# Administrative Barriers to Trade

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**Abstract**

We build a model of administrative barriers to trade to understand how they affect trade volumes, shipping decisions and welfare. Because administrative costs are incurred with every shipment, exporters have to decide how to break up total trade into individual shipments. Consumers value frequent shipments, because they enable them to consume close to their preferred dates. Hence per-shipment costs create a welfare loss.

We derive a gravity equation in our model and show that administrative costs can be expressed as bilateral ad-valorem trade costs. We estimate the ad-valorem equivalent in Spanish shipment-level export data and find it to be large. A 50 percent reduction in per-shipment costs is equivalent to a 9 percentage point reduction in tariffs. Our model and estimates help explain why policy makers emphasize trade facilitation and why trade within customs unions is larger than trade within free trade areas.

*Keywords:* administative barriers, trade facilitation, customs union, gravity equation

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## 1. Introduction

Exporters and importers around the globe face many administrative barriers. They have to comply with complex regulations, deal with a large amount paperwork, subject their cargo to frequent inspections, and wait for lengthy customs clearance. Minimizing the burden of these procedures, "trade facilitation," has been a priority for policymakers from developed and developing countries alike. In December of 2013, all members of the World Trade Organization (WTO) have agreed to the Bali Package, the first comprehensive agreement of the Doha round of negotiations. The main component of the Bali Package is an agreement on trade facilitation, requiring WTO members to adopt a host of measures streamlining the customs process, such as pre-arrival processing of shipments, electronic documentation and payment, and the release of goods prior to the final determination of customs duties, "[w]ith a view to minimizing the incidence and complexity of import, export, and transit formalities and to decreasing and simplifying import, export, and transit documentation requirements [...]"[1]

Why do countries rush to facilitate trade? They hope to increase trade volumes without endangering government revenues by reducing inefficiencies. In fact, studies of various trade facilitation measures find that they are associated with larger trade volumes.[2] Even among countries within free trade areas (FTAs), tighter economic integraton and a reduction of administrative barriers often leads to higher trade.[3]

We build a model of administrative barriers to trade to understand how they affect trade volumes, shipping decisions and welfare. A large part of administrative trade barriers are costs that accrue per each shipment, such as filling in customs declaration and other forms, or having the cargo inspected by health and sanitary officials. Hornok and Koren (forthcoming) document

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[1] World Trade Organization (2013), Article 10, 1.1.

[2] See Engman (2005) and Francois, van Meijl and van Tongeren (2005) for a survey of the empirical evidence. Moïsé, Orliac and Minor (2011) construct various trade facilitation indicators and find that, taken together, they can reduce trade costs by up to 10 percent.

[3] Hornok (2012) finds that countries joining the European Union (EU) in 2004 have witnessed a 5 percent reduction in trade costs even though they already had FTAs with the EU since the mide 1990s. Handley and Limão (2012) find similar trade-creating effect of the EU accession for Portugal. Chen and Novy (2011) estimate that EU countries within the Schengen area, which are not subject to border control, enjoy 10 percent lower trade frictions than other EU countries.

that countries with high administrative barriers to importing (as reported in the Doing Business survey of the World Bank) receive less frequent and larger shipments. The starting point of our model is hence a tradeoff between administrative costs and shipping frequency. In the presence of per-shipment administrative costs, exporters would want to send fewer and larger shipments. 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. With infrequent shipments a supplier of such products can compete only for a fraction of consumers in a foreign market.

We first use our model to derive a modified gravity equation of trade flows, in which administrative barriers show up as an additional tax on imports. Intuitively, when administrative barriers are high and shipments are infrequent, customers suffer utility losses that can be quantified as an ad-valorem tax equivalent. They also substitute towards local products accordingly.[4]

We then show how to measure the welfare losses from administrative barriers to trade by estimating two key elasticities from the data. First, we need to know the sensitivity of consumers to timely shipments. This can be recovered from the observed shipping choices of exporters: if customers are very sensitive to timeliness, firms send many small shipments. Second, we need to estimate shippers' reaction to administrative costs. Calculating deadweight losses from the elasticity of consumer and firm behavior to prices is in the spirit of semi-structural estimation of Harberger (1964), Chetty (2009) and Arkolakis et al. (2012).

In our empirical analysis, we first show that per-shipment trade costs are sizeable and important for trade flows. We use the Doing Business database to measure the cost of shipping. Across 161 countries, the average trade shipment was subject to $3,000 shipping cost in 2009. High shipping costs are associated with low volumes of trade: country pairs at the 25th percentile of per-shipment costs trade 58 percent more than country pairs at the 75th percentile. This magnitude is comparable to the trade creating effect of having access to a coast.

In addition, we find that administrative costs help explain trade flows among countries with no preferential trade agreements and even within FTAs,

[4] An implication of this result is that the formula of Arkolakis, Costinot and Rodriguze-Clare (2012) can still be used to characterize the gains from trade.

but not within customs unions. One potential reason for this is that customs unions are subject to much less administrative barriers than FTAs and our measured administrative costs do not apply. In fact, this could provide a new explanation for why trade within customs unions is so much higher than trade within FTAs.[5] Traditionally, the analysis of FTAs relative to customs unions focused on tariff harmonization, rules of origin and political economy (Krueger, 1997 and Frankel, Stein and Wei, 1997 and 1998).

We then study how exporters break down trade into shipments by exploiting shipment-level data for Spain for the period 2006–2012. We find that countries facing higher administrative barriers receive fewer shipments. This is similar to the finding of Hornok and Koren (forthcoming).

Using our estimated elasticity of the number of shipments with respect to per-shipment costs, we can calibrate the welfare effect of these costs. We conduct a simple counterfactual trade facilitation experiment in the model and reduce per-shipment costs by half. In the model, this is equivalent to about a 9 percent reduction in tariffs and results in a 40 to 90 percent increase in trade volumes. This suggests large trade creating effects of trade facilitation.

