EFIGE IS A PROJECT DESIGNED TO HELP IDENTIFY THE INTERNAL POLICIES NEEDED TO IMPROVE EUROPE'S EXTERNAL COMPETITIVENESS

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Administrative Barriers and the Lumpiness of Trade*

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Abstract

We document that administrative trade costs of per shipment nature (documentation, customs clearance and inspection) lead to less frequent and larger-sized shipments, i.e., more lumpiness, in international trade. We build a model where consumers have heterogeneous preferences for the arrival time of a non-storable product and firms compete by selecting the time of their shipment. Per shipment costs reduce shipment frequency, increase the shipment size and the product price and lead to welfare losses. We provide empirical evidence for these effects on detailed export data from the US and Spain. We find that US and Spanish exporters send fewer and larger shipments to countries with higher administrative barriers. However, we find no robust evidence that such destination would command higher prices.

Keywords: administrative trade barriers, shipments

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1 Introduction

With the diminishing use of tariff-type trade restrictions, the focus of trade policy makers has been increasingly shifted towards less standard sorts of trade barriers, including administrative barriers to trade. We define administrative trade barriers as bureaucratic procedures ("red tape") that a trading firm has to get through when shipping the product from one country to the other. Note that this definition does not involve administrative regulations as product standards, technical or health regulation per se. As an example, administrative barrier is the task of preparing health certificates, but not that of making the product itself comply with the health requirements.

We argue that administrative barriers to trade, as defined above, are typically trade costs of a "per shipment" nature. They are not an iceberg type, for they are not proportional to the value of the product. Nor are they per unit costs. The tasks of trade documentation, cargo inspection, or customs clearance have to be performed for each shipment, and shipments may contain varying quantities of the product.

Administrative costs are not negligible in magnitude. Documentation and customs procedures in a typical export transaction of the United States take 18 working days and cost 4.6% of the shipment value (most of it occurring in the importing country, see Table 1). The same figures for a typical Spanish export transaction are 20 days and 7.2%. There is large variation in the magnitude of the administrative burden by country. Completing the documentation and customs procedures of an import transaction in Singapore takes only 2 days, in Venezuela 2 months.

Table 1: Costs of trade documentation and the customs procedure

	Cost in US	Cost in Spain	Cost in importer country median	min	max
Time cost in days	3	5	15	2	61
Financial cost in USD	250	400	450	92	1830
as % of the median shipment value					
- in US exports	1.6%		3.0%	0.6%	12.0%
- in Spanish exports		3.4%	3.8%	0.8%	15.5%

Notes: Cost data is from the Doing Business survey 2009 for 170 countries. Shipment size is based on "almost" shipment-level US and shipment-level Spanish export data from 2005. Trade in raw materials and low-value shipments excluded.

Exporters who can sell their products in fewer and larger shipments bear less of these costs. Bunching goods into fewer and larger shipments, involves tradeoffs, however. An exporter waiting to fill a container before sending it off or choosing a slower transport mode to accommodate a larger shipment sacrifices timely delivery of goods and risks losing orders to other, more flexible (e.g., local) suppliers. Similarly, holding large inventories between shipment arrivals incurs substantial costs and prevents fast and flexible adjustment of product attributes to changing consumer tastes. Moreover, certain products are storable only to a limited extent or not at all. With infrequent shipments a supplier of such products can compete only for a fraction of consumers in a foreign market.

This paper focuses on the trade-off of sending larger shipments less frequently versus serving more of the demand in a timely fashion in the foreign market. We abstract from the possibility of inventory holdings and simply assume that the product is non-storable. We build a "circular city" discrete choice model in the spirit of Salop (1979) on the timing of shipments and with per shipment costs. Consumers have preferred dates of consumption and are distributed uniformly along a circle that represents the time points in a year. They suffer utility loss from consuming in dates other than the preferred one. Firms - that for simplicity are assumed to send only one shipment each - decide on entering the market and choose the timing of their shipment. Per shipment administrative costs make firms send larger-sized shipments less frequently and increase the product price.

We also provide empirical evidence on US and Spanish export transactions data with 170 and 143 destination countries, respectively. We run both product-level and aggregate country cross section regressions on a decomposition of export flows into several margins, including shipment frequency, size and price margins. In the aggregate analysis we are able to see adjustments in the shipment size also via changing the transport mode or the exported product mix. Administrative trade barriers are captured by the World Bank's *Doing Business* data on the cost of trade documentation and customs procedure in the importing country. We find convincing evidence that both the US and Spain exports less and larger-sized shipments to countries with larger administrative costs of importing. We find however no evidence on a positive price effect or adjustments in the transport mode or the exported product mix.

Our emphasis on shipments as a fundamental unit of trade follows Armenter and Koren (2010), who discuss the implications of the relatively low number of shipments on empirical models of the extensive margin of trade. The importance of per shipment trade costs or, in other words, fixed transaction costs has recently been emphasized by Alessandria, Kaboski and Midrigan (2010). They argue that per shipment costs lead to the lumpiness of trade transactions: firms economize on these costs by shipping products infrequently and in large shipments and maintaining large inventory holdings. Per shipment costs cause frictions of a substantial magnitude (20% tariff equivalent) mostly due to inventory carrying expenses. We consider our paper complementary to Alessandria, Kaboski and Midrigan (2010). Our paper exploits the cross-country variation in administrative barriers to show that shippers indeed respond by increasing the lumpiness of trade. On the theory side, we focus on the utility loss consumers face when consumption does not occur at the preferred date. Moreover, our framework also applies to trade of non-storable products.

This paper relates to the recent literature that challenges the dominance of iceberg trade costs in trade theory, such as Hummels and Skiba (2004) and Irarrazabal, Moxnes and Opromolla (2010). These papers argue that a considerable part of trade costs are per unit costs, which has important implications for trade theory. Per unit trade costs do not necessarily leave the within-market relative prices and relative demand unaltered, hence, welfare costs of per unit trade frictions can be larger than those of iceberg costs. Although these authors do not consider per shipment costs, Hummels and Skiba (2004) obtain an interesting side result on a rich panel data set, which is consistent with the presence of per shipment costs. The per unit freight cost depends negatively on total traded quantity. Hence, the larger the size of a shipment in terms of product units, the less the per-unit freight cost is.

Our approach is strongly related to the literature on the time cost of trade. An important message of this literature is that time in trade is far more valuable than what the rate of depreciation of products (either in a physical or a technical sense) or the interest cost of delay would suggest. Hummels (2001) demonstrates that firms are willing to pay a disproportionately large premium for air (instead of ocean) transportation to get fast delivery. Hornok (2011) finds that eliminating border waiting time and customs clearance significantly contributed to the trade creating effect of EU enlargement in 2004. A series of papers (Harrigan and Venables (2006), Evans and Harrigan (2005), Harrigan (2010)) look at the implications of the demand for timeliness on production location and transport mode choice. When timeliness is important, industries tend to agglomerate and firms source from nearby producers even at the expense of higher wages and prices. Faraway suppliers, as Harrigan (2010) argues, have comparative advantage in goods that are easily transported by fast air transportation.

More policy-oriented papers give estimates on the effects of time-related and administrative barriers on trade. Using *Doing Business* data, Djankov, Freund and Pham (2010) incorporate the number of days spent with documentation, customs, port handling and inland transit into an augmented gravity equation and find that each additional day delay before the product is shipped reduces trade by more than 1%. Part of the policy literature is centered around the notion of "trade facilitation," i.e., the simplification and harmonization of international trade procedures. This line of literature provides ample evidence through country case studies, gravity estimations and CGE model simulations on the trade-creating effect of reduced administrative burden.[1]

The paper is structured as follows. Section 2 presents the model and carries out comparative statics and welfare analysis on per shipment costs. Section 3 describes the indicators of administrative trade barriers, Section 4 presents the US and Spanish export databases and descriptive statistics on trade lumpiness. Product-level estimations are in Section 5. Section 6 develops a novel decomposition of aggregate trade flows and presents the country cross section estimations. In this section, we elaborate on a theory-based gravity estimating equation with a non-bilateral trade cost variable. Section 7 concludes.

2 A model of shipping frequency

This section presents a version of the "circular city" discrete choice model of Salop (1979) that determines the number and timing of shipments to be sent to a destination market. Sending shipments more frequently is beneficial, because the specifications of the product can be more in line with the demands of the time.

[1] An assessment of estimates shows that trade facilitation can decrease trade costs by at least 2% of the trade value, and this number may get as large as 5-10% for less developed countries. For more see e.g. Engman (2005) or Francois, van Meijl and van Tongeren (2005).

2.1 Consumers

There are L consumers in the destination country.[2] Each consumer buys one unit of a good at unit price p.[3] Goods are differentiated only by the time of their arrival to the destination market. Consumers are heterogeneous with respect to their preferred date of consumption: some need the good on January 1, some on January 2, etc. The preferred date is indexed by $t \in [0,1]$, and can be represented by points on a circle.[4] The distribution of t across consumers is uniform, that is, there are no seasonal effects in demand.[5]

Consumers are willing to consume at a date other than their preferred date, but they incur a cost doing so. In the spirit of the trade literature, we model the cost of substitution with an iceberg transaction cost.[6] A consumer with preferred date t who consumes one unit of the good at date s only enjoys $e^{-\tau|t-s|}$ *effective units*. The parameter $\tau > 0$ captures the taste for timeliness. Consumers are more willing to substitute to purchase at dates that are closer to their preferred date and they suffer from early and late purchases symmetrically.

The utility of a type-t consumer purchasing one type-s good at price p is

$$U(t,s,p) = e^{-\tau|t-s|} - p,$$

where the consumers' gross valuation for the product is normalized to 1.[7] Note that the timing of consumption enters the utility function symmetrically around the preferred date. We believe both early and late delivery have costs (e.g. spoilage versus the cost of waiting), and treat the preference for timely delivery as symmetric to maintain analytical tractability.

2.2 Suppliers

There is an unbounded pool of potential suppliers to the destination country. Every supplier can send only one shipment.[8] They first decide whether or not to send a shipment to this destination. They then choose a time of shipment, s. After all suppliers fixed their time, they simultaneously pick a price $p(s)$, playing Bertrand competition. At that price suppliers serve all the demand they face, which determines the number of goods per shipment, $q(s)$, i.e., shipment size.[9]

There are two types of costs suppliers face: the per unit cost of producing and shipping the good c and a per shipment cost (fixed transaction cost) f. All suppliers face the same per unit and per

[2]For simplicity, we are omitting the country subscript in notation.

[3]We assume that the consumers' gross valuation is high enough so that all consumers purchase the product.

[4]Note that this puts an upper bound of $\frac{1}{2}$ on the distance between the firm and the consumer.

[5]Seasonality seems an interesting and important extension that we wish to tackle later.

[6]This is different from the tradition of address models that feature linear or quadratic costs, but gives more tractable results.

[7]This utility function can be derived from a quasilinear preference structure where the outside good enters the utility function linearly.

[8]Alternatively, one may allow for multiple shipments per supplier but fix the total number of suppliers. Such an approach is followed by Schipper, Rietveld and Nijkamp (2003) on the choice of flight frequency in the airline market.

[9]We abstract from capacity constraints in shipping. Large adjustments in capacity can be achieved by changing the transport mode. Note however that we assume per unit costs to be invariant to a modal switch.

shipment costs. Profits per shipment are

$$\pi(s) = [p(s) - c]q(s) - f.$$

2.3 Equilibrium and comparative statics

We focus on symmetric equilibria. In symmetric equilibrium, shipping times will be uniformly distributed throughout the year, i.e., firms locate evenly-spaced on the circle. This follows from the uniform distribution of consumers, symmetry of c and the convexity of the timeliness cost.[10] By backward induction, we first characterize the residual demand facing a supplier at time s. This pins down her optimal price. We then study the choice of shipping times. Finally, we use the zero profit condition to pin down the number of suppliers, and hence, shipping dates.

In equilibrium with symmetric location, the firm that ships at s only competes with its two nearest neighbors. Suppose that one neighbor ships at time $s_{-1} < s$, the other at time $s_{+1} > s$. The first has price p_{-1}, the second p_{+1}. Firms locate at equal distances from their neighbors, taking the location of their neighbors as given. Hence, the time difference between two adjacent suppliers is $\frac{1}{n}$, where n is the number of suppliers that enter the market. The demand function that firm at s faces can be derived using the indifferent consumer both left and right from s.

A consumer at a distance x from s on the left is indifferent to buy from the firm at s or his competitor at s_{-1} if $pe^{\tau x} = p_{-1}e^{\tau(\frac{1}{n}-x)}$. Similarly, a consumer x distant from s on the right is indifferent to buy from the firm at s or the firm at s_{+1} if $pe^{\tau x} = p_{+1}e^{\tau(\frac{1}{n}-x)}$. Solving for x in both equalities and summing them over the mass of consumers gives the demand a supplier faces, $q = 2xL$, as a function of the number of shipments, the competitors' and own price,

$$q(n, p, p_{-1}, p_{+1}) = \frac{L}{\tau}\left(\frac{1}{2}\ln p_{-1} + \frac{1}{2}\ln p_{+1} - \ln p\right) + \frac{L}{n}.$$

After substituting the demand equation in the profit function, the first order condition from the profit maximization with respect to p gives the best response function for the price as a function of the competitors' prices.[11] Imposing symmetry, $p_{-1} = p = p_{+1}$, one gets the expression for the mark-up in equilibrium,

$$\frac{p - c}{p} = \frac{\tau}{n}.$$

Firms can charge a higher mark-up, the more the consumers value timeliness and the larger the time distance between two shipments is. Both effects reduce the substitutability between two shipments occurring at adjacent times and increase the market power of sellers.

The zero profit condition with the mark-up equation determines n in equilibrium,

$$n^* = \frac{\tau}{2}\left(1 + \sqrt{1 + \frac{4cL}{\tau f}}\right).$$

[10] Economides (1986) shows that for convex transportation costs equilibrium exists with maximum differentiation of locations.

[11] The second order condition is satisfied.

More firms will enter the market, the more consumers value timeliness, the larger the market, the higher the marginal cost and the lower the per shipment cost is. The equilibrium shipment size and price can also be expressed as functions of the model parameters via the equilibrium relationships $q^* = \frac{L}{n^*}$ and $p^* = \frac{cn^*}{n^* - \tau}$. (See derivations in Appendix A.)

Taking the partial derivatives with respect to the per shipment cost one finds that equilibrium shipment frequency decreases, while both the equilibrium shipment size and price increases with f: $\frac{\partial n^*}{\partial f} < 0$, $\frac{\partial q^*}{\partial f} > 0$ and $\frac{\partial p^*}{\partial f} > 0$. (See derivations in Appendix A.) Hence, the model implies that facing larger per shipment costs firms send fewer and larger shipments at a higher per unit product price.

2.4 Welfare

Aggregate welfare is the sum of aggregate consumer surplus and aggregate firm profit. The former is the sum of the individual utilities over L consumers, the latter is the sum of the individual firm profits over n^* firms.

Individual consumer utility depends on the distance, x, between the preferred and the actual arrival time of the product. At the lower end, the two dates coincide and $x = 0$. At the higher end, the consumer's preferred date lies at the borderline between the markets of two adjacent competitors and $x = \frac{1}{2n^*}$. Total consumer surplus can be obtained by integrating individual utilities over the $2n^*$ intervals of length $\frac{1}{2n^*}$ on the time circle and multiplying by the mass of consumers L,

$$CS = 2n^* \int_{x=0}^{\frac{1}{2n^*}} \left(e^{-\tau x} - p^*\right) L dx.$$

Aggregate profit of n^* firms at equilibrium is

$$\Pi = (p^* - c)L - n^* f,$$

where we already used that $q^* = \frac{L}{n^*}$. Solving the integral in CS and adding the two components, we get aggregate welfare,

$$W = \frac{2n^* L}{\tau} \left(1 - e^{-\frac{\tau}{2n^*}}\right) - Lc - n^* f.$$

The first term captures the consumers' utility net of the cost of time discrepancy between the preferred and the actual consumption dates. This term is always positive and increases with the shipment frequency, because more shipments reduce time discrepancies. Note that the equilibrium price does not affect welfare. This is due to the fact demand is completely inelastic.

In competitive equilibrium, the total effect of per shipment cost f on welfare is the sum of an indirect effect through the equilibrium number of shipments and a direct effect,

$$\frac{\mathrm{d}W}{\mathrm{d}f} = \left.\frac{\partial W}{\partial n}\right|_{n=n^*} \frac{\partial n^*}{\partial f} + \frac{\partial W}{\partial f}.$$

The direct effect is clearly negative: a marginal increase in f decreases welfare in proportion to the number of shipments. The indirect effect of a marginal increase in f works through a decrease in the equilibrium number of shipments, which has two consequences. First, it decreases the consumer surplus, and hence welfare, due to larger distances between preferred and actual consumption dates. Second, it increases welfare by decreasing the total amount of per shipment costs to be paid. Whether the sum of the two counteracting effects is positive or negative depends on the parameter values. The sign of the total effect in the competitive equilibrium is also ambiguous, but for reasonable parameter values it is negative.

The socially optimal number of suppliers, n^o, that maximizes welfare is determined by the condition $\frac{\partial W}{\partial n} = 0$, which does not yield a closed form solution.[12] The number of suppliers in the competitive equilibrium, n^*, can be smaller or larger than n^o, depending on the parameter values. In the social optimum, the total effect of per shipment costs on welfare equals the marginal effect evaluated at $n = n^o$ (envelope theorem), which gives

$$\frac{\mathrm{d}W^o}{\mathrm{d}f} = \frac{\partial W}{\partial f}\bigg|_{n=n^o} = -n^o.$$

Hence, in the social optimum a marginal increase in f unambiguously decreases welfare.

3 Indicators of administrative barriers

We capture administrative trade barriers in the importing country with indicators on the the burden of import documentation and customs clearance and inspection. Data is from the *Doing Business* survey of the World Bank, carried out in 2009.[13] The survey includes, among others, questions on the time required to complete a foreign trade transaction and the financial costs associated with it. The data is country-specific and does not vary with the trading partner or across products.

The *Doing Business* survey is carried out among trade facilitators at large freight-forwarding companies. The majority of world trade is done via freight-forwarders and trade facilitators are well informed about the transaction procedures. The survey questions refer to a standardized containerized cargo of goods shipped by sea.[14] Since data is specific to ocean transport, controlling for the transport mode in the regression analysis will be important. The questions refer to all procedures from the vessel's arrival at the port of entry to the cargo's delivery at the warehouse in the importer's largest city.

