Border Processing, Trade Costs and New Trade Policy[†]

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Abstract

Borders impose high costs on trade flows. Research and policy focus on tariffs, quotas and all encompassing border effects to explain and quantify these costs. We highlight random processing times due to administrative and physical handling of shipments as a source of friction. Highly detailed Peruvian import-processing data from 2007-2013 show that firms absorb longer processing times with shorter storage times. Endogenizing this time management of shipment flow, our theory delivers a log-linear estimation equation, and, based on conventional measures of border time, provides quantifiable border-time-cost functions that generalize existing time cost estimates. We identify the effect of border-processing time on import values. Applying these estimates, border-processing costs range between 17 and 35 ad-valorem equivalent. For comparison, applied world wide WTO tariffs are about 9 percent. We find that eliminating physical document inspection would reduce border-processing costs between 6 and 12 percent. Results show that border-processing costs are especially high for new trade relationships and vary in firm size. Therefore, contrary to product specific trade policy such as tariffs, border processing costs are high in magnitude and relate to standard sources of firm heterogeneity.

Keywords: Trade Costs, Border Processing, Trade Facilitation

J.E.L. Classification: F10, F13, F14

[†]We thank Bruce Blonigen, Alexandre Skiba, Keith Maskus, Joaquin Blaum, Denis Novy, Keith Head, Matilde Bombardini, Roberta Piermartini, and seminar participants at TIGN/Ridge Conference, Singapore Management University, National University of Singapore, EIIT at Oregon, Midwest Meetings at IUPUI, RMET, CAF, CORE conferences, IBS Seminar. The views and interpretations in this paper are strictly those of the authors and should not be attributed to the Inter-American Development Bank, its executive directors, its member countries, or SUNAT. Other usual disclaimers also apply. Contact: jeronimo.carballo@colorado.edu, graziano@econ.umd.edu, gschaur@utk.edu, and christianv@iadb.org

1. Introduction

Border crossings impose numerous and diverse costs on trade flows. Traditionally, trade policy and research focus on tariffs and quotas. These policy instruments are observable and international agreements define how they apply to cross-border shipments. Instead, recently the WTO focuses on the processing of shipments at the border. For instance, the 2013 Trade Facilitation Agreement, a worldwide policy initiative, includes distinct policy provisions related to border processing, document management, inspections, and the movement of shipments. The hopes for trade facilitation are high, but it is not clear how to incorporate these border mechanisms in standard trade models, measure how well these process are executed, examine effects on trade flows, or, evaluate the impact of policy changes. To make progress, our theory examines firms' optimal time management related to the processing of shipments. Our empirical work employs detailed firm-level imports and processing data to estimate structural parameters and quantify border processing costs. This firm-level approach can be interpreted within standard trade models and integrates border-related trade facilitation policies into the framework.

Our starting point is that slow supply chains raise costs (Djankov et al., 2010; Hummels and Schaur, 2013; Volpe Martincus et al., 2015; Fernandes et al., 2015; Evans and Harrigan, 2005; Harrigan 2010). Therefore, a common measure of border performance is *total-border time*, the time shipments take between arriving at the port and clearing customs. However, total-border times include endogenous storage times. Our novel transaction-level customs data for Peru includes detailed information of each stage of the border process for the period 2007-2013. Storage times account for about 67 percent of the total border time on average. In addition, we provide evidence that firms absorb longer processing times with shorter storage times, mitigating the effect of longer processing on total-border times. This complicates interpreting total border times as an exogenous measure of border frictions. Thus, we focus on *processing time* as border performance measure. This measure focuses on administrative processing and physical handling of shipments, excluding intermediate storage steps.

Based on this evidence, our theory endogenizes the optimal time management of shipments through the border. Tight supply chains save money, but optimal time management also considers the risk of missing the delivery date. Missing the delivery date is costly due to late fees, reputation effects and potential disruptions of the production process (Harrigan and Venables, 2006). If the cost of missing the desired delivery window is high and storage costs are low, then firms schedule longer storage times to avoid running late in the case of a longer processing time. Formalizing this tradeoff delivers a theory driven definition of a *processing tariff*, an ad-valorem tariff equivalent that captures all steps of clearing borders as a function of processing time.

Consistent with the literature on time to trade, our model implies that an increase in time raises costs with constant elasticity (Djankov et al., 2010; Hummels and Schaur, 2013; Volpe Martincus et al., 2015; Fernandes et al., 2015). But, our theory extends existing time cost measures in three important ways. First, our model shows that processing-time cost elasticities depend on the shape of the processing time distribution. Second, cost elasticities based on total-border times are greater and structurally different from the elasticities based on processing times. As a consequence of these insights, elasticity estimates do not necessarily apply across different stages of the supply chain and identification approaches. Third, the theory shows that elasticities alone are not enough to determine border costs, because the optimized border-processing-cost function includes a cost multiplier that is necessary to determine economic significance of time related costs. Existing identification approaches implicitly relegate this parameter to fixed effects or the error term. We define a theory-consistent lower bound and apply simple calibrations to examine the empirical and economic relevance of this parameter.

To quantify the processing tariff, we integrate the time-cost function from our theory into a standard log-linear import demand system. Then we use data on imports and median processing times at firm-product-origin-year level to identify the necessary parameters. Our detailed data allow us to control for omitted variable bias related to importer characteristics, differences in product quality, exporter characteristics and differences in transportation infrastructure across origins. Despite rigorous sets of fixed effects, generating empirical proxies for theoretical counterparts creates attenuation bias. An instrumental variable approach based on customs risk management systems (Volpe Martincus et al., 2015) and a new instrument based on port congestion solve this identification problem. Compared to the existing literature, we distinguish the effect of different measures of border time on trade and estimate a theory-consistent border processing tariff that quantifies border processing costs using a more comprehensive approach.

We find that a one percent increase in the median processing time reduces trade by about 0.236 percent. Applying demand elasticities from the literature and our own estimates this raises border-handling costs between 0.08 and 0.152 percent. Our descriptive statistics show that eliminating all physical document inspections reduces processing times by 3 days at the median. Our estimates imply that trade costs would decline by about 7 percent, a time cost reduction of about 2.3 percent per day. This is consistent with the high end of what we would expect from the literature.