Our emphasis on shipments as a fundamental unit of trade follows Armenter and Koren (2014), who discuss the implications of the relatively low number of shipments on empirical models of the extensive margin of trade.

We relate 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). They 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.[6]

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 also argue that per-shipment costs lead to the lumpi-

[5] See, for example, Roy (2010) and also Section 4 of this paper.

[6] 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.

ness 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 percent tariff equivalent) mostly due to inventory carrying expenses. We consider our paper complementary to Alessandria, Kaboski and Midrigan (2010) in that we exploit 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 and embed our model in a standard gravity equation. Moreover, our framework also applies to trade of non-storable products.

Our work is most related to Kropf and Sauré (2014), who build a heterogenous-firm trade model to study how fixed costs per shipment affect shipment size. They then recover shipment costs from the observed shipment sizes, showing that these imputed costs are large and correlate plausibly with geographic variables and trade agreements. Our focus here is different: we want to understand the welfare consequences of administrative trade costs in a tractable aggregate framework. We also offer new evidence on the trade effects of administrative barriers within and outside customs unions.

## 2. A model of the shipping frequency of trade

This section presents a model that determines the number and timing of shipments to be sent to a destination market. Sending shipments more frequently is beneficial, because consumers value timely shipment. Producers engage in monopolistic competition as consumers value the differentiated products they offer. Each producer can then send multiple shipments to better satisfy the demands of its consumers.

There are $J$ countries, each hosting an exogenous number of sellers and consumers. A seller can sell to a domestic consumer at no shipping cost. It can also sell to a foreign destination $j$, in which case it has to pay iceberg shipping costs as well as the administrative cost of exporting to country $j$.

The difference between administrative barriers and other trade costs is that the former apply for every shipment. We hence model them as per-shipment costs that are pure waste.

We characterize the shipping problem of sellers, and derive a gravity equation for trade flows between countries. We show that administrative costs act as an ad-valorem tax on bilateral trade. We then discuss the welfare implications of administrative costs, deriving a semi-structural formula for consumer surplus in the spirit of Harberger (1964), Chetty (2009) and Arkolakis et al. (2012).

### *2.1. Consumers*

There is a unit mass of consumers in every destination country $j$.[7] 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.[8] The distribution of $t$ across consumers is uniform, that is, there are no seasonal effects in demand.

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.[9] A consumer with preferred date $t$ who consumes one unit of the good at date $s$ only enjoys $e^{-\delta|t-s|}$ *effective units*. The parameter $\delta > 0$ captures the taste for timeliness.[10] Consumers are more willing to purchase at dates that are closer to their preferred date and they suffer from early and late purchases symmetrically.

Other than the time cost, consumers value the shipments *from the same producer* as perfect substitutes. The utility of a type-$t$ consumer purchasing from producer $\omega$ is

$$X_j(t, \omega) = \sum_{s \in S(\omega)} e^{-\delta|t-s|} x_j(t, \omega, s). \tag{1}$$

Clearly, because of perfect substitution, the consumer will only purchase the shipment(s) with the closest shipping dates, as adjusted by price, $e^{-\delta|t-s|}/p_s$.

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[7] Because preferences are homothetic, this is without loss of generality.

[8] Note that this puts an upper bound of $\frac{1}{2}$ on the distance between the firm and the consumer. We are following the "circular city" discrete choice model of Salop (1979).

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

[10] As an alternative, but mathematically identical interpretation, we may say that the consumer has to incur time costs of waiting or consuming too early (e.g., storage) so that the total price paid by her is proportional to $e^{\delta|t-s|}$.

The consumer has constant-elasticity-of-substitution (CES) preferences over the bundles $X_j(t, \omega)$ offered by different firms.

$$U_j(t) = \int_\omega X_j(t, \omega)^{1-1/\sigma} d\omega, \tag{2}$$

where $\sigma$ is the elasticity of substitution. Let $E_j$ denote the total income and, in the absence of trade imbalances, total expenditure of consumers in country $j$. By our assumption of symmetry, all consumer types have the same income $E_j(t) = E_j$.

*2.2. Exporters*

There is a fixed $M_i$ measure of firms producing in each country $i$. Because there are no entry costs, each firm exports to each destination country $j$.[11]

Exporters decide how many shipments to send at what times. Sending a shipment incurs a per-shipment cost of $f_{ij}$. They then decide how to price their product. Both decisions are done simultaneously by the firms.

The marginal cost of production of supplier $\omega$ is constant at $c(\omega)$.[12] It takes gross iceberg costs $t_{ij} > 1$ for goods to reach country $j$ from country $i$. This involves the per-unit costs of shipping, such as freight charges and insurance. (It does not include per-shipment costs.) The cost-insurance-freigh value of a good in country $j$ is hence $c(\omega)t_{ij}$. We abstract from capacity constraints in shipping, that is, any amount can be shipped to the country at this marginal costs.

Given this cost structure, we can write the profit function of a producer $\omega$ from country $i$ selling to country $j$ as

$$\pi_j(\omega) = \int_t \sum_{s=s_1,\ldots,s_{n_j(\omega)}} [p_j(t, \omega, s) - c(\omega)t_{ij}] x_j(t, \omega, s) dt - n_j(\omega) f. \tag{3}$$

Net revenue is markup times the quantity sold to all different types of consumers at different shipping dates. The per-shipment costs have to be incurred based on the number of shipping dates, which we denote by $n_j(\omega)$.[13]

[11] The working paper version of Hornok and Koren (2012) endogenizes the measure of exporters via free entry into each destination $j$.

[12] We will later assume symmetry across firms from the same country—a Krugman (1980) model. For now, however, we keep the dependence on $\omega$ in notation to illustrate how our model can be extended in a Melitz (2003) framework.

[13] Clearly, the firm would not send two shipments on the same date, as it would only reach the same type of consumers. More on the equilibrium shipping dates below.

*2.3. Equilibrium*

An *equilibrium* of this economy is a product price $p_j(t,\omega,s)$, the number of shipments per firm $n_j(\omega)$, and quantity $x_j(t,\omega,s)$ such that (i) consumer demand maximizes utility, (ii) prices maximize firm profits given other firms' prices, (iii) shipping frequency maximizes firm profits conditional on the shipping choices of other firms, and (iv) goods markets clear.

To construct the equilibrium, we move backwards. We first solve the pricing decision of the firm at given shipping dates. We then show that shipments are going to be equally spaced throughout the year. Given the revenues the firm is collecting from $n$ equally spaced and optimally priced shipments, we can solve for the optimal number of shipments.

*Pricing.* The revenue function of firm $\omega$ for its shipment at time $s$, coming from consumer $t$ is

$$R_j(t,\omega,s) = \max_p E_j(t)\left[\frac{pe^{\delta|s-t|}}{P_j(t)}\right]^{1-\sigma}, \tag{4}$$

where $E_j(t)$ is the expenditure of consumer $t$, $p$ is the price of the product, and

$$P_j(t) = \left[\int_\omega p_j(\omega)^{1-\sigma}e^{-(\sigma-1)\delta|t-s(\omega)|}d\omega\right]^{1/(1-\sigma)}$$

is the ideal price index of consumer $t$.

Because there is a continuum of competitors, an individual firm does not affect the price index $P_j(t)$ nor expenditure $E_j(t)$. This implies that the firm's demand is isoelastic with elasticity $\sigma$. As a consequence, the firm will follow the inverse elasticity rule in its optimal pricing,

$$p_j(\omega) = \frac{\sigma}{\sigma-1}c_i(\omega)t_{ij}. \tag{5}$$

Price is a constant markup over the constant marginal cost. Firms may be heterogeneous in their marginal cost because of differences in productivity or factor prices in their source country. Importantly, a given firm charges the same price for each shipment date.

*Shipping dates.* Clearly, revenue (4) is concave in $|s-t|$, the deviation of shipping times from optimal. Because of that, the firm would like to keep shipments equally distant from all consumers. This implies that shipments will be equally spaced, $s_2 - s_1 = s_3 - s_2 = ... = 1/n$. The date of the first shipment is indeterminate, and we assume that firms randomize across all possible dates uniformly.

Because all shipments have the same price, consumers will pick the one closest to their preferred date $t$. (Other shipments are strictly inferior.) The set of consumers purchasing from a particular shipment $s$ is $t \in [s - \frac{1}{2n}, s + \frac{1}{2n})$.

An equal-spaced shipping equilibrium is shown on Figure 1.

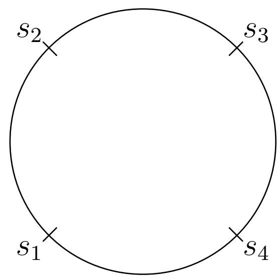


Figure 1: Symmetric equilibrium shipping dates

*Revenue.* To obtain the revenue from a shipment $s$, we integrate across the set of buyers buying from that shipment,

$$R_j(\omega, s) = \int_{t=s-\frac{1}{2n}}^{s+\frac{1}{2n}} E_j(t) \left[\frac{p_j(\omega)}{P_j(t)}\right]^{1-\sigma} e^{-(\sigma-1)\delta|s-t|} dt = E_j \left[\frac{p_j(\omega)}{P_j}\right]^{1-\sigma} \int_{t=s-\frac{1}{2n}}^{s+\frac{1}{2n}} e^{-(\sigma-1)\delta|s-t|} dt,$$

where we have exploited the symmetry of consumers. The integral in the last term evaluates to

$$\int_{t=s-\frac{1}{2n}}^{s+\frac{1}{2n}} e^{-(\sigma-1)\delta|s-t|} dt = 2 \cdot \frac{1 - e^{-\frac{1}{2}(\sigma-1)\delta/n}}{(\sigma-1)\delta}.$$

Because of the symmetry of consumers, each shipment brings the same revenue. The revenue from all shipments is then

$$R_j(\omega) = n_j(\omega) R_j(\omega, s) = E_j \left[\frac{p_j(\omega)}{P_j}\right]^{1-\sigma} \frac{1 - e^{-\frac{1}{2}(\sigma-1)\delta/n_j(\omega)}}{\frac{1}{2}(\sigma-1)\delta/n_j(\omega)}. \tag{6}$$

Let $r_j(\omega)$ denote the revenue of the firm if it sends timely shipments ($n \to \infty$),

$$r_j(\omega) = E_j \left[\frac{p_j(\omega)}{P_j}\right]^{1-\sigma},$$

and $\tau(n)$ denote the ad-valorem equivalent of infrequent shipments,

$$\tau(n) = \left[\frac{\frac{1}{2}(\sigma-1)\delta/n}{1-e^{-\frac{1}{2}(\sigma-1)\delta/n}}\right]^{1/(\sigma-1)}.$$

The function $\tau(n)$ is independent of $j$ or $\omega$. We can write the revenue of a firm $\omega$ as

$$R_j(\omega) = r_j(\omega)\tau[n_j(\omega)]^{1-\sigma}. \tag{7}$$

The revenue of a firm is the product of two components: one depending only on market size and relative price as in a Krugman model, the other solely a function of shipping frequency. The ad-valorem equivalent of infrequent shipping, $\tau(n)$, has the following properties. It is decreasing in $n$: the more shipments the firm sends the more consumers it can reach at a low utility cost. Because they appreciate the close shipping dates, they will perceive this firm as relatively cheap. At the extreme, if $n \to \infty$, $\tau(n)$ converges to 1, and the firm sells $r(\omega)$. From the firm's point of view, the demand for timely shipping is fully captured by the function $\tau(n)$, which acts as an ad-valorem tax on the firm's product. Later we will show that this analogy also applies to welfare calculations.

With this notation, we can write the price index of consumers in country $j$ as

$$P_j = \left[\int_\omega p_j(\omega)^{1-\sigma}\tau[n_j(\omega)]^{1-\sigma}d\omega\right]^{1/(1-\sigma)}.$$

*Number of shipments.* The firm cares about the net revenue coming from its sales. Because markup is constant, net revenue is just a constant $1/\sigma$ fraction of gross revenue. Choosing the profit-maximizing number of shipments involves maximizing

$$\frac{r_j(\omega)\tau(n)^{1-\sigma}}{\sigma} - nf_{ij}$$

with respect to $n$. Net revenue is $r_j(\omega)\tau(n)^{1-\sigma}/\sigma$ and each shipment incurs the per-shipment cost $f_{ij}$. Revenue $R_j$ only depends on the number of shipments through $\tau(n)$.

**Proposition 1.** *The first-order condition for the profit-maximizing number of shipments is*

$$\frac{dR_j/\sigma}{dn} = \frac{1-\sigma}{\sigma}r_j(\omega)\tau(n)^{-\sigma}\tau'(n) = f_{ij}. \tag{8}$$

*Given the known function $\tau(n)$, this equation implicitly defines the optimal number of shipments, $n_j(\omega)$, which increases in $\delta$ (less patient consumers), increases in $\sigma$ (consumers willing to substitute to other firms), increases in $E_j/P_j$ (bigger firms in equilibrium) and decreases in $f_{ij}$ (costly shipments).*

The number of shipments only depends on the ratio of maximal firm size $r_j(\omega)$ and per-shipment cost $f_{ij}$. Everything that makes the firm larger in a market (large market size, weak competition, low costs of production and shipping) increases the optimal frequency of shipments. Large firms lose more by not satisfying their customers' need for timeliness and they are willing to incur per-shipment costs more frequently. Intuitively, lower per-shipment costs also imply more frequent shipments. At the extreme, as $f_{ij}$ tends to zero, the firm sends instantenous shipments, $n_j(\omega) \to \infty$ and $\tau$ converges to one.

To anticipate the calculation of the welfare effect, we rewrite (8) as an expression of an elasticity,

$$\frac{-n_j(\omega)\tau'[n_j(\omega)]}{\tau'[n_j(\omega)]} = \frac{\sigma}{\sigma - 1}\frac{n_j(\omega)f_{ij}}{R_j(\omega)}. \tag{9}$$

The left-hand side of this equation is the absolute value of the elasticity of $\tau$ with respect to $n$. The right-hand side is a constant markup times total shipping costs paid by the firm $(nf)$, divided by total revenue of the firm. The last fraction can hence be thought of as the ad-valorem amount of shipping costs.

The intuition for this result is that the more elastic $\tau$ is with respect to the number of shipments, the less willing is the firm to sacrifice revenue with infrequent shipments. It will hence send many small shipments, making the ad-valorem amount of shipping costs large. We can use this formula to recover the elasticity of $\tau$ from the data.

*Trade flows.* To derive aggregate trade flows, suppose that firms within the same country are identical in their cost of production, $c_i(\omega) \equiv c_i$.[14] They then charge the same price in a given destination country $j$,

$$p_j(\omega) = \frac{\sigma}{\sigma - 1}c_i t_{ij}$$

[14]Kropf and Sauré (2014) instead assume heterogeneous firms with Pareto-distributed unit costs.

and the price index can be written as

$$P_j = \frac{\sigma}{\sigma - 1} \left[ \sum_i M_i c_i^{1-\sigma} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}. \tag{10}$$

The source countries differ in the number of exporters $M_i$, the marginal cost of production $c_i$, the iceberg trade cost $t_{ij}$, and the ad-valorem loss from infrequent shipments $\tau(n_{ij})$. All these enter the price index of consumers.

**Proposition 2.** *The total value of exports from country $i$ to country $j$ is given by*

$$T_{ij} = \frac{E_i E_j}{E_w} \frac{t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma}}{\tilde{\Pi}_i^{1-\sigma} \tilde{P}_j^{1-\sigma}},$$

*with*

$$\tilde{\Pi}_i^{1-\sigma} \equiv \sum_j \frac{E_j}{E_w} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \tilde{P}_j^{\sigma-1}$$

*and*

$$\tilde{P}_j^{1-\sigma} \equiv \sum_i \frac{E_i}{E_w} \tilde{\Pi}_i^{\sigma-1} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma}.$$

This is exactly the gravity equation in Anderson and van Wincoop (2003) and Eaton and Kortum (2002), except for the additional term $\tau(n_{ij})$. Infrequent shipment hence acts as a bilateral trade cost between countries. We can use this insight to calculate the magnitude of trade losses from administrative barriers.

## 3. Welfare

What is the welfare cost of administrative barriers? Here we calculate how welfare depends on the choice of shipping frequency. The utility of the representative consumer is a monotonic function of real income $E_j/P_j$. We hence need to calculate the income and the price index faced by the representative consumer.

Because we only consider changes to $f_{ij}$ when analyzing welfare, we can treat customer income $E_j$ as fixed as long as $j$ is a small country. In this case, changes in the profits of exporters in country $i$ do not matter for consumer income in country $j$. We can focus on changes to the price index.[15]

Recall from (10) the price index

$$P_j = \frac{\sigma}{\sigma - 1} \left[ \sum_i M_i c_i^{1-\sigma} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}.$$

As the constant markup formula shows, individual product prices do not depend on $n_{ij}$ or $f_{ij}$. We are hence interested in how $\tau$ changes. We begin by log differentiating the price index with respect to the number of shipments per firm $n_{ij}$,

$$\frac{d \ln P_j}{d \ln n_{ij}} = -\frac{T_{ij}}{E_j} \frac{-n_{ij} \tau'(n_{ij})}{\tau(n_{ij})}.$$

Countries that receive more shipments have lower perceived prices and higher customer utility. The effect on the price index depends on the size of the trade flow (timely shipments form a small trade partner being less important) and on the elasticity of $\tau$ with respect to $n$. We can use (9) to substitute in for this elasticity,

$$\frac{d \ln P_j}{d \ln n_{ij}} = -\frac{\sigma}{\sigma - 1} \frac{T_{ij}}{E_j} \frac{n_{ij} f_{ij}}{R_{ij}}.$$

This leads to the followig proposition.

**Proposition 3.** *The elasticity of the price index with respect to the per-shipment cost is given by*

$$\frac{d \ln P_j}{d \ln f_{ij}} = \sum_i \frac{T_{ij}}{E_j} \psi_{ij},$$

*with*

$$\psi_{ij} = \frac{\sigma}{1 - \sigma} \frac{d \ln n_{ij}}{d \ln f_{ij}} \frac{n_{ij} f_{ij}}{R_{ij}}.$$

The welfare effect of a change in per-shipment costs is a weighted average across source countries. The contribution of country $i$ to this welfare effect is $\psi_{ij}$. We use this result in the counterfactual exercise in Section 5 when we estimate $\psi_{ij}$.

[15] An alternative way to close the model would be to assume free entry of exporters. In this case, profits would be zero, and consumer income would be simply wage income. This would also be unchanged if all both production costs and per shipment costs were denominated in labor.

## 4. Evidence on administrative barriers and trade

We study how administrative barriers affect trade flows. We first estimate a gravity equation for bilateral trade volumes, including cost of shipping as an additional bilateral trade cost. We then show how shipping costs affect the number of shipments going to a country.

### *4.1. Data and measurement*

We identify administrative costs from the Doing Business survey of the World Bank, from 2006 to 2012. Doing Business measures the costs of exporting and importing a standard containerized cargo, noting the various customs and administrative procedures, documents, and the time and moneythey take. Our measure of shipping costs are the total monetary cost per shipment incurred by the exporter and the importer. Although not all components of these costs are strictily administrative, these correspond to the per-shipment cost in our model.[16]

Table 1 reports the average shipping costs across counries, broken down by the type of procedure and the direction of trade (export or import). Taken together, the average trade transaction would be subject to a total of $3,000 cost and a waiting time of 50 days.

Table 1: Average per-shipment costs across countries

| | Exporting | | Importing | |
|---|---|---|---|---|
| | Monetary | Time | Monetary | Time |
| Document preparation | $275 | 12.0 | $307 | 13.8 |
| Customs clearance and inspection | $160 | 3.0 | $207 | 3.7 |
| Port and terminal handling | $282 | 4.1 | $318 | 4.7 |
| Transit from port to destination | $670 | 5.0 | $772 | 4.6 |
| Total | $1,387 | 24.1 | $1,604 | 26.8 |

Note: Based on Doing Business survey from 2009. Time costs are in days, monetary costs in US dollars.

Data on trade flows comes from the UN Comtrade database. We use bilateral distance measures and geographical variables from CEPII, and gross

[16]Hornok and Koren (forthcoming) also discuss the various components of per-shipment costs separately. Documentation and customs takes about the third of the monetary costs and two thirds of the time costs of shipping.

domestic product data from the World Bank. To estimate how shipping choices depend on administrative costs, we need information on shipments. We use the shipment-level export database of the Spanish *Agencia Tributaria*. This contains information on every single shipment leaving Spain.

Table 2 reports some shipment-level statistics about Spanish export in 2009. It shows, for selected destinations, the shipment value of the median product, the number of times it is shipped in a month, and the number of months it is shipped in a year. Our first observation is that shipments are relatively large and infrequent. The average shipment size across all importers in $13,234 and the typical product only ships twice a year to the typical destination. This observation, noted before by Armenter and Koren (2014) and Hornok and Koren (forthcoming) motivated us to model shipments as infrequently spread through time. We also find that countries with lower per-shipment costs receive smaller and more frequent shipments.

Table 2: Shipping costs and the number of shipments

| | Median shipment value (US$) | Number of times good shipped in a month | Number of months in year good shipped |
|---|---|---|---|
| *Selected low per-shipment cost importers* | | | |
| France | $14,203 | 1.5 | 9 |
| Germany | $14,217 | 1.3 | 7 |
| Japan | $9,674 | 1.0 | 2 |
| USA | $15,592 | 1.0 | 3 |
| *Selected high per-shipment cost importers* | | | |
| Algeria | $15,894 | 1.0 | 2 |
| China | $19,442 | 1.0 | 2 |
| Russia | $12,263 | 1.0 | 2 |
| South Africa | $11,725 | 1.0 | 2 |
| All importers | $13,234 | 1.0 | 2 |

Notes: Reproduced from Hornok and Koren (forthcoming), Table 2. Spanish exports to 144 non-EU and 25 EU importers in 2009 in 8,381 eight-digit product lines ($N$=3,019,277). The median value of individual shipments is converted to U.S. dollars with monthly average USD/EUR exchange rates. Shipment frequency statistics are for the median product. Trade in fuels and low-value shipments (less than EUR 2,000 for Spain) are excluded.

In order to differentiate customs unions from free trade areas, we use the May 2013 version of the database created by Baier and Bergstrand (2007) to measure economic integration agreements. Because that data ends in 2005 and Doing Business starts in 2006, we use the year 2006 in our estimation of trade volumes.

### *4.2. Trade volumes*

We first estimate a gravity equation of bilateral imports. We are interested in the trade-creating effect of customs unions relative to free trade areas, as well as the effects of per-shipment costs.

Our main specification is derived from Proposition 2. We let the iceberg trade cost $t_{ij}$ depend on geographic variables such as distance, landlocked status, adjacency, colonial history, and the economic integration of the countries. The ad-valorem equivalent of shipping costs, $\tau(n_{ij})$, in turn, depends on the per-shipment costs accrued by exporters from country $i$ to country $j$. The estimating equation is

$$\ln T_{ij} = \beta_0 + \beta_1 \mathrm{FTA}_{ij} + \beta_2 \mathrm{CU}_{ij} + \beta_3 \ln f_{ij} + \beta_4' \mathrm{gravity}_{ij} + u_{ij}. \tag{11}$$

Imports from country $i$ to country $j$ depend on an FTA and a customs union dummy, per-shipment costs, as well as standard gravity variables.

Table 3 reports the results. All specifications are estimated by ordinary least squares (OLS). Columns 1 through 3 are estimated on the full sample of 161 exporter countries and 147 importer countries. The specifications vary by the degree of economic integration of the country pairs. We include an FTA and a customs union dummy, as well as our measure of shipping costs. The omitted category of economic integration includes country pairs with no trade agreement, or only preferential trade agreements short of an FTA.

All standard gravity variables have the expected sign and magnitude. Larger countries both export and import more. Distant countries as well as landlocked countries trade less. A common colonial history and a common border are both associated with higher trade.

As column 1 shows, countries in FTAs trade much more with one another than countries outside. An FTA is associated with a three-fold increase in trade. In column 2, we separate customs unions from FTAs. Since all customs unions are also FTAs, the estimated effect of a customs union is *in addition to* the effect of being in an FTA. That is, customs unions are associated with a three-fold increase in trade relative to FTAs. This is consistent with the model and the fact that customs unions require much less administration than FTAs.

Table 3: Gravity equation estimates for bilateral imports

| Dep. var.: Imports (log) | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Sample | Full | Full | Full | No FTA | FTA only | CU |
| Free trade area (dummy) | 1.168*** | 1.023*** | 0.900*** | | | |
| | (0.0734) | (0.0759) | (0.0766) | | | |
| Customs union (dummy) | | 1.152*** | 1.215*** | | | |
| | | (0.175) | (0.183) | | | |
| Per-shipment cost (log) | | | -0.919*** | -0.959*** | -0.736*** | -0.266 |
| | | | (0.0689) | (0.0747) | (0.235) | (0.318) |
| Exporter GDP (log) | 1.230*** | 1.233*** | 1.219*** | 1.255*** | 1.096*** | 0.951*** |
| | (0.00972) | (0.00972) | (0.00975) | (0.0104) | (0.0373) | (0.0367) |
| Importer GDP (log) | 1.017*** | 1.020*** | 0.993*** | 1.034*** | 0.733*** | 0.779*** |
| | (0.00976) | (0.00976) | (0.00993) | (0.0106) | (0.0361) | (0.0265) |
| Distance (log) | -1.133*** | -1.126*** | -1.171*** | -1.155*** | -1.059*** | -1.301*** |
| | (0.0337) | (0.0337) | (0.0339) | (0.0389) | (0.0620) | (0.0868) |
| Exporter is landlocked (dummy) | -0.610*** | -0.605*** | -0.306*** | -0.325*** | 0.186 | -0.456*** |
| | (0.0560) | (0.0560) | (0.0585) | (0.0647) | (0.171) | (0.143) |
| Importer is landlocked (dummy) | -0.483*** | -0.476*** | -0.169*** | -0.153** | -0.343* | -0.0627 |
| | (0.0570) | (0.0569) | (0.0601) | (0.0665) | (0.185) | (0.135) |
| Economic union (dummy) | -0.645*** | -1.639*** | -1.789*** | | | -0.756*** |
| | (0.0850) | (0.175) | (0.183) | | | (0.192) |
| Adjacent country (dummy) | 0.968*** | 0.898*** | 0.902*** | 1.042*** | 1.399*** | 0.0740 |
| | (0.132) | (0.134) | (0.133) | (0.235) | (0.215) | (0.183) |
| Former colony (dummy) | 1.328*** | 1.308*** | 1.422*** | 1.613*** | 0.982*** | 0.917*** |
| | (0.106) | (0.106) | (0.109) | (0.121) | (0.242) | (0.272) |
| Common colonizer (dummy) | 1.495*** | 1.465*** | 1.450*** | 1.286*** | 1.603*** | 1.062*** |
| | (0.0805) | (0.0803) | (0.0803) | (0.0869) | (0.260) | (0.352) |
| Observations | 14,916 | 14,916 | 14,916 | 13,084 | 1,070 | 762 |
| R-squared | 0.675 | 0.676 | 0.680 | 0.636 | 0.686 | 0.859 |

Notes: Dependent variable is imports between the pair of countries (log). Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Sample is for 2006. See text for variable definitions and estimation details.

Column 3 reports the elasticity of trade volumes with respect to per-shipment cost to be strongly negative at $-0.92$. The interquartile range of per-shipment costs is \$1900 to \$3100. This implies that country pairs at the 25th percentile of shipping costs trade 58 percent more than country pairs at the 75th percentile.[17]

[17] Although quite speculatively, we could explain the trade effects of customs unions if

What is the relationship between administrative costs, FTAs and customs unions? To answer this question, we break the sample into three. Column 4 includes country pairs that are not members of an FTA. Column 5 includes country pairs that are in an FTA but not in a customs union. Column 6 includes members of customs unions. We are interested in how the effect of shipping costs varies across these samples. Since the Doing Business survey asks about a standard cargo, it does not allow for the special administrative provisions of FTAs and customs unions.

We find that the negative effect of per-shipment cost is strongest among countries outside of FTAs. The effect is somewhat smaller (in absolute value) among FTA members, but is still highly significantly negative. The negative effect of shipping costs disappears for customs union members. Indeed, for these country pairs, much of the shipping costs do not apply, as there is no customs clearance and documentation needs are much reduced.

*4.3. Shipments*

We then turn to see how exporters break down total trade into shipments. We use shipment-level export data from Spain for the period 2006–2012. We identify the number of shipments $n_{ij}$ as the total number of shipments going from Spain to country $j$ in given year. One drawback of the Spanish data is that it contains no firm identifiers. We thus cannot calculate the number of shipments per firm, we use the total number instead. Although admittedly a limitation, this measure is consistent with the model, where all firms are symmetric, and the total number of shipments $N_{ij} = M_i n_{ij}$ is just a constant multiple of the number of shipments per firm.

Equation 12 is our estimating equation. The log number of shipments depends on per-shipment costs as well as standard gravity variables, including importer size (GDP), distance, a landlocked importer indicator, an adjacency indicator and former colony dummy. Country 0 is Spain. We omit Spain-specific variables because they are soaked up by time dummies $\nu_t$. One specifications also includes an importer country fixed effect $\mu_j$.

$$\ln N_{0jt} = \beta_1 \ln f_{0jt} + \beta_2' \text{gravity}_{0jt} + \mu_j + \nu_t + u_{0jt}. \tag{12}$$

Table 4 reports the estimates. Because administrative procedures vary greatly whether trade is within or outside the European Union (EU), we estimate the

they corresponded to a $\exp(-1.152/0.919) \cdot 100 - 100 = 71$ percent decrease in per-shipment costs.

regression separately for EU and non-EU destinations.[18] Column 1 reports

Table 4: Shipping costs and the number of shipments

| Dep. var.: Shipments (log) | (1) OLS non-EU | (2) OLS EU | (3) FE non-EU |
|---|---|---|---|
| Per-shipment cost (log) | -0.775** | 0.220 | -0.545 |
| | (0.384) | (0.993) | (0.355) |
| Importer GDP (log) | 0.930*** | 0.555*** | 0.940*** |
| | (0.0384) | (0.0769) | (0.196) |
| Distance (log) | -1.535*** | -0.737 | |
| | (0.166) | (0.563) | |
| Importer is landlocked (dummy) | -1.041*** | -0.359 | |
| | (0.260) | (0.212) | |
| Former colony (dummy) | 1.843*** | | |
| | (0.206) | | |
| Adjacent country (dummy) | | 1.427** | |
| | | (0.640) | |
| Observations | 831 | 158 | 831 |
| R-squared | 0.885 | 0.906 | 0.473 |
| Country fixed effects | no | no | yes |
| Year fixed effects | yes | yes | yes |
| Number of countries | 123 | 24 | 123 |

Notes: Dependent variable is the annual number of shipments from Spain to the destination country (log). Standard errors in parentheses are clustered by destination country. *** p<0.01, ** p<0.05, * p<0.1. Sample is 2006–2012. See text for variable definitions and estimation details.

a simple OLS estimate for the 123 non-EU destinations. Standard errors are clustered by destination. Countries with higher per-shipment cost receive significantly fewer shipments, with an elasticity of $-0.77$. The interquartile range of per-shipment costs for non-EU destinations is \$2000 to \$3000. A country with \$2000 per-shipment costs receives 34 percent more shipments from Spain than a country with \$3000 costs.

As Column 2 shows, there is no correlation between per-shipment costs and the number of shipments within the EU. This is expected, since shipping

[18] An additional reason for splitting the sample is that reporting standards are different for intra-EU trade and hence the number of shipments is mechanically lower there.

is drastically simpler within the European single market and the standard costs recorded by Doing Business do not apply.

Column 3 reports a specification with destination fixed effects. Such fixed effects can soak up any time-invariant heterogeneity across countries and their relation to Spain. (This is why the gravity variables are omitted.) The coefficient of per-shipment costs is still negative but no longer significant, with a $p$-value of 0.12.[19]

Our preferred estimate of the elasticity of the number of shipments with respect to per-shipment costs is the more conservative $-0.545$. We will use this estimate in the counterfactual exercise.

In Hornok and Koren (forthcoming), we have estimated product-level regressions to determine the elasticity of the number of shipments and the average shipment size with respect to per-shipment costs. Countries with higher per-shipment import costs receive fewer and larger shipments from both the U.S. and Spain. The elasticity of the number of shipments is between $-0.262$ and $-0.104$.[20] Our estimates are larger. One possible explanation is that there are many zero trade flows at the product level, which biases a log-linear estimation. Missing trade is not an issue at the country level with a large exporting country such as Spain.

Table 5 of Hornok and Koren (forthcoming) also shows that shipments are spread throughout the year: countries with high per-shipment cost receive shipments in fewer months. These empirical patterns motivated our model.

## 5. The effects of a reduction in administrative costs

To quantify the effects of administrative costs in the model, we conduct a simple counterfactual exercise. In a simple trade facilitation scenario, we reduce all per-shipment costs $f_{ij}$ by half. As seen from Propositions 2 and 3, both the trade volume and the welfare effects are as if bilateral tariffs changed. We hence only need to calculate the tariff equivalent changes, $\psi_{ij}$.

To calculate $\psi_{ij}$, we need to know $\sigma$. Following Eaton and Kortum (2002), we calibrate $\sigma = 8.2$. This means that a 1 percent increase in ad-valorem trade costs reduces trade by $\sigma - 1 = 7.2$ percent. It also implies a 14 percent

[19]This $p$-value is calculated with standard errors clustered by destination. The White heteroskedasticity-corrected $p$-value is 0.007.

[20]Hornok and Koren (forthcoming), Tables 3-4.

markup. We also report results with the estimates of Simonovska and Waugh (2014), $\sigma = 4.1$.

We calibrate $d \ln n_{ij} / d \ln f_{ij}$ to $-0.545$ from Table 2. The ad-valorem amount of per-shipment costs is calculated for each destination $j$ as

$$\frac{\hat{f}_{0j} N_{0j}}{T_{0j}},$$

where $\hat{f}_{0j}$ is the dollar measure of shipping costs in Doing Business with the exporter being Spain, $N_{0j}$ is the total number of shipments from Spain to country $j$, and $T_{0j}$ is total imports of country $j$ from Spain.

Table 5 reports the average effects across non-EU countries. The first column use a calibration of $\sigma = 8.2$, whereas the second column reports results with $\sigma = 4.1$. Reducing per-shipment costs by half is equivalent to reducing tariffs by 8.5 and 9.9 precentage points, respectively. This does not depend heavily on $\sigma$.

Trade volumes go up dramatically after this reduction in per-shipment costs. With $\sigma = 8.2$, the trade creating effect of this trade facilitation reform is 90.6 percent. Even with $\sigma = 4.1$, we see a 38.1 percent trade increase. These magnitudes are comparable to the trade creating effects of customs unions (Table 3).

Table 5: Effects of reducing per-shipment costs by half

| | $\sigma = 8.2$ | $\sigma = 4.1$ |
|---|---|---|
| Tariff equivalent | $-8.5\%$ | $-9.9\%$ |
| Trade response | $+90.6\%$ | $+38.1\%$ |

There is a wide distribution of the effects across countries, because they are subject to different per-shipment costs. Figure 2 plots the tariff equivalent of the per-shipment cost reduction for the cross-section of non-EU countries. For the bulk of the countries, the counterfactual trade facilitation reform is equivalent to 0 to 20 percentage point reduction in tariffs.

## 6. Conclusion

We built a model of administrative barriers to trade to understand how they affect trade volumes, shipping decisions and welfare. Because adminis-

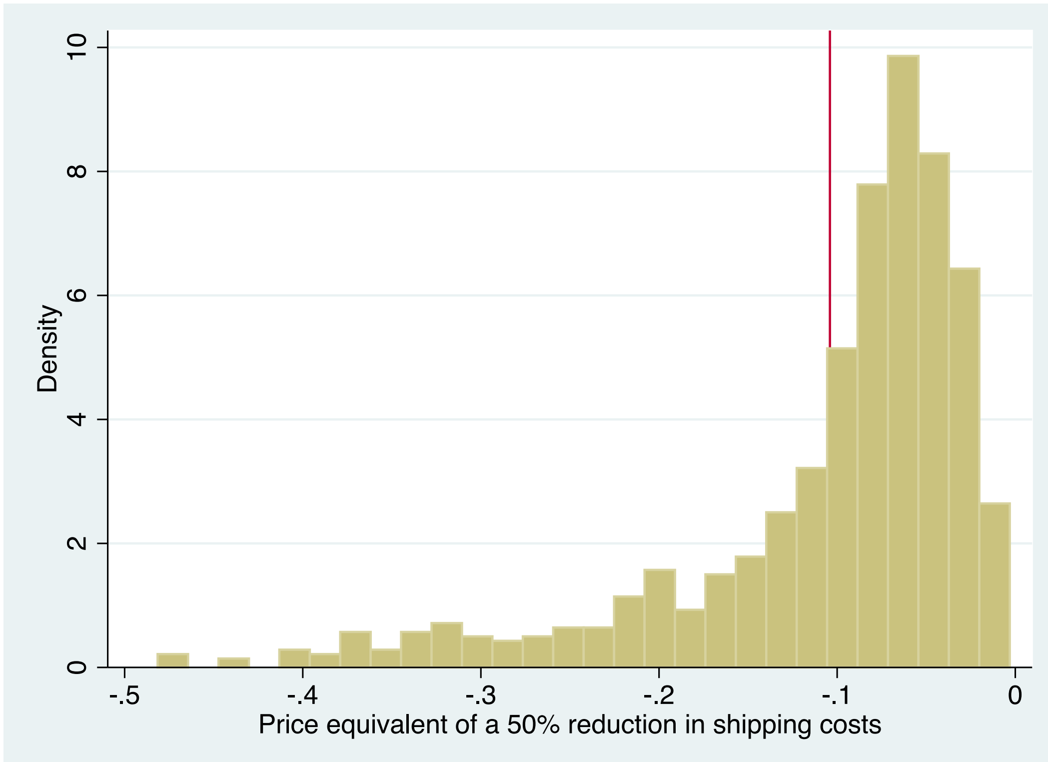


Figure 2: Tariff equivalent of shipping cost reduction

trative costs are incurred with every shipment, exporters have to decide how to break up total trade into individual shipments. Consumers value frequent shipments, because they enable them to consume close to their preferred dates. Hence per-shipment costs create a welfare loss.

We derived a gravity equation in our model and show that administrative costs can be expressed as bilateral ad-valorem trade costs. We estimated the ad-valorem equivalent in Spanish shipment-level export data and find it to be large. A 50 percent reduction in per-shipment costs is equivalent to a 9 percentage point reduction in tariffs. Our model and estimates help explain why policy makers emphasize trade facilitation and why trade within customs unions is larger than trade within free trade areas.

## Appendix A. Proof of Proposition 2

We can write firm revenue as

$$R_{ij} = r_{ij}\tau(n_{ij})^{1-\sigma},$$

where

$$r_{ij} = E_j \frac{c_i^{1-\sigma} t_{ij}^{1-\sigma}}{\sum_k M_{kj} c_k^{1-\sigma} t_{kj}^{1-\sigma} \tau(n_{kj})^{1-\sigma}}$$

Total import from country $i$ to country $j$ is

$$T_{ij} = M_i r_{ij} \tau(n_{ij})^{1-\sigma} = E_j \frac{M_i c_i^{1-\sigma} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma}}{\sum_k M_k c_k^{1-\sigma} t_{kj}^{1-\sigma} \tau(n_{kj})^{1-\sigma}.}$$

With $\tilde{P}_j$ denoting $(1 - 1/\sigma)P_j$,

$$T_{ij} = E_j M_i c_i^{1-\sigma} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \tilde{P}_j^{\sigma-1}.$$

Add up all the sales of country $i$,

$$\sum_j T_{ij} \equiv E_i = M_i c_i^{1-\sigma} \sum_j E_j t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \tilde{P}_j^{\sigma-1}.$$

$$M_i c_i^{1-\sigma} = \frac{E_i}{\sum_j E_j t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \tilde{P}_j^{\sigma-1}.}$$

Let

$$\tilde{\Pi}_i^{1-\sigma} \equiv \sum_j \frac{E_j}{E_w} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma} \tilde{P}_j^{\sigma-1}$$

so that we can write the above more succinctly as

$$M_i c_i^{1-\sigma} = \frac{E_i}{E_w} \tilde{\Pi}_i^{\sigma-1}.$$

$$\tilde{P}_j^{1-\sigma} = \sum_i \frac{E_i}{E_w} \tilde{\Pi}_i^{\sigma-1} t_{ij}^{1-\sigma} \tau(n_{ij})^{1-\sigma}.$$

Substituting in, we get the result.

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