriguing, these findings leave open several questions. Chief among these is a precise description of what these proxies capture and the size of the barrier. Why exactly does language matter? Similarity of preferences? Minimizing search costs in foreign lands? Do distance and adjacency effects represent the costs of moving goods, or the cost of moving information? Do borders appear "thick" because they are truly costly to surmount? To make progress, this paper offers direct and indirect evidence on trade barriers, moving us toward a comprehensive geography of trade costs.

Section II provides a set of stylized facts on directly measured trade barriers in the form of detailed freight and tariff rate data. There are two main findings. One, freight rates have higher means and variances than tariff rates. Two, aggregate expenditures on freight are on the low end of a wide range of observed rates. This suggests that the aggregate rates significantly understate shipping costs borne by most exporters and that transportation costs play a significant allocative role in bilateral trade. That is, aggregate freight expenditures are low because import choices are made to minimize transport costs.

The next step is to formally assess the relative importance of freight costs in trade. Section III describes the one-sector monopolistic competition model used to motivate most indirect estimates of trade barriers and recounts evidence relating barrier proxies to trade volumes. This model identifies substitution as the primary channel through which barriers affect trade: holding constant the locations of production, importers substitute away from goods with relatively high trade costs. Unfortunately, the use of proxies in place of direct cost data prevents researchers from identifying the elasticity of substitution or the size of the trade barriers the proxies represent. We estimate the technological relationship between freight rates and distance and use this to infer the elasticity of substitution and the trade barrier equivalents of common proxies. The resulting calculation reveals implausibly large barriers.

Section IV uses a multi-sector monopolistic competition framework to introduce an additional channel through which barriers operate. Given substitution, production migrates to minimize costs so that close neighbors produce complementary sets of goods. This magnifies the effects of barriers on trade volumes and may explain the large estimates from aggregate models.

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[3] This is by no means an exhaustive list of the proxies associated with bilateral trade flows, but they are perhaps the most robust.

Section V provides structural estimates of the multi-sector model that identify the elasticity of substitution for each good, and the trade barrier equivalent for common proxy variables. Attention to functional form and level of aggregation provides a potential method for separating three alternative interpretations of what common proxies measure: trade barriers, preferences, and production composition. In addition, the model provides a structural interpretation of the regression residuals in terms of unobserved preference parameters (with an implicit willingness-to-pay interpretation). This allows a complete characterization of the size and shape of barriers, and a partition of these barriers into explicitly measured costs (freight plus tariffs), costs captured by proxies, and unmeasured but implied costs. The evidence suggests that, for many goods, explicitly measured costs are most of the story.

II. Directly Measuring Trade Costs: Stylized Facts on Freight and Tariff Rates

In this section we provide stylized facts on the level and variation of freight and tariff rates at highly disaggregated commodity levels. The data include imports of the US, New Zealand, and five Latin American countries (Argentina, Brazil, Chile, Paraguay and Uruguay) in 1994. In each case, customs officials collect data on import values, quantities (weights), and freight and insurance charges for each entering shipment. These are reported with exporter and commodity detail with approximately 3000 goods for New Zealand and Latin American imports and over 15,000 goods for US imports. Additional detail on these data is provided in the appendix.

Table 1 and Figure 1 provide evidence on the level and distribution of freight rates for each importer. In the trade data an observation includes the transportation expenditure F, and the value of imports exclusive of these charges V, in a commodity l (measured at the 5-digit SITC level, or 3000 goods), originating from exporter j. The ad-valorem freight rate for each observation is

$$f_{jl} = \frac{F_{jl}}{V_{jl}}$$

Table 1 displays ad-valorem freight rates, calculated both as trade-weighted and unweighted average rates of all observations within a 2-digit SITC commodity group k (62 goods). Summing freight expenditures and the value of trade separately over all export partners and over all commodities l within a 2-digit group k yields the trade-weighted average freight rate in commodity k,

$$(1) \qquad f_k = \frac{F_k}{V_k} = \frac{\sum_{j,l\in k} f_{jl}}{\sum_{j,l\in k} V_{jl}} = \sum_{j,l\in k} S_{jl} f_{jl}$$

where S_{jl} is the value-share of an observation *jl* in bilateral trade for the 2-digit commodity *k*. This rate is reported in the left panel of Table 1. The right panel reports the unweighted average freight rate over all observations within a 2-digit commodity *k*. The weighted and unweighted average freight rates will be equal if there is zero correlation between the observation freight rate and the share of that observation in trade.

Several broad facts emerge from this table. One, while aggregate expenditures on freight are quite low (only 3.8 percent of trade value in the US, and somewhat higher for other importers), rates for most goods are much higher. Two, land-locked Paraguay stands out as having exceptionally high freight rates.[4] Three, freight rates are lower for manufactured goods (SITC 5-9) than for commodities (SITC 0-4). Four, in nearly all cases, the unweighted freight rate is considerably higher than the trade-weighted freight rate. That is, observations with the lowest freight rates enjoy the largest share of trade.

Further evidence on the dispersion of freight rates is provided in Figure 1, which plots the inner-quartile range of all observed freight rates (exporter x 5 digit SITC commodity) within each two-digit group.[5] The IQR is represented as a line (with the 25th and 75th percentiles as endpoints), and the trade-weighted average freight rate for each commodity is circled. The figure indicates first, that there is wide variation of rates within each commodity category, and second, that trade-weighted rates are on the lower end of a large range of observed rates.

Rates have been reported at the two-digit level for ease in display, but the basic patterns revealed in Table 1 and Figure 1 persist at more disaggregated levels. That is, considerable variation in freight rates across exporters exists even for narrow product classifications. This variation suggests that transportation costs *could* play an important allocative role in trade. Further, exporters with the lowest freight rates in these narrow product classifications enjoy the

[4] Directly comparing rates across countries is somewhat tricky because of differences in valuation. In particular, loading expenses are included in US and New Zealand data, but not in Latin American data.
[5] The inner-quartile range is used in place of the full range of observed rates to minimize the importance of potentially mismeasured outliers.

largest share of trade. This fact suggests that transportation costs *do* play an allocative role – aggregate freight expenditures are low because import choices are made so as to minimize transport costs.

Figures 2 and 3 provide evidence on the level and variation of freight rates relative to tariff rates. We first compare the trade-weighted average freight and tariff rates. Freight rates are calculated as above. Tariff rates are calculated by applying ad-valorem rates from schedules in the TRAINS database to yield the duty owed on each observation. This database includes both MFN and preferential tariff rates and preferential rates are applied where appropriate.[6] Summing duties owed over all exporters and commodities within a two-digit group and expressing them as a ratio over the value of trade yields the trade-weighted average tariff rate.

Figure 2 reports the *difference* between the average freight and tariff rates. For the US and New Zealand, freight rates are substantially higher than tariff rates for all but a handful of manufactured goods, where both rates are very low. For Latin American countries, freight rates are substantially higher than tariff rates for commodity categories, and the reverse for manufactured goods.

Figure 3 compares the relative dispersion in freight and tariff rates by plotting the *difference* in the size of the inner quartile ranges of observations within a two-digit group. For example, in SITC 00 (Live Animals) in the US, the quartile freight rates are 25.6% and 5.6% yielding an IQR of 20%, while the quartile tariff rates are 2.5% and 0% for an IQR of 2.5%. This yields the plotted difference of 17.5%. If all countries were accorded MFN tariff status, the tariff IQR would be zero.[7] The figure makes clear that there is considerably more variation in freight rates than in tariff rates. This is true even when mean tariffs are higher, as in the Argentine and Brazilian manufacturing sectors.

We have seen above that unweighted mean freight rates are much higher than weighted mean rates. The same is not true of tariffs, because there is such little variation across exporters. This means that in a comparison of unweighted means, freight rates are nearly always higher than tariff rates. Again, these patterns persist when calculated at more disaggregated levels, suggesting that it is exporter composition and not heterogeneity of goods within product classifications that leads to these results.

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[6] See appendix for details.

[7] It will also be zero if tariff-preferred exporters lie entirely below the 25th percentile.

III. Indirectly Measuring Trade Costs in the One Sector Model

The preceding section suggests that transportation costs may play an important role in allocating trade over partner countries. The difficulty in assessing their relative importance lies in measuring barriers we suspect may exist, but have no way of observing directly. This requires a model of trade. A commonly invoked baseline model for evaluating bilateral trade barriers is the one-sector monopolistic competition model and its companion, the gravity equation. As the model is very well known we identify key features here and refer readers to the seminal work in Krugman (1980).

In the usual formulation, utility is CES over varieties within a sector, and σ is the elasticity of substitution between varieties.

$$U = (\sum_j (C_j)^q)^{1/q} \quad \text{where } q = \frac{s-1}{s}$$

Assuming monopolistically competitive firms and iceberg transport costs leads to the following results. Each firm produces a unique variety so that it may have monopoly power over that variety, expressed as the markup of price over marginal cost, $p / mc = q^{-1}$. The number of varieties produced in each country is determined by the available labor force, the size of fixed costs, and the substitution elasticity, $n_j = L_j / a s$. Variation in pricing across export markets is determined entirely by the iceberg transport cost factor, so if p_j is the exporter's price exclusive of trade barriers and $t_{ij} \geq 1$ is the ad-valorem trade cost, the price faced by importer *i* is $p = p_j t_{ij}$. Consumers in country i import a quantity of each variety produced in exporter j given by

$$q_{ij} = Y_i (t_{ij})^{-s} \left(\frac{p_j}{P_i^{-1/s}} \right)^{-s}$$

where $P_i = \sum_l (p_l t_{il})^{1-s}$ is a price index over all varieties purchased by importer i. Demands are symmetric for all varieties from j, so multiplying the quantity purchased by the number of varieties and price of each variety leads to an expression for the volume of bilateral trade.

(2) $M_{ij} = kY_iY_j(t_{ij})^{-s}\left[\frac{p_j}{P_i^{-1/s}}\right]^{-s}$

Suppose trade costs t_{ij} rise. In this model, production *cannot* adjust across sectors because there is only one sector, and production *will not* adjust across varieties, because one variety is just as good as another. The only role trade costs can play is to cause substitution toward less expensive varieties, with the rate of substitution given by σ.

Estimates from the Literature

We are interested in three questions. One, what cost components belong in the ad-valorem trade barrier? Two, how large is that barrier? Three, what is the elasticity of substitution between goods? To answer the first question, researchers typically experiment by including proxies for trade costs such as the distance between partners, and indicators for common language and adjacency (when countries share land borders). Several studies also include domestic "trade", along with a variable to indicate flows that take place within a country. McCallum (1995) and Helliwell (1996) use explicit data on trade between regions within Canada as well as trade between Canadian regions and US states. Wei (1996) and Helliwell (1997) measure the implied value of trade within OECD countries by netting exports from gross output.[8]

Implicit in these proxies is a relationship between the proxy variable and the ad-valorem trade costs they represent. Let ad-valorem trade costs increase in distance, according to $t(d) = (DIST_{ij})^{d_1}$, and denote the ad-valorem trade cost *savings* from common language, adjacency, and not crossing national borders respectively as (d_2, d_3, d_4).[9] These proxies enter in multiplicative form for ease in estimation, yielding a trade barrier function of

(3) $$t_{ij} = (DIST_{ij})^{d_1}\exp(d_2 lang_{ij} + d_3 adj_{ij} + d_4 \text{home}_{ij})$$

[8] There are several difficulties in constructing the value of "home consumption" for these studies. First, exports are netted from gross output by taking GDP (value-added) and grossing it up by an aggregate gross-output/value-added ratio. This ignores substantial cross-sector variation in the ratio. Second, there is no clearly correct way to measure internal distances (how far is a country from itself?) without explicit intra-national flow data. Since estimates are very sensitive to these measurement issues, caution is urged in interpreting the results.

[9] That is, indicators take a value of 1 when language and a land border are shared and when goods flows stay within a country. If these all correspond to the absence of barriers, the respective delta terms are negative indicating cost savings.

Taking logs, and ignoring the price terms, we arrive at the estimating equation.

$$(4) \qquad \ln M_{ij} = a_0 + a_1 \ln Y_i Y_j + b_1 \ln DIST_{ij} + b_2 lang_{ij} + b_3 adj_{ij} + b_4 \text{home}_{ij} + e_{ij} .$$

The trade barrier coefficients are interpreted as $b_n = -d_n(s)$ for $n = 1..4$. Common estimates of these terms are collected in Table 2. The first column is an estimate by the author of a standard gravity equation using trade data taken from the Statistics Canada World Trade Database. The dependent variable is the value of bilateral imports, summed over all goods, for all country pairs with positive values for trade. Domestic consumption is excluded. National GDP's, distance, and indicators for adjacency and common language are included in the regression. The second and third columns are taken from McCallum (1995) and Helliwell (1997).[10]

While the econometric interpretation of the trade barrier coefficients is straightforward – doubling distance halves trade, intra-national trade is 8 to 20 times larger than international trade – the economic interpretation is not. It is not clear whether costs rise rapidly with distance and borders are very costly to surmount or whether goods are sufficiently close substitutes that small cost differences yield large volume effects. Similarly, the larger border effect measured by McCallum may indicate that the US Canadian border is costlier to surmount than OECD borders generally, or may indicate that US-Canadian products are closer substitutes. Without knowing σ we cannot infer the size of the trade barrier, and without knowing the size of the barrier we cannot infer σ.[11]

Estimating the Freight—Distance Relationship

The explicit freight data described in the previous section provide a way out of this impasse. Suppose that the distance term simply captures freight charges. Using freight data we can directly estimate d_1, the technological relationship between transportation costs and distance. Combining this with the trade-distance relationship (b_1) estimated from the import demand

[10] These are Table 1, column 2 and Table 2 column 3, respectively.

[11] Several authors including Wei (1997) make this point, but lacking explicit trade cost data they cannot identify the relevant elasticity.

equations yields s. That in turn may be used to interpret the size of the trade barriers implied by the other proxies.

We estimate the technological relationship between the ad-valorem freight rate and distance with a log-linear function that includes distance shipped, importer intercepts, and the weight to value ratio of the shipment to capture differences in transportability across goods. Below, we experiment with different functional forms.

$$(5) \qquad \ln \frac{F_{ijk}}{V_{ijk}} = a_i + b_1 \ln \frac{WGT_{ijk}}{V_{ijk}} + b_2 \ln DIST_{ij} + e_{ijk}$$

We estimate (5) using three distinct data sets. First, we use US, New Zealand and Latin American data pooled over all commodities and importers and estimate a common relationship for all goods. An observation consists of imports into importer i, from exporter j, in commodity k (measured at the 5-digit SITC commodity level).[12] In US and Latin American data, imports from adjacent countries have been omitted for two reasons. One, without specific entry and exit points, constructing shipping distance becomes extremely problematic for very close countries. Two, in the Latin American data, transport costs are calculated only between the exporter's exit port and the importer's entry port. For shipments over land, these are the same and so freight expenditures are registered as zero in the data.[13]

A second estimation uses only US import data but employs richer detail available from that source. US Census data include detail on shipment mode (ocean, air, land) and ports of entry. This distinguishes imports entering Virginia from those entering Hawaii and allows a more precise calculation of distance shipped. See appendix for details. An observation consists of imports into port i from exporter j in commodity k, and (5) is estimated separately for ocean and air transport. As comparability in the level of aggregation is not an issue, we use all observations at their most disaggregated (10 digit HS) level.

A third set of estimates employs data from the US Transborder Surface Freight database. This includes, for over-land imports from Canada, the province of origin, the entry port and the shipment mode (rail or truck). This allows a reasonably precise calculation of distance shipped for over-land travel. An observation now consists of imports into entry port i from exporting

[12] US data are reported at much more disaggregated levels (10 digit HS). These data are concorded to the 5-digit SITC categorization for comparability with the other data.
[13] Estimates that include adjacent partners along with an adjacency dummy yield similar distance coefficients.

province j in commodity k, and (5) is estimated separately for rail and truck transport. These data have less commodity detail, providing disaggregation only to the 2-digit HS level (90 goods).

The first panel of Table 3 reports the pooled estimates, along with predicted freight rates over varying distances for each importer (evaluated at the country mean weight/value ratio). We find a precisely estimated distance elasticity of 0.27. These are quite similar to those found in much older studies using less extensive data.[14]

The second panel reports estimates for US data by transport mode. Distance elasticities vary over shipment mode in sensible ways – additional mileage is very expensive for air freight, less so for ocean freight. The estimates for air freight are very close to estimated distance elasticities for air travel terminating in the US contained in the International Civil Aviation Organization's Air Cargo Survey, 1993.[15] However the ICAO estimates much higher numbers for air travel terminating in every other market, with distance elasticities as large as 1.0 and greater. This suggests that the US numbers are a lower bound.[16]

Also noteworthy in the US data are differences in levels of freight rates across modes. Despite similar elasticities, land-based shipment incurs much lower overall charges. A possible explanation may be that when countries share a land border, truck and rail modes allow direct point to point shipment and a minimum of costly mode switching. It also provides a reasonable explanation for the adjacency effect found in trade volume regressions.

We applied several robustness checks to these estimates and experimented with different functional forms. First, allowing commodity-specific distance coefficients in the pooled regression yields distance elasticities tightly clustered in the 0.2 to 0.3 range. Second, the transportation technology for a particular vessel is almost certainly affine in distance. The vessel incurs some fixed costs of loading and unloading and marginal costs (fuel, manning) that are very nearly linear in distance. However, this shape is difficult to identify because the shipping fleet is very heterogeneous, with small vessels (low fixed costs, high marginal costs) used for short hauls, and larger vessels (larger fixed costs, lower marginal costs) used for longer hauls. The data do not distinguish vessel type and so we observe a lower envelope of vessel costs, as

[14] See Lipsey and Weiss (1974) and Moneta (1959).

[15] The ICAO surveys passenger and cargo air fares for a large number of origin and destination cities world-wide. Descriptive statistics published in "Survey of Air Fares" include a regression of ln(air fare) for a 45 kg package on ln(distance), pooled over all cities and for specific geographic route groups.

[16] It also suggests that the distance coefficient may capture more than a technological relationship between rates and distance. Two additional candidates are selection (see robustness checks) and price discrimination is air markets that are less competitive than the US.

represented in Figure 4. Attempts to identify this shape with functional forms that allow non-zero fixed costs or splines result in poor fit and nonsensical results.[17]

Finally, the evidence from Table 1 suggests that data censoring may be a problem. Suppose that at any range of distance there is a set of available goods from which an importer may select, and these goods exhibit some unobserved heterogeneity in their ad-valorem freight rates. At short distances, freight rates are sufficiently low that importers buy all available goods. However, at longer distances freight rates may rise so as to prohibit trade entirely, and we will not observe these rates in the trade data. This is illustrated in Figure 5 with observed rates shaded. OLS estimates of the freight-distance relationship may be biased downward by the censoring and so a Heckman selection model is employed. The first step estimates a probit where the dependent variable is an indicator for bilateral trade (0 if no trade takes places between importer i and exporter j in commodity k, and 1 otherwise). Independent variables include importer and exporter intercepts, distance shipped, and as an exogenous variable, the tariff rate that would be applied to that flow. Selection corrected coefficients are not significantly different from OLS estimates in the pooled regression and yield no clear pattern in commodity-specific regressions.[18] We conclude from this that the Table 3 estimates are unaffected by selection bias.

Interpreting Estimates from the Literature

We now use the estimated technological relationship between freight and distance to interpret the proxy variable coefficients in the one-sector estimates. These are reported in the second panel of Table 2. For the simple gravity regression and the Helliwell regression we use estimates on ocean and air freight distance elasticities from the US data as lower and upper bounds, $\hat{d}_1 \in [.22,.46]$. For the McCallum data, we use estimates for truck and rail elasticities for US and Canadian trade taken from the US Transborder Surface Freight Data to provide bounds, $\hat{d}_1 \in [.27,.39]$.

We solve for the implied substitution elasticity using $\hat{s} = -\hat{b}_1 / \hat{d}_1$. This provides a range from 2 to 5.26, depending on the particular estimates employed. These elasticities have a direct

[17] Spline estimates, for example, yield line segments that are sharply decreasing in distance, or non-concave in distance.

[18] We estimate (5) separately for each commodity using OLS and a Heckman correction. In comparing the distance elasticities across specifications for 62 goods, half yielded no difference between the estimates, one-quarter yielded slightly larger OLS coefficients, and the remaining quarter yielded slightly larger Heckman coefficients.

interpretation in terms of both the effect of barriers on trade volumes and the monopoly markup over marginal cost that firms may charge. These estimates imply markups ranging from 23% (for σ=5.26) to 100% (for σ=2).

We use the substitution elasticity to solve for the implied elasticities of trade costs with respect to language, adjacency, and border crossing using $\hat{d}_i = \hat{b}_i / \hat{s}$, and represent these in their ad-valorem equivalent form by exponentiating the terms. This yields enormous implied costs from these barriers. Not speaking a common language implies a barrier as high as 135% ad-valorem, while non-adjacency raises prices by as much as 141%. The border effects measured by McCallum and Helliwell are astronomically expensive, adding about 200% to goods prices. Note that the ad-valorem equivalent of the border is about the same when comparing the US-Canadian versus OECD borders. The US-Canadian border only looks thicker in a trade volume sense because US and Canadian goods are much closer substitutes than OECD goods as a whole. Finally, the Helliwell estimate also includes an indicator variable for EC countries, and its interpretation implies that non-members face a tariff of 100%.

These enormous estimates suggest a plausibility check. What barrier could language or non-adjacency pose that has the effect of more than doubling the price of imports? What happens at borders to effectively increase prices three-fold? The external tariff on EC members is not nearly 100% so what else does this capture? There are three potential explanations. One, the barriers really are that large. Two, the technique is flawed. Three, the proxy variables capture something other than (or in addition to) barriers to trade. We leave the reader to evaluate the first explanation and take up the last two.

First, these barrier estimates hinge critically on the estimated substitution elasticities and, judging by the sizable monopoly markup they imply, these seem too low. This may be because, when using aggregate data and the one sector model, we are assuming that cars and computers and coal are symmetric substitutes. Of course identifying σ requires the assumption that the distance term proxies entirely for freight costs. Rauch (1998) interprets the distance term as measuring information costs. If both freight and information costs are captured this may imply a larger distance δ, a smaller σ, and therefore even larger implied barriers from language, adjacency and home bias estimates. Second, we rely entirely on the *shape* of the freight barrier, while ignoring its *level*. The technique would have given the same answers had freight barriers been ten times as large. Or, we could have as easily interpreted the distance term as proxying for the cost of making an international telephone call, which rises with an eerily familiar distance elasticity of 0.27.[19] However relying wholly on the shape of the distance function follows from taking seriously the multiplicative functional form for trade barriers employed in the literature.

In the following sections we provide estimates that address all these issues and determine substitution elasticities directly from the regression structure. We also provide insight into a final explanation for large aggregate effects, that our proxy measures capture production composition and preferences instead of (or in addition to) trade barriers.

IV. Indirectly Measuring Trade Costs in the Multi-Sector Model

The one sector-model provides an overly simple characterization of the effect of barriers on trade and implies costs that seem implausibly large. This section introduces a multi-sector framework that suggests another channel, an endogenous production response, through which trade barriers affect trade volumes.

Utility is Cobb-Douglas over sectors and CES within sectors.

$$U_i = \prod_{k=1}^{K} (X^k)^{a_i^k} \qquad \text{where} \quad X^k = (\textstyle\sum_j (C_j)^{q_k})^{1/q_k} \quad \text{and } q_k = \frac{s_k - 1}{s_k}$$

X^k is a CES aggregator over varieties in sector *k*, and the Cobb-Douglas shares a_i^k can be country-specific. Sector expenditure shares are determined exogenously by preferences, while the within-sector distribution of expenditures depends endogenously on relative prices.[20] The multi-sector version of the bilateral import demand equation looks similar to the one sector case. The quantity demanded of a single variety from country j is given by

$$q_{ij}^k = a_i^k Y_i (t_{ij}^k)^{-s_k} \left(\frac{p_j^k}{(P_i^k)^{-1/s_k}} \right)^{-s_k}$$

[19] Phone tariff rates available from OECD Communications Outlook, 1993. A simple regression of ln(rate) on ln(distance) yields a distance elasticity of 0.27.

[20] An alternative explanation for the variation in sector expenditure shares arises from differences in the composition of final goods production across countries and the resulting variation in demands for intermediate goods. In this case the expenditure shares are endogenously determined in general equilibrium.

where $P_i^k = \sum_l (p_l^k t_{il}^k)^{1-s_k}$ is the price index for importer i in sector k. Iceberg transport cost factors and substitution elasticities are sector-specific. With n_j^k varieties available from exporter j, multiplying the quantity purchased by the number of varieties and price of each variety leads to an expression for the volume of bilateral trade

$$M_{ij}^k = (a_i^k Y_i) n_j^k (t_{ij}^k)^{-s_k} \left(\frac{p_j^k}{(P_i^k)^{1/(1-s_k)}} \right)^{1-s_k} \tag{6}$$

Closing this model requires a solution for the number of varieties in each sector, that is, the composition of output. This is where multi-sector models with barriers become exceptionally difficult. Krugman (1980) and Weder (1995) describe in very simple multi-sector models how output responds endogenously to a "home market" effect. In the presence of trade costs and variation in expenditure shares, countries produce more of the goods for which home demand is greater. Extending this argument to a multi-country framework, this becomes a "local market" effect, in which countries produce more of the goods (n_j^k high) for which local (t_{ij}^k low) demand ($a_i^k Y_i$) is highest. Davis and Weinstein (1996, 1998) estimate these "home" and "local" market effects in a simplified framework that relates production to idiosyncratic demand and endowments. They find large production responses to "local" market demand.[21]

In terms of the sector-level import demand equations above, the volume of trade depends on trade barriers directly, through substitution, and indirectly, through their effect on production. This magnifies the effect of trade barriers. For example, if production possibilities are very similar in the US and Canada then a small barrier induces a large production response. Canadian production is matched to Canadian consumption, with large resulting trade volume effects.[22]

One would like to separately identify and measure substitution and production location effects. However, this requires a fully described general equilibrium model that marries exogenous explanations for specialization (technology, endowments) with endogenous home

[21] Davis and Weinstein obviate the need for a complicated model of economic geography by narrowly examining the elasticity of sectoral output with respect to idiosyncratic local demand for that sector. Models with constant returns to scale suggest an upper bound of 1 (when the supply curve is flat). They estimate an elasticity of 1.6, suggesting strong geography effects. However, equation (6) suggests it is necessary to control for production composition so long as the elasticity is greater than zero.

[22] This also suggests caution when pooling across multiple bilateral pairs. If each pair has a different relative cost structure, production responses (and the trade volumes they induce) will vary even when the trade barrier is the same.

market effects. Such models quickly become intractable, yield little useful insight for empirical work, and in any case they lie beyond the scope of the current paper. Our current interest lies with measuring the size and shapes of trade barriers themselves, and this requires only controlling for the production effect in order to measure the size of the substitution effect.

This is not possible when using aggregate data. Rewrite (6) using $n_j^k x_j^k p_j^k = Y_j^k$ where x_j^k is the output of each variety and $g_j^k Y_j = Y_j^k$ where g_j^k is the share of output devoted to sector k, and aggregate over all sectors.

(7) $$M_{ij} = \sum_k M_{ij}^k = Y_i Y_j \sum_k \left\{ \left(a_i^k \frac{g_j^k}{x_j^k} \right) (t_{ij}^k)^{-s} \left(\frac{p_j^k}{(P_i^k)^{-1/s_k}} \right)^{-s_k} \right\}$$

This expression bears some resemblance to the one sector model from equation (2). The difficulty comes in measuring, as a single variable, all the terms in the summation in equation (7). Indeed, it is not clear how one would construct such a summation as the included terms are a mix of endogenous and exogenous factors and the researcher would need to know precisely what one wants to estimate: the size of the trade barrier and the substitution elasticities.

Finally, suppose that importers prefer certain varieties within sector *k*. That is, apart from an overall division of expenditures on sectors (cars versus textiles), we allow differences in utility gained from specific types of cars. This can be represented by including preference weights (b_{ij}^k) in the CES sub-utility function for sector *k*.

(8) $$X^k = (\sum_j b_{ij}^k (C_{ij}^k)^{q^k})^{1/q^k}$$

We rewrite (6) to reflect the inclusion of preference weights as

(9) $$M_{ij}^k = (b_{ij}^k)^{s_k} (a_i^k Y_i) n_j^k (t_{ij}^k)^{-s_k} \left(\frac{p_j^k}{(P_i^k)^{1/(1-s_k)}} \right)^{1-s_k} \quad \text{where} \quad P_i^k = \sum_l (b_{il}^k)^{s_k} (p_l^k t_{il}^k)^{1-s_k}$$

The preference weights allow a straightforward interpretation in terms of the price premium an importer will pay to make him indifferent between varieties (i.e. import the same volume). Let c denote the country to which importer i assigns the mean preference weight in that sector ($b_{ic}^k = 1$). Setting equal *i*'s imports from *j* and *c* and solving for the price premium we have

$$(10) \qquad \left(p_j^k / p_c^k\right) = (b_{ij}^k)^{(\sigma_k - 1)/\sigma_k} \quad \text{or} \quad \ln\left(p_j^k / p_c^k\right) = \sigma_k \ln(b_{ij}^k) / (\sigma_k - 1)$$

If a variety is preferred (b_j>1), then the importer will pay a higher price and still import the same amount.

V. Evidence from the Multi-Sector Model

In this section we estimate sector-level import demand equations using explicit data on freight and tariff rates. The goal here is not merely to provide estimates loosely motivated by the model from the previous section, but to implement the model in a careful structural way. This provides several benefits. One, it allows us to identify the elasticity of substitution between goods. Two, it provides a meaningful interpretation of common proxy variables in terms of their ad-valorem trade barrier equivalent and in terms of implied preferences (and willingness to pay) for specific varieties of goods. Three, attention to the functional form and level of aggregation provides a possible method for distinguishing competing explanations of what precisely common proxy variables capture. Four, it provides an interpretation for regression residuals in terms of their price premium equivalents. This allows us a check on the appropriateness of the underlying structural model that is more directly useful than standard measures of regression fit.

Estimation Technique

Taking logs of equation (6),

$$(11) \qquad \ln M_{ij}^k = \ln \alpha_i^k Y_i + \ln n_j^k + (1 - \sigma_k) \ln p_j^k - \ln P_i^k - \sigma_k \ln t_{ij}^k$$

There are two problems with empirical implementation. The first is measuring “true” trade costs, t_{ij}^k. The second is measuring everything else. We begin with the latter.

Output, expenditure shares, prices, and the price index are unmeasured. The omitted data problem is common in this literature, which puts researchers in the uncomfortable position of estimating demand curves without data on supply or prices! It would be highly problematic here as well, but the model structure and the research question at hand provide a convenient work-around. We sweep out the omitted variables using vectors of importer x commodity and exporter x commodity intercepts. This leaves only the trade cost function and the substitution elasticity to be estimated.

Using intercepts in this manner dramatically reduces the scope for omitted variables and mis-measurement to plague our estimates, as the intercepts take out all variation that is not specific to bilateral pairs. For example, non-tariff barriers that are common to all partners are swept out. Similarly, differences across importers in their method of valuing freight charges (e.g. whether loading expenses are included, whether overland freight is excluded) that are common to all exporters are also eliminated. However, some barriers may operate only through a production effect and not through substitution. Such effects will be missed entirely by this estimation. Also, our trade barrier data must exhibit substantial bilateral variation to identify the substitution elasticity.

The standard approach to measuring trade costs is captured in equation (3). Total trade costs are represented as the product of several component costs that are captured by proxy variables. While convenient for estimation, the multiplicative form has odd economic implications. Equation (3) implies that the marginal effect of a change in one cost depends on all other costs. The estimates in Table 2 suggest that a tariff increase of 10% raises total trade costs by 10% when countries share both a common language and an adjoining border, but costs rise by almost 25% if they share neither. And, whatever costs language capture, they are especially high for goods with high tariff and freight rates. The implication for tariffs is clearly wrong, and it is difficult to think of specific transactions costs captured by language that would depend critically on the level of tariff and freight rates.[23]

A more sensible specification combines the components of costs additively.

$$(12) \qquad t_{ij}^{k} = (f_{ij}^{k} + tar_{ij}^{k} + d_0^k (DIST_{ij})^{d_1^k} + d_2^k lang_{ij} + d_3^k adj_{ij})$$

In addition to the aforementioned barrier proxies we include ad-valorem freight and tariff rates. This specification indicates that a tariff increase of 10% increases total trade costs by 10%, regardless of what other barriers might be operating. Since the data include explicit *relative*

[23] One story does come to mind. Suppose uncertainty about import product quality is rising in our proxy variables, and that uncertainty cannot be resolved until products are imported. Then the cost of resolving the uncertainty is magnified by the costs (freight, tariffs) of importing the products.

prices in the form of tariff and freight rates, the coefficient on the trade barrier function can be interpreted directly as the substitution elasticity, σ. This depends critically on a result from the monopolistic competition model that was discussed above – variation in pricing across export markets is determined entirely by iceberg trade cost factor. The model then implies that bilateral variation in explicit trade costs plus exporter fixed effects exactly identifies variation in prices faced by importers.[24] Note also that the coefficients on proxy indicator variables within the trade barrier function can be interpreted directly in terms of their ad-valorem equivalents. That is, a coefficient of -.07 on the language indicator literally indicates that speaking a common language lowers costs by 7%. The direct interpretation extends to both the *shape* (d_1 in (12)) and *level* (d_0 in (12)) of the distance variable. In contrast, the multiplicative form allows only an assessment of the shape of barriers, which makes difficult the interpretation of what, precisely, the proxy captures.[25]

A careful consideration of functional form points to a different interpretation for standard proxy variables. Rather than viewing distance, a common language, or adjacency as capturing trade barriers, it may be more sensible to regard these as preference indicators.
Taking logs of equation (9) we have

$$(13) \qquad \ln M_{ij}^k = \ln \alpha_i^k Y_i + \ln n_j^k + (1-\sigma_k)\ln p_j^k - \ln P_i^k - \sigma_k \ln t_{ij}^k + \sigma_k \ln b_{ij}^k$$

Preferences interact multiplicatively with barriers. To implement this we assume that only freight and tariff rates belong in the ad-valorem trade cost functions, and allow common proxies to capture the preference parameter

$$(14) \qquad b_{ij}^k = (DIST_{ij})^{b_1^k} \exp(b_2^k lang_{ij} + b_3^k adj_{ij}) \quad \text{or} \quad \ln b_{ij}^k = b_1^k \ln(DIST_{ij}) + b_2^k lang_{ij} + b_3^k adj_{ij}$$

The common language proxy lends itself naturally to a preference interpretation, but motivating the inclusion of observables such as distance and adjacency requires a story about hysteresis in production patterns. Suppose trade barriers lead to home or local market effects in which producers specialize in locally preferred varieties. If scale economies lock in the particular

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[24] If firms price-to-market, the price exclusive of trade costs is also affected by the trade costs and so the freight and tariff data are insufficient to identify cross-market variation.
[25] See the discussion about freight versus telephone costs at the end of Section III.

varieties, the home market effect will persist even after the barriers are gone. This story is closely related to the endogenous production response described in connection with equation (6), differing only in the level of aggregation. We think of variation in sector expenditure and production (a_i^k, n_j^k) as capturing local market effects that operate at high levels of aggregation (shifting from automobile production to airplane production). These are eliminated through the use of country x commodity intercepts in the estimating equation. The preference parameters (b_{ij}^k) capture local market effects at low levels of aggregation (shifting from a very specific kind of machine tool to another). These are not eliminated by the intercepts, but may be captured by the proxies or in the residual.

Since proxies are used to estimate the preference weights the degree of preference is confounded by the substitution elasticity

$$(15) \qquad \hat{b}_n^k = s_k \ln b_n^k \text{ for n} = 1\ldots3$$

This is acceptable as the *b* terms are not by themselves useful and (10) allows us to directly evaluate the regression coefficients for each component in terms of the price premium they imply.

$$(16) \qquad \ln\left(\frac{p_j^k}{p_c^k}\right) = \hat{b}_n^k / (\hat{s}_k - 1)$$

Using $\ln(1+x) \approx x$ this gives the increased willing-ness to pay relative to the comparison country for each component. The comparison country c does not share a common language or border, and is further than j from the importer. The coefficients are then interpreted as the discount the importer must be offered to trade with a partner of greater distance and the premium the importer will pay to trade with a partner of common language and sharing a border.

The estimating equations are

$$(17) \quad \ln M_{ij}^{kl} = a_o + a_i^k + a_j^k + b^k \ln(f_{ij}^{kl} + tar_{ij}^{kl} + d_0^k (DIST_{ij})^{d_1^k} + d_2^k lang_{ij} + d_3^k adj_{ij}) + e_{ij}^{kl}$$

$$(18) \quad \ln M_{ij}^{kl} = a_o + a_i^k + a_j^k + b^k \ln(f_{ij}^{kl} + tar_{ij}^{kl}) + b_1^k \ln(DIST_{ij}) + b_2^k lang_{ij} + b_3^k adj_{ij} + e_{ij}^{kl}$$

An observation is the volume of imports into importer *i* from exporter *j* in a 5-digit SITC "variety" *l* that belongs to a larger two-digit "good" *k*. All observations within a two-digit good are pooled and estimated together, with each of 62 goods estimated separately. We assume that all variables super-scripted k in (17) and (18) are identical across varieties *l* within a good. Vectors of importer and exporter dummy variables (as opposed to interactions with commodity effects) are then sufficient to capture all the omitted variables. This leaves only the substitution elasticity and the trade cost or preference function to be estimated, and these are specific to each good. Below we provide an interpretation for the regression residuals.

Results

We employ 1992 data from the US, New Zealand, Argentina, Brazil, Chile, and Paraguay, with data drawn from the national sources described in section 2 and the appendix.[26] Table 4 reports OLS estimates of equation (18) for each sector. Table 6 averages effects over all 62 goods (treating insignificant estimates as zeros). The coefficient on the freight + tariff variable is directly interpreted as the CES elasticity ($s_k = -\hat{b}_k$) for that good. We find significant estimates for 57 of the 62 2-digit "goods" with an average value of 5.6 and most goods in a range from 3 to 8. The elasticity is useful both as an indicator of the effect of trade barriers on trade volumes and as a measure of the markup over marginal cost that producers of differentiated goods can charge. The average elasticity value implies that a 10% tariff increase lowers trade by 56 percent and that markups are on the order of 22 percent. Goods within SITC 7 (Machinery) have the largest elasticities, averaging 8.

Distance, language and adjacency effects are significant for 35, 23, and 16 of the 62 goods, respectively. The sizes of the proxy variable coefficients are not directly useful, and so we use equation (15) to interpret them in terms of the price premium they imply. We also provide means and standard deviations on the freight + tariff variable for comparison. Averaging over all goods, the price premia indicate that importers will pay a 4 percent premium to trade with partners of a common language and a 2 percent premium to trade with adjacent countries. Importers demand an average premium of 8 percent to buy from partners who are twice as distant. Effects differ substantially across goods, with proxies rarely significant in the commodity categories (SITC 0-4). In all cases, the price premia from the proxy variables are comparable in size or smaller than explicitly measured barriers (freight + tariffs).

Table 5 reports non-linear least squares estimates of equation (17). The distance variable is normalized to mean 1 so that it is comparable in size to the other variables. The adjacency variable is dropped as it is insignificant in all estimates. Out of 56 goods[27], significant substitution elasticities were estimated for 41 goods, with an average value of 9.3. However, these estimates are significantly different from OLS estimates in only 12 goods. Several sectors had extremely high substitution elasticities, including feedstuffs (58.98) and scientific instruments (78.6).

Note that predicted signs on proxy variables are the opposite of equation (18) because the coefficients are directly interpreted as trade costs. Significant and positive distance effects were found for only ten of the sectors, with three additional sectors having significant and negative effects (greater distance *lowers* costs). To interpret distance coefficients as ad-valorem equivalents, we calculate the cost of moving the sample mean distance (from 7,000 to 10,000 km, depending on the good) and the additional cost of one standard deviation increase in distance. Of the significant estimates, the size of the effect varies widely, from reducing costs by 60 percent, to increasing them fourteen-fold. These extreme estimates (very large substitution elasticities and negative distance effects) are highly sensitive to the inclusion of the language variable.[28] Language effects are significantly negative for 23 sectors and indicate that speaking a common language lowers costs by an average of 5 percent (all sectors, treating insignificant as zero) to 12 percent (significant estimates only).[29]

What precisely do these proxies capture? Comparing the results from (17), where proxies enter as trade barriers, and (18), where proxies enter as preference parameters, we cautiously conclude two things. One, language effects are significant for roughly the same set of goods and are of similar size (when comparing ad-valorem and price premium equivalents). This provides no useful insight into which interpretation is most appropriate. Two, adjacency effects never matter and distance effects rarely matter when interpreted directly as trade barriers. When interpreted as price premia, distance and adjacency are significant for half and a quarter of the goods, respectively. Further, distance premia are large (doubling distance increases the premia

[26] Uruguay is omitted, as data are not available until later years for which we have no matching tariff data.
[27] 5 goods are omitted from the table as the NLS routine could not converge on a solution.
[28] Excluding language yields no negative distance effects. The substitution elasticity for scientific instruments drops to 12.4.

by 20-25) for cork and wood, inorganic chemicals, paper and paperboard, nonmetallic minerals, iron and steel, rubber manufactures and cork and wood manufactures. These goods are all characterized by relatively high transport costs (see Table 1). Since these costs are explicitly in the regression, the distance coefficient may be identifying an endogenous production response. Transport costs operate indirectly by placing the production of specific varieties proximate to locations where these varieties are strongly preferred.[30] A similar force may be captured by the adjacency variable, as adjacency effects are largest for bulky products (furniture, prefabricated buildings).

Next, we provide robustness checks on the level of aggregation. In estimating (17) and (18) with two-digit "goods" we assumed that all variables with *k* superscripts were common to 5-five-digit varieties within that good. This may result in two sorts of difficulties. First, varieties within each "good" may be so heterogeneous that it is not possible to identify the substitution elasticity.[31] In the extreme case the pooled goods may not be substitutes at all. This suggests that, when measured for narrower product categories, estimated substitution elasticities should rise.

Second, the omitted variables (prices, output and expenditure shares) may exhibit heterogeneity across varieties within a good and are therefore only partially controlled for by importer and exporter intercepts. This may simply create noise in the regression, in which case moving to three- or four-digit “goods” will not change estimate elasticities, but it will shrink estimated residuals. Heterogeneity may also manifest itself in the form of the endogenous production response just discussed in connection with distance and adjacency variables. Since production responses reinforce and magnify the effects of trade barriers, moving to narrow product categories should reduce their measured effects as the intercepts do a progressively better job of controlling for composition. This suggests that, when measured for narrower product categories, estimated substitution elasticities should fall. Combined with the effect described above, changing the level over which goods are pooled has an ambiguous effect on the estimated CES elasticity. However, if the intercepts better control for composition at lower levels we should see smaller estimated volume effects on the proxy variables.

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[29] However, distance effects are not meaningful unless both distance coefficients and the CES elasticity are significant. Language effects are meaningful if the CES elasticity is significant.

[30] It may also be that the freight + tariff variable is noisily measured, or that the model's assumption about transport cost incidence is inappropriate. In these cases, distance may capture transport effects directly.

[31] In SITC 05, for example, we are literally comparing apples to oranges.

We re-estimate (18) by pooling all 5-digit "varieties" l within a "good" k, where k is defined variously as a one-, three-, and four-digit classification. As before we include vectors of importer and exporter intercepts, but these intercepts now isolate country x "good" specific information at varying levels of aggregation. To economize on tables, we report in Table 6 three values for each variable at each level of aggregation. These include: the number of significant estimates; the mean estimated coefficient (with mean calculated only over significant coefficients); and the mean price premium implied by the components in the preference vector (with the mean calculated over all regressions at that level, and insignificant coefficients are treated as zeros). We also report summary information for all goods within SITC codes 5-9 (manufacturing).

The price premia indicate that importers will pay a 3 to 5 percent premium to trade with partners of a common language and a 1 to 3 percent premium to trade with partners who are adjacent. Importers demand a premium of 4 to 11 percent to buy from partners who are twice as distant. Regarding the level of pooling, first note that the mean CES elasticity grows larger when pooling over narrower product categories. Moving from one- to four-digit regressions we find nearly all the estimated elasticities of trade volume with respect to proxy variables growing larger. However, since the CES elasticities are also growing larger, the estimated price premia do not change much when averaging over all goods. When averaging over manufactures only, the premia shrink as we move from two- to four-digit pooling. This supports the notion that the proxy variables capture matching of "local" production and consumption and that at progressively lower levels the country intercepts better capture these composition effects. Not all effects are eliminated, suggesting that some preferences operate on very narrow product specifications that we are unable to measure.

We repeat our non-linear least squares estimates of equation (17), pooling over all varieties l within a three-digit "good" k (for a total of 248 goods). The non-linear form and long lists of intercepts estimated in (17) require substantial variation to identify and further disaggregation eliminates too many observations to be of much use. Again, the adjacency variable is dropped, as it is insignificant in all regressions. The estimated substitution elasticities for three-digit goods indicate no clear pattern of difference from two-digit estimates.[32] Distance effects are only significant and positive for 10 goods, though very large (traveling the

[32] The substitution elasticity for three-digit goods is significantly larger than the corresponding two-digit goods in 15% of cases, significantly smaller in 15%, and no different in the rest.

mean distance roughly doubles goods prices) in each case. Language effects are significant in 41 goods, and of similar magnitude to two-digit estimates.

Interpreting the Residuals

The R^2 reported in Tables 4 and 5 indicate that the models in (17) and (18) explain only a small part, a third or less, of the variation in trade volumes. It is not clear, however, what this poor fit means. Perhaps the structural model is inappropriate, or perhaps we have omitted important trade costs that would help fit the bilateral pattern of trade. An intriguing third possibility is that the structural model is fine and omitted costs are very small, but that the elasticity of substitution is very high. In this case we can account for unexplained trade volumes with small unmeasured trade barriers. To evaluate this hypothesis, we provide a structural interpretation of the regression residuals in terms of the willing-ness to pay for preferred varieties.[33] This allows a partition of trade costs into explicitly measured costs (freight and tariffs), costs captured by proxies, and unmeasured costs.

Suppose that there are "preferred" varieties, as in equation (9) and that the regression residuals exactly reflect unobserved preference parameters ($\ln b_{ij}^k = \hat{e}_{ij}^k$). That is, deviations from the regression model are ascribed entirely to preferences. We can rewrite the residual in terms of a price premium relative to the mean variety as in equation (16).[34] Employing the estimated elasticity we have

$$(19) \qquad \frac{p_j^k}{p_c^k} = \exp(\hat{e}_{ij}^k / (\hat{s}_k - 1))$$

The implied price premium in (19) is small when the residual is small and when the substitution elasticity is large.

In the regressions associated with Tables 4-6, each observation has its own residual with its own price premium interpretation. Some goods are favored (premium greater than one) and

[33] See Leamer (1988) for a study that employs residuals to measure countries' "open-ness" to trade. The structural context in that study differs considerably from this, employing constant returns models, and ignoring bilateral trade.
[34] The residual is from a regression estimated in logs and must be exponentiated to equal the preference term.

some are disliked (premium less than one) and the mean price premium equals one by construction.[35] We calculate the absolute deviation from one and report its mean and standard deviation for each two-digit "good" in Tables 4 and 5. In the interests of space, we provide calculations using only the point estimate on the substitution elasticity – one could also place confidence intervals around the premia using the relevant standard errors.

There are several findings. In cases with above average substitution elasticities ($\hat{s} > 7$), the residual implies an average price premium less than or equal to the freight and tariff rates. Smaller substitution elasticities imply much larger residual premia. That is, given the low degree of substitutability between varieties, an importer must have extremely strong preferences to generate observed deviations from mean trade volumes.

The pattern of price premia make clear that traditional measures of regression fit are not especially informative about unmeasured trade barriers. In Table 4, for example, the R^2 for SITC 52 (Inorganic Chemicals) and SITC 54 (Pharmaceuticals) are very similar. However, the unmeasured price premium is six times larger for SITC 52 because the substitution elasticity is so much lower. Similarly, there is no difference in regression fit for the different levels of aggregation examined in Table 6, but the implied price premium shrinks as the substitution elasticity grows.

Of course, several cautions should be offered. First, interpreting the residuals as unmeasured barriers or preferences admits that the estimation suffers from omitted variables, along with the attendant biases they induce. These are especially problematic if they affect the estimated substitution elasticity.

Second, the residuals may be sensitive to measurement error. This seems like a fairly minor concern, as tariff rates are taken from customs schedules, and the import volumes and freight rates come from carefully collected customs information data. National customs offices have strong incentives (the desire to levy duties) to verify that these data are correct, and the wherewithal to physical detain and inspect shipments for reporting accuracy. One suspects this leads to greater accuracy here than is obtainable with any other industrial statistic. Clearly the proxies are subject to error, but that is largely the point. We do not know what precisely they capture and we want to partition costs into the measured, the proxied for, and the unmeasured.

Third, the underlying structural model may not properly characterize import demands, or may only fit the data for certain goods. However, this interpretation makes the price premium

[35] That is, the least squares routine generates a log normal error with mean zero, corresponding to an unobserved preference weight of one.

equivalents very useful as a kind of test of model fit. One can look at residuals that imply unmeasured trade barriers equal to or smaller than freight and tariff rates and believe such barriers plausibly exist. When residuals imply barriers that are orders of magnitude larger it becomes clear that the model at hand simply isn't right.

Where might the model go wrong? There are several possibilities. First, the aggregation argument offered above cites problems with omitted variables and comparing heterogeneous goods when pooling over a broad set of goods. Table 6 suggests that narrowing the definition of a "good" raises the substitution elasticity, and shrinks the price premia implied by the residual. Related to this, we may simply not have enough variation to identify the relevant elasticities. This is especially problematic in non-linear least squares estimates of equation (17) for goods with small numbers of observations.

Second, our assumptions on the incidence of transport costs on goods pricing are critical. If firms lower export prices when trade costs are high, variation in freight and tariff rates will overstate actual variation in prices faced by importers. This results in low estimated elasticities, and large price premia implied by the residuals.

Three, the model emphasizes smooth substitution and ignores selection effects. SITC 05 (Fruits and Vegetables) in Table 4 and SITC 02 (Fish) in Table 5 have low substitution elasticities and imply unobserved barriers that swamp freight and tariff rates. Yet, freight rates on these goods are exceptionally high and vary considerably over trading partners. The answer may be that in these goods freight rates work mostly on the extensive margin – importers buy from proximate sources of supply or not at all.

Conclusion

Trade barriers play a central role in models of international specialization and trade, and empirical evaluation of these models must ultimately confront trade costs. This paper offers direct and indirect evidence on trade barriers, moving us toward a comprehensive geography of trade costs. There are three main contributions.

One, we provide new data on freight rates for a number of importers. Rates vary substantially over exporters, and aggregate expenditures on freight are at the low end of the observed range. This suggests import choices are made so as to minimize transportation costs. Two, we estimate the technological relationship between freight rates and distance and use this to interpret the trade barriers equivalents of common proxy variables from the literature. The resulting calculations reveal implausibly large barriers. Three, we use a multi-sector model of trade to isolate channels through which trade barriers affect trade volumes. The model motivates an estimation technique that delivers direct estimates of substitution elasticities. This allows a complete characterization of the trade costs implied by trade flows and a partition of those costs into three components: explicitly measured costs (tariffs and freight), costs associated with common proxy variables, and costs that are implied but unmeasured. Explicitly measured costs are, for many goods, most of the story.

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Table 1 -- Commodity Distribution of Freight Rates

(Freight as % of Imports, Aggregated over all Partners, 1994)

		Average Freight Rate (Trade-Weighted)							Average Freight Rate (Unweighted)						
SITC		USA	Argentina	Brazil	Chile	Paraguay	Uruguay	N Zealand	USA	Argentina	Brazil	Chile	Paraguay	Uruguay	N Zealand
	All goods	**3.8**	**7.5**	**7.3**	**8.8**	**13.3**	**4.6**	**8.3**							
0	**Food and Live Animals**	**8.2**	**9.9**	**10.4**	**12.7**	**12.0**	**3.6**	**14.5**	**14.1**	**21.6**	**23.1**	**21.9**	**12.8**	**7.4**	**15.4**
00	Live Animals	2.4	20.7	5.8	16.9	13.1	13.4	4.3	21.1	37.7	40.5	42.1	10.9	18.2	21.8
01	Meat And Meat Products	6.7	6.7	5.4	6.8	12.9	2.6	8.8	9.7	13.6	17.8	21.9	12.4	5.3	15.7
02	Dairy Products	6.3	8.4	5.2	11.6	12.9	7.1	8.8	9.9	16.8	15.7	17.8	12.0	7.1	12.6
03	Fish	5.2	7.0	7.0	6.3	10.7	5.3	6.4	13.2	23.6	20.3	24.6	13.0	8.3	14.0
04	Cereals	8.3	12.6	12.8	14.2	11.2	5.7	22.1	14.0	23.3	27.9	27.9	13.4	9.1	20.0
05	Vegetables And Fruits	15.6	15.3	11.1	23.4	11.4	4.3	25.7	17.4	23.7	24.7	21.7	12.6	7.0	16.9
06	Sugars, Sugar Prep	9.8	12.0	6.8	12.3	10.4	3.5	9.3	12.7	20.6	21.7	18.6	13.1	8.7	14.1
07	Coffee, Tea	5.0	5.9	10.3	10.2	10.0	1.3	7.3	10.8	18.0	19.8	20.2	12.5	5.2	12.1
08	Feeding Stuff	8.0	13.3	6.8	16.4	10.6	3.8	17.4	16.3	16.7	24.7	17.2	13.5	7.5	16.3
09	Misc food products	6.1	9.6	6.2	9.1	11.6	2.4	8.2	11.5	22.4	22.6	20.5	13.5	8.8	14.8
1	**Beverages & Tobacco**	**6.9**	**11.3**	**9.0**	**8.4**	**10.4**	**4.8**	**9.4**	**14.4**	**20.6**	**18.3**	**18.2**	**12.8**	**8.0**	**14.0**
11	Beverages	7.2	12.0	10.4	8.8	9.4	4.5	9.9	14.3	21.2	18.3	18.0	12.5	7.7	14.4
12	Tobacco	5.3	4.9	5.3	5.7	11.7	5.6	6.4	14.6	18.2	18.8	19.7	13.9	9.0	12.5
2	**Crude Materials**	**8.2**	**15.2**	**7.7**	**12.0**	**10.2**	**3.7**	**16.3**	**15.1**	**20.5**	**20.1**	**23.1**	**12.0**	**8.3**	**20.6**
21	Hides, Skins	1.5	10.9	7.9	6.7	12.9	2.3	5.7	9.3	10.4	13.8	8.4	12.5	3.1	11.6
22	Oil Seeds	5.2	8.9	7.5	10.8	13.2	5.2	15.0	15.6	27.4	13.0	22.8	12.6	3.9	16.6
23	Crude Rubber	8.1	10.8	8.8	13.5	12.1	2.9	12.3	13.7	12.9	17.6	17.0	12.0	3.3	16.3
24	Cork And Wood	5.8	6.6	2.8	18.5	12.3	2.2	13.0	16.0	15.2	22.7	24.5	10.4	8.1	19.8
25	Pulp And Waste	6.0	15.2	11.8	24.0	8.8	3.9	20.9	15.5	25.5	19.4	33.3	10.6	7.1	24.7
26	Textile Fibers	5.8	8.2	5.1	10.0	11.2	1.7	10.1	15.8	23.5	20.7	19.6	13.7	7.6	16.1
27	Crude Fertilize	27.0	34.4	21.1	38.6	9.3	17.0	63.5	21.1	26.1	31.3	33.3	11.3	13.1	33.4
28	Metalliferous Ores	8.9	21.9	6.1	6.3	8.8	27.4	7.2	12.6	22.1	13.5	36.0	10.1	17.7	22.5
29	Crude Animal n.e.s	10.9	10.1	6.6	7.6	12.3	4.5	7.7	12.9	17.5	16.1	17.1	12.3	7.9	15.3
3	**Mineral fuels, lubricants**	**6.6**	**14.7**	**10.7**	**11.8**	**20.9**	**4.7**	**9.9**	**15.7**	**20.5**	**20.3**	**24.9**	**13.8**	**9.2**	**18.7**
32	Coal, Coke	15.7	34.5	15.7	29.7	9.3	2.2	55.7	28.6	44.9	19.8	47.3	8.6	5.1	49.3
33	Petroleum,	6.9	15.6	8.9	9.4	21.5	3.8	9.8	12.6	18.5	16.9	21.2	13.9	9.3	16.9
34	Gas, Natural	3.5	0.5	26.1	28.9	13.1	19.4	11.4	23.6	11.2	28.7	24.4	14.3	11.0	13.3
4	**Animal & Veg Oils, Fats**	**7.1**	**10.8**	**5.4**	**9.3**	**12.5**	**2.6**	**10.6**	**10.6**	**17.4**	**17.6**	**16.6**	**11.7**	**5.0**	**12.0**
41	Animal Oils	6.7	15.4	10.7	17.8	11.6	5.3	13.0	10.8	18.6	17.3	17.7	10.7	4.5	14.2
42	Vegetable Fats	7.0	9.8	4.6	8.5	12.8	2.4	10.4	9.5	16.1	15.0	13.6	12.5	4.8	11.2
43	Animal Or Veget fats	8.3	10.1	12.2	13.4	11.4	2.3	10.7	12.7	18.6	21.6	19.4	10.7	5.6	12.8
5	**Chemicals & Related Prod**	**4.5**	**7.6**	**6.8**	**10.2**	**10.4**	**3.0**	**9.0**	**9.0**	**12.3**	**14.0**	**14.4**	**12.4**	**4.7**	**13.0**
51	Organic Chemical	4.2	6.4	5.1	9.3	11.4	3.2	7.5	6.6	10.1	11.5	12.5	12.0	3.1	11.6
52	Inorganic Chemicals	7.1	18.9	13.8	21.5	11.4	5.2	19.8	12.2	16.4	18.4	19.8	11.8	4.5	17.8
53	Dyeing, Tanning	3.4	7.1	5.9	5.5	9.7	2.0	7.1	6.8	11.9	12.0	13.2	12.7	4.7	11.2
54	Pharmaceuticals	1.2	3.2	2.0	4.6	10.9	1.3	2.8	3.9	6.8	8.2	7.9	12.5	2.9	7.7
55	Essential Oils	3.4	8.5	8.8	8.5	11.0	3.6	8.0	8.9	13.6	18.9	17.1	13.0	6.7	12.4
56	Fertilizers	14.3	17.1	13.4	18.1	8.5	2.6	22.4	15.4	18.4	14.5	23.4	10.1	4.8	27.3

Table 1 -- Commodity Distribution of Freight Rates

(Freight as % of Imports, Aggregated over all Partners, 1994)

SITC		Average Freight Rate (Trade-Weighted)							Average Freight Rate (Unweighted)						
		USA	Argentina	Brazil	Chile	Paraguay	Uruguay	N Zealand	USA	Argentina	Brazil	Chile	Paraguay	Uruguay	N Zealand
57	Plastics In Primary	5.0	9.5	8.1	11.2	9.6	4.0	12.0	13.6	13.3	14.2	13.9	12.4	4.8	13.0
58	Plastics In Nonprimary	4.6	8.3	7.9	9.4	11.0	3.8	8.4	10.8	13.6	16.8	16.0	13.4	7.1	12.4
59	Chemical Materials nes	4.6	7.1	7.4	7.5	10.2	2.8	7.9	8.8	14.2	16.0	14.4	12.2	6.0	13.7
6	**Manuf. Goods (by material)**	**5.3**	**9.4**	**8.5**	**10.9**	**11.2**	**4.7**	**10.0**	**10.3**	**15.5**	**17.7**	**14.7**	**13.3**	**7.9**	**13.1**
61	Leather manufactures	3.8	6.2	2.1	4.3	11.0	0.9	4.3	8.2	17.1	9.5	12.4	12.8	5.2	10.6
62	Rubber Manufactures	5.3	7.6	7.7	10.8	10.2	3.6	10.8	10.9	13.6	16.8	15.3	13.3	6.9	12.9
63	Cork And Wood Manufactures	6.9	8.3	8.7	11.6	10.2	4.2	12.2	13.5	23.0	27.2	23.1	12.2	10.2	18.2
64	Paper, Paperboard	6.0	13.1	15.5	14.2	9.6	5.4	13.8	12.4	18.8	23.0	18.0	12.6	8.9	16.4
65	Textile Yarn	4.9	8.0	7.0	8.3	13.3	3.9	7.5	11.1	15.9	18.3	14.2	13.6	7.6	11.7
66	Nonmetallic Manufactures	4.8	13.0	12.5	19.7	10.7	6.0	15.6	12.2	19.2	21.9	18.6	13.3	10.7	17.2
67	Iron And Steel	8.4	8.1	10.1	11.5	11.2	6.7	12.8	9.8	13.3	14.7	12.8	11.5	6.9	13.7
68	Nonferrous Metals	2.2	4.3	4.2	6.2	9.5	2.9	5.2	5.8	11.5	12.6	12.3	12.2	5.1	8.9
69	Manufactures Of metals nes	4.8	10.0	9.6	9.0	12.0	5.1	7.4	7.9	13.5	16.0	12.9	13.8	7.4	11.4
7	**Machinery & Transp Equip**	**2.0**	**5.6**	**5.1**	**6.3**	**13.8**	**4.1**	**6.3**	**5.7**	**11.2**	**11.5**	**11.3**	**13.5**	**7.3**	**9.6**
71	Power Generating Machinery	1.7	4.4	4.1	4.0	12.4	3.5	3.7	5.6	11.0	10.7	11.3	12.5	7.9	10.0
72	Machinery Specialized	2.9	5.8	4.7	5.9	12.0	3.8	5.9	6.3	11.3	10.5	11.3	13.0	6.8	10.1
73	Metalworking Machinery	3.1	5.4	4.4	5.0	12.0	3.2	5.0	5.2	9.5	8.7	11.6	13.8	5.9	8.4
74	General Industrial Machinery	3.0	6.6	6.1	6.6	13.2	4.2	6.2	6.5	11.6	12.0	10.7	13.4	6.7	10.5
75	Office Machines	1.7	4.9	4.8	4.7	15.5	4.5	2.7	3.5	10.0	10.4	9.4	13.7	7.5	5.9
76	Telecommunications	1.9	4.8	6.6	5.0	15.6	3.3	3.5	4.1	10.4	10.8	11.2	14.0	6.8	7.6
77	Electrical Machinery	1.8	7.0	5.6	7.2	12.6	4.5	5.3	4.9	10.7	11.9	11.0	13.7	7.0	8.9
78	Road Vehicles	2.1	5.7	4.8	8.1	13.0	4.2	10.5	8.3	13.5	15.9	15.2	14.0	11.1	14.8
79	Transport Equip	0.9	2.8	1.6	4.9	14.3	5.6	3.3	6.0	12.3	10.8	13.0	12.3	7.5	10.1
8	**Misc Manufactures.**	**4.7**	**9.3**	**8.1**	**9.1**	**15.2**	**5.8**	**6.6**	**8.3**	**16.9**	**18.7**	**15.3**	**13.9**	**9.0**	**12.1**
81	Prefabricated Buildings	7.0	11.7	16.7	11.5	14.2	5.1	9.9	10.0	18.0	22.5	18.8	14.1	8.6	13.9
82	Furniture	6.7	12.5	15.3	17.7	13.7	8.1	15.0	12.7	22.6	32.0	26.8	13.5	14.9	20.3
83	Travel Goods	6.9	14.8	20.1	11.9	18.0	9.6	8.9	12.9	23.0	25.5	16.5	14.2	13.0	13.3
84	Apparel	5.2	9.2	11.9	9.2	13.8	5.2	5.7	8.6	18.4	20.7	14.7	14.0	8.2	12.4
85	Footwear	4.9	7.6	7.9	8.6	16.0	4.5	6.8	10.6	15.2	20.1	14.0	13.9	8.3	11.1
87	Scientific Instruments	2.0	5.1	3.8	4.9	11.8	3.0	3.9	4.4	10.1	8.6	9.9	13.1	6.3	7.7
88	Photographic Equipment	2.5	5.5	6.0	5.3	15.6	3.7	4.3	4.9	12.5	13.0	10.6	13.8	7.6	9.7
89	Miscellaneous Manufactures	4.7	12.1	12.8	12.0	15.6	7.5	7.4	8.7	18.5	21.6	17.9	14.3	10.1	13.0
9	**All other goods, NES**	**1.0**	**4.5**	**0.8**	**7.6**	**6.8**	**2.5**	**0.6**	**2.5**	**18.3**	**7.0**	**11.8**	**7.7**	**2.5**	**7.6**
	Weighted < unweighted rate: count	71	69	72	66	47	64	66							

Notes

1. Commodity rates describe the importer's total freight expenditure relative to total imports for that commodity
2. Final columns describe the distribution over exporters (to US and to NZ) of freight rates for that commodity.

Sources: US Census, Statistics New Zealand, ALADI Secretariat. See appendix for details.

Table 2: Barrier Effects on Trade Volumes and Ad-valorem Equivalents

	Barrier Estimates: Volume Effects				Barrier Estimates: Ad-valorem Equivalents					
	Gravity	McCallum	Helliwell		Gravity		McCallum		Helliwell	
Distance	-1.01	-1.42	-0.92	elasticity of costs	0.22	0.46	0.27	0.39	0.22	0.46
	(0.03)	(0.06)	(0.03)	w.r.t. distance						
				implied sigma	4.59	2.20	5.26	3.64	4.18	2.00
Language	0.66		0.58		**115**	**135**			**115**	**134**
	(0.06)		(0.12)							
Adjacency	0.76		0.15		**118**	**141**			**104**	**108**
	(0.15)		(0.15)							
Border	..	3.09	2.09				**180**	**234**	**165**	**284**
		(0.13)	(0.29)							
EC			0.26						**106**	**114**
			(0.1)							
obs	8610	683	465							
R2	0.65	0.81	0.89							

Volume Effects are estimated, Ad-valorem equivalents are constructed
1. Elasticity of costs w.r.t. distance taken from freight regressions in table 3
2. Sigma = B1/d1
3. Ad - valorem equivalents = 100* exp(Bi/sigma)

Gravity dep var: aggregate bilateral imports for 125 importers and exporters (no domestic consumption) from StatCan database

McCallum dep var: aggregate bilateral imports between Canadian provinces and US states (Table 1, Column 2)

Helliwell dep var: aggregate bilateral imports between OECD countries, including implied value of domestic consumption (Table 2, Column 3)

All regressions include partner country/state GDP terms in regression

Table 3: Spatial Structure of Freight Rates
(Regression Evidence from 7 Importers, 1994)

Pooled Regression: All importers

	const	weight-value (kg/$)	Distance to exporter (km)	Adj R2	obs	Predicted freight rate -- % of import value (for cargo of country mean kg/$) *km*	*2500*	*5000*	*10000*	*15000*
		0.246	0.267	0.283	278869					
Intercepts		(0.001)	(0.002)			**mean kg/$**				
US	-4.62					**0.62**	7.1	8.5	10.2	11.4
Argentina	-4.17					**0.44**	10.2	12.3	14.8	16.4
Brazil	-4.23					**1.44**	12.8	15.4	18.6	20.7
Chile	-4.19					**0.41**	9.8	11.8	14.2	15.8
Paraguay	-3.99					**1.71**	17.0	20.5	24.6	27.4
Uruguay	-4.66					**0.38**	6.0	7.2	8.7	9.7
New Zealand	-4.25					**0.23**	7.9	9.6	11.5	12.8

Notes:
1. All variables in logs. Standard Errors in parentheses
2. Observations consist of all data, exporter x commodity (at most disaggregated level available)

US Data: Imports by Mode

	const	weight-value (kg/$)	Distance to exporter (km)	Adj R2	obs	Predicted freight rate -- % of import value (for cargo of modal mean kg/$) *km*	*2500*	*5000*	*10000*	*15000*
US Imports (Census)										
						mean kg/$				
AIR	-4.66	0.572	0.459	0.45	534088	**0.06**	6.9	9.4	13.0	15.6
	(.030)	(.0008)	(.003)							
OCEAN	-4.17	0.473	0.220	0.38	541333	**0.45**	5.9	6.9	8.0	8.8
	(.019)	(.0008)	(.002)							
						km	*300*	*750*	*1500*	*3000*
US Imports from Canada (Transborder Surface Freight Data)										
						mean kg/$				
TRUCK	-5.60	0.235	0.275	0.19	33183	**1.53**	1.8	2.3	2.7	3.3
	(.040)	(.003)	(.006)							
RAIL	-6.46	0.574	0.388	0.31	11965	**3.61**	1.4	2.0	2.7	3.5
	(.069)	(.009)	(.010)							

Table 4: OLS Estimates of Import Demand

		Volume Effects						Freight + Tariffs		Implied Price Premium				
													Residual	
		CES	DIST	LANG	ADJ	R2	OBS	Mean	s.d.	DIST	LANG	ADJ	Mean	s.d.
00	Live Animals	**-3.25***	-0.59	-0.04	-0.11	0.24	196	0.28	0.30				0.39	0.42
		(1.05)	(0.43)	(0.66)	(0.77)									
01	Meat And Meat Products	**-8.00***	-0.55	0.05	-1.47	0.37	464	0.20	0.18				0.23	0.21
		(1.26)	(0.3)	(0.62)	(0.76)									
02	Dairy Products	**-7.01***	-0.34	-0.94	-0.96	0.30	499	0.25	0.20				0.24	0.20
		(1.01)	(0.34)	(0.51)	(0.76)									
03	Fish	**-4.76***	**0.37***	**0.6***	0.68	0.31	1829	0.19	0.19	0.08	0.13		0.37	0.33
		(0.48)	(0.18)	(0.27)	(0.45)									
04	Cereals	**-5.45***	-0.53*	-0.21	-0.36	0.28	1028	0.27	0.23	-0.10			0.35	0.30
		(0.73)	(0.24)	(0.37)	(0.52)									
05	Vegetables And Fruits	**-2.46***	-0.04	0.06	0.17	0.26	3413	0.25	0.21				0.71	0.83
		(0.34)	(0.14)	(0.18)	(0.29)									
06	Sugars, Sugar Prep	**-2.42***	-0.53	0.18	-1.08	0.28	728	0.24	0.18				0.71	0.75
		(0.99)	(0.3)	(0.41)	(0.69)									
07	Coffee, Tea	**-4.6***	0.01	**0.55***	-0.49	0.27	1764	0.20	0.19		0.12		0.39	0.35
		(0.58)	(0.18)	(0.26)	(0.42)									
08	Feeding Stuff	**-3.61***	0.07	0.40	1.37	0.20	261	0.24	0.22				0.47	0.46
		(1.3)	(0.46)	(0.69)	(1.03)									
09	Misc food products	**-4.86***	-0.24	**0.69***	0.19	0.28	998	0.27	0.23		0.14		0.36	0.29
		(0.69)	(0.24)	(0.31)	(0.54)									
11	Beverages	-1.48	-0.45	0.44	0.21	0.24	808	0.27	0.17					
		(0.91)	(0.26)	(0.3)	(0.54)									
12	Tobacco	**-6.62***	-0.62	-0.61	-0.70	0.29	192	0.27	0.30				0.28	0.20
		(1.34)	(0.82)	(0.98)	(1.52)									
21	Hides, Skins	**-5.96***	-0.23	0.54	-1.62	0.24	257	0.11	0.12				0.23	0.19
		(1.94)	(0.39)	(0.59)	(0.84)									

Table 4: OLS Estimates of Import Demand

		Volume Effects						Freight + Tariffs					Residual	
		CES	DIST	LANG	ADJ	R2	OBS	Mean	s.d.	DIST	LANG	ADJ	Mean	s.d.
22	Oil Seeds	**-3.83***	0.14	**1.77***	0.18	0.38	231	0.22	0.24		0.46		0.40	0.36
		(1.17)	(0.43)	(0.64)	(1.04)									
23	Crude Rubber	**-6.27***	-0.22	-0.42	-0.02	0.27	558	0.20	0.17				0.25	0.19
		(0.99)	(0.32)	(0.44)	(0.74)									
24	Cork And Wood	**-3.29***	**-1.00***	0.47	-0.80	0.25	448	0.21	0.18	-0.31			0.48	0.47
		(1.11)	(0.35)	(0.5)	(0.88)									
25	Pulp And Waste	**-4.43***	-0.08	0.45	0.86	0.40	151	0.29	0.30				0.36	0.30
		(1.37)	(1.06)	(0.94)	(1.97)									
26	Textile Fibers	**-5.12***	0.24	0.62	0.75	0.14	977	0.24	0.23				0.34	0.29
		(0.66)	(0.25)	(0.32)	(0.49)									
27	Crude Fertilize	**1.64***	-0.30	-0.39	-0.45	0.25	1393	0.30	0.27				1410	22931
		(0.39)	(0.21)	(0.26)	(0.48)									
28	Metalliferous Ores	-1.10	-0.44	-0.28	1.04	0.29	742	0.17	0.20					
		(0.8)	(0.3)	(0.42)	(0.64)									
29	Crude Animal n.e.s	**-4.07***	0.03	-0.05	0.13	0.23	1989	0.19	0.20				0.38	0.32
		(0.39)	(0.15)	(0.19)	(0.37)									
32	Coal, Coke	**-4.4***	0.29	0.11	-1.64	0.45	77	0.37	0.32				0.33	0.33
		(1.94)	(0.76)	(1.1)	(1.62)									
33	Petroleum,	**-5.61***	**-1.07***	0.76	-0.80	0.33	496	0.23	0.19	-0.19			0.41	0.36
		(1.24)	(0.44)	(0.56)	(0.87)									
34	Gas, Natural	3.58	-0.65	0.44	0.92	0.54	124	0.23	0.17					
		(2.49)	(0.83)	(1.46)	(1.66)									
41	Animal Oils	-1.74	-0.71	-1.26	1.19	0.18	127	0.18	0.10					
		(3.11)	(0.48)	(0.88)	(1.35)									
42	Vegetable Fats	**-6.59***	-0.20	-0.21	-0.18	0.41	481	0.18	0.17				0.24	0.20
		(1.18)	(0.31)	(0.45)	(0.68)									

Table 4: OLS Estimates of Import Demand

		Volume Effects						Freight + Tariffs					Residual	
		CES	DIST	LANG	ADJ	R2	OBS	Mean	s.d.	DIST	LANG	ADJ	Mean	s.d.
43	Animal Or Veget fats	**-3.83***	-0.44	-0.15	0.03	0.35	252	0.22	0.15				0.35	0.28
		(1.4)	(0.39)	(0.57)	(0.83)									
51	Organic Chemical	**-7.5***	**-0.86***	-0.03	**-1.23***	0.27	7037	0.17	0.13	-0.11		-0.16	0.22	0.17
		(0.33)	(0.1)	(0.11)	(0.22)									
52	Inorganic Chemicals	**-1.41***	**-0.76***	-0.09	**-0.74***	0.23	3705	0.21	0.18	-0.54		-0.52	1.08	1.62
		(0.35)	(0.13)	(0.16)	(0.28)									
53	Dyeing, Tanning	**-6.37***	**-0.33***	0.31	0.05	0.32	2524	0.20	0.16	-0.05			0.24	0.18
		(0.46)	(0.13)	(0.17)	(0.27)									
54	Pharmaceuticals	**-9.53***	**-0.36***	**0.57***	-0.23	0.22	2704	0.14	0.12	-0.04	0.06		0.18	0.14
		(0.58)	(0.15)	(0.17)	(0.33)									
55	Essential Oils	**-5.5***	**-0.69***	**0.53***	0.12	0.35	2344	0.24	0.21	-0.12	0.10		0.30	0.25
		(0.43)	(0.14)	(0.18)	(0.32)									
56	Fertilizers	-1.34	-0.67	-0.64	-1.50	0.17	453	0.23	0.19					
		(1.16)	(0.4)	(0.54)	(0.85)									
57	Plastics In Primary	**-6.06***	**-0.76***	0.28	-0.43	0.32	2775	0.21	0.17	-0.13			0.24	0.19
		(0.4)	(0.13)	(0.16)	(0.26)									
58	Plastics In Nonprimary	**-5.54***	**-0.82***	**0.95***	0.61	0.38	2171	0.23	0.16	-0.15	0.17		0.28	0.21
		(0.53)	(0.15)	(0.19)	(0.34)									
59	Chemical Materials nes	**-6.75***	**-0.3***	**0.34***	-0.11	0.26	3362	0.22	0.18	-0.04	0.05		0.25	0.19
		(0.38)	(0.13)	(0.16)	(0.27)									
61	Leather manufactures	**-8.92***	-0.20	0.12	-0.04	0.36	1001	0.17	0.18				0.18	0.14
		(0.75)	(0.21)	(0.28)	(0.49)									
62	Rubber Manufactures	**-3.57***	**-0.77***	**0.36***	**1.07***	0.33	2891	0.24	0.18	-0.22	0.10	0.30	0.46	0.44
		(0.44)	(0.14)	(0.18)	(0.31)									
63	Cork And Wood Manufactures	**-3.99***	**-0.79***	-0.03	0.37	0.40	1741	0.25	0.22	-0.20			0.39	0.34
		(0.48)	(0.17)	(0.22)	(0.41)									

Table 4: OLS Estimates of Import Demand

		Volume Effects						Freight + Tariffs					Residual	
		CES	DIST	LANG	ADJ	R2	OBS	Mean	s.d.	DIST	LANG	ADJ	Mean	s.d.
64	Paper, Paperboard	**-4.25***	**-1.05***	0.25	0.29	0.30	4544	0.27	0.22	-0.25			0.42	0.38
		(0.33)	(0.12)	(0.15)	(0.27)									
65	Textile Yarn	**-7.82***	**-0.3***	**0.24***	-0.13	0.27	14384	0.25	0.19	-0.04	0.03		0.22	0.18
		(0.18)	(0.06)	(0.08)	(0.14)									
66	Nonmetallic Manufactures	**-2.65***	**-0.59***	**0.29***	**0.52***	0.31	6524	0.26	0.21	-0.22	0.11	0.20	0.61	0.67
		(0.24)	(0.09)	(0.12)	(0.2)									
67	Iron And Steel	**-3.53***	**-0.86***	0.21	-0.40	0.29	6024	0.20	0.14	-0.24			0.44	0.38
		(0.34)	(0.1)	(0.12)	(0.22)									
68	Nonferrous Metals	**-6.66***	**-0.64***	0.31	**-0.79***	0.26	2839	0.14	0.15	-0.10		-0.12	0.29	0.23
		(0.54)	(0.15)	(0.19)	(0.33)									
69	Manufactures Of metals nes	**-4.85***	**-0.63***	**0.49***	**0.65***	0.36	10889	0.22	0.17	-0.13	0.10	0.13	0.35	0.29
		(0.24)	(0.07)	(0.09)	(0.17)									
71	Power Generating Machinery	**-7.87***	**-0.5***	**0.99***	0.26	0.38	2937	0.19	0.16	-0.06	0.13		0.22	0.17
		(0.49)	(0.15)	(0.17)	(0.34)									
72	Machinery Specialized	**-8.52***	**-0.58***	**0.32***	-0.31	0.35	7444	0.19	0.15	-0.07	0.04		0.18	0.14
		(0.29)	(0.08)	(0.1)	(0.19)									
73	Metalworking Machinery	**-8.09***	**-0.8***	**0.55***	**-0.61***	0.44	3771	0.19	0.15	-0.10	0.07	-0.08	0.16	0.13
		(0.37)	(0.11)	(0.13)	(0.25)									
74	General Industrial Machinery	**-6.98***	**-0.67***	**0.7***	**0.45***	0.41	13375	0.20	0.15	-0.10	0.10	0.06	0.23	0.18
		(0.22)	(0.06)	(0.07)	(0.14)									
75	Office Machines	**-11.02***	-0.21	**0.66***	-0.32	0.38	2472	0.18	0.17		0.06		0.17	0.13
		(0.66)	(0.17)	(0.19)	(0.39)									
76	Telecommunications	**-9.44***	**-0.35***	0.29	**1.11***	0.46	3812	0.22	0.18	-0.04		0.12	0.19	0.15
		(0.42)	(0.13)	(0.15)	(0.31)									
77	Electrical Machinery	**-5.88***	**-0.66***	**0.76***	**1.09***	0.40	13750	0.20	0.16	-0.11	0.13	0.19	0.30	0.25
		(0.24)	(0.07)	(0.08)	(0.17)									

Table 4: OLS Estimates of Import Demand

		Volume Effects						Freight + Tariffs					Residual	
		CES	DIST	LANG	ADJ	R2	OBS	Mean	s.d.	DIST	LANG	ADJ	Mean	s.d.
78	Road Vehicles	**-7.11***	**-0.4***	**0.68***	**0.73***	0.30	2674	0.26	0.20	-0.06	0.10	0.10	0.28	0.25
		(0.48)	(0.16)	(0.19)	(0.35)									
79	Transport Equip	**-7.4***	-0.20	0.38	0.39	0.31	947	0.16	0.20				0.25	0.21
		(0.73)	(0.24)	(0.36)	(0.63)									
81	Prefabricated Buildings	**-4.4***	**-0.6***	-0.08	**1.2***	0.43	1433	0.27	0.21	-0.14		0.27	0.35	0.29
		(0.56)	(0.19)	(0.22)	(0.47)									
82	Furniture	**-3.64***	**-0.64***	0.30	**1.22***	0.52	2250	0.32	0.27	-0.18		0.33	0.39	0.34
		(0.39)	(0.15)	(0.18)	(0.35)									
83	Travel Goods	**-5.05***	**-0.53***	0.10	0.69	0.56	1296	0.33	0.24	-0.11			0.26	0.21
		(0.53)	(0.17)	(0.21)	(0.4)									
84	Apparel	**-5.61***	**-0.46***	**0.42***	**1.04***	0.46	11219	0.31	0.21	-0.08	0.07	0.19	0.30	0.25
		(0.22)	(0.07)	(0.09)	(0.16)									
85	Footwear	**-7.22***	**-0.43***	-0.01	0.09	0.39	1486	0.31	0.19	-0.06			0.24	0.19
		(0.59)	(0.18)	(0.24)	(0.44)									
87	Scientific Instruments	**-6.72***	**-0.63***	**0.59***	**0.63***	0.43	6405	0.18	0.14	-0.09	0.09	0.09	0.23	0.18
		(0.36)	(0.09)	(0.11)	(0.21)									
88	Photographic Equipment	**-8.13***	**-0.25***	**0.4***	0.04	0.33	4131	0.20	0.17	-0.03	0.05		0.22	0.19
		(0.43)	(0.12)	(0.15)	(0.29)									
89	Miscellaneous Manufactures	**-4.88***	**-0.42***	**0.59***	**0.53***	0.37	14386	0.25	0.22	-0.09	0.12	0.11	0.36	0.31
		(0.18)	(0.06)	(0.08)	(0.15)									

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
00	Live Animals	-4.53	0.58	0.37	-0.08	0.24	196					
		(3.79)	(1.74)	(1.15)	(0.24)							
01	Meat And Meat Products	-3.10	**-0.81***	-0.02	0.00	0.37	464					
		(1.62)	(0.23)	(0.04)	(0.07)							
02	Dairy Products	-4.53	-0.52	-0.04	0.16	0.30	499					
		(3.44)	(0.69)	(0.11)	(0.1)							
03	Fish	**-1.19***	**-0.94***	0.00	-0.04	0.32	1829				1.35	2.15
		(0.22)	(0.04)	(0.01)	(0.03)							
04	Cereals	**-5.03***	-0.15	-0.28	0.07	0.28	1028				0.38	0.33
		(2.03)	(0.45)	(0.59)	(0.08)							
06	Sugars, Sugar Prep	**-2.41***	0.08	3.39	-0.10	0.28	728				0.71	0.76
		(1.01)	(0.15)	(2.46)	(0.21)							
08	Feeding Stuff	**-58.98***	**20.15***	0.01	-0.11	0.20	261				0.03	0.02
		(4.66)	(5.21)	(0.01)	(0.25)							
09	Misc food products	-5.74	0.30	0.28	**-0.18***	0.28	998			-0.18		
		(3.18)	(0.96)	(0.97)	(0.08)							
12	Tobacco	**-7.56***	0.14	0.72	0.18	0.30	192				0.25	0.17
		(2.31)	(0.5)	(2.46)	(0.21)							
21	Hides, Skins	-3.46	-0.43	0.02	-0.10	0.23	257					
		(6.06)	(1.29)	(0.13)	(0.11)							
22	Oil Seeds	**-3.57***	0.01	2.82	**-0.42***	0.38	231			-0.42	0.42	0.39
		(1.19)	(0.11)	(14.34)	(0.17)							
23	Crude Rubber	-38.23	7.27	0.01	0.09	0.27	558					
		(206.58)	(47.51)	(0.05)	(0.1)							
24	Cork And Wood	-5.27	0.99	0.35	-0.16	0.25	448					
		(5.43)	(2.32)	(0.85)	(0.2)							
25	Pulp And Waste	-5.22	0.25	0.45	-0.21	0.40	151					
		(5.11)	(1.64)	(3.33)	(0.23)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
26	Textile Fibers	**-5.17***	0.03	1.44	-0.13	0.14	977				0.34	0.29
		(0.72)	(0.11)	(3.06)	(0.07)							
27	Crude Fertilize	**1.43***	-0.09	1.67	-0.29	0.25	1393				9.E+05	2.E+07
		(0.44)	(0.21)	(2.51)	(0.16)							
28	Metalliferous Ores	**-0.8***	**-0.66***	**-0.09***	-0.16	0.28	742	-0.66	-0.69		2.35	5.78
		(0.36)	(0.21)	(0.04)	(0.18)							
29	Crude Animal n.e.s	**-4.06***	0.00	-1.12	0.02	0.23	1989				0.38	0.32
		(0.41)	(0.02)	(2.08)	(0.06)							
33	Petroleum,	**-5.75***	0.08	2.37	**-0.22***	0.34	496			-0.22	0.40	0.35
		(1.28)	(0.12)	(1.54)	(0.11)							
34	Gas, Natural	1.71	-0.75	0.20	0.23	0.54	124					
		(2.02)	(0.51)	(0.41)	(0.49)							
41	Animal Oils	-4.06	1.10	0.82	0.52	0.19	127					
		(3.69)	(2.15)	(0.94)	(0.92)							
42	Vegetable Fats	-8.20	0.35	0.11	0.05	0.41	481					
		(10.79)	(2.34)	(0.74)	(0.09)							
43	Animal Or Veget fats	**-4.86***	0.35	0.61	0.05	0.36	252				0.28	0.22
		(2.04)	(0.63)	(1.15)	(0.18)							
51	Organic Chemical	**-8.08***	**0.1***	**1.35***	0.00	0.27	7037	0.10	0.04		0.21	0.16
		(0.35)	(0.03)	(0.32)	(0.02)							
52	Inorganic Chemicals	**-2.03***	**0.53***	**1.41***	0.03	0.23	3705	0.53	0.21		0.77	0.95
		(0.4)	(0.25)	(0.43)	(0.12)							
53	Dyeing, Tanning	**-7.35***	0.22	0.41	-0.05	0.33	2524				0.21	0.16
		(0.94)	(0.19)	(0.39)	(0.03)							
54	Pharmaceuticals	**-10.09***	0.09	0.59	**-0.06***	0.22	2704			-0.06	0.17	0.13
		(0.8)	(0.08)	(0.57)	(0.02)							
55	Essential Oils	-10.46	1.34	0.13	**-0.13***	0.35	2344					
		(6.4)	(1.73)	(0.17)	(0.04)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
56	Fertilizers	-1.55	0.38	2.78	0.76	0.18	453					
		(1.21)	(0.8)	(2.32)	(1.03)							
57	Plastics In Primary	**-6.85***	**0.22***	**1.2***	**-0.07***	0.34	2775	0.22	0.11	-0.07	0.22	0.17
		(0.43)	(0.06)	(0.24)	(0.03)							
58	Plastics In Nonprimary	**-7.57***	**0.49***	**0.55***	**-0.18***	0.38	2171	0.49	0.34	-0.18	0.21	0.16
		(0.83)	(0.17)	(0.21)	(0.04)							
59	Chemical Materials nes	**-7.3***	0.13	0.51	**-0.07***	0.26	3362			-0.07	0.24	0.18
		(0.67)	(0.13)	(0.53)	(0.03)							
61	Leather manufactures	**-9.25***	0.05	0.66	-0.02	0.36	1001				0.18	0.14
		(1.01)	(0.13)	(1.66)	(0.04)							
62	Rubber Manufactures	**-7.87***	1.63	0.25	**-0.12***	0.33	2891			-0.12	0.23	0.18
		(3.01)	(1.18)	(0.19)	(0.06)							
63	Cork And Wood Manufactures	-11.04	2.47	0.12	-0.01	0.40	1741					
		(12.58)	(4.54)	(0.22)	(0.07)							
64	Paper, Paperboard	**-3.7***	-0.31	-0.24	-0.06	0.29	4544				0.48	0.45
		(0.77)	(0.21)	(0.14)	(0.03)							
65	Textile Yarn	**-8.32***	**0.1***	**0.58***	**-0.04***	0.27	14384	0.10	0.07	-0.04	0.21	0.17
		(0.29)	(0.05)	(0.29)	(0.01)							
67	Iron And Steel	**-2.93***	-0.30	-0.27	-0.05	0.28	6024				0.52	0.48
		(0.81)	(0.24)	(0.18)	(0.03)							
68	Nonferrous Metals	**-7.26***	0.13	0.85	**-0.07***	0.26	2839			-0.07	0.27	0.21
		(0.63)	(0.08)	(0.48)	(0.03)							
71	Power Generating Machinery	**-9.08***	0.22	0.44	**-0.15***	0.38	2937			-0.15	0.19	0.15
		(0.92)	(0.14)	(0.32)	(0.02)							
72	Machinery Specialized	**-9.51***	**0.16***	**0.56***	**-0.04***	0.35	7444	0.16	0.11	-0.04	0.16	0.13
		(0.43)	(0.06)	(0.22)	(0.01)							
73	Metalworking Machinery	**-9.24***	**0.21***	**0.55***	**-0.08***	0.44	3771	0.21	0.15	-0.08	0.15	0.11
		(0.57)	(0.08)	(0.23)	(0.02)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
74	General Industrial Machinery	**-9.18***	**0.44***	**0.36***	**-0.11***	0.41	13375	0.44	0.34	-0.11	0.18	0.14
		(0.6)	(0.11)	(0.1)	(0.01)							
75	Office Machines	**-3.3***	**-0.91***	0.01	**-0.02***	0.39	2472			-0.02	0.50	0.47
		(0.39)	(0.03)	(0.01)	(0.01)							
76	Telecommunications	**-8.85***	-0.09	**-0.39***	-0.01	0.46	3812				0.20	0.16
		(0.67)	(0.07)	(0.18)	(0.02)							
77	Electrical Machinery	**-12.97***	1.67	0.13	**-0.15***	0.40	13750			-0.15	0.14	0.11
		(4.69)	(1.11)	(0.08)	(0.02)							
78	Road Vehicles	**-3.97***	**-0.6***	**-0.09***	**-0.08***	0.30	2674	-0.60	-0.63	-0.08	0.49	0.53
		(0.8)	(0.14)	(0.04)	(0.03)							
79	Transport Equip	**-7.79***	**0.08**	**0.41**	-0.09	0.31	947				0.24	0.20
		(1.72)	(0.29)	(1.72)	(0.05)							
81	Prefabricated Buildings	**-2.99***	**-0.56***	**-0.15**	0.02	0.42	1433				0.49	0.46
		(1.01)	(0.25)	(0.09)	(0.05)							
82	Furniture	**-5.89***	**0.9***	**0.45***	**-0.14***	0.51	2250	0.90	0.68	-0.14	0.25	0.20
		(1)	(0.41)	(0.22)	(0.06)							
83	Travel Goods	**-7.35***	**0.66**	0.29	-0.04	0.56	1296				0.19	0.15
		(2.19)	(0.66)	(0.32)	(0.05)							
84	Apparel	-24.59	4.90	**0.04**	**-0.11***	0.46	11219			-0.11		
		(17.95)	(4.7)	(0.03)	(0.02)							
85	Footwear	**-6.6***	-0.14	**-0.30**	0.01	0.39	1486				0.26	0.21
		(1.44)	(0.25)	(0.36)	(0.04)							
87	Scientific Instruments	**-78.6***	**14.73***	**0.01***	**-0.12***	0.43	6405	14.73	14.61	-0.12	0.02	0.02
		(1.15)	(0.63)	(0)	(0.02)							
88	Photographic Equipment	**-8.92***	0.14	0.30	**-0.06***	0.33	4131			-0.06	0.20	0.17
		(1.32)	(0.22)	(0.52)	(0.02)							
89	Miscellaneous Manufactures	**-8.97***	1.22	0.12	**-0.15***	0.36	14386			-0.15	0.21	0.16
		(2.72)	(0.81)	(0.08)	(0.02)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
00	Live Animals	-4.53	0.58	0.37	-0.08	0.24	196					
		(3.79)	(1.74)	(1.15)	(0.24)							
01	Meat And Meat Products	-3.10	**-0.81***	-0.02	0.00	0.37	464					
		(1.62)	(0.23)	(0.04)	(0.07)							
02	Dairy Products	-4.53	-0.52	-0.04	0.16	0.30	499					
		(3.44)	(0.69)	(0.11)	(0.1)							
03	Fish	**-1.19***	**-0.94***	0.00	-0.04	0.32	1829				1.35	2.15
		(0.22)	(0.04)	(0.01)	(0.03)							
04	Cereals	**-5.03***	-0.15	-0.28	0.07	0.28	1028				0.38	0.33
		(2.03)	(0.45)	(0.59)	(0.08)							
06	Sugars, Sugar Prep	**-2.41***	0.08	3.39	-0.10	0.28	728				0.71	0.76
		(1.01)	(0.15)	(2.46)	(0.21)							
08	Feeding Stuff	**-58.98***	**20.15***	0.01	-0.11	0.20	261				0.03	0.02
		(4.66)	(5.21)	(0.01)	(0.25)							
09	Misc food products	-5.74	0.30	0.28	**-0.18***	0.28	998			-0.18		
		(3.18)	(0.96)	(0.97)	(0.08)							
12	Tobacco	**-7.56***	0.14	0.72	0.18	0.30	192				0.25	0.17
		(2.31)	(0.5)	(2.46)	(0.21)							
21	Hides, Skins	-3.46	-0.43	0.02	-0.10	0.23	257					
		(6.06)	(1.29)	(0.13)	(0.11)							
22	Oil Seeds	**-3.57***	0.01	2.82	**-0.42***	0.38	231			-0.42	0.42	0.39
		(1.19)	(0.11)	(14.34)	(0.17)							
23	Crude Rubber	-38.23	7.27	0.01	0.09	0.27	558					
		(206.58)	(47.51)	(0.05)	(0.1)							
24	Cork And Wood	-5.27	0.99	0.35	-0.16	0.25	448					
		(5.43)	(2.32)	(0.85)	(0.2)							
25	Pulp And Waste	-5.22	0.25	0.45	-0.21	0.40	151					
		(5.11)	(1.64)	(3.33)	(0.23)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
26	Textile Fibers	**-5.17***	0.03	1.44	-0.13	0.14	977				0.34	0.29
		(0.72)	(0.11)	(3.06)	(0.07)							
27	Crude Fertilize	**1.43***	-0.09	1.67	-0.29	0.25	1393				9.E+05	2.E+07
		(0.44)	(0.21)	(2.51)	(0.16)							
28	Metalliferous Ores	**-0.8***	**-0.66***	**-0.09***	-0.16	0.28	742	-0.66	-0.69		2.35	5.78
		(0.36)	(0.21)	(0.04)	(0.18)							
29	Crude Animal n.e.s	**-4.06***	0.00	-1.12	0.02	0.23	1989				0.38	0.32
		(0.41)	(0.02)	(2.08)	(0.06)							
33	Petroleum,	**-5.75***	0.08	2.37	**-0.22***	0.34	496			-0.22	0.40	0.35
		(1.28)	(0.12)	(1.54)	(0.11)							
34	Gas, Natural	1.71	-0.75	0.20	0.23	0.54	124					
		(2.02)	(0.51)	(0.41)	(0.49)							
41	Animal Oils	-4.06	1.10	0.82	0.52	0.19	127					
		(3.69)	(2.15)	(0.94)	(0.92)							
42	Vegetable Fats	-8.20	0.35	0.11	0.05	0.41	481					
		(10.79)	(2.34)	(0.74)	(0.09)							
43	Animal Or Veget fats	**-4.86***	0.35	0.61	0.05	0.36	252				0.28	0.22
		(2.04)	(0.63)	(1.15)	(0.18)							
51	Organic Chemical	**-8.08***	**0.1***	**1.35***	0.00	0.27	7037	0.10	0.04		0.21	0.16
		(0.35)	(0.03)	(0.32)	(0.02)							
52	Inorganic Chemicals	**-2.03***	**0.53***	**1.41***	0.03	0.23	3705	0.53	0.21		0.77	0.95
		(0.4)	(0.25)	(0.43)	(0.12)							
53	Dyeing, Tanning	**-7.35***	0.22	0.41	-0.05	0.33	2524				0.21	0.16
		(0.94)	(0.19)	(0.39)	(0.03)							
54	Pharmaceuticals	**-10.09***	0.09	0.59	**-0.06***	0.22	2704			-0.06	0.17	0.13
		(0.8)	(0.08)	(0.57)	(0.02)							
55	Essential Oils	-10.46	1.34	0.13	**-0.13***	0.35	2344					
		(6.4)	(1.73)	(0.17)	(0.04)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
56	Fertilizers	-1.55	0.38	2.78	0.76	0.18	453					
		(1.21)	(0.8)	(2.32)	(1.03)							
57	Plastics In Primary	**-6.85***	**0.22***	**1.2***	**-0.07***	0.34	2775	0.22	0.11	-0.07	0.22	0.17
		(0.43)	(0.06)	(0.24)	(0.03)							
58	Plastics In Nonprimary	**-7.57***	**0.49***	**0.55***	**-0.18***	0.38	2171	0.49	0.34	-0.18	0.21	0.16
		(0.83)	(0.17)	(0.21)	(0.04)							
59	Chemical Materials nes	**-7.3***	0.13	0.51	**-0.07***	0.26	3362			-0.07	0.24	0.18
		(0.67)	(0.13)	(0.53)	(0.03)							
61	Leather manufactures	**-9.25***	0.05	0.66	-0.02	0.36	1001				0.18	0.14
		(1.01)	(0.13)	(1.66)	(0.04)							
62	Rubber Manufactures	**-7.87***	1.63	0.25	**-0.12***	0.33	2891			-0.12	0.23	0.18
		(3.01)	(1.18)	(0.19)	(0.06)							
63	Cork And Wood Manufactures	-11.04	2.47	0.12	-0.01	0.40	1741					
		(12.58)	(4.54)	(0.22)	(0.07)							
64	Paper, Paperboard	**-3.7***	-0.31	-0.24	-0.06	0.29	4544				0.48	0.45
		(0.77)	(0.21)	(0.14)	(0.03)							
65	Textile Yarn	**-8.32***	**0.1***	**0.58***	**-0.04***	0.27	14384	0.10	0.07	-0.04	0.21	0.17
		(0.29)	(0.05)	(0.29)	(0.01)							
67	Iron And Steel	**-2.93***	-0.30	-0.27	-0.05	0.28	6024				0.52	0.48
		(0.81)	(0.24)	(0.18)	(0.03)							
68	Nonferrous Metals	**-7.26***	0.13	0.85	**-0.07***	0.26	2839			-0.07	0.27	0.21
		(0.63)	(0.08)	(0.48)	(0.03)							
71	Power Generating Machinery	**-9.08***	0.22	0.44	**-0.15***	0.38	2937			-0.15	0.19	0.15
		(0.92)	(0.14)	(0.32)	(0.02)							
72	Machinery Specialized	**-9.51***	**0.16***	**0.56***	**-0.04***	0.35	7444	0.16	0.11	-0.04	0.16	0.13
		(0.43)	(0.06)	(0.22)	(0.01)							
73	Metalworking Machinery	**-9.24***	**0.21***	**0.55***	**-0.08***	0.44	3771	0.21	0.15	-0.08	0.15	0.11
		(0.57)	(0.08)	(0.23)	(0.02)							

Table 5: Non-linear Least Squares Estimates of Import Demand

		Volume Effects						Ad-valorem equivalent			Residual (price premium)	
		CES	DIST - d0	DIST - d1	LANG	R2	OBS	Dist (mean)	Dist(sd)	LANG	Mean	s.d.
74	General Industrial Machinery	**-9.18***	**0.44***	**0.36***	**-0.11***	0.41	13375	0.44	0.34	-0.11	0.18	0.14
		(0.6)	(0.11)	(0.1)	(0.01)							
75	Office Machines	**-3.3***	**-0.91***	0.01	**-0.02***	0.39	2472			-0.02	0.50	0.47
		(0.39)	(0.03)	(0.01)	(0.01)							
76	Telecommunications	**-8.85***	-0.09	**-0.39***	-0.01	0.46	3812				0.20	0.16
		(0.67)	(0.07)	(0.18)	(0.02)							
77	Electrical Machinery	**-12.97***	1.67	0.13	**-0.15***	0.40	13750			-0.15	0.14	0.11
		(4.69)	(1.11)	(0.08)	(0.02)							
78	Road Vehicles	**-3.97***	**-0.6***	**-0.09***	**-0.08***	0.30	2674	-0.60	-0.63	-0.08	0.49	0.53
		(0.8)	(0.14)	(0.04)	(0.03)							
79	Transport Equip	**-7.79***	**0.08**	**0.41**	-0.09	0.31	947				0.24	0.20
		(1.72)	(0.29)	(1.72)	(0.05)							
81	Prefabricated Buildings	**-2.99***	**-0.56***	**-0.15**	0.02	0.42	1433				0.49	0.46
		(1.01)	(0.25)	(0.09)	(0.05)							
82	Furniture	**-5.89***	**0.9***	**0.45***	**-0.14***	0.51	2250	0.90	0.68	-0.14	0.25	0.20
		(1)	(0.41)	(0.22)	(0.06)							
83	Travel Goods	**-7.35***	**0.66**	0.29	-0.04	0.56	1296				0.19	0.15
		(2.19)	(0.66)	(0.32)	(0.05)							
84	Apparel	-24.59	4.90	**0.04**	**-0.11***	0.46	11219			-0.11		
		(17.95)	(4.7)	(0.03)	(0.02)							
85	Footwear	**-6.6***	-0.14	**-0.30**	0.01	0.39	1486				0.26	0.21
		(1.44)	(0.25)	(0.36)	(0.04)							
87	Scientific Instruments	**-78.6***	**14.73***	**0.01***	**-0.12***	0.43	6405	14.73	14.61	-0.12	0.02	0.02
		(1.15)	(0.63)	(0)	(0.02)							
88	Photographic Equipment	**-8.92***	0.14	0.30	**-0.06***	0.33	4131			-0.06	0.20	0.17
		(1.32)	(0.22)	(0.52)	(0.02)							
89	Miscellaneous Manufactures	**-8.97***	1.22	0.12	**-0.15***	0.36	14386			-0.15	0.21	0.16
		(2.72)	(0.81)	(0.08)	(0.02)							

Table 6: Sensitivity to "pooling" level (OLS estimates)

All Goods

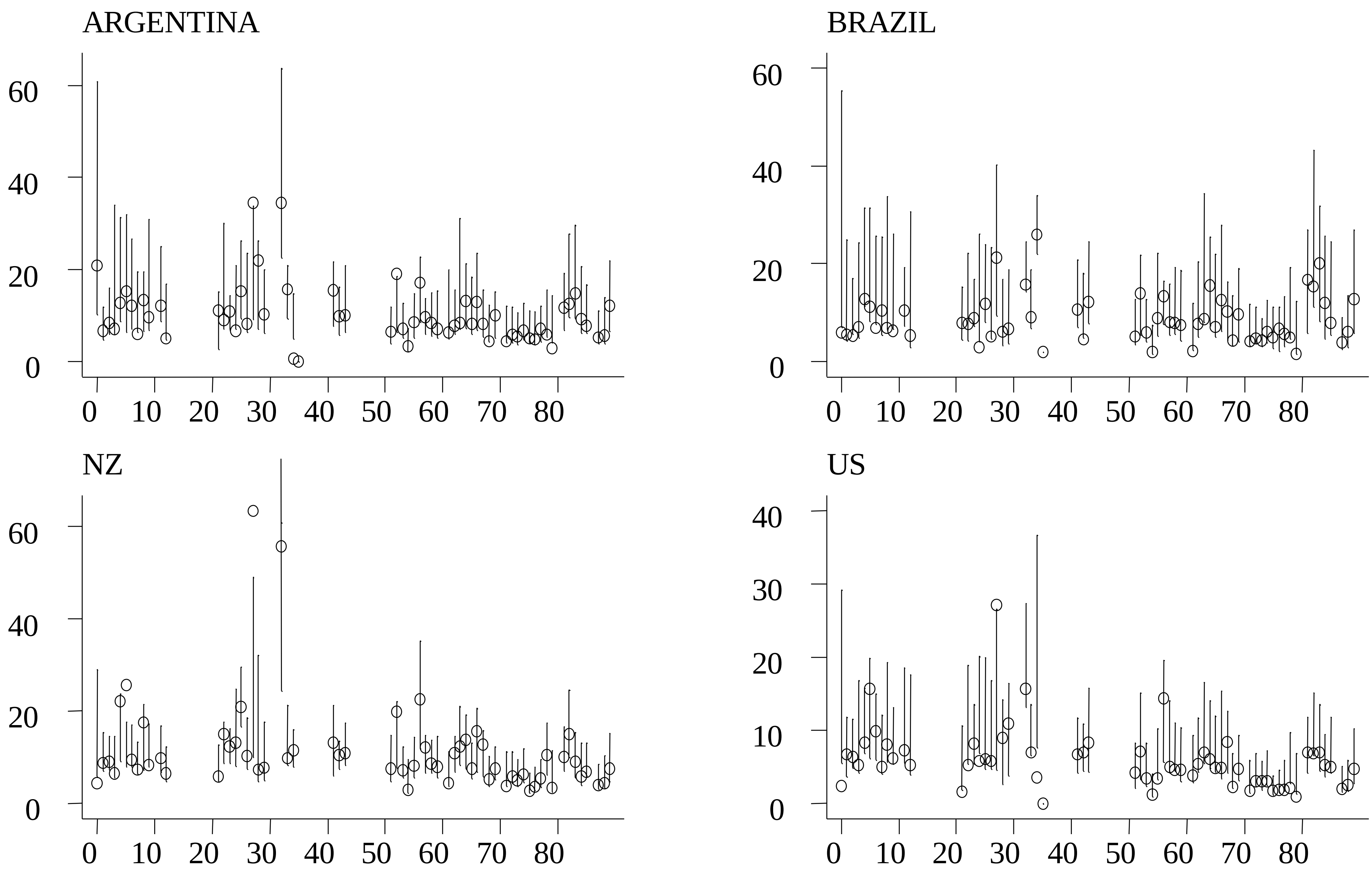
	1 digit # signif. (9 total)	1 digit mean coeff	1 digit price premium	2 digit # signif. (62 total)	2 digit mean coeff	2 digit price premium	3 digit # signif. (239 total)	3 digit mean coeff	3 digit price premium
CES	9	4.79		57	5.57		190	6.91	
DIST	4	-0.54	-0.04	35	-0.59	-0.07	109	-1.09	0.07
LANG	4	0.37	0.03	23	0.61	0.04	65	1.36	0.03
ADJ	4	0.25	0.03	16	0.43	0.02	46	-0.45	0.01
Residual			0.42			0.33			0.26

Manufactures: SITC 5-9

	1 digit # signif. (5 total)	1 digit mean coeff	1 digit price premium	2 digit # signif. (34 total)	2 digit mean coeff	2 digit price premium	3 digit # signif. (164 total)	3 digit mean coeff	3 digit price premium	4 digit # signif. (670 total)	4 digit mean coeff	4 digit price premium
CES	5	5.79		33	6.26		148	7.04		473	8.26	
DIST	4	-0.54	-0.07	31	-0.59	-0.11	96	-0.84	-0.09	217	-1.28	-0.05
LANG	4	0.37	0.05	19	0.55	0.05	58	0.78	0.04	130	1.21	0.03
ADJ	4	0.17	0.02	16	0.43	0.03	38	0.39	0.02	73	1.08	0.02
Residual			0.31			0.31			0.25			0.19

Mean coefficient calculated as average over all significant estimates in that set of regressions
Implied price premium calculated as average over all estimates in that set, with insignificant coefficients treated as zeros

Figure 1: Freight Rates by 2 dig SITC: Dispersion over Partners



Line length displays size of inner quartile range; circle denotes trade-weighted average rate

Figure 2: Freight and Tariff Rates – Relative Levels by 2 dig SITC

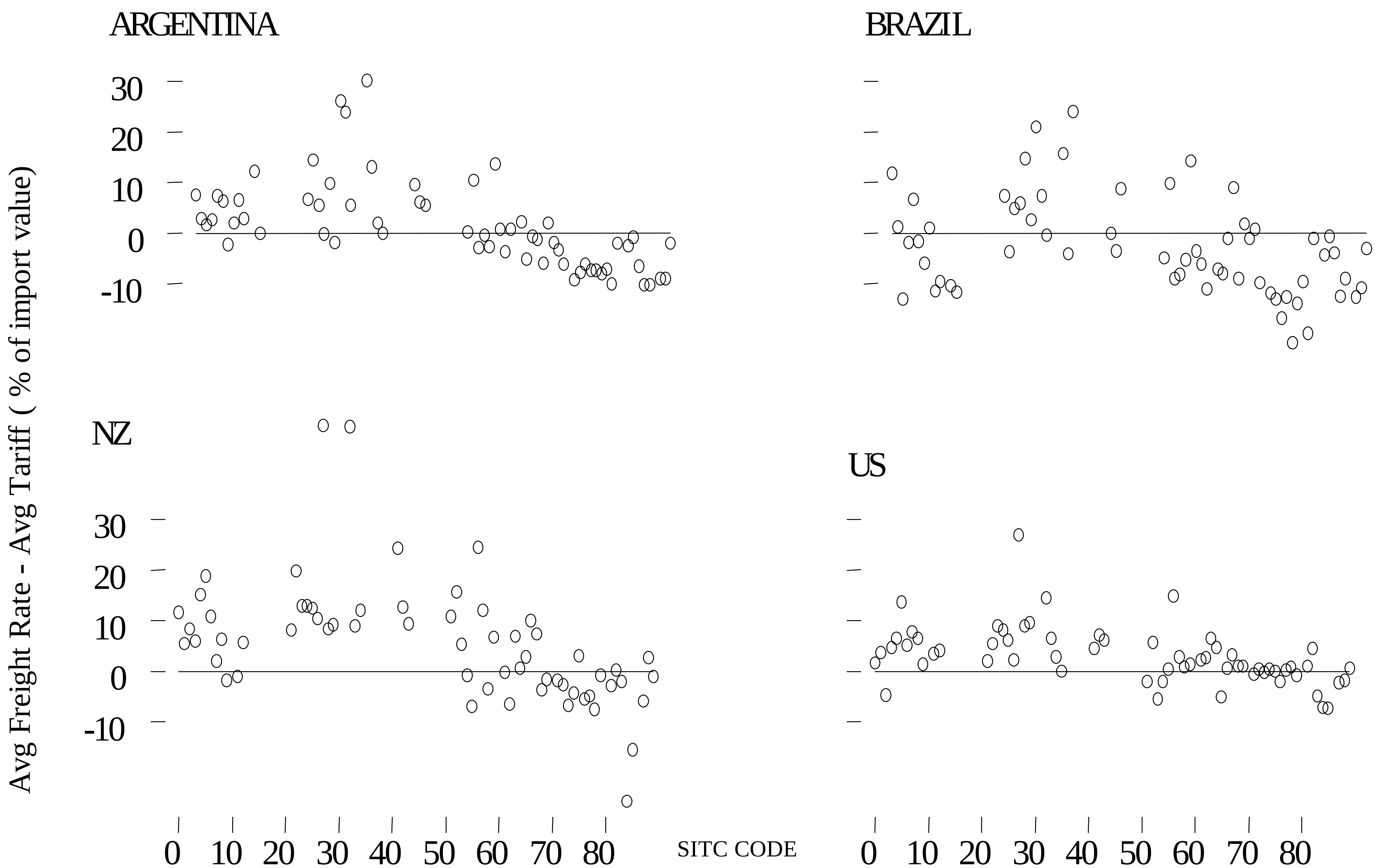


Figure 3: Freight and Tariff Rates: Relative Dispersion by 2 dig SITC

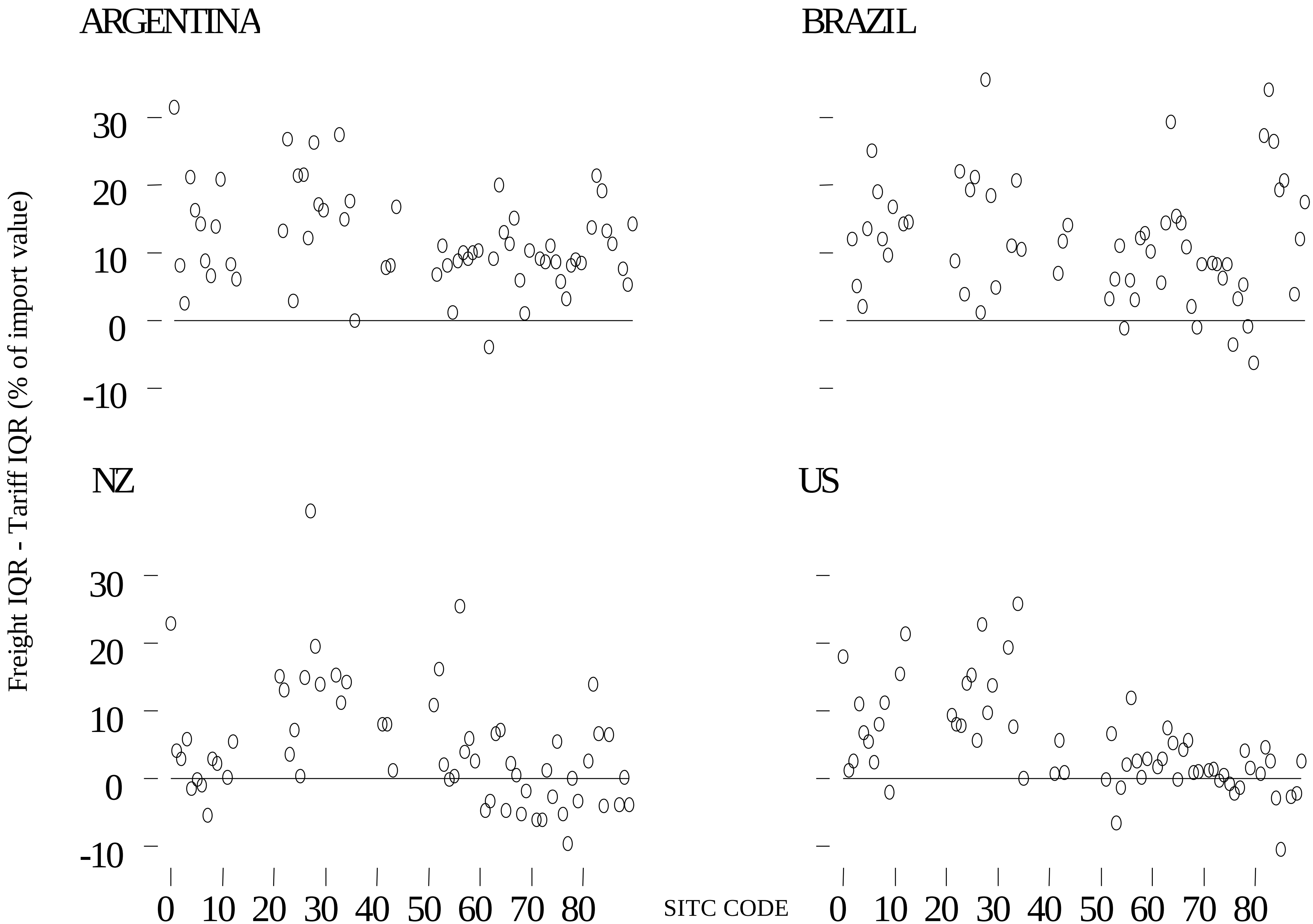


Figure 4: Technological Relationship – Shipping and Distance

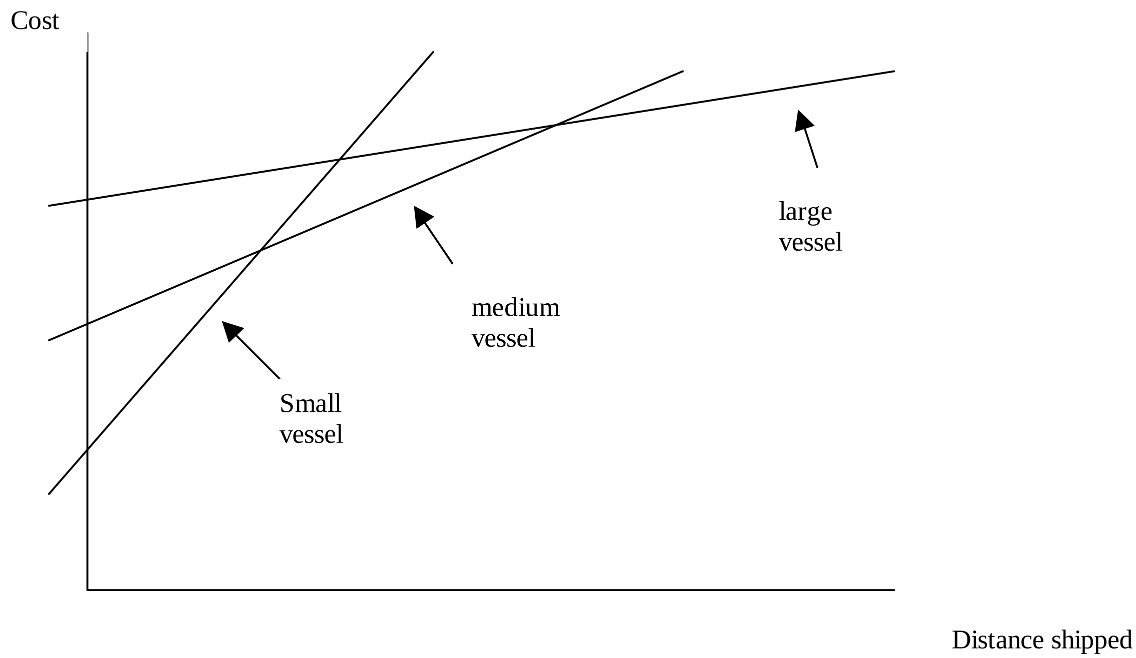
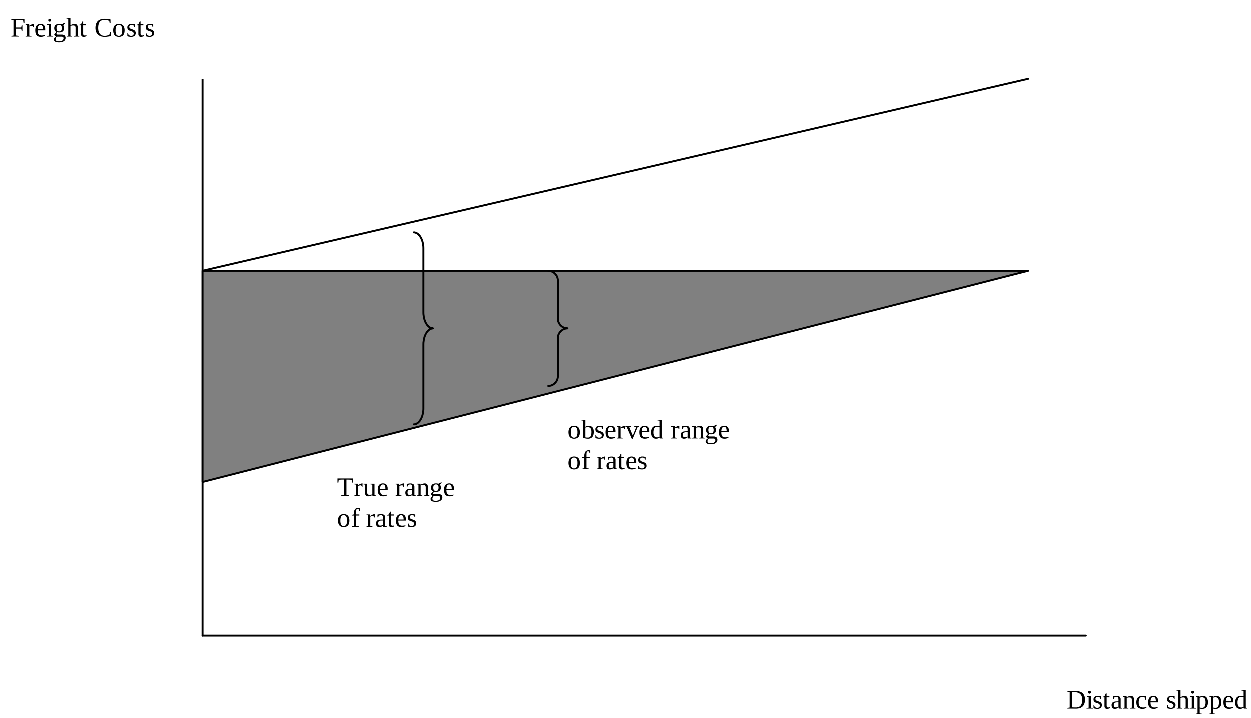


Figure 5: Selection in Shipping and Distance Relationship



Appendix A: Data

Imports and Transport Cost Data.

For all listed sources data from 1994 are used in Tables 1-3 and in Figures 1-3. Data from 1992 are used in Tables 4-7 to provide a better match with tariff data.

US Census Bureau, "US Imports of Merchandise". These data report extremely detailed customs information on US imports from all exporting countries (approximately 160) from 1974 to the present. The data are reported at the 10 digit Harmonized System level (approximately 15300 goods categories). For comparability to other national data, these are concorded to 5-digit SITC using the concordance found in Feenstra (1996). Data include the valuation of imports, inclusive and exclusive of freight and insurance charges, shipment quantity (by count and by weight), transportation mode, district of entry into the US, and duties paid. Goods are valued FAS, or "free alongside ship" meaning that freight charges include loading and unloading expenses.

Statistics New Zealand, "New Zealand's Imports". Available on CD from 1988-1997, reports imports by 5 digit SITC (approximately 3000 goods) and exporting country, including CIF and CVD (equivalent to FAS, or "free alongside ship") valuation and shipment weight.

ALADI Secretariat, "Latin American Trade". Reports imports of Argentina, Brazil, Chile, Paraguay, and Uruguay from 1991-1994 at the 6 digit Harmonized System coding (approximately 3000 goods). These are concorded to the 5-digit SITC classification using the concordance in Feenstra (1996) for comparability. Data include exporter, value of imports, weight, freight charges and insurance charges (separately). Freight charges are based on FOB ("free on board" - exclusive of loading costs") valuation of goods. For overland transport within the ALADI countries it appears that the freight field has a zero value. This is because charges are only incurred between exit and entry ports, and these are the same for overland transport. Note, however, that this does not change the relative valuation of freight charges across export partners. All trade incurs some overland shipping from factory to exporting port and from importing port to location of consumption and these costs are missing from all the data. One can then think of the observed values as a distribution that is simply shifted to the left relative to the true set of values.

US Department of Transportation, "Transborder Surface Freight Data". These data are only used in Table 3 to construct estimates of the shape of freight rates between the US and Canada. Also based on Census data, these data are restricted to North American surface trade, that is, all trade between the US, Mexico and Canada not transported by air or ocean vessel. US imports are reported at the 2-digit Harmonized system and include value, quantity, freight and insurance, detailed modal data (rail, truck, pipeline, etc.) origin and destination states and provinces, and district of entry into the US.

OTHER DATA

Distance

The industry standard for measuring bilateral distance is the "Great Circle" straight-line distance between partner countries, which may involve polar transit or travel that intersects a continent. We improve on this in two ways. First, for pooled estimates in Table 3 and for Tables 4-7, we use port-to-port distances constructed by forcing shipments to round continental bodies. The difference can be substantial in some cases. As an example, German goods shipped to the US east coast are approximately straight-line, whereas goods shipped to the US west coast must transit through the Panama Canal – roughly doubling the straight line distance.

For Table 3 estimates on US imports by mode, we use US Census data on US District of Entry, which can be used to separate imports coming into Hawaii from those entering Miami, Boston and Los Angeles. A common complaint with Census data on US district of entry (for imports) or exit (for exports) is that these districts do not necessarily capture the ultimate US consumer or the original US producer of traded goods. This is not a concern here as we are primarily interested in the measured cost of freight in getting the goods to the entry point where customs officials stop calculating freight charges.

We use the following across modes:

1. Air mode. Use the straight-line distance between the exporting country's capital city and the US district of entry.
2. Ocean shipped. Use port-to-port distances as described above.
3. Truck and Rail. Use straight line distance from provincial capital to US district of entry.

The detailed entry port data for the US are not used in Tables 4-7 or in the pooled regression so that the data are comparable to New Zealand and Latin American data.

Tariff Data

Bilateral tariff data are available for the seven importers. While the precise year varies somewhat across countries, most of the data are from 1990. The data originally come from the TRAINS dataset, reported at the 6 digit level of the Harmonized System. Jon Haveman painstakingly constructed bilateral tariff rates using preference indicators in these data. See Haveman, Nair, and Thursby, 1998a,b.

In regressions using tariff rates we match the tariff schedule to the exporter and (6 digit HS) commodity to generate a tariff rate. We then concord the 6-digit HS data to 5-digit SITC data. In cases where more than one HS category matches a 5-digit SITC category we calculate a weighted average tariff rate for that exporter. There is a fairly close match between these systems so the concordance is straightforward and little averaging is needed.