Combining these trade cost elasticities with theory-consistent estimates of cost multipliers allows us to compute the total processing tariff. Our estimates show that even at a processing time of one day firms incur a theory-consistent lower bound processing tariff between 1.3 and 2.6 percentage points. A back of the envelope estimate returns a processing tariff as high as 6 percent. Evaluating the processing tariff at the median processing time of 5 days and time-cost elasticity of 0.08 percent implies a lower bound processing tariff of 15.2 percent. Applying our back-of-the-envelope multiplier raises border processing costs to 21 percent. Therefore, rankings of border-processing costs should take into account the cost multiplier and its heterogeneity.

Our theory allows us to separate total costs into two parts. About one fourth is due to expected costs from missing the delivery window. The remainder is due to expenses related to scheduling buffer time to clear the port. This informs trade facilitation policy and costs rankings on the costs of uncertain shipment processing.

Our cost parameters combine with our descriptive statistics on processing times to perform simple policy experiments. If trade facilitation eliminates the need for physical document inspections in Peru, then this reduces trade processing costs between 6 and 12 percentage points.

Comparing trade policies, Roberto Azevedo, Director General of the WTO, noted that "*The impact of the Trade Facilitation Agreement could be greater than the elimination of all existing tariffs around the world*". Figure 1 shows that he has a point. Applied world-wide average WTO tariffs are lower than our estimates for processing tariffs. Also, the wide dispersion in processing tariffs suggests that a general simplification of border procedures will distribute benefits heterogeneously.

Our results speak to firm-level mechanisms concealed by aggregate data and more restrictive theoretical foundations. Holmes and Stevens (2012) show that more productive firms invest to reduce ad-valorem border costs. Focusing on importer heterogeneity we find that importing firms that are larger and export have greater processing-time elasticities and slightly greater cost multipliers. However, large firms on average experience lower processing times, resulting in slightly lower processing tariffs. New importers pay a processing tariff of almost 50 percent compared to a 14 percent tariff paid by incumbent importers. Therefore, processing related trade costs and investment to reduce border related costs are particularly important for theories and evidence related to the formation of new relationships (Bernard et al., 2017ab).

We are not the first to consider costs related to border times. The World Bank's Doing Business reports and Enterprise Survey are both ambitious and valuable initiatives that include measures of the time it takes to clear borders. Varying measurement conventions complicate interpretation of these widely used data sources (Hallward-Driemeier and Pritchett, 2015). The Enterprise Survey measures the time to import from arrival of shipments to customs clearance. This is closer to our measure of total-border time.[1] For comparison, The recent Doing Business Trading Across Border's measures distinguish the time required for border compliance and documentary compliance.[2] Their measure of border compliance is more closely related to our measure of processing time, while document compliance is endogenous to a firm's optimal document management.[3] Our theory and evidence help reconcile differences across these data sources to facilitate interpretation and cost rankings.

Several papers examine other trade costs related to border crossings such as administrative costs, transit regulations, and border agencies procedures (Hornok and Koren, 2015a, 2015b; Kropf and Sauré, 2014; Carballo et al., 2016a; Carballo et al., 2016b). All of these costs are included in our processing tariff as long as they affect processing times at borders. We also perform robustness checks distinguishing products by their administrative burden. Elasticity estimates are not affected. Therefore, if administrative burden enters our specification beyond the processing time, then this is appropriately captured by fixed effects.

[1]See Enterprise Surveys Indicator Descriptions, September 11, 2017, page 121. `http://www.enterprisesurveys.org/data/exploretopics/~/media/GIAWB/EnterpriseSurveys/Documents/Misc/Indicator-Descriptions.pdf`

[2]`http://www.doingbusiness.org/data/exploretopics/trading-across-borders/what-measured`

[3]To illustrate the differences, the Enterprise Survey reports 20 days to import for Peru in 2010. The Doing Business Report for 2010 suggests 24 days. According to the more recent methodology the Doing Business Report measures 72 hours for border compliance and 72 hours for documentary compliance.

Our findings also add to a number of papers that identify trade costs (see, e.g., the survey Anderson and van Wincoop, 2004), especially with respect to frictions related to crossing borders (see, e.g., McCallum, 1995; Helliwell, 1996; and Anderson and va Wincoop, 2003) and studies that explores the implications of ports efficiency for economic outcomes such as population growth, employment composition, and trade (see, e.g., Clark et al., 2014; Blonigen and Wilson, 2008). Different from these papers, we derive a border related cost function that is optimally determined by firm decisions as opposed to exogenously given and we use firm-specific measures of border processing. In doing so, we build a connection across these literatures.

2. Import Processing at the Border

Importing involves various steps and diverse actors. Some of these steps involve processing of shipments by port workers, shipping agents, customs brokers, and government officials. These steps are mostly out of the control of importing firms. Other steps depend on the importing firms' active management of shipment flows through the entry process such as storage between steps, or, preparation for customs and delivery. In this section, we describe the import process along with these individual procedures at Peru's main seaport, Callao. We use highly disaggregated data taken from customs import declarations and load manifests over the period 2007-2013 kindly provided by Peru's National Tax Agency (Superintendencia Nacional de Administración Tributaria -SUNAT). These data allow us to know the exact date associated with each of the various entry procedures. More specifically, we observe the date when the ship arrived, the date the shipment was unloaded, the date the customs import declaration was created and registered, the date the physical inspection took place, the customs channel, and the date the shipment was released by customs for each shipment clearing through the port of Callao.

After arrival in Callao, the ship has to be unloaded by the port operators. Unloaded shipments can then be stored in shipyards before the shipment starts the customs clearance process. To initiate customs clearance, an electronic Single Customs Document (Declaración Única de Aduanas-DUA) is completed and sent to the customs -SUNAT-. SUNAT returns a message containing the date, and information on obligatory tax and customs payments.

Upon payment (or warranty of it) of duties and fees, the shipments are assigned to a verification channel based on the customs' risk management system. The system randomly allocates these shipments to no inspection (green channel), documentary inspection (orange channel), or documentary and physical inspection (red channel) conditional on administrative, fiscal and security risk factors.[4] For imports these factors include the exporting firm,

[4] No more than 15% of the DUAs numbered in a given month in Callao can be subject to material control (see SUNAT, 2015). Documents to be presented when assigned to the orange or red channels include authenticated copies of the transport document, the invoice, and origin certificate if applicable. Among others, the inspector verifies the risk of the good; consistency between the documentation and the DUA; description, tariff classification, and value of the goods as well as tax and customs payments (see SUNAT, 2015). When a shipment is allocated to the red channel, the customs agent chooses randomly and inspects no

the origin country, the transport mode, the transport company, the countries where intermediate stops (if any) took place, the customs broker, the customs branch, the product, and the importing firm in Peru.[5] In addition to the time it takes to clear the process, there are some small direct costs associated with the (orange and) red customs channels due to the need to move, open, unload, reload, and close containers. At the Callao port, these basic operations cost on average 40 US dollars each. After the verification, if any has taken place, customs releases the DUA and clears the shipment. At this stage, goods can be immediately picked up or sit for some time if firms decide to take advantage of port storage facilities.

Table 1 presents percentiles of the distribution of the total number of days from ship arrival to customs' exit (Total Border Time) as well as those for each of the main segments of the import process for transactions processed at the port of Callao in 2013, unconditionally and conditional on customs verification channel.[6] Based on these tables, we establish a first fact.

Fact 1: Total-border times are a combination of official and necessary processing times of shipments -i.e. port and customs handling-, and storage time after and between necessary processing steps.

For every import stage, the mean clearance time is greater than the median clearance time. This skewness is consistent with the fact emerging from Figure 2, which shows the distribution of the duration for total and processing steps of border entry. This is our second fact.

Fact 2: Entry times are highly skewed to fast clearance times with a long tail of slow clearances.

About 50 percent of the shipments are cleared in 12 days or less, but clearance can take over 40 days at the high end of the distribution. Average total border times are between 16 and 17 days. For comparison, the ocean voyage from Rotterdam to Callao takes about 18 days.[7] Based on existing estimates, this suggests that the complete entry process is about as expensive as shipping in terms of time costs.

Unloading is the smallest part of the total border time taking between one and four days with a relatively tight distribution. Not surprisingly, there is no variation across customs channels in this stage. Document preparation, shipment review, and storage account for the majority of the total time with a wide distribution ranging from two to over 30 days. In this regard, note that storage at port facilities is cheaper than market alternatives up to a

less than 5% of the packs. In particular, the agent checks the consistency between the documents -including transport document, invoice, and DUA- and the actual shipment. In so doing, the official can take samples and pictures (see SUNAT, 2010b).

[5]Aggregate information provided by SUNAT indicates that most importing firms work with just one customs broker and one maritime transport company, particularly when importing from a given origin country. Hence, their consideration in the risk management scheme is most likely to be subsumed by firm-year (or firm-origin-year) fixed effects. Similarly, intermediate stops tend to be specific to origin countries, so that, in principle, their incidence can be considered controlled for by (product-)origin country-year fixed effects.

[6]Data in other years are very similar. Detailed tables are available upon request or can be seen in the working paper version. We count 1 day for stages cleared within the same day.

[7]Data comes from searates.com.

certain number of days. Unconditionally, shipments that must clear customs under the red channel rest for slightly longer in this intermediate stage.

At the median, actual customs clearance times are low, but with a wide distribution taking from one to 14 days. As expected, much of this variation is explained by the assigned customs channels. Shipments subject to documentary and especially physical inspection (orange and red channels, respectively) take significantly longer. It is worth mentioning that customs times only account for less than 20% of the total times for the median shipment and not more than 50% of the total time for those physically inspected. Hence, in the case of imports and unlike exports, customs is certainly a component in the process that adds transit time between origins and destinations but is definitely not the only one and may not even be the most important.

Table 2 shows a significant amount of heterogeneity across different firms. Measuring firm size by the number of employees such that firms with more than 200 employees are considered large (see Volpe Martincus and Carballo, 2008), the data reveal that mean and median times are about three days shorter for the so-defined large firms.[8] This heterogeneity is primarily due to differences at the customs stage (see the upper panel of Table 2). Differences are even more pronounced when we compare new and incumbent importers (see the lower panel of Table 2) or exporting and non-exporting firms. Table 2 also highlights that there is variation in the shape of the distribution. While for different firm types the various time measures are fairly similar for low percentiles, they diverge at the high end of the distribution.

In order to systematically examine how times relate to origin countries and exporting firms, products, and importing firms, we take the log median entry time over all shipments for each importer i purchasing product h from origin country x in year t, $\ln(Time_{ihxt})$. Next, we regress the log median entry time on various sets of fixed effects capturing the different dimensions of the data. Table 3 reports the r-squared from these regressions for 2013.[9] For all stages of the entry process, country of origin explains a relatively small portion of observed times. Augmenting the regression with product fixed effects improves slightly the fit of the regressions suggesting that the product and country of origin are not the main drivers of the variation in entry times. Importer fixed effects account for by far the largest portion of the time variation across all stages of the entry process. This suggests that heterogeneity across importers is directly related to observed entry times across all the stages. We summarize these findings in our third fact.

Fact 3: Entry times are heterogeneous across origin countries, products, and particularly importing firms.

In the bottom panel of Table 3, we report the correlation between the times at consecutive border stages controlling for fixed effects.[10] Border times may be endogenous for two reasons. First, more careful firms may take longer to prepare their shipments in storage areas to avoid

[8]The same pattern prevails when we group firms based on their total imports. A table with these data is available from the authors upon request.

[9]Results for other years are very similar and available upon request or in the working paper version of the document.

[10]More specifically, we control for firm, product-origin, firm-product-origin and day fixed effects.

long customs times. Second, firms may absorb random shocks in the physical handling of shipments with shorter storage times. Estimates show that time spent on preparation and storage does not significantly affect customs times. Hence, customs time can be considered conditionally exogenous to the firm's storage and preparation times. More interestingly, estimates reveal a significant negative relationship between port time and time spent at storage facilities and in preparing for customs. This is consistent with the intuition that firms' use storage as a buffer to absorb delays in the supply chain. This result is reflected in our fourth and final empirical fact.

Fact 4: Firms absorb long unloading times with shorter storage and preparation times.

The descriptive statistics presented in this section have several implications for modeling and estimating the impacts of border times. The following sections address both theoretically and empirically these issues to properly model and identify the costs of border times by taking advantage of the high dimensionality of our data and the instruments they allow us to construct.

3. Theory

3.1. Expected Total Border Entry Costs

International trade involves both physically moving shipments and administrative steps regulated by governments such as customs procedures. Firms allow for these procedures by placing shipments in advance of desired delivery dates. The tradeoff firms consider is that allowing for longer delivery times is costly, but shortening the gap between the shipping and delivery date runs the risk of missing the desired delivery window. We model this tradeoff focusing on border procedures consistent with the empirical facts in Section 2, but our approach extends to the entire supply chain. We choose functional forms to inform existing approaches and estimates in the literature. For a discussion of more general functional forms and queueing see Appendix 9.

Let v denote the total import value including transportation costs, tariffs and insurance. Let $t_c > 1$ be the time that importers optimally schedule to clear import procedures. Slow supply chains are costly. Therefore, let the cost of allowing for more time to clear import procedures, $t_c^{\vartheta} v$, be proportional to the shipment value and increasing with constant elasticity, $\vartheta > 0$. If actual processing times are deterministic, then $\vartheta > 0$ captures time cost elasticities similar to what is currently considered in the literature for other stages of the supply chain.

The facts in Section 2 are inconsistent with the assumption that processing times are deterministic. Instead, processing times at the port of entry are random due to congestion, customs risk management and equipment failures. As a result, actual processing times may not meet a firm's scheduled time. Consistent with Fact 2, let the actual processing time t_p be distributed $t_p \sim \frac{\varphi t_{min}^{\varphi}}{t_p^{\varphi+1}}$ with support $[t_{min}, \infty)$.[11] If the processing time turns out shorter than

[11] We proxy the processing times cumulative distribution with a Pareto distribution. This is consistent with the empirical distribution we show in Section 2. Additionally, we show in Appendix A that our setup

planned, $t_p \leq t_c$, then the firm stores the shipment until the desired delivery date at zero additional cost. This is in line with Fact 4, shorter unloading times result in longer storage times, and actual procedures in the logistics industry.[12] Late shipments, $t_p > t_c$, accrue container demurrage, product depreciation and late fee penalties. These costs, $(t_p/t_c)^{\omega} rv$, increase in the delay relative to the scheduled time as a factor of the import value, $rv > 0$. Most directly, an increase in r captures greater late delivery penalties, in a broader sense it captures reputation effects for unreliable firms.[13] Taking these costs into account, the importer considers the expected total cost of importing:

$$ETC(t_c) = \int_{t_c}^{\infty} \left(\frac{t_p}{t_c}\right)^{\omega} \left(\frac{t_{min}}{t_p}\right)^{\varphi} \frac{\varphi r v}{t_p} dt_p + t_c^{\vartheta} v \tag{1}$$

Allowing for more time, t_c, to clear the border lowers the probability of missing the delivery date and expected costs of late arrivals, but raises time costs $t_c^{\vartheta} v$ due to slower supply chains. Considering this tradeoff, the importer chooses an optimal buffer time t^* to minimize expected total costs of importing:

$$t^* =_{t_c}^{min} ETC(t_c) = t_{min}^{\frac{\varphi}{\varphi+\vartheta}} \left(\frac{r\varphi^2}{(\varphi-\omega)\,\vartheta}\right)^{\frac{1}{\varphi+\vartheta}} \tag{2}$$

Therefore, optimal buffer time is the total amount of time firms consider in their international supply chains to clear the border including necessary processing steps and storage steps if $t_p < t^*$.[14]

Substituting (2) into (1) and taking advantage of the fact that we can write the minimum processing time as a function of the median processing time, $t_{med} = t_{min} \sqrt[\varphi]{2}$, we obtain the minimized expected cost:[15]

$$ETC = \lambda \times (t_{med})^{\chi} \times v \tag{3}$$

where $\chi = \frac{\varphi\vartheta}{\varphi+\vartheta}$ and λ is a cost shifter that is a function of parameters $\{r, \varphi, \vartheta, \omega\}$ that we will discuss later .[16] The multiplier, median processing time and elasticity combine to define the border-processing tariff, $\lambda \times (t_{med})^{\chi}$, as a ad-valorem tariff equivalent on the total import value, v.

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holds more generally under mild assumptions on the cumulative distribution function for the processing times.

[12] Logistics providers at the port of Callao allows for storage within container yards and warehouses without additional costs for up to 10 days. (e.g. Neptunia)

[13] We take r as an exogenous parameter. Future research may endogenize this parameter.

[14] An alternative definition of buffer time is the difference between the time that minimizes expected costs with uncertainty and the time the firm would have scheduled in the absence of uncertainty, $t^* - t_{min}$. This distinction does not make a difference to our discussion and we find our definition more intuitive to follow.

[15] For interior solutions, we require $r > (\varphi - \omega)\vartheta t_{min}^{\varphi}/\varphi^2$ or that firms care enough about late delivery costs such that they choose $t^* > t_{min}$. In the expected cost function, the cost elasticity and shape parameter combine to the restriction that $\omega - \varphi - 1 < -1$ for the integral on the expected time cost to exist, as standard in the Pareto distribution. This results in the parameter restriction $\varphi > \omega$.

[16] More specifically, we denote $\lambda = r^{\frac{\vartheta}{\vartheta+\varphi}} (\varphi - \omega)^{-\frac{\vartheta}{\vartheta+\varphi}} \left(\vartheta^{\frac{\varphi}{\vartheta+\varphi}} \varphi^{-\frac{\varphi-\vartheta}{\vartheta+\varphi}} + \vartheta^{-\frac{\vartheta}{\vartheta+\varphi}} \varphi^{\frac{2\vartheta}{\vartheta+\varphi}}\right) / 2^{\frac{\vartheta}{\varphi+\vartheta}}$

The cost function provides insights regarding the costs of processing time and its measurement for individual steps in the supply chain, or multiple steps as long as random processing times at individual stages combine to the appropriate distributional assumption. Given the data we have availability, we discuss Equations (2) and (3) with respect to the border entry process.

Equation (2) shows that buffer time is determined by distribution parameters (t_{min}, φ) and cost parameters (ω, r, ϑ) in a non-separable way. Therefore, observed border times may be heterogeneous across firms even if the underlying processing distribution is the same. The reason is intuitive. Firms that are more sensitive to late arrivals (a high ω or r) or have low time costs (a low ϑ) schedule longer buffer times. As a result, these firms' shipments experience longer storage time between stages of border processing resulting in heterogeneous observed total border times. This non-separability has implications for cross country evaluation of trade facilitation measures. Two countries processing time distribution may be identical, but total observed border times may differ because firms optimally allocate time to clear these processes based on their heterogeneous costs parameters. Hence rankings of average total entry times don't necessarily provide reliable cost rankings.[17]

According to Equation (3), the time cost elasticity, $\chi = \varphi\vartheta/(\varphi + \vartheta)$, combines the scheduled time cost elasticities, ϑ, and the shape parameter of the underlying processing distribution, φ. This clarifies what fundamentals potentially drive estimated time-cost elasticities in the existing literature (Djankov et al., 2010; Hummels and Schaur 2013; Volpe Martincus et al. (2015); Fernandes et al. (2015)) that are based on average measures of processing time. Furthermore, this equation shows the necessary restrictions on the processing distribution such that time-cost-elasticity estimates from one part of the supply chain can be applied to other parts of the supply chain. To be precise, if the processing distribution for imports is different than for exports, then import time cost elasticities do not apply to evaluate export related time costs. Similarly, if country level policy differences translate to different processing distributions, then estimates from one country do not apply to evaluate costs for another country even if firms' costs parameters are similar across countries.

In the case that costs are heterogeneous across firms, Equation (3) highlights potential distributional consequences of trade facilitation policy. If the combined time cost elasticity, χ, is heterogeneous across firms due to for example customs risk management systems or transportation infrastructure, then even a homogeneous policy such as a reduction in processing times of 1 percent across all shipments may lead to relative changes in import costs within and across industries. Without information on these heterogeneities, we don't know how costs and benefits of policies are distributed within the economy or across countries depending on differences in specialization patterns and policies.

Equation (3) specifies import costs as a function of fundamental parameters governing the processing distribution. However, detailed administrative data might not be available.

[17]Furthermore, Equation (2) shows that the observed distribution of total entry time at a country not only is a function of the costs parameters, the time distribution parameters but also of the composition of trade. Thus, comparing and ranking countries in terms of some summary measure of the total border time is not necessarily going to provide the correct inference across countries.

Instead survey data on firms' scheduled times, t^*, may be obtainable. To see the difference due to the alternative time measures, we solve Equation (2) for the minimum clearance time and substitute for t_{min} in Equation (3) to obtain:

$$ETC = \frac{\varphi + \vartheta}{\varphi} \times (t^*)^{\vartheta} \times v \tag{4}$$

By construction, note that costs in (3) and (4) are identical, but expressed as a function of a different time measure. Comparing the elasticities, costs are more elastic with respect to buffer time, t^*, as compared to median processing times, t_{med}, because $\chi = \frac{\varphi\vartheta}{\varphi+\vartheta} < \vartheta$. The intuition follows from the model. If firms schedule buffer time and buffer time is costly, then a given percent increase in the median processing time leads to smaller percentage increase in buffer time, t^*. Therefore, the same changes in costs is associated with a smaller percentage change in t^* compared to t_{med}. Consequently, costs must be more elastic with respect to t^*. Therefore, evaluating trade costs and the interpretation of elasticity estimates depend on the underlying data source.

We expect the cost multiplier $\lambda > 1$, because even if the median import time is only one day, the total costs in (3) should not be less than the c.i.f. import value v. Note that λ is a cumbersome function of multiple parameters, r, ω, φ, and ϑ. As a consequence, based on the elasticity estimates alone, it is difficult to say how high time cost elasticities are related to cost shifters. Hence, to evaluate border costs we need to get an estimate of λ. This is challenging, because to our knowledge there is not systematic data on late fees and reputation costs included in r and ω. Nevertheless, we are able to provide some insights. First, combining equations (3) and (4) provides a lower bound, $\lambda > \frac{\vartheta+\varphi}{\varphi}/2^{\frac{\vartheta}{\vartheta+\varphi}} = \underline{\lambda}$ that can be estimated with our data.[18] Second, with some additional assumptions, we will calibrate the late fee parameter r based on our data and model. This exercise will provide some additional guidance on values for λ. We expect that the calibrated value would be greater than the lower bound. Therefore this simple numerical exercise also provides an additional test for consistency of our data and model.

In summary, the model implies that contrary to tariff policies where changes in costs are directly observable and interpretable, trade costs associated with trade procedures are harder to measure, require more data, and are more difficult to interpret within and across countries. They potentially depend on heterogeneous parameters, endogenous supply chain management and the specific indicator of supply chain performance. Equation (2) relates optimally chosen buffer times to fundamentals of the processing distribution. This implies a challenge for empirical evaluations since there no data sources that report both buffer times and fundamentals of the processing distribution. Instead, in the next section we relate Equation (2) to import values such that we can examine the empirical relevance of the insights provided by the theory using administrative import data in the empirical section.

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[18] Setting the equations equal and rearranging, we obtain $\frac{\vartheta+\varphi}{\varphi}/2^{\frac{\vartheta}{\vartheta+\varphi}} \times (t^*)^{\vartheta} / t_{min}^{\frac{\vartheta\varphi}{\vartheta+\varphi}} = \lambda$. Then, $t^* > t_{min}$ and $\vartheta > \frac{\vartheta\varphi}{\vartheta+\varphi} \Rightarrow (t^*)^{\vartheta} / t_{min}^{\frac{\vartheta\varphi}{\vartheta+\varphi}} > 1$. This in turn implies that $\lambda > \frac{\vartheta+\varphi}{\varphi}/2^{\frac{\vartheta}{\vartheta+\varphi}} = \underline{\lambda}$

3.2. Import Demand

Firm i imports m_{ihxy} units of product h from sourcing country x in year y. To prepare and distribute the total quantity q_{ihxy} of the final product on the domestic market, the firm combines the imported product with labor, l_{ihxy}, according to the Cobb-Douglas production function $q_{ihxy} = \alpha_i m_{ihxy}^{\beta} l_{ihxy}^{1-\beta}$, where $0 < \beta < 1$ and α_i is a productivity parameter. The total cost of importing including border costs equals $\lambda_{ihx} t_{med,ihxy}^{\chi} v_{ihxy}$ as derived in Equation (3), where $v_{ihxy} = m_{ihxy} w_{ihxy}$ is the import value inclusive freight, insurance and tariff charges. Assuming that products are differentiated across export locations and not substitutable, the firm's objective is to minimize $m_{ihxy} w_{ihxy} \lambda_{ihx} t_{med,hx}^{\chi} + w_{ily} l_{ihxy}$ such that $q_{ihxy} = \alpha_i l_{ihxy}^{1-\beta} m_{ihxy}^{\beta}$ where w_{ily} denotes firm specific wages.[19] Taking the c.i.f. prices and wages as given, the cost minimizing import demand is then:

$$m_{ihxy} = \frac{q_{ihxy}}{\alpha_i} \left(\frac{\beta}{1-\beta} \right)^{1-\beta} w_{ily}^{1-\beta} \left(\lambda_{ihx} t_{med,ihxy}^{\chi} \right)^{\beta-1} w_{ihxy}^{\beta-1} \tag{5}$$

Hence, the import demand elasticity with respect to entry times combines both cost and demand parameters, $(\beta - 1)\chi$. An increase in the median entry time raises the cost of importing h by χ percent. The elasticity $(\beta - 1)$ translates this relative cost increase to changes in relative import demand. Thus, isolating time cost elasticities from import demand elasticities requires information about the demand elasticity.

Equation (5) also shows that import demand depends on the time cost multiplier λ_{ihx}. This has multiple consequences for border cost estimation. First, fixed-effect estimation strategies to identify elasticities from import demands in log-linear models potentially absorb relevant time-cost information. Second, heterogeneity in this cost shifter determines the level of fixed effects necessary for identification of elasticities. Consequently, an empirical approach for border cost estimation and identification of elasticities that provides information related to this shifter is desirable.

The market output q_{ihxy} can be determined in equilibrium by demand and market structures standard in the trade literature. Let the consumer's demand on the domestic market be $A_{hy}(p_{ihxy}^{c})^{-\sigma} = q_{ihxy}$ where A_{hy} captures real expenditure on industry h, p_{ihxy}^{c} is the consumer price and σ the elasticity of the domestic consumer demand. Since the Cobb-Douglas technology implies constant marginal costs of supplying the consumer market, then $q_{ihxy} = A_{hy} \left[\mu K w_{ily}^{1-\beta} \left(w_{ihxy} \lambda_{ihx} t_{med,ihxy}^{\chi} \right)^{\beta} \right]^{-\sigma}$ where $\mu = 1$ in Bertrand competition and $\mu > 1$ in monopolistic competition.[20] Let the f.o.b price, $p_{hxy} = \frac{w_{ihxy}}{\tau_{ihxy}}$ be the c.i.f. import price divided by the trade cost factor τ_{ihxy}. This implies that f.o.b. prices are constant across firms within a origin-product-year triplet. But we allow for trade costs to be heterogeneous across firms. Substituting quantities into (5) and assuming that wages are equalized across

[19]We discuss later the case where products are substitutable according to a CES aggregator in the production function.

[20]Marginal cost equals $K w_{ily}^{1-\beta} \left(\lambda_{ihx} t_{med,ihxy}^{\chi} w_{ihxy} \right)^{\beta}$ where K is a constant.

firms, we multiply the import demand by f.o.b. prices to obtain the f.o.b. import value

$$v_{ihxy}^{fob} = m_{ihxy} p_{ihxy}^{fob} = \frac{\delta_{hy}}{\delta_{iy}} \times \tau_{ihxy}^{\beta(1-\sigma)} \times p_{hxy}^{1+\beta(1-\sigma)} \times \left(\lambda_{ihx} t_{med,ihxy}^{\chi}\right)^{\beta(1-\sigma)} \tag{6}$$

where δ_{hy} and δ_{iy} summarize cost and demand parameters.

Equation (6) provides the structural foundation for the estimation equation we will derive in the empirical section. Before doing so, we discuss multi-product firms and the selection of sourcing partners.

The import demand setting encompasses both firms that import and distribute multiple products and firms that combine multiple imported products into a single product. In the first case, if firms import multiple products and distribute each product, then as long as these products are not substitutable, import demands for each product are independent and can be characterized by Equation (6). In the second case, if imported products are substitutable, then consistent with the literature we assume that firms combine imported products according to a standard CES aggregator as in Halpern et al. (2015) and Gopinath and Neiman (2015). In this second case, the import demand for each imported product turns out to be more restrictive than the in first case. For a given demand shock for the firm's final product, import demands within each product respond equally across all imported inputs. Despite this difference, the log-linear structure of the import demand in Equation (6) remains unchanged for identification purposes of the time cost elasticity.[21]

Next we discuss how f.o.b. export prices may be determined in equilibrium. Substitute the CES consumer demand into (5) and sum over all firms importing a given product h from sourcing origin x in year y. This aggregate demand is constant elasticity in the f.o.b. export price. Then, in a monopolistic setting for example, firms follow a constant markup rule to maximize profits. If marginal production costs are constant then demand shocks do not feed back to prices.

A remaining question is how importers select a sourcing partners. In the CES case it is optimal to import all available varieties to maximize productivity. If products are not substitutable, firms discretely choose the sourcing partner to minimize costs based on observed information and a importer-exporter specific random shock.[22] Antràs et al. (2017) develop a firm's optimal sourcing strategy as a function of productivity, taking into account complementarities through the cost function.[23] For this an all remaining sections, we account for productivity differences and take the set of import-sourcing relationships for each firm as exogenous.

[21]To see this, let $q = \alpha L^{1-\beta}(\sum_{h\in H_{iy}} m_{hx}^{\sigma})^{\beta/\sigma}$, then $m_{hx} = w_L^{1-\beta}(t_{med,hx}^{\chi}\lambda w_{hx})^{\frac{1}{\sigma-1}} \frac{q}{\alpha} W$, where $W = (\frac{\beta}{1-\beta})^{1-\beta}(\sum_{hx} w_{hx} t_{med,hx}^{\chi}\lambda)^{\frac{\beta\sigma-\beta-\sigma}{\sigma}}$. Therefore, in log-linear form, an increase in the distributed output q affects the import demand across all imported products equally.

[22]For such an approach see Monarch (2016).

[23]Taking the sourcing strategy as given, their import demand relationships preserve a log-linear structural form similar to our import demand equation.

In this section, we have shown how border costs enter firms' import demand in standard trade settings. In the next section, we describe our import data and explain how we match it with the theory to derive an empirical specification and develop an identification approach.

4. Trade Data, Empirical Specification, Identification

4.1. Trade Data

We observe highly detailed import data obtained from Peru's National Tax Agency SUNAT from 2007 to 2013. Our data reports import values, quantities in kilograms, freight and tariff charges for each recorded transaction. In addition, for each record we see the ID of each importing firm, the origin country of the flow, the exporting firm in this country, the product code (10-digit HS), the customs office clearing the shipment, and, the vessel that carried the shipment. These data cover all transactions entering Peru. The objective is to merge import data with our information on processing times we observe for the port of Callao described in Section 2 and generate an estimation sample to identify the import demand equation.

Before doing so, Table 4 compares the universe of import transactions for Peru with the sample of imports that arrive at the seaport of Callao. Imports clearing Callao account for approximately three quarters of the total import value, two thirds of the total number of importers, 60% of all import transactions, and 90% or more of all imported products and countries of origin. We therefore capture most of Peru's imports. An advantage of focusing on Callao is that the concentration of business activity around neighboring Lima mitigates concerns that heterogeneity in inland transportation impacts our results or that imports clearing through other ports are destined for Lima (see Volpe Martincus et al., 2015). Furthermore, the Callao-average importer is similar to the national-average importer. More specifically, the Callao-average importer has 65 employees, is eight years old, and buys 12.4 products from 2.8 countries for approximately 650,000 US dollars (See Table 8 in the appendix for details).[24]

To merge the processing information with the import information, note that there are 22 customs offices in Peru, but the average firm uses only 1.03 customs offices and does not appear to utilize multiple ports of entry in response to port congestion, long queues at customs, or other delays. Consequently, imports arriving at Callao represent the majority of the firm's imports. Therefore, merging the processing information at Callao with the firm's import information is akin to merging the firms total imports with it's processing data. Hence, we aggregate the import information at the importer-product-origin-year level and merge it with the processing information we described previously. Combined, we have

[24]The national-average importer has 52 employees, is seven years old, and buys 14 products from 3.1 countries for roughly one million US dollars (See Table 8 in the appendix for details). Hence the Callao-average importer looks like the national-average importer, but imports less in terms of value spread over a smaller number of shipments. The difference are due to heavy goods being imported through other ports located closer to the production facilities and imports entering through airports which typically consists of smaller more frequent transactions (see Table 8 in the appendix).

an estimation sample that includes f.o.b. import values, v^{fob}_{ihxy}; freight charges, tariffs and insurance charges. Therefore, we compute τ_{ihxy} as the sum of f.o.b import value, freight charges, insurance charges, tariff charges and divide this sum by the f.o.b. value. In addition to this import information, we generate median times for various stages in the import process at the port of Callao as reported in Section 2.

4.2. Empirical Model and Identification

An identification advantage of our data and theory is that our empirical model identifies time cost parameters based on exogenous processing times that are independent of firm decisions instead of using total times that are managed by importing firms. Nevertheless, we have to solve several identification problems.

Throughout the theory, we treat the median processing time, $t_{med,ihxy}$, as a known parameter. Naturally, we don't observe the firm-specific parameter $t_{med,ihxy}$. Instead we do observe the realized median processing time $\hat{t}_{med,ihxy}$. Our identifying assumption is that the observed median processing time in the data is a good proxy for this parameter.[25] To be precise, let $\hat{t}_{med,ihxy} = t_{med,ihxy} + e_{ihxy}$, where e_{ihxy} is a random shock. Taking logs of the import value equation, (6), and substituting the data equivalents, we obtain the baseline empirical model:

$$\begin{aligned} ln(v^{fob}_{ihxy}) =& \delta_{hy} + \delta_{iy} + (1+\gamma)ln(p^{fob}_{hxy}) + \gamma ln(\lambda_{ihx}) \\ & + \gamma ln(\tau_{ihxy}) + \gamma\chi ln(\hat{t}_{med,ihxy}) + u_{ihxy} \end{aligned} \tag{7}$$

where $\gamma = \beta(1-\sigma)$ and the main parameter of interest is χ. Given the log-linear specification demand, productivity and cost shifters $(\delta_{hy}, \delta_{iy}, \lambda_{ihx})$ can be absorbed with appropriate fixed effects. Then, after accounting for import prices and border times, u_{ihxy} captures measurement error including e_{ihxy}.

The empirical model clarifies pooling restrictions with respect to comparable models in the literature (Hummels and Schaur, 2013; Volpe Martincus et al., 2015; Djankov et al., 2010; Fernandes et al (2015)). Recalling that $\chi = \frac{\vartheta\varphi}{\vartheta+\varphi}$ then in order to identify χ we require stability in the shape parameter φ and in the buffer time cost elasticity ϑ. Therefore, within a sample of observations, the identifying variation in median border times only comes from shifts in the minimum border times under the Pareto assumption. Across subsamples, variation in the shape is a source for heterogeneity estimates identified by the existing literature. We let the elasticity vary across subsamples to examine the relevance of this restriction.[26]

[25] Instead, firms may be uncertain about the distributional parameter t_{med}. In that case our approach can be considered akin to a plug in solution as in Granger and Machina (2006), where the firm substitutes the unknown parameter with its forecast. They show that if the firms object is to minimize absolute deviations, then the median is the optimal forecast.

[26] Ultimately, it would be desirable to turn the shape parameter into data. Within the current setting this would result in a complicated non-linear model not comparable to the existing literature requiring a non-linear identification strategy that accommodates a large number of fixed effects avoiding the incidental parameter problem and instrumental variables to break endogeneity. We are not aware of a convenient estimator to handle these challenges and leave this problem for future research.

Estimating the parameter with standard empirical approaches raises several concerns of attenuation bias. First, large shipments may be more likely to get unexpectedly delayed because of longer processing times. As a consequence, high trade values may be associated with longer border times. Second, high dimensional fixed effects exacerbate attenuation bias due to measurement error, because variation of the independent variable around the fixed effects usually emphasizes variation in idiosyncratic measurement error (Griliches and Hausman, 1986; Mckinish, 2008).

We develop two instruments based on port congestion and inspection probabilities. Simultaneous arrival of several vessels translates into longer border handling and processing times due to capacity constraints of port infrastructure. Hence, we use the median number of vessels that arrive on the day before the shipments of a given importer-product-origin within a given year as measure of congestion and therefore as our first instrument.[27] Our second instrument is based on the fact that time at customs is primarily determined by assignment to different processing channels, conditional on importing firm and product-origin (sourcing firm) characteristics.[28] Custom's risk management model assigns shipments to control channels. The assignment is random after controling for product, origin and importer characteristics with respective fixed effects (see Volpe Martincus et al., 2015). This assignment to alternative customs channels has a significant effect on processing times and total border times (see Table 1). We use the median assignment to the orange or red channel (ORC) as our second instrument. In particular, ORC takes the value of one if 50% or more of the shipments in a given firm-product-origin-year quadruple is assigned to the orange or red channels. Therefore, the instrument captures the exogenous probability of assignment to more time consuming inspection channels.[29]

We provide multiple tests related to the validity of the instrument in the empirical section. From a conceptual point of view, if $\hat{t}_{med,ihxy} = t_{med,ihxy} + e_{ihxy}$, then the instrument must be correlated with the unobserved $t_{med,ihxy}$ and not the measurement error e_{ihxy}. The intuition is that port congestion and inspection probabilities are included in the known median border times $t_{med,ihxy}$.

A concern for our instrument is that importing firms can affect assignment of the customs channel. At the transaction level, we do not find evidence that firms repeatedly get assigned to the same customs channel suggesting that assignment is in fact conditionally exogenous. There are several reasons that explain this outcome. Electronic processing of documents and payments at the port of Callao minimize personal interaction. Sequeira and Djankov (2014) show that informal processing is more of a concern in ports with face-to-face interaction. Finally, importers can take advantage of a formal express channel and don't have to resort to informal means. We examine this channel as a robustness check.

We absorb f.o.b. export prices with fixed effects assuming that prices are determined by

[27]On the robustness section, we also consider different windows length for our congestion instrument.

[28]In the appendix, we also generalize our setup by allowing the customs process to be different across channels where firms face random assignment to various channels with degenerate distributions.

[29]The natural alternative, the sample proportion, has the drawback that the total number of shipments appears in the denominator which is systematically related to border times invalidating the simple average as an instrument (Volpe Martincus et al., 2015)

aggregate demand and importers take prices as given. As explained in the theory section, if sourcing firms produce with constant marginal cost of production, then demand shocks do not feed back to export prices. Even if supply curves are upward sloping, as long as they are determined by aggregate demand, then all importers pay the same prices and export prices are absorbed in relative import demands. [30]

We follow two identification strategies related to trade costs, first absorbing them with fixed effects. Second, including them in the specification to obtain elasticity estimates to recover time costs identified within our framework. Transportation rates are set by shippers according to rate schedules. We consider them exogenous conditional on product, firm and exporter characteristics. Even though, tariffs may not vary along the many dimensions we exploit for identification of trade costs, it is important to include them in τ_{ihxt} as they are not log separable, affect the scale of the trade cost and therefore impact the elasticity estimates.

We take advantage of the multiple dimensions of our data to examine robustness with respect to omitted variables. For example, importing firm-year fixed effects account for size, experience and supply chain complexity. Origin country-product-year fixed effects account for time, distance and supply chain characteristics before shipments arrive at the port of entry. To facilitate estimation, we first difference equation (7). Then, country-product-year fixed effects account for changing unobserved export prices and unobserved trade costs. Firm-year fixed effects account for importers' changing productivity and demand on the final product market.

Finally, we use the estimates from our main specification combined with additional data to recover the structural parameters of the model. These parameters $\chi, \vartheta, \underline{\lambda}$ are not directly estimated, but are transformations of the elasticity estimates we obtain from the regressions. In order to evaluate the significance of these structural and keeping things comparable, we bootstrap standard errors for all the structural parameters. We re-sample across firms and also across strata when appropriate to account for clustering. In all cases the bootstrapped standard errors are based on 300 repetitions (see Efron and Tbshirani, 1994).

5. Results

Table 5 reports border time elasticities for processing time (left panel) and total time including storage (right panel) estimated using (7) in first-differences. Standard errors are clustered at the firm-product-origin level.[31] First stage statistics provide evidence regarding the validity of the instrumental variable approach. The bottom panel reports values of structural parameters based on the estimates. When not directly available from the regressions, we bootstrap the standard errors.

Across all estimates, an increase in the processing time reduces import demand. According to the OLS estimate, a one percent increase in processing time reduces import demