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EFIGE working paper 51  
August 2012

Funded under the  
Socio-economic  
Sciences and  
Humanities  
Programme of the  
Seventh  
Framework  
Programme of the  
European Union.

LEGAL NOTICE: The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 225551. The views expressed in this publication are the sole responsibility of the authors and do not necessarily reflect the views of the European Commission.



The EFIGE project is coordinated by Bruegel and involves the following partner organisations: Universidad Carlos III de Madrid, Centre for Economic Policy Research (CEPR), Institute of Economics Hungarian Academy of Sciences (IEHAS), Institut für Angewandte Wirtschaftsforschung (IAW), Centro Studi Luca D'Agliano (Ld'A), Unitcredit Group, Centre d'Etudes Prospectives et d'Informations Internationales (CEPII).

The EFIGE partners also work together with the following associate partners: Banque de France, Banco de España, Banca d'Italia, Deutsche Bundesbank, National Bank of Belgium, OECD Economics Department.

# Welfare Effects of Administrative Barriers to Trade\*

Cecília Hornok<sup>†</sup> and Miklós Koren<sup>‡</sup>

July 2012

## Abstract

We build a model to analyze the welfare effects of per-shipment administrative trade costs. Exporters decide not only how much to sell at a given price, but also how to break up total trade into individual shipments. Consumers value frequent shipments, because they enable them to consume close to their preferred dates. Having fewer shipments hence entails a welfare cost. Calibrating the model to observed shipping frequencies and per-shipment costs, we show that countries would gain substantially by eliminating such barriers. This suggests that trade volumes alone are insufficient to understand the gains from trade.

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\*Koren is grateful for the financial support from the “EFIGE” project funded by the European Commission’s Seventh Framework Programme/Socio-economic Sciences and Humanities (FP7/2007-2013) under grant agreement n° 225551. Hornok thanks for financial support from the Marie Curie Initial Training Network “GIST.”

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# 1 Introduction

What are the welfare losses from trade barriers? This question is as old as the theory of international trade. Trade barriers distort relative prices and result in deadweight losses for consumers and producers. They also distort profit opportunities from firm entry and result in fewer varieties. Recently, Arkolakis, Costinot and Rodriguez-Clare (2012) have shown that, in a wide class of models, all these welfare effects can be succinctly summarized by a sufficient statistic: how much does import penetration change with trade barriers? Two conclusions emerge from this: First, trade barriers have small welfare costs.<sup>1</sup> Second, the peculiarities of trade models do not matter much for the magnitude of welfare costs.

In this paper we build a model with a new margin of welfare effects of trade barriers, in particular, per-shipment trade costs. Exporters decide not only how much to sell at a given price, but also how to break up total trade into individual shipments. When per-shipment trade costs are higher, they will choose to send fewer, but potentially larger shipments. Consumers value frequent shipments, because they enable them to consume close to their preferred dates. Having fewer shipments hence entails a welfare cost, even holding the total volume of trade and import penetration fixed.

In our previous work (Hornok and Koren, 2011), we have shown that significant administrative barriers to trade accrue per each shipment. 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. These costs are of a “per-shipment” nature. 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

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<sup>1</sup>Eaton and Kortum (2002) and Alvarez and Lucas (2008) report welfare gains in the order of 1 percent of GDP.

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: Reproduced from Hornok and Koren (2011).  
 Cost data is from the Doing Business survey 2009 for 170 countries.  
 Shipment size is based on shipment-level US and Spanish  
 export data from 2005. Trade in raw materials and low-value shipments excluded.

How important are the welfare costs of less frequent shipments? To answer this question, we conduct counterfactual exercises in a calibrated version of our model. We calibrate our model to match the key moments of our reduced-form estimates of a shipment-level gravity equation in Hornok and Koren (2011). The overall elasticity of trade volumes to trade costs is governed by the price elasticity of demand and can be estimated in standard ways. We infer the preference for timely shipments from the elasticity of shipment frequency to per-shipment costs. Intuitively, if consumers care much about timely delivery, then firms will ship as frequently as they can, and shipping frequency is not very sensitive to per-shipment costs.

We then report how welfare would change in a country if it adopted the trade policy mix of the United States. For the typical country, this entails lower tariffs, as well as lower administrative barriers. The present paper only focuses on administrative barriers. The median country would gain 8.8 percent of consumption-equivalent with such trade liberalization. There is also a wide distribution of these welfare gains. Countries at the 75th percential would gain 15.1 percent. This is in contrast to the gains from trade estimated by, for example, Alvarez and Lucas (2008) to be of the order of 1 percent of GDP. That is, administrative barriers are responsible for a sizeable share of the welfare costs of trade.

The starting point of our paper is a tradeoff between per-shipment trade costs and shipping frequency. 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.

We abstract from the possibility of inventory holdings and simply assume that the product is non-storable. We build a 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 decide on entering the market and choose the timing and size of their shipment. Per shipment administrative costs make firms send larger-sized shipments less frequently and increase the product price. These predictions are born out by the empirical analysis in Hornok and Koren (2011).<sup>2</sup>

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.

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<sup>2</sup>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.

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 and Schaur (2012) 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.

## **2 A model of the welfare costs 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.

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.

## 2.1 Consumers

There is a unit mass of consumers in the destination country.<sup>3</sup> 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.<sup>4</sup> 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.<sup>5</sup> 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.<sup>6</sup> 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

$$X(t, \omega) = \sum_{s \in S(\omega)} e^{-\tau|t-s|} x(t, \omega, s). \quad (1)$$

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

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<sup>3</sup>For simplicity, we are omitting the country subscript in notation.

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

<sup>5</sup>This is different from the tradition of address models that feature linear or quadratic costs, but gives more tractable results.

<sup>6</sup>As an alternative, but mathematically identical interpretation, we may say that the consumer has to incur time costs of waiting or consuming too late (e.g., storage) so that the total price paid by her is proportional to  $e^{\tau|t-s|}$ .

The consumer then has constant-elasticity-of-substitution (CES) preferences over the bundles  $X(t, \omega)$  offered by different firms.<sup>7</sup>

$$U(t) = \int_{\omega} X(t, \omega)^{1-1/\sigma} d\omega, \quad (2)$$

where  $\sigma$  is the elasticity of substitution.

Consumers spend a fixed  $E$  amount on imported goods.<sup>8</sup>

## 2.2 Suppliers

There is an unbounded pool of potential suppliers to the destination country. Every supplier can choose the number and timing of shipments they send. We are interested in a symmetric equilibrium, where all suppliers are identical in their costs and chose identical actions.

Suppliers first decide whether or not to enter a particular destination market. This has a fixed cost  $f_e$ , which captures the costs of doing business in the country and setting up a distribution network there. They then decide how many shipments to send at what times. Sending a shipment incurs a per-shipment cost of  $f$ . Finally, they decide how to price their product. All these decisions are done simultaneously by the firms.

The marginal cost of selling one unit of the good is constant at  $c$ . This involves the costs of production, but also the per-unit costs of shipping, such as freight charges and insurance. (It does not include per-shipment costs.) We abstract from capacity constraints in shipping, that is, any amount can be shipped to the country at this marginal costs.<sup>9</sup>

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<sup>7</sup>We model the substitution across firms separately from the substitution across shipments for analytical tractability. This way, the traditional competition effects are almost independent from the choice of shipping frequency.

<sup>8</sup>It is straightforward to endogenize  $E$  in a Krugman-type model. Because we are focusing on the new margin, we are expressing the welfare effects for given total export.

<sup>9</sup>This is not going to be a concern in the symmetric equilibrium of the model. Larger, more attractive countries will be served by many firms, so none of them would like to send oversized shipments.



Given this cost structure, we can write the profit function of producers as

$$\pi(\omega) = [p(\omega) - c] \int_t \sum_{s=s_1, \dots, s_{n(\omega)}} x(t, \omega, s) dt - n(\omega)f - f_e. \quad (3)$$

Net revenue is markup times the quantity sold to all different types of consumers at different shipping dates. We have already anticipated that each consumer faces the same price, which is something we prove below. The per-shipment costs have to be incurred based on the number of shipping dates.<sup>10</sup> We also subtract the market entry cost.

## 2.3 Equilibrium

We focus on symmetric equilibria. A *symmetric equilibrium* of this economy is a product price  $p$ , a measure of firms serving the market  $M$ , the number of shipments per firm  $n$ , and quantity  $x(s, t)$  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, (iv) firms make zero profit, and (v) 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. Finally, we can determine the number of exporting firms from the free entry condition.

**Pricing.** The demand (in terms of revenue) for the product of firm  $\omega$  shipped at time  $s$ , coming from consumer  $t$  is

$$R(t, \omega, s) = E(t) \left[ \frac{p(\omega)e^{\tau|s-t|}}{P(t)} \right]^{1-\sigma}, \quad (4)$$

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<sup>10</sup>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.

where  $E(t)$  is the expenditure of consumer  $t$ ,  $p(\omega)$  is the price of the product, and

$$P(t) = \left[ \int_{\omega} p(\omega)^{1-\sigma} e^{-(\sigma-1)\tau|t-s(\omega)|} d\omega \right]^{1/(1-\sigma)}$$

is the ideal price index of consumer  $t$ . Because there is a continuum of competitors, an individual firm does not affect the price index  $P(t)$  nor expenditure  $E(t)$ . 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,

$$p(\omega) = \frac{\sigma}{\sigma - 1} c. \quad (5)$$

Price is a constant markup over the constant marginal cost. Because all firms charge the same price to all consumers, we drop the  $\omega$  in the notation below.

**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,  $s_2 - s_1 = s_3 - s_2 = \dots = 1/n$ . 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.

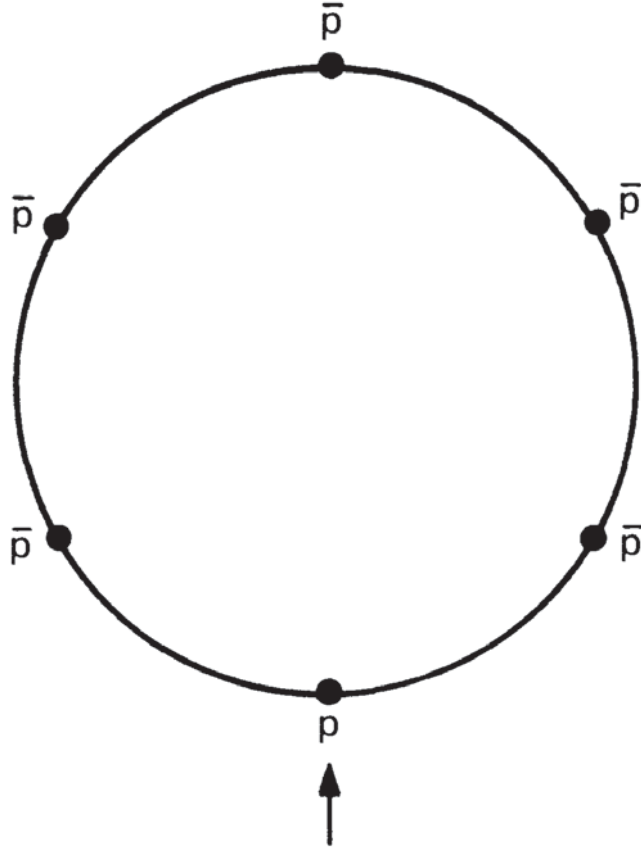
**Net revenue.** The firm will care about the net revenue coming from its sales. Because markup is constant, net revenue is just a constant  $1/\sigma$  fraction of gross revenue.

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

$$R(s) = \int_{t=s-\frac{1}{2n}}^{s+\frac{1}{2n}} E(t) \left[ \frac{p}{P(t)} \right]^{1-\sigma} e^{-(\sigma-1)\tau|s-t|} dt = E \left( \frac{p}{P} \right)^{1-\sigma} \int_{t=s-\frac{1}{2n}}^{s+\frac{1}{2n}} e^{-(\sigma-1)\tau|s-t|} dt,$$

where we have exploited the symmetry of consumers and firms.

Figure 1: Symmetric equilibrium shipping dates



The integral in the last term evaluates to

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

To economize on notation later, we introduce the term

$$\chi \equiv (\sigma-1) \frac{\tau}{2n} \tag{6}$$

and write the integral as

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

The revenue from all shipments is

$$R = \sum_s R(s) = nR(s) = E \left( \frac{p}{P} \right)^{1-\sigma} \frac{1 - e^{-\chi}}{\chi}. \quad (7)$$

This is increasing 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 demand more from this firm relative to other firms. At the extreme, if  $n \rightarrow \infty$ , the last term converges to 1, and the firm sells  $Ep^{1-\sigma}P^{\sigma-1}$ .

**Optimal number of shipments.** Choosing the optimal number of shipments involves maximizing

$$\max \frac{R}{\sigma} - nf$$

with respect to  $n$ . Net revenue is  $R/\sigma$  and each shipment incurs the per-shipment cost  $f$ . Revenue  $R$  only depends on the number of shipments through  $\chi$ . The first-order condition for the optimum is

$$\frac{dR/\sigma}{dn} = \frac{R}{\sigma n} \frac{1 - (1 + \chi)e^{-\chi}}{1 - e^{-\chi}} = f. \quad (8)$$

**Free entry.** Free entry ensures that firms make zero profit,

$$\frac{R}{\sigma} - nf - f_e = 0.$$

In symmetric equilibrium,  $R$  is equally divided among firms,

$$R = \frac{E}{M},$$

where  $E = \int_{t=0}^1 E(t)dt$  is the overall import expenditure of the country and  $M$  is the measure of firms exporting there.

$$\frac{E}{M} = \sigma(f_e + nf) \quad (9)$$

Combining the first-order condition (8) with the free entry condition (9), we get the following proposition.

**Proposition 1.** *The optimal number of shipments  $n^*$  is implicitly determined by*

$$\frac{\chi^*}{e^{\chi^*} - 1} = \frac{f_e}{f_e + n^* f}, \quad (10)$$

where  $\chi^* = \frac{1}{2}(\sigma - 1)\tau/n^*$ . The solution to this equation exists and is unique.

*Proof.* Note that  $\chi$  is decreasing in  $n$  by the definition (6), so the left-hand side is increasing in  $n$ . The right-hand side, in turn, is decreasing in  $n$ . This ensures uniqueness.

When  $n = 0$ , we have  $\chi = \infty$ , and the LHS is zero, while the RHS is one. When  $n = \infty$ ,  $\chi = 0$  and the LHS is one, whereas the RHS is zero. This ensures existence.  $\square$

Proposition 1 yields interesting comparative statics for the profit-maximizing shipping frequency  $n^*$ . Most importantly, it is decreasing in per shipment costs  $f$  and increasing in the importance of timely delivery  $\tau$ .

## 2.4 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  $E/P$ . We hence need to calculate the price index faced by the representative consumer. Using the definition of the price index, the fact that firms are symmetric, and the free entry condition pinning down the mass of firms,

$$P = pe^{\frac{1}{2}\tau/n} \left( \frac{\sigma f_e}{E} \right)^{1/(\sigma-1)}.$$

The price index is increasing in prices. It is also increasing in  $\tau$ , the utility cost of waiting and decreasing in  $n$ . When there are many shipments, the consumer will perceive them as a cheaper way to achieve the same level of utility. The price index also decreases in the size of the market  $E$  because of the usual love-of-variety effects: a large market can sustain many producers and many valuable varieties.

Substituting into the formula for utility, we get the following result.

**Proposition 2.** *The utility of the representative consumer is given by*

$$U = \frac{E}{P} = E^{\sigma/(\sigma-1)} \frac{\sigma-1}{\sigma c} \exp\left(-\frac{\tau}{2n}\right). \quad (11)$$

*It is increasing in the number of shipments  $n$ .*

At the extreme, when  $n \rightarrow \infty$ , waiting costs vanish and welfare is the same as under the Krugman model. We introduce the following notation for the additional “welfare bias” coming from administrative trade barriers:

$$B = e^{\frac{1}{2}\tau/n}. \quad (12)$$

This is the gap between welfare in our model and welfare in the the Krugman model and will be our key object of interest throughout the calibration. More specifically, a consumer would be willing to spend  $B - 1$  fraction of imports in order to get rid of per-shipment costs.

Note that our notion of welfare costs only includes the consumer, and does not account for the profit losses of the producer. The reason is that profits are zero in equilibrium so, ex ante, firms are indifferent with respect to per-shipment trade costs.

### 3 Calibration

We are interested in a quantitative evaluation of the welfare losses from per shipment costs. We conduct a simple calibration exercise. The key parameters of the model are  $\sigma$ , the elasticity of substitution,  $\tau$ , the preference for timely shipments, per shipment costs  $f$  and entry costs  $f_e$ .

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 8.2 percent. It also implies a 14 percent markup. We also report results with the estimates of Simonovska and Waugh (2010),  $\sigma = 4.5$ .

We capture administrative trade barriers in the importing country with indicators on the the burden of import documentation and customs clearance and inspection

(see next subsection). The remaining key parameter is  $\tau$ . We calibrate it using the following strategy.

We can infer the preference for timely shipments from the demand for shipments. Hornok and Koren (2011) estimate how the number of shipments vary with per-shipment costs. Taking the elasticity  $-0.278$  from their Table C.9., we equate it with the corresponding elasticity in the model,

$$\varepsilon(n, f) \equiv \frac{d \ln n}{d \ln f} = -\frac{d \ln \chi}{d \ln f} = \frac{1}{e^x - 1} - \frac{1}{\chi}. \quad (13)$$

An additional complication is that we do not observe shipments by firm  $n$  in the data, only the total number of shipments  $N = nM$ . In the calibration exercise, we want to express the welfare measure as a function of observables. This is given by the following proposition.

**Proposition 3.** *The log welfare gap is given by*

$$\ln B = \frac{1}{2} \frac{\sigma}{\sigma - 1} \frac{Nf}{E} \frac{1}{|\varepsilon(n, f)|}. \quad (14)$$

*Welfare costs are high when per-shipment costs are high in ad-valorem terms ( $Nf/E$ ) and when the elasticity of shipments to per-shipment costs is low.*

*Proof.* The formula follows from straightforward substitutions of (13) into (12) and

$$\chi = (\sigma - 1) \frac{\tau}{2N} M = (\sigma - 1) \frac{\tau}{2N} \frac{E}{\sigma(f_e + nf)} = \frac{\sigma - 1}{\sigma} \frac{E}{N} \frac{\tau}{f_e + nf}.$$

□

The intuition behind this result is as follows. Welfare costs of per-shipment costs naturally depend on their magnitude  $Nf/E$ . The sensitivity of welfare with respect to per-shipment costs is the inverse of the elasticity of the number of shipments with respect to such costs. When timely delivery is very important ( $\tau$  is high), consumers will demand many shipments, and shipping frequency will not be very sensitive to shipping costs. This is when shipping costs have the biggest welfare bias. By contrast, if people do not value timeliness much ( $\tau$  is low), shipping frequency will be very

sensitive to costs, as that part of the trade-off becomes more important. Welfare costs of per-shipment costs are low in this case.<sup>11</sup>

To express the welfare cost as a fraction of GDP, we multiply  $\ln B$  by the import penetration of the country  $E/Y$ . Such a welfare measure is more comparable to existing measures of gains from trade.

### 3.1 Data and measurement

Here we describe the data used for the calibration exercise.<sup>12</sup>

**Shipments.** We need transaction-level (shipment-level) trade data. The Customs Bureaus in the US record trade flows at the shipment level, but the published 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 A.

We consider 170 destination countries. Product classification is very detailed, covering around 8,000 different product lines (10-digit Schedule B).

**Administrative costs.** Data is from the *Doing Business* survey of the World Bank, carried out in 2009.<sup>13</sup> 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.

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<sup>11</sup>Note that a similar formula applies to the formula for the welfare cost of *ad valorem* trade costs, equation (1) of Arkolakis et al (2012). The intuition there is also similar.

<sup>12</sup>This description closely follows Hornok and Koren (2011).

<sup>13</sup>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.



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.<sup>14</sup> 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 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.<sup>15</sup>

As our preferred measure of per-shipment trade cost, we convert monetary costs to ad-valorem costs by multiplying them with the number of shipments and dividing by the total value. In other specifications, we also added the ad-valorem equivalent of time costs, using the cost of time estimated by Hummels and Schaur (2012) at 0.6 percent per day. Naturally, this only made the effect of per-shipment costs bigger.

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<sup>14</sup>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>)

<sup>15</sup>See Hornok and Koren (2011) for a more detailed discussion of administrative barriers to trade.

## 3.2 Results

Table 2: Calibration results

	$\sigma = 8.2$	$\sigma = 4.5$
Monetary costs	1.01%	
Time costs	9.00%	
Total costs	10.02%	
Welfare loss (percent of GDP)		
from monetary costs	1.00%	1.14%
from time costs	7.61%	8.59%
total	8.84%	9.97%

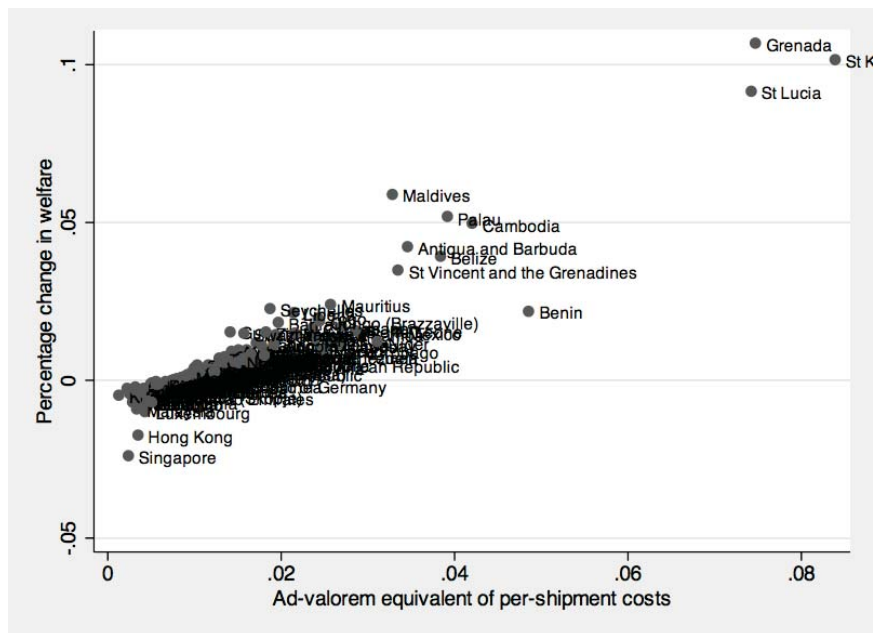
Table 2 shows the median ad-valorem trade costs for the 170 countries in our sample. It also displays the median welfare loss from per-shipment costs for different parameter values. Monetary costs are, for the median country, 1 percent of shipment value. This corresponds to a welfare loss from infrequent shipments in the order of 1 percent of GDP, though somewhat larger for lower elasticities of substitution. When we add the time costs of trade, the welfare losses become 9–10 percent of GDP.

We also ask how welfare would change in each country if they adopted the import procedures of the U.S. A typical U.S. import shipment waits only 3 days for customs clearance and documentation, and this procedure costs \$295.

Figure 2 reports the welfare change (in percentage of the country’s GDP) plotted against the ad-valorem equivalent of per-shipment costs. We only use the monetary costs in this figure; the welfare changes with time costs are correspondingly larger. The figure is constructed for  $\sigma = 8.2$ .

There are several European economies and the entrepot economies of Singapore and Hong Kong that would actually lose from adopting the U.S. standards. These countries have even lower administrative barriers and trade in large volumes. However, for the majority of countries, the welfare gains are positive (0.6 percent of GDP, on average).

Figure 2: Welfare gains from adopting U.S. administrative barriers: The role of trade barriers



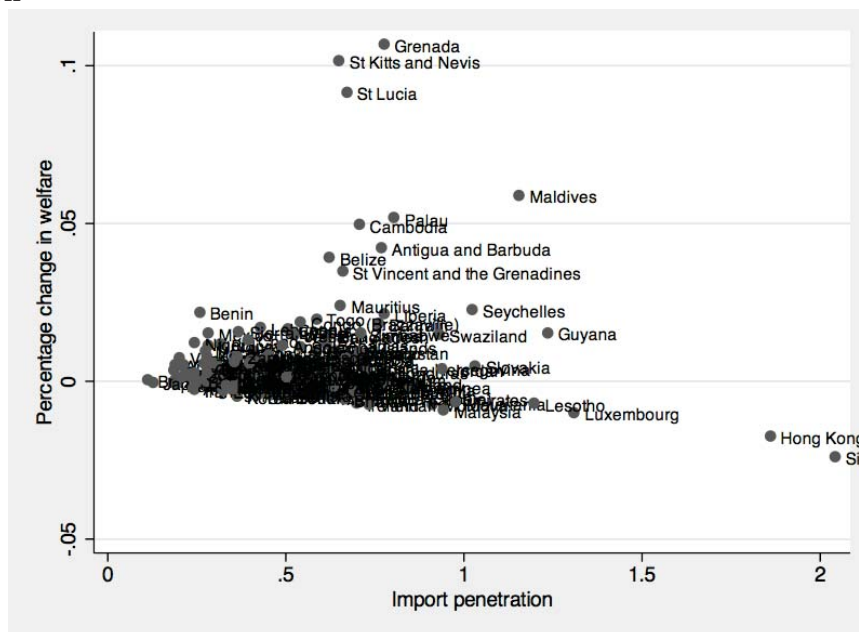
Not surprisingly, potential welfare gains are increasing in the magnitude of administrative costs. These are costs that would be replaced under the counterfactual policy. The gains can be as large as 5–10 percent of GDP.

Figure 3 reports the same welfare gain as a function of the import penetration of the country. Mechanically, countries with a high share of import would gain more, because they can enjoy the benefits of lower trade barriers on a larger amount. However, we see an opposite pattern: countries with the largest import penetration, such as Luxembourg, Hong Kong and Singapore actually lose via the policy changes. Such highly open countries tend to already have very low administrative barriers.

## 4 Conclusion

We build a model to analyze the welfare effects of per-shipment administrative trade costs. Exporters decide not only how much to sell at a given price, but also how to

Figure 3: Welfare gains from adopting U.S. administrative barriers: The role of import penetration



break up total trade into individual shipments. Consumer value frequent shipments, because they enable them to consumer close to their preferred dates. Having fewer shipments hence entails a welfare cost, even holding the total volume of trade and import penetration fixed. Calibrating the model to observed shipping frequencies and per-shipment costs, we show that countries would gain substantially by eliminating such barriers. This suggests that trade volumes alone are insufficient to understand the gains from trade.

## 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] Alvarez, Fernando and Lucas, Robert Jr., 2007. “General equilibrium analysis

of the Eaton-Kortum model of international trade,” *Journal of Monetary Economics*, Elsevier, vol. 54(6), pages 1726-1768, September.

- [3] Anderson, J. E. and van Wincoop, E. (2003) “Gravity with Gravitas: A Solution to the Border Puzzle,” *American Economic Review*, 93, pp. 170-192.
- [4] Arkolakis, Costas, Arnaud Costinot and Andres Rodriguez-Clare, 2012. “New Trade Models, Same Old Gains?,” *American Economic Review*, American Economic Association, vol. 102(1), pages 94-130, February.
- [5] Armenter, R. and Koren, M. (2010) “The Balls-and-Bins Model of Trade,” CEPR Discussion Paper No. DP7783.
- [6] 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.
- [7] Behar, A. (2009) “De Bonus Vetus OLS: Approximating the international trade-cost effects of red tape,” FREIT Working Paper No. 37.
- [8] Djankov, S., Freund, C. and Pham, C. S. (2010) “Trading on Time,” *Review of Economics and Statistics*, MIT Press, 92(1), pp. 166-173.
- [9] Eaton, Jonathan, and Samuel Kortum. 2002. “Technology, Geography and Trade.” *Econometrica*, Vol. 70(5).
- [10] Economides, N. (1986) “Product Differentiation in Hotelling’s Duopoly,” *Economics Letters*, 21 pp. 67-71.
- [11] Engman, M. (2005) “The Economic Impact of Trade Facilitation,” OECD Trade Policy Working Papers No. 21.
- [12] Evans, C. and Harrigan, J. (2005) “Distance, Time an Specialization: Lean Retailing in General Equilibrium,” *American Economic Review*, 95(1), pp. 292-313.

- [13] Feenstra, Robert. 1994. "New Product Varieties and the Measurement of International Prices." *American Economic Review* 84(1): 157-77.
- [14] Francois J., van Meijl, H. and van Tongeren, F. (2005) "Trade Liberalization in the Doha Development Round," *Economic Policy*, April 2005, pp. 349-391.
- [15] Harrigan, J. (2010) "Airplanes and Comparative Advantage," *Journal of International Economics*, 82(2), pp. 181-194.
- [16] Harrigan, J. and Venables, A. J. (2006) "Timeliness and Agglomeration," *Journal of Urban Economics*, 59, pp. 300-316.
- [17] Head, K. (2003) "Gravity for Beginners," Available at: <http://strategy.sauder.ubc.ca/head//gravity.pdf>.
- [18] Hornok, C. (2011) "Need for Speed: Is Faster Trade in the EU Trade-creating?" CEPR Discussion Paper No. 8451.
- [19] Hornok, C. and Koren M. (2011) "Administrative Barriers and the Lumpiness of Trade." CeFiG Working Paper No. 14.
- [20] Hummels, D. and Schaur G. (2012) "Time as a Trade Barrier," NBER Working Paper no. 17758.
- [21] 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.
- [22] 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.
- [23] Klenow, Peter J., and Andrés Rodríguez-Clare. (1997). "Quantifying Variety Gains from Trade Liberalization." Unpublished.
- [24] Krugman, Paul. (1980). "Scale Economies, Product Differentiation, and the Pattern of Trade." *American Economic Review* 70(5): 950-9.

- [25] Salop, S. C. (1979) “Monopolistic Competition with Outside Goods,” *The Bell Journal of Economics*, 10(1), pp. 141-156.
- [26] Schipper, Y., Rietveld, P. and Nijkamp, P. (2003) “Airline Deregulation and External Costs: A Welfare Analysis,” *Transportation Research Part B*, 37, pp. 699-718.
- [27] Simonovska, Ina and Waugh, Michael E., 2010. “The Elasticity of Trade: Estimates and Evidence,” CAGE Online Working Paper Series 13, Competitive Advantage in the Global Economy (CAGE).

## A Data reference

### A.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.<sup>16</sup> 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.<sup>17</sup>

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

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<sup>16</sup>The US Census Bureau defines a shipment accordingly: “Unless as otherwise provided, all goods being sent from one USPPPI 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 USPPPI 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.”

<sup>17</sup>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”.



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 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.