The importing process is broken down into four procedures: document preparation, customs clearance and inspection, port and terminal handling, and inland transportation and handling from the nearest seaport to the final destination. Both the time and the financial cost are reported for each procedural stage separately. Time is expressed in calendar days, financial cost in US dollars per

[12] In the social optimum, $\frac{2L}{\tau} - \left(\frac{2L}{\tau} + \frac{L}{n^o}\right) e^{-\frac{\tau}{2n^o}} - f = 0$. The second derivative is negative, so n^o maximizes welfare.

[13] Detailed survey data is unfortunately not available publicly from earlier surveys. Though the trade data is from 2005, we do not see the time mismatch problematic. Doing Business figures appear to be strongly persistent over time.

[14] The traded product is assumed to travel in a dry-cargo, 20-foot, full container load via ocean. It weighs 10 tons, is valued at USD 20,000, is not hazardous and does not require special treatment or standards. (http://www.doingbusiness.org/MethodologySurveys/TradingAcrossBorders.aspx)

container. Financial costs of the four procedures are fees for documents and the customs clearance, customs broker fees, terminal handling charges, and the cost of inland transport, and do not include customs tariffs, trade taxes or bribes.

We take the sum of data on the first two procedures (document preparation + customs clearance and inspection) as our indicator of administrative barriers. The other two procedures are more closely related to moving and storing the goods than to administrative tasks. It appears that administrative barriers are better represented by the amount of time lost than by a financial measure. In particular, document preparation is the most time-consuming out of the four procedures. As Table C.3 in the Appendix shows, document preparation takes 13.7 days and represents half of the total time for the average importer. In terms of financial costs, inland transportation is the most burdensome, taking up almost half of the total cost for the average importer.

The time and the financial cost measures of administrative barriers are not particularly strongly correlated (Table C.4 in Appendix). The correlation coefficient is 0.39. In contrast, the time and financial cost measures for the sum of the other two procedures has a correlation coefficient of 0.68. This, and the fact that administrative tasks are more time-intensive, will make us rely more on our empirical results for the administrative time and less on the administrative financial cost indicator.

The level of administrative barriers is negatively correlated with the economic development of the importer. The latter is often considered as a proxy for the overall institutional quality of a country. The correlation coefficients with the level of GDP per capita in the last row of Table C.4 are significantly negative. The same pattern can be seen in Table C.5, which presents summary statistics of the administrative barrier indicators by continent. Administrative tasks to import take 21 days and cost USD 630 for the median African country. The same import transaction to complete takes only 7 days and costs USD 280 for the median European importer.

4 Evidence on trade lumpiness

We examine disaggregated data on exports from the US and Spain to a large set of countries in 2005. We want to look at the lumpiness of trade transactions, i.e., how frequently the same good is exported to the same destination country within the year, as well as the typical size of a shipment.

This exercise requires transaction-level (shipment-level) trade data. Customs Bureaus in both the US and Spain record trade flows at the shipment level. The Spanish database is made publicly available at this same level, whereas the US database is somewhat aggregated up. An entry in the publicly available US Foreign Trade statistics reported by the Census Bureau is differentiated by product, country of destination, month of shipment, and shipping Census region. Most importantly, the dataset also reports the number of shipments aggregated in each entry. More than half of the entries contain only one shipment, and the average number of shipments per entry is only four. In both databases, the identity of the exporting firm is omitted for confidentiality reasons. A more detailed data description is in Appendix B.

We consider 170 destination countries for the US and 166 (143 non-EU) destinations for Spain. Product classification is very detailed in both cases, covering around 8,000 different product lines

(10-digit Schedule B in the US and 8-digit Combined Nomenclature in the Spanish case). In the case of US exports, which is not a shipment-level database, we can calculate the value of a shipment per each cell by dividing the trade value with the number of shipments in that cell. Similarly, physical shipment size is trade quantity divided by the number of shipments.

Tables 2 and 3 report descriptive statistics for the US and Spain, respectively. In both cases four-four importers are selected that are relatively important trading partners and are countries with either low or high administrative barriers to import. The selected country sets partially overlap to enable direct comparison of US and Spanish figures.

Table 2: Lumpiness in US exports

importer	median shipment value ($)	how many times good shipped in a month	fraction of months in year good shipped	days to complete doc.&customs procedure
Selected low per shipment cost importers				
Canada	14515	14.1	1.00	5
Germany	16452	2.0	0.64	4
Israel	17864	1.3	0.36	6
Singapore	17275	1.6	0.55	2
Selected high per shipment cost importers				
Chile	12422	1.3	0.36	15
China	24540	1.9	0.64	19
Russia	21705	1.0	0.18	29
Venezuela	19405	1.4	0.36	61
All 170 importers	15200	1.2	0.27	15

Notes: U.S. exports to 170 importers in 2005 with 7,917 ten-digit product categories. Shipment size is the frequency-weighted median of data points at the highest-level of disaggregation. N=2,993,218. Shipment frequency statistics are for the median product. Trade in raw materials and low-value shipments (< USD 2,500) excluded. Days to complete documentation and customs procedures is from the Doing Business database for 2009.

Table 3: Lumpiness in Spanish exports

importer	median shipment value ($)	how many times good shipped in a month	fraction of months in year good shipped	days to complete doc.&customs procedure
Selected low per shipment cost importers				
Australia	8981	1.0	0.17	4
France	12238	1.8	0.92	0^a
Germany	12810	1.4	0.67	0^a
USA	14316	1.5	0.33	3
Selected high per shipment cost importers				
Algeria	13494	1.0	0.17	16
China	21848	1.0	0.17	19
Russia	12308	1.3	0.25	29
South Africa	13906	1.0	0.17	18
All 166 importers	11842	1.0	0.17	15

Notes: Spanish exports to 143 non-EU and 23 EU importers in 2005 in 8,234 eight-digit product lines. N=2,937,335. Shipment value is the median of individual shipments, converted to US dollars with monthly average USD/EUR exchange rates. Shipment frequency statistics are for the median product. Trade in raw materials and low-value shipments (< EUR 2,000) excluded. Days to complete documentation and customs procedures is from the Doing Business database for 2009. [a] Imposed for intra-EU.

The first column shows the value of the median shipment in US dollars, calculated from the most disaggregated data (the number of entries is almost 3 million for both exporters). US statistics are weighted by the number of shipments per entry. The value of the typical export shipment is USD

15,200 in the US, which is 28% larger than the typical shipment value in Spain.[15] Shipment sizes for selected individual destinations range between USD 9,000 (Spain to Australia) and USD 24,500 (US to China). These differences may depend on several factors, such as the nature of the exported products and the transport mode, which we will account for in the regression analysis.[16]

The second column reports how many times the median product is shipped to a given destinations in a month, if there was positive trade in that month. The third column shows the fraction of months in the year with positive trade in the median product to a given destination. Apart from the very strong US-Canada trade relationship, the median product is shipped only 1 or 2 times a month and trade is positive in a relatively small fraction of the months (typically 3 months for the US and 2 months for Spain). Both statistics show a somewhat stronger lumpiness in Spanish than in US exports. These figures are comparable to statistics reported by Alessandria, Kaboski and Midrigan (2010) for monthly US imports from six selected exporters during 1990-2005. These authors also demonstrate that lumpiness is not driven by seasonality and that it is pervasive across different types of traded goods.

The last column reports the indicator for the administrative trade barrier: the number of days trade documentation and the customs procedure take in the destination country. For the moment we impose zeros for intra-EU trade, indicating that administrative trade barriers within the EU are very low. Later, in the regression analysis, EU countries will be dropped from the Spanish sample. As far as the selected countries are concerned, shipment sizes are somewhat smaller for those with low barriers, and shipments to these countries show less strong lumpiness features than shipments to high-barrier destinations. Of course, these differences may be due to other factors as well, which we aim to control for in the regression analysis.

5 Product-level estimation

We want to test the predictions of the model in Section 2 and see how the frequency, the number, the size of shipments and the price vary with the level of administrative barriers. We create databases of exports by product and transport mode (air, sea, ground) to 170 importers for the US and 143 importers (EU members excluded)[17] for Spain and decompose the value of exports of product g by mode m to country j as

$$X = h\bar{n}v = h\bar{n}pq, \qquad (1)$$

where we omitted the jgm subscripts. h is the number of months in the year product g is exported by mode m to country j, $\bar{n}$ is the average number of shipments per month with positive trade

[15] We believe, this cannot be an artifact of statistical reporting requirements, because we used the same threshold value to drop low-value shipments in both databases.

[16] Sea and ground transport modes accommodate much larger shipment sizes than air transportation. We report shipment sizes in both value and weight (kilogram) for these three modes in Table C.2 in the Appendix. The differences are larger for the physical shipment size than for the shipment value, reflecting typically high weight-to-value cargos in air transportation.

[17] Destination countries in the US and Spanish sample are listed in Table C.1 in the Appendix. We exclude EU members from the Spanish sample, because the administrative barriers indicators are not relevant for intra-EU trade.

for a given j, g and m and v is the corresponding average shipment value, which can be further decomposed into price, p, and physical shipment size, q.

Our model predicts that administrative barriers decrease shipment frequency and increase the shipment value by both increasing the physical shipment size and the price. Both h and $\bar{n}$ are margins of shipment frequency. Looking at their responses separately tells us whether the concentration of shipments in relatively few months (h) is also responsive to administrative barriers. Our model is consistent with a responsive h margin, given its prediction on evenly-spaced shipments on the time circle.

We estimate simple OLS regressions with product-mode fixed effects with either the logarithm of the export value or one of the elements of decomposition (1) on the left-hand side. The estimating equation, with the export value on the left-hand side, is

$$\ln X_{jgm} = \beta \cdot \text{admin}_j + \gamma \cdot \text{other regressors}_j + \nu_{gm} + \epsilon_{jgm}, \tag{2}$$

where admin_j is the importer-specific administrative barrier variable with coefficient β, other importer-specific regressors are also included, ν_{gm} are product-mode fixed effects and ϵ_{jgm} is the error term.[18] Other regressors are those typically used in gravity estimations: logarithm of GDP and GDP per capita[19], geographical distance from the US or Spain, dummies for being landlocked or an island, Free Trade Agreement and Preferential Trade Agreement, common language and colonial relationship with the US or Spain, and the sum of the other two *Doing Business* import cost indicators (port handling + inland transport).

We drop observations from the US database, where the transport mode is not uniquely defined (5.8% of observations). To have a unique quantity measure, we restrict the US sample to those observations, where quantity is reported in kilograms. Since weight in kilograms is reported for all air- or ocean-transported shipments of the US, we need to exclude only part of the ground-transported trade, overall 4.5% of the US sample.[20]

For both the US and Spain, we first run regressions on a sample with all transport mode categories, then restrict the sample to sea (ocean) transported trade. The *Doing Business* survey question explicitly refers to an ocean-transported shipment. Nevertheless, estimations with all transport modes can be relevant too, since the documentation and customs burden (unlike port handling and inland transport) is probably similar across transport modes.

We focus on the estimation results with the time indicator of administrative barriers (Tables 4 and 5) and present the results with the financial cost indicator in the Appendix (Tables C.6 and C.7). We report only the β estimates. Consistent with the decomposition, the coefficient estimates

[18] We do not account for zeros in trade and, hence, adjustment at the product extensive margin. The aggregate specification in Section 6 accounts for zeros.

[19] GDP per capita also serves as a proxy for the overall institutional quality of the importer. This way we can ensure that the administrative burden variable does not pick up effects from other elements of institutional quality, with which it may be highly correlated.

[20] Ground-transported trade is mostly with Canada and Mexico. We check how excluding these two importers alters the results. Estimation results without Canada and Mexico (available on request) are qualitatively the same as the reported ones.

Table 4: Product-level estimates for US, Time cost

Dependent variable	β estimate	Robust s.e.	Adj.R^2
	all modes		
log export	-0.003	[0.002]	0.41
log number of months	-0.003**	[0.001]	0.38
log shipment per month	-0.002***	[0.001]	0.38
log value shipment size	0.002***	[0.000]	0.38
log physical shipment size	0.001	[0.001]	0.68
log price	0.001**	[0.001]	0.73
Number of observations	400096		
Number of clusters	10934		
Number of product-mode effects	18060		
	only sea		
log export	0.004*	[0.002]	0.33
log number of months	0.001	[0.001]	0.30
log shipment per month	0.001	[0.001]	0.26
log value shipment size	0.003***	[0.001]	0.33
log physical shipment size	0.002**	[0.001]	0.49
log price	0.001	[0.001]	0.59
Number of observations	195228		
Number of clusters	9599		
Number of product effects	7658		

Notes: OLS estimation of (2) separately for each margin in (1) on a sample of US exports to 170 countries in 10-digit HS products in 2005. If transport mode is not restricted to sea, it is air, sea, or ground. Product-mode fixed effects included. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and time to complete port/terminal handling and transport from nearest seaport. Only trade with quantity measured in kilograms included. Clustered robust standard errors with country and 2-digit product clusters. * sign. at 10%, ** 5%; *** 1%.

Table 5: Product-level estimates for Spain, Time cost

Dependent variable	β estimate	Robust s.e.	Adj.R^2
	all modes		
log export	0.000	[0.001]	0.43
log number of months	-0.002***	[0.000]	0.36
log shipment per month	-0.001***	[0.000]	0.43
log value shipment size	0.003***	[0.001]	0.45
log physical shipment size	0.002**	[0.001]	0.74
log price	0.001**	[0.001]	0.79
Number of observations	117544		
Number of clusters	7126		
Number of product-mode effects	15893		
	only sea		
log export	-0.002	[0.001]	0.39
log number of months	-0.004***	[0.001]	0.34
log shipment per month	-0.002***	[0.000]	0.41
log value shipment size	0.004***	[0.001]	0.40
log physical shipment size	0.004***	[0.001]	0.60
log price	0.001	[0.001]	0.72
Number of observations	64467		
Number of clusters	6010		
Number of product effects	6586		

Notes: OLS estimation of (2) separately for each margin in (1) on a sample of Spanish exports to 143 non-EU countries in 8-digit CN products in 2005. If transport mode is not restricted to sea, it is air, sea, or ground. Product- -mode fixed effects included. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and time to complete port/terminal handling and transport from nearest seaport. Clustered robust standard errors with country and 2-digit product clusters. * sign. at 10%, ** 5%; *** 1%.

in the second to fourth rows in all the result tables sum up to the coefficient estimate in the first row, and the estimate in the fourth row (value shipment size) is the sum of the estimates in the fifth and sixth rows (physical shipment size and price). Robust standard errors are clustered by importer and broad product group, where product groups are 2-digit groups of the 10-digit HS and 8-digit CN classifications of the US and Spain, respectively.

The most robust result is that, within product and mode, the value of shipments that are sent to countries with larger administrative barriers tends to be significantly larger (fourth rows). If completing the administrative tasks takes one day longer, the value of a shipment for a given transport mode and product is on average 0.2-0.4% larger. This is mostly the result of a larger physical shipment size (fifth rows) and less of a larger price per kilogram (sixth rows).

We also find evidence on a negative response of the shipment frequency (second and third rows). Larger administrative barriers tend to coincide with more lumpiness of trade for a given product and transport mode. Both the number of months with trade (h) and the average number of shipments per month with trade ($\bar{n}$) tend to be lower in destinations with higher administrative time. This effect is however not significant in the US sample with only sea-transported trade.

The (within-product-mode) value of exports does not seem to respond, or responds only modestly, to a change in the administrative barrier (first rows). Administrative barriers make firms send fewer and larger shipments, but they hardly affect the magnitude of export sales. This suggests that simply looking at the effect of administrative barriers on trade flows leaves an important part of the adjustment hidden.[21]

When we replace the administrative time indicator with the financial cost indicator (Tables C.6 and C.7 in Appendix), the main findings are similar. Evidence on the shipment frequency is however more mixed. A significant negative effect on shipment frequency is found only in the US sample.

6 Estimation on a country cross section

In this section we present aggregate cross sections estimates. We develop a decomposition of aggregate exports to a country into five margins: the number of shipments, the price, the physical shipment size for a given product and transport mode, the transport mode, and the product composition margins. The five margins separate five possible ways of adjustment. In response to higher administrative barriers firms may reduce the number of shipments, increase the price, pack larger quantities of goods in one shipment, switch to a transport mode that allows larger shipments (sea or ground),[22] or change the export product mix towards products that are typically shipped in large shipments.

The possibility to see adjustments on the last two margins (transport mode and product composition) is an advantage of the country cross section analysis over the product-level regressions in Section 5. The disadvantage is that the sample size is reduced to the number of importers (170 for US, 143 for Spain), which can bring up degrees of freedom concerns in the estimation.

[21] We do not account for adjustments at the product extensive margin, which can also be important.

[22] Shipment size statistics by mode of transport are in Table C.2 in Appendix.

6.1 A decomposition of aggregate exports

Let g index products, m modes of shipment (air, sea, ground), and j importer countries. Let country 0 be the benchmark importer (the average of all of the importers in the sample), for which the share of product-level zeros are the lowest. In fact, we want all products to have nonzero share, so that the share of different modes of transport are well defined for the benchmark country.[23]

Let n_{jgm} denote the number of shipments of good g through mode m going to country j. Similarly, q_{jgm} denotes the average shipment size for this trade flow in quantity units, p_{jgm} is the price per quantity unit. We introduce the notation

$$s_{jgm} = \frac{n_{jgm}}{\sum_k n_{jgk}}$$

for the mode composition of good g in country j, and

$$s_{jg} = \frac{\sum_k n_{jgk}}{\sum_l \sum_k n_{jlk}}$$

for the product composition of country j. We define s_{0gm} and s_{0g} similarly for the benchmark (average) importer.

We decompose the ratio of total trade value (X) to country j and the benchmark country,

$$\frac{X_j}{X_0} = \frac{\sum_g \sum_m n_{jgm} p_{jgm} q_{jgm}}{\sum_g \sum_m n_{0gm} p_{0gm} q_{0gm}} = \frac{n_j \sum_g s_{jg} \sum_m s_{jgm} p_{jgm} q_{jgm}}{n_0 \sum_g s_{0g} \sum_m s_{0gm} p_{0gm} q_{0gm}},$$

as follows,

$$\frac{X_j}{X_0} = \frac{n_j}{n_0} \cdot \frac{\sum_g s_{jg} \sum_m s_{jgm} p_{jgm} q_{jgm}}{\sum_g s_{jg} \sum_m s_{jgm} p_{0gm} q_{jgm}} \cdot \frac{\sum_g s_{jg} \sum_m s_{jgm} p_{0gm} q_{jgm}}{\sum_g s_{jg} \sum_m s_{jgm} p_{0gm} q_{0gm}} \cdot \frac{\sum_g s_{jg} \sum_m s_{jgm} p_{0gm} q_{0gm}}{\sum_g s_{jg} \sum_m s_{0gm} p_{0gm} q_{0gm}} \cdot \frac{\sum_g s_{jg} \sum_m s_{0gm} p_{0gm} q_{0gm}}{\sum_g s_{0g} \sum_m s_{0gm} p_{0gm} q_{0gm}}.$$

The first term is the shipment extensive margin. It shows how the number of shipments sent to j differs from the number of shipments sent to the average importer. The ratio is greater than 1 if more than average shipments are sent to j. The second term is the price margin. It shows how much more expensive is the same product shipped by the same mode to country j, relative to the average importer. The third term we call the *within* physical shipment size margin. It tells how physical shipment sizes differ in the two countries for *the same product and mode of transport*. The fourth term is a mode of transportation margin. If it is greater than 1, transport modes that accommodate larger-sized shipments (sea, ground) are overrepresented in j relative to the benchmark. The last term is the product composition effect. It shows to what extent physical shipment sizes differ in the two countries as a result of differences in the product compositions. If bulky items and/or items that typically travel in large shipments are overrepresented in the imports of j, the ratio gets larger than 1.

[23]Note that the mode of transport will not be well defined for a product/country pair if there are no such shipments. This will not be a problem because this term will carry a zero weight in the index numbers below.

We express the same decomposition identity simply as

$$X_{j,\text{total}} = X_{j,\text{extensive}} \cdot X_{j,\text{price}} \cdot X_{j,\text{within}} \cdot X_{j,\text{transport}} \cdot X_{j,\text{prodcomp}}. \tag{3}$$

If administrative trade barriers make firms send less and larger shipments, one should see the shipment *extensive* margin to respond negatively and the *within* physical shipment size margin positively to larger administrative costs. If firms facing per shipment administrative costs choose to switch to a large-shipment transport mode, the transport margin should respond positively. If firms shift the composition of the traded product mix towards typically large shipment products, it should show up as a positive response on the product composition margin.

6.2 Simple cross section estimation

We run simple cross section regressions with elements of decomposition (3) (in logs) on the left-hand side and the administrative barrier and other "gravity" regressors on the right-hand side. The estimating equation is

$$\log X_{j,z} = \beta \cdot \text{admin}_j + \gamma \cdot \text{other regressors}_j + \nu + \eta_j, \tag{4}$$

where $z \in$ [total, extensive, price, within, transport, prodcomp] denotes the different margins, ν is a constant and η_j is the error term. Additional regressors are the same as in the product-level estimation. We estimate (4) with simple OLS and robust standard errors in the case of the total margin. In the case of the five margins, we exploit the correlatedness of the errors and apply Seemingly Unrelated Regressions Estimation (SURE). The Breusch-Pagan test always rejects the independence of errors.

We report β estimates for the administrative time indicator for both the US and Spain in Table 6. Estimation results for the financial cost administrative barrier indicator are in Table C.8 in the Appendix. By construction, the coefficients on the five margins sum up to the coefficient in the total margin regression. The sum of the price and the within margins is the value shipment size. We report Wald test statistics for the significance of the sum of these two coefficients.

The signs of the coefficient estimates are in most of the cases the expected, though only some of them are statistically significant. The strongest result is a significant positive response on the value shipment size to the administrative time variable: the larger administrative barriers are, the larger the value of the average shipment is. This effect mainly comes from adjustment on the (within) physical shipment size and not from a price effect. There is also evidence of a negative response on the shipment extensive margin, though it is statistically significant only in the Spanish sample. We find no effects on either the transport mode or the product composition margins.

6.3 Estimating theory-based gravity

So far we have estimated atheoretical gravity equations: we regressed exports (or its components) on variables of economic size and trade costs between the exporter and the importer. In this section we derive and estimate a theory-based reduced form gravity equation that is applicable to

Table 6: Simple cross section estimation results, Time cost

Dependent variable	β estimate	s.e.	Adj./Pseudo R^2
	Exporter is US		
log total export	0.000	[0.007]	0.85
log shipment extensive	-0.007	[0.008]	0.85
log price	-0.001	[0.002]	0.05
log within physical size	0.007***	[0.003]	0.39
log transport mode	0.001	[0.001]	0.33
log product composition	0.000	[0.002]	0.14
Number of observations	170		
Test $\beta_{price}+\beta_{within}$=0	$\chi^2(1)$=5.28, p-val=0.022		
Breusch-Pagan test	$\chi^2(10)$=73.97, p-val=0.000		
	Exporter is Spain		
log total export	-0.011	[0.008]	0.89
log shipment extensive	-0.015**	[0.006]	0.91
log price	0.003	[0.002]	0.18
log within physical size	0.003	[0.004]	0.24
log transport mode	-0.001	[0.001]	0.07
log product composition	-0.001	[0.003]	0.13
Number of observations	143		
Test $\beta_{price}+\beta_{within}$=0	$\chi^2(1)$=3.34, p-val= 0.067		
Breusch-Pagan test	$\chi^2(10)$=75.95, p-val=0.000		

Notes: OLS estimation of (4) with robust standard errors for total exports, SURE for the margins, on a cross section of importers. Pseudo R^2 is for SURE. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and time to complete port/terminal handling and transport from nearest seaport. Breusch-Pagan test is for residual independence in SURE. * sign. at 10%, ** 5%; *** 1%.

a cross section of importers and a multilateral trade cost variable. The administrative barriers are multilateral in nature in that they apply to all trading partners (except domestic trade).

As the seminal paper of Anderson and van Wincoop (2003) has shown, a proper gravity estimation should control for the Multilateral Trade Resistances (MTR) of the exporter and the importer. The MTR of the importer country (inward MTR) is an average measure of trade barriers the suppliers of this country (including trade partners and domestic suppliers) face. Similarly, outward MTR is an average measure of trade barriers that the exporter faces when exporting to the rest of the world. In the theory-based gravity equation trade depends not directly on trade costs between the two partners, but on the ratio of these trade costs to the exporter's and importer's MTRs. The theory links bilateral trade costs and inward and outward MTRs to each other in a complex non-linear way.

We follow the method of Baier and Bergstrand (2009) to control for the MTRs.[24] They propose a first-order log-linear Taylor series approximation of the non-linear MTR expressions around an equilibrium with symmetric trade frictions, i.e. when all bilateral trade costs are equal. This method allows for simple OLS estimation and, under some conditions, comparative static analysis. Moreover, it does not rely on the assumption of bilaterally symmetric trade costs. We can simplify the reduced form gravity equation of Baier and Bergstrand (2009) to the case of a cross section of

[24]Most empirical applications use country fixed effects (or country-time fixed effects in panels) to control for the MTRs. In our case fixed-effects estimation is not applicable for two reasons: we have only a country cross section and we want to identify the effect of a trade cost variable that has no bilateral variation. Alternatively, Anderson and van Wincoop (2003) apply structural estimation, but they need to rely on the assumption of bilateral trade cost symmetry.

importers to get

$$\ln\left(\frac{X_{ij}}{Y_j}\right) = \alpha + (1-\sigma)\left[\ln T_{ij} - \sum_{k=1}^{N} \theta_k \ln T_{kj}\right], \tag{5}$$

where X_{ij} is export from either the US or Spain to country j, Y_j is income of j, T_{ij} are trade costs between the US or Spain and j, α is a constant, σ is the elasticity of substitution between domestic and foreign goods, $\theta_k = \frac{Y_k}{\sum_{l=1}^{N} Y_l}$ is the share of country k in world income and N is the number of countries in the world (also including j). The sum of income-weighted trade costs between j and all the countries (second term in the bracket with negative sign) captures the inward MTR of j. Note that the sum also includes domestic trade costs, i.e. trade costs of j with itself.

This formula capture the intuition behind Anderson's and van Wincoop's (2003) result: trade flows only depend on relative trade costs. If all trade costs (including domestic trade cost T_{jj}) go up by the same amount, then trade does not change, because $\sum_{k=1}^{N} \theta_k = 1$. To conduct comparative statics with respect to an element of trade costs, we need to check how it affects *relative* trade costs.

We need to take into account that not all the trade cost variables have true bilateral variation. Let us define a log-linear trade cost function that contains two types of costs and an additive error term,

$$\ln T_{ij} = \delta_1 t_{ij} + \delta_2 f_{ij} + u_{ij},$$

where $f_{ij} = f_j$ for all $i \neq j$ and $f_{ij} = 0$ for $i = j$ and the δ's are parameters. It is easy to see that the term in the bracket in equation (5) simplifies to $\theta_j f_j$ for the second type of trade cost. After substituting the trade cost function in (5), the gravity equation becomes

$$\ln\left(\frac{X_{ij}}{Y_j}\right) = \alpha + (1-\sigma)\delta_1\left[t_{ij} - \sum_{k=1}^{N} \theta_k t_{kj}\right] + (1-\sigma)\delta_2\theta_j f_j + u_{ij}. \tag{6}$$

In principle, estimating this equation gives consistent estimates of the gravity parameters. In practice, however, there are two issues to consider. First, if we do not restrict income elasticity to unity and put Y_j on the right-hand side, we face a multicollinearity problem between $\theta_j f_j$ and Y_j because θ_j is the income share of country j. Moreover, the inclusion of more than one $\theta_j f_j$ terms can lead to an even more severe multicollinearity problem. Second, the gravity parameter to estimate for the administrative barrier variable will be far larger than the corresponding comparative static effect (Behar, 2009). The gravity parameter is $(1-\sigma)\delta_2$ and the comparative static effect (specific to j) is approximately $(1-\sigma)\delta_2\theta_j$. The difference is a factor of the importer's income share, so it is always large.[25]

We propose a modification of the estimating equation that helps resolve both concerns above. Decompose $\theta_j f_j$ in equation (6) as

$$\theta_j f_j = \bar{\theta}\, f_j + (\theta_j - \bar{\theta}) f_j, \tag{7}$$

[25] The difference can get non-negligible for trade costs with bilateral variation too, if at least one of the trade partners has a relatively large income share. Formally, the comparative static effect for the bilateral trade cost is $(1-\sigma)\,\delta_1\,(1-\theta_j-\theta_i+\theta_i\theta_j)$.

where $\bar{\theta}$ is the mean of the θ_js across all importers. If instead of $\theta_j f_j$ we include f_j and $(\theta_j - \bar{\theta})f_j$ separately in the estimating equation, we can consistently estimate the comparative static effect for the average-sized importer, $(1-\sigma)\delta_2\bar{\theta}$, as the coefficient on f_j, which is not collinear with Y_j.

Table 7: Results from theory-based gravity, Time cost

Dependent variable	β estimate	s.e.	Adj./Pseudo R^2
	Exporter is US		
log total export	-0.006	[0.008]	0.85
log shipment extensive	-0.015*	[0.009]	0.85
log price	-0.001	[0.002]	0.07
log within physical size	0.007**	[0.003]	0.38
log transport mode	0.002	[0.001]	0.32
log product composition	0.002	[0.003]	0.09
Number of observations	170		
Test $\beta_{price}+\beta_{within}=0$	$\chi^2(1)=3.74$, p-val=0.053		
Breusch-Pagan test	$\chi^2(10)=80.57$, p-val=0.000		
	Exporter is Spain		
log total export	-0.027***	[0.008]	0.87
log shipment extensive	-0.033***	[0.009]	0.88
log price	0.003	[0.003]	0.20
log within physical size	0.005	[0.005]	0.24
log transport mode	-0.001	[0.002]	0.08
log product composition	0.000	[0.003]	0.08
Number of observations	143		
Test $\beta_{price}+\beta_{within}=0$	$\chi^2(1)=3.10$, p-val= 0.079		
Breusch-Pagan test	$\chi^2(10)=81.45$, p-val=0.000		

Notes: OLS estimation with robust standard errors for total exports, SURE for the margins, on a cross section of importers. Pseudo R^2 is for SURE. Other regressors: log GDP, log GDP per capita, log distance, dummies for island landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and time to complete port/terminal handling and transport from nearest seaport. MTR is controlled for by the method of Baier and Bergstrand (2009). Breusch-Pagan test is for residual independence in SURE. * sign. at 10%, ** 5%; *** 1%.

We calculate the MTR-adjusted trade costs as in the bracket in equation (6) for the trade cost variables in the regression (distance, landlocked, island, FTA, PTA, colonial relationship and common language dummies, and the port/terminal handling and inland transport cost).[26] Income shares are based on GDP data, and the world total is the sum of importers plus the exporter in either of the two samples. We apply the solution in (7) only to the administrative barrier variable. We estimate (4) for each margin with the MTR-adjusted trade cost variables, log GDP and log GDP per capita on the right-hand side.

The results, presented in Table 7, reinforce the previous findings. The value shipment size is significantly larger for larger administrative barriers, which is primarily due to a larger physical shipment size and not a higher price. Compared to the simple cross section estimates, we find stronger evidence for a negative response on the shipment extensive margin. If administrative barriers are higher, the number of shipments is significantly lower in both US and Spanish exports. Finally, we find qualitatively small and statistically not significant coefficients on the transport mode and product composition margins.

[26] Domestic trade costs are internal distance for distance, 1 for FTA and PTA, colony and language dummies, 0 for landlocked and island and for the port/terminal handling and inland transport cost.

7 Conclusion

Administrative barriers to trade such as document preparation and the customs process are non-negligible costs to the trading firm. Since such costs typically arise after each shipment, the firm can economize on them by sending fewer but larger shipments to destinations with high administrative costs. Such a firm response can partly explain the lumpiness of trade transactions, which has recently been documented in the literature.

Less frequent shipments cause welfare losses because of the larger discrepancy between the actual and the desired time of consumption. This paper built a simple "circular city" discrete choice model without inventories to study the effect of per shipment costs on shipment frequency, shipment size, price and welfare. The model implies that larger per shipment costs decrease shipment frequency, increase the shipment size and the price, and in the social optimum they unambiguously decrease welfare.

Exploiting the substantial variation in administrative trade costs by destination country, this paper provided empirical evidence on disaggregated US and Spanish export data. A decomposition of exports by destination enables us to identify responses to administrative costs separately on the shipment frequency, the price and the physical shipment size margins. Regarding the latter, we are also able to see adjustments via altering the transport mode or the export product mix. Evidence confirms that firms send larger-sized shipments less frequently to high-cost destinations, while total sales respond only marginally, if at all. We find however no convincing evidence for a positive price effect.

References

[1] Alessandria, G., Kaboski, J. and Midrigan, V. (2010) "Inventories, Lumpy Trade, and Large Devaluations," *American Economic Review*, 100(5), pp. 2304-39.

[2] Anderson, J. E. and van Wincoop, E. (2003) "Gravity with Gravitas: A Solution to the Border Puzzle," *American Economic Review*, 93, pp. 170-192.

[3] Armenter, R. and Koren, M. (2010) "The Balls-and-Bins Model of Trade," CEPR Discussion Paper No. DP7783.

[4] Baier, S. L. and Bergstrand, J. H. (2009) "Bonus vetus OLS: A Simple Method for Approximating International Trade-Cost Effects Using the Gravity Equation," *Journal of International Economics*, 77, pp. 77-85.

[5] Behar, A. (2009) "De Bonus Vetus OLS: Approximating the international trade-cost effects of red tape," FREIT Working Paper No. 37.

[6] Djankov, S., Freund, C. and Pham, C. S. (2010) "Trading on Time," *Review of Economics and Statistics*, MIT Press, 92(1), pp. 166-173.

[7] Economides, N. (1986) "Product Differentiation in Hotelling's Duopoly," Economics Letters, 21 pp. 67-71.

[8] Engman, M. (2005) "The Economic Impact of Trade Facilitation," OECD Trade Policy Working Papers No. 21.

[9] Evans, C. and Harrigan, J. (2005) "Distance, Time an Specialization: Lean Retailing in General Equilibrium," *American Economic Review*, 95(1), pp. 292-313.

[10] Francois J., van Meijl, H. and van Tongeren, F. (2005) "Trade Liberalization in the Doha Development Round," Economic Policy, April 2005, pp. 349-391.

[11] Harrigan, J. (2010) "Airplanes and Comparative Advantage," *Journal of International Economics*, 82(2), pp. 181-194.

[12] Harrigan, J. and Venables, A. J. (2006) "Timeliness and Agglomeration," *Journal of Urban Economics*, 59, pp. 300-316.

[13] Head, K. (2003) "Gravity for Beginners," Available at: http://strategy.sauder.ubc.ca/head//gravity.pdf.

[14] Hornok, C. (2011) "Need for Speed: Is Faster Trade in the EU Trade-creating?" CEPR Discussion Paper No. 8451.

[15] Hummels, D. (2001) "Time as a Trade Barrier," GTAP Working Paper No. 18.

[16] Hummels, D. and Skiba A. (2004) "Shipping the Good Apples out? An Empirical Confirmation of the Alchian-Allen Conjecture," *Journal of Political Economy*, 112(6), pp. 1384-1402.

[17] Irarrazabal, A., Moxnes, A. and Opromolla, L. D. (2010) "The Tip of the Iceberg: Modeling Trade Costs and Implications for Intra-industry Reallocation," CEPR Discussion Paper No. DP7685.

[18] Salop, S. C. (1979) "Monopolistic Competition with Outside Goods," *The Bell Journal of Economics*, 10(1), pp. 141-156.

[19] Schipper, Y., Rietveld, P. and Nijkamp, P. (2003) "Airline Deregulation and External Costs: A Welfare Analysis," Transportation Research Part B, 37, pp. 699-718.

A Additional derivations

A.1 Equilibrium number of shipments

The zero profit condition is

$$(p - c)q = f.$$

After substituting the equilibrium relationships $p = \frac{cn}{n-\tau}$ and $q = \frac{L}{n}$ and some manipulations we get a second degree polynomial equation in n

$$fn^2 - f\tau n - c\tau L = 0.$$

The solution that yields $n^* > 0$ is

$$n^* = \frac{\tau}{2}\left(1 + \sqrt{1 + \frac{4cL}{\tau f}}\right).$$

Taking the partial derivative with respect to f,

$$\frac{\partial n^*}{\partial f} = -\frac{Lc}{f^2}\left(1 + \frac{4cL}{\tau f}\right)^{-\frac{1}{2}} < 0.$$

A.2 Equilibrium shipment size

In symmetric equilibrium the shipment size is

$$q^* = \frac{L}{n^*}.$$

Substituting the solution for n^* and collecting terms yields

$$q^* = \frac{2L}{\tau\left(1 + \sqrt{1 + \frac{4cL}{\tau f}}\right)}.$$

Taking the partial derivative with respect to f,

$$\frac{\partial q^*}{\partial f} = \frac{4cL^2}{\tau^2 f^2}\left(1 + \sqrt{1 + \frac{4cL}{\tau f}}\right)^{-2}\left(1 + \frac{4cL}{\tau f}\right)^{-\frac{1}{2}} > 0.$$

A.3 Equilibrium price

In symmetric equilibrium the price is given by

$$p^* = \frac{cn^*}{n^* - \tau}.$$

Substituting for n^* one gets

$$p^* = c\frac{\sqrt{1 + \frac{4cL}{\tau f}} + 1}{\sqrt{1 + \frac{4cL}{\tau f}} - 1}.$$

Taking the partial derivative with respect to f and collecting terms,

$$\frac{\partial p^*}{\partial f} = \frac{4c^2L}{\tau f^2}\left(1+\frac{4cL}{\tau f}\right)^{-\frac{1}{2}}\left(\sqrt{1+\frac{4cL}{\tau f}}-1\right)^{-2} > 0.$$

B Data reference

B.1 US export data

US exports data is from the foreign trade database of the US Census Bureau. We consider only exports in 2005 to 170 destination countries. Monthly trade flows are recorded in 10-digit HS (Harmonized System) product, destination country and US district of origin dimensions. Although it is not a shipment-level database, more than half of the observations represent only one shipment.[27] Information is available on the number of shipments, the value in US dollars and the quantity of trade, as well as the value and weight of trade transported by air or vessel.

If the value of trade by air or vessel does not cover total trade value, we assume ground transportation. We drop those observations, where trade is associated with more than one transport mode (5.8% of observations, 25% of total number of shipments). Hence, one of the three transport modes (air, vessel, ground) is uniquely assigned to each observation.

We drop product lines, which correspond to low-value shipments. In the Census database trade transactions are reported only above a trade value threshold (USD 2,500 for exports). Low value shipment lines are estimates based on historical ratios of low value trade, except for Canada, where true data is available. They are classified under two product codes as aggregates. Hence, they appear erroneously as two large shipments and distort the shipment size distribution.[28]

We also drop product lines that mainly cover raw materials and fuels according to the BEC (Broad Economic Categories) classification. These are the products under the BEC codes 111-112 (primary food and beverages), 21 (primary industrial supplies), 31 (primary fuels and lubricants) and 321-322 (processed fuels and lubricants).

In the database there is no single quantity measure, which would apply to all product categories: product quantities are measured either in kilograms, numbers, square meters, liters, dozens, barrels, etc. In addition, weight in kilograms is recorded as separate variables for trade shipped by air or vessel.

We calculate price as a unit value, i.e. value over quantity. It is an f.o.b. price, since exports are valued at the port of export in the US and include only inland freight charges. It is important

[27]The US Census Bureau defines a shipment accordingly: "Unless as otherwise provided, all goods being sent from one USPPI to one consignee to a single country of destination on a single conveyance and on the same day and the value of the goods is over \$2,500 per schedule B or when a license is required.", where USPPI is a U.S. Principal Party in Interest, i.e. "The person or legal entity in the United States that receives the primary benefit, monetary or otherwise, from the export transaction."

[28]Low value shipment lines are 9880002000: "Canadian low value shipments and shipments not identified by kind", 9880004000: "Low value estimate, excluding Canada". In addition, we also drop the product line 9809005000: "Shipments valued USD 20,000 and under, not identified by kind".

to calculate the price at least at the 10-digit product level, where the quantity measure per product is unique. For some products the quantity measure is not defined; here we assume that quantity equals value, i.e. the quantity measure is a unit of US dollar.

B.2 Spanish export data

Data on Spanish exports in 2005 is from the Spanish Tax Authority (Agencia Tributaria). It is a universal shipment-level database that records, among others, the month, the 8-digit CN (Combined Nomenclature) product code, the destination country, the transport mode, the value in euros and the weight in kilograms for each transaction.

In 2005 Spain exported only to 166 out of the 170 destination countries we consider for the US. In the regression analysis, we drop exports within the EU and, hence, the number of destination countries fall to 143. (Malta is not among the 166.)

This database includes low-value transactions. To make it comparable to the US database we drop transactions of value below EUR 2,000 (USD 2,500 converted to euros with the annual average exchange rate in 2005). Similar to the US case, we also drop transactions in raw materials and fuels. When necessary, we convert data in euros to US dollars with monthly average exchange rates.

B.3 Other regressors

GDP and GDP per capita of the importer countries in current USD for year 2005 is from the World Bank's World Development Indicators database.

Gravity variables (bilateral geographical distance, internal distance, dummies for landlocked, common language, colonial ties) are from CEPII. Bilateral distance is the population-weighted average of bilateral distances between the largest cities in the two countries, common language dummy refers to official language, colonial ties dummy refers to colonial relationship after 1945.[29]

The FTA and PTA dummies indicates free trade agreements and preferential trade agreements, respectively, effective in year 2005. They are based on the Database on Economic Integration Agreements provided by Jeffrey Bergstrand on his home page.[30] We define PTA as categories 1-2, FTA as categories 3-6 in the original database.

[29]Description of variables by CEPII: http://www.cepii.fr/distance/noticedist_en.pdf

[30]http://www.nd.edu/~jbergstr/#Links

C Figures and Tables

Table C.1: Importer countries in the regressions

US	Spain	importer	US	Spain	importer	US	Spain	importer
1	1	Afghanistan	58	47	Gabon	115	95	Norway
2	2	Albania	59	48	Gambia	116	96	Oman
3	3	Algeria	60	49	Georgia	117	97	Pakistan
4	4	Angola	61	50	Ghana	118	98	Panama
5	5	Antigua and Barbuda	62		Greece	119	99	Papua New Guinea
6	6	Argentina	63	51	Grenada	120	100	Paraguay
7	7	Armenia	64	52	Guatemala	121	101	Peru
8	8	Australia	65	53	Guinea	122	102	Philippines
9		Austria	66	54	Guinea-Bissau	123		Poland
10	9	Azerbaijan	67	55	Guyana	124		Portugal
11	10	Bahamas	68	56	Haiti	125	103	Qatar
12	11	Bahrain	69	57	Honduras	126	104	Republic of Yemen
13	12	Bangladesh	70	58	Hong Kong	127	105	Romania
14	13	Belarus	71		Hungary	128	106	Russia
15		Belgium	72	59	Iceland	129	107	Rwanda
16	14	Belize	73	60	India	130	108	Sao Tome and Principe
17	15	Benin	74	61	Indonesia	131	109	Saudi Arabia
18		Bhutan	75	62	Iran	132	110	Senegal
19	16	Bolivia	76		Ireland	133	111	Seychelles
20	17	Bosnia-Herzegovina	77	63	Israel	134	112	Sierra Leone
21	18	Botswana	78		Italy	135	113	Singapore
22	19	Brazil	79	64	Ivory Coast	136		Slovakia
23	20	Brunei	80	65	Jamaica	137		Slovenia
24	21	Bulgaria	81	66	Japan	138	114	Solomon Islands
25	22	Burkina	82	67	Jordan	139	115	South Africa
26	23	Burundi	83	68	Kazakhstan	140		Spain
27	24	Cambodia	84	69	Kenya	141	116	Sri Lanka
28	25	Cameroon	85	70	Korea, South	142	117	St Kitts and Nevis
29	26	Canada	86	71	Kuwait	143	118	St Lucia
30	27	Cape Verde	87	72	Kyrgyzstan	144	119	St.Vincent&Grenadines
31	28	Central African Rep.	88	73	Laos	145	120	Sudan
32	29	Chad	89		Latvia	146	121	Suriname
33	30	Chile	90	74	Lebanon	147	122	Swaziland
34	31	China	91		Lesotho	148		Sweden
35	32	Colombia	92	75	Liberia	149	123	Switzerland
36	33	Comoros	93		Lithuania	150	124	Syria
37	34	Congo (Brazzaville)	94		Luxembourg	151	125	Tajikistan
38		Congo (Kinshasa)	95	76	Macedonia (Skopje)	152	126	Tanzania
39	35	Costa Rica	96	77	Madagascar	153	127	Thailand
40	36	Croatia	97	78	Malawi	154	128	Togo
41		Cyprus	98	79	Malaysia	155		Tonga
42		Czech Republic	99	80	Maldives	156	129	Trinidad and Tobago
43		Denmark	100	81	Mali	157	130	Tunisia
44	37	Djibouti	101	82	Mauritania	158	131	Turkey
45	38	Dominica	102	83	Mauritius	159	132	Uganda
46	39	Dominican Republic	103	84	Mexico	160	133	Ukraine
47	40	Ecuador	104	85	Moldova	161	134	United Arab Emirates
48	41	Egypt	105	86	Mongolia		135	USA
49	42	El Salvador	106	87	Morocco	162		United Kingdom
50	43	Equatorial Guinea	107	88	Mozambique	163	136	Uruguay
51	44	Eritrea	108	89	Namibia	164	137	Uzbekistan
52		Estonia	109	90	Nepal	165	138	Vanuatu
53	45	Ethiopia	110		Netherlands	166	139	Venezuela
54		Germany	111	91	New Zealand	167	140	Vietnam
55	46	Fiji	112	92	Nicaragua	168	141	Western Samoa
56		Finland	113	93	Niger	169	142	Zambia
57		France	114	94	Nigeria	170	143	Zimbabwe

Table C.2: Shipment size by mode of transport

Transport mode	Value shipment size ($) mean	median	st.dev	Physical shipment size (kg) mean	median	st.dev
Exporter is US						
air	37169	12757	249284	318	72	1264
sea	62102	21424	364305	51156	5368	838271
ground	28838	14273	681885	13870	7131	45985
all	35193	15200	460577	15188	964	389427
Exporter is Spain						
air	28833	6570	408154	468	92	10325
sea	57418	14808	946887	42081	5350	522298
ground	69472	11947	566320	21781	1540	396921
all	61325	11842	686071	25248	1512	416202

Notes: US exports to 170 importers (most detailed data) and Spanish exports to 166 importers (shipment-level data) in 2005. In the case of US exports, statistics are frequency-weighted and physical shipment size is taken only when quantity is reported in kilograms.

Table C.3: Time and financial costs of four import procedures

Procedure	Time cost (days) Mean	% of total	CV	Financial cost (US$) Mean	% of total	CV
Document preparation	13.7	51.7	0.75	306.1	19.0	0.61
Custom clearance and inspection	3.7	14.0	0.74	213.7	13.2	0.97
Port and terminal handling	4.5	16.8	0.74	317.0	19.6	0.56
Inland transportation from seaport	4.7	17.5	1.56	778.0	48.2	1.08
Total	26.6	100.0	0.69	1614.8	100.0	0.63

Notes: Own calculations based on Doing Business data from 2009. Time and financial cost of the four procedures of an import transaction. Statistics for 170 countries. CV is coefficient of variation (standard deviation over the mean).

Table C.4: Correlation coefficients of the Doing Business indicators

	Admin time	Transit time	Log admin cost	Log transit cost
Admin time	1			
Transit time	0.534	1		
	[0.000]			
Log admin cost	0.394	0.349	1	
	[0.000]	[0.000]		
Log transit cost	0.551	0.684	0.341	1
	[0.000]	[0.000]	[0.000]	
Log GDP per capita	-0.567	-0.479	-0.397	-0.366
	[0.000]	[0.000]	[0.000]	[0.000]

Notes: Own calculations based on Doing Business data from 2009. Admin = documentation + customs, Transit = port handling + inland transport. Time refers to the time cost, cost to the financial cost indicators. Statistics for 170 countries. Significance levels of correlation coefficients in brackets.

Table C.5: Administrative barrier indicators by continent

Continent	Number of countries	Time cost (days) median	min	max	Financial cost (US$) median	min	max
Africa	51	21	9	57	630	115	1830
America	32	12	5	61	526	235	1500
Asia	42	16	2	61	386	92	1100
Europe	37	7	2	28	280	175	600
Pacific	8	11	4	23	263	170	389
Total	170	15	2	61	450	92	1830

Notes: Own calculations based on Doing Business data from 2009. Time and financial cost of the documentation and customs procedures of an import transaction. Statistics for 170 countries.

Table C.6: Product-level estimates for US, Financial Cost

Dependent variable	β estimate	Robust s.e.	Adj.R^2
	all modes		
log export	-0.202***	[0.036]	0.41
log number of months	-0.127***	[0.015]	0.38
log shipment per month	-0.089***	[0.014]	0.38
log value shipment size	0.014	[0.012]	0.38
log physical shipment size	0.020	[0.016]	0.68
log price	-0.006	[0.009]	0.73
Number of observations	400096		
Number of clusters	10934		
Nr of product-mode effects	18060		
	only sea		
log export	-0.152***	[0.038]	0.33
log number of months	-0.128***	[0.018]	0.30
log shipment per month	-0.056***	[0.012]	0.26
log value shipment size	0.032**	[0.015]	0.33
log physical shipment size	0.034*	[0.018]	0.49
log price	-0.001	[0.010]	0.59
Number of observations	195228		
Number of clusters	9599		
Number of product effects	7658		

Notes: OLS estimation of (2) separately for each margin in (1) on a sample of US exports to 170 countries in 10-digit HS products in 2005. If transport mode is not restricted to sea, it is air, sea or ground. Product-mode fixed effects included. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and cost to complete port/terminal handling and transport from nearest seaport. Only trade with quantity measured in kilograms included. Clustered robust standard errors with country and 2-digit product clusters. * sign. at 10%, ** 5%; *** 1%.

Table C.7: Product-level estimates for Spain, Financial Cost

Dependent variable	β estimate	Robust s.e.	Adj.R^2
	all modes		
log export	0.044**	[0.022]	0.43
log number of months	0.004	[0.012]	0.36
log shipment per month	0.021***	[0.006]	0.43
log value shipment size	0.019	[0.012]	0.45
log physical shipment size	0.038**	[0.015]	0.74
log price	-0.019*	[0.010]	0.79
Number of observations	117544		
Number of clusters	7126		
Nr of product-mode effects	15893		
	only sea		
log export	0.063**	[0.027]	0.39
log number of months	0.008	[0.015]	0.34
log shipment per month	0.019***	[0.007]	0.41
log value shipment size	0.035**	[0.016]	0.40
log physical shipment size	0.039**	[0.019]	0.60
log price	-0.004	[0.012]	0.72
Number of observations	64467		
Number of clusters	6010		
Number of product effects	6586		

Notes: OLS estimation of (2) separately for each margin in (1) on a sample of Spanish exports to 143 non-EU countries in 8-digit CN products in 2005. If transport mode is not restricted to sea, it is air, sea, or ground. Product--mode fixed effects included. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and cost to complete port/terminal handling and transport from nearest seaport. Clustered robust standard errors with country and 2-digit product clusters. * sign. at 10%, ** 5%; *** 1%.

Table C.8: Simple cross section estimation results, Financial Cost

Dependent variable	β estimate	s.e.	Adj./Pseudo R^2
	Exporter is US		
log export	0.011	[0.182]	0.86
log number of shipments	-0.058	[0.144]	0.86
log price	-0.078**	[0.032]	0.09
log physical shipment size	0.113**	[0.049]	0.37
log mode composition	0.000	[0.020]	0.33
log product composition	0.034	[0.047]	0.15
Test $\beta_{price}+\beta_{physicalsize}=0$	$\chi^2(1)$=0.56, p-val=0.455		
Breusch-Pagan test	$\chi^2(10)$=68.73, p-val=0.000		
	Exporter is Spain		
log export	-0.020	[0.162]	0.89
log number of shipments	-0.016	[0.122]	0.91
log price	0.017	[0.046]	0.16
log physical shipment size	0.048	[0.084]	0.24
log mode composition	0.006	[0.028]	0.07
log product composition	-0.075	[0.052]	0.15
Number of observations	143		
Test $\beta_{price}+\beta_{physicalsize}=0$	$\chi^2(1)$=0.93, p-val= 0.336		
Breusch-Pagan test	$\chi^2(10)$=72.58, p-val=0.000		

Notes: OLS estimation with robust standard errors for total exports, SURE for the margins, on a cross section of importers. Pseudo R^2 is for SURE. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and cost to complete port/terminal handling and transport from nearest seaport. Breusch-Pagan test is for residual independence in SURE. * sign. at 10%, ** 5%; *** 1%.

Table C.9: Results from theory-based gravity, Financial Cost

Dependent variable	β estimate	s.e.	Adj./Pseudo R^2
	Exporter is US		
log export	-0.148	[0.161]	0.85
log number of shipments	-0.278*	[0.146]	0.85
log price	-0.052	[0.032]	0.08
log physical shipment size	0.109**	[0.048]	0.37
log mode composition	0.008	[0.020]	0.31
log product composition	0.064	[0.048]	0.10
Number of observations	170		
Test $\beta_{price}+\beta_{physicalsize}=0$	$\chi^2(1)$=1.57, p-val=0.211		
Breusch-Pagan test	$\chi^2(10)$=77.05, p-val=0.000		
	Exporter is Spain		
log export	-0.020	[0.171]	0.86
log number of shipments	-0.017	[0.148]	0.86
log price	0.026	[0.045]	0.19
log physical shipment size	0.005	[0.083]	0.23
log mode composition	0.012	[0.028]	0.06
log product composition	-0.046	[0.052]	0.09
Number of observations	143		
Test $\beta_{price}+\beta_{physicalsize}=0$	$\chi^2(1)$=0.21, p-val= 0.648		
Breusch-Pagan test	$\chi^2(10)$=82.04, p-val=0.000		

Notes: OLS estimation with robust standard errors for total exports, SURE for the margins, on a cross section of importers. Pseudo R^2 is for SURE. Other regressors: log GDP, log GDP per capita, log distance, dummies for island, landlocked, Free Trade Agreement, Preferential Trade Agreement, colonial relationship, common language, and cost to complete port/terminal handling and transport from nearest seaport. MTR is controlled for by the method of Baier and Bergstrand (2009). Breusch-Pagan test is for residual independence in SURE. * sign. at 10%, ** 5%; *** 1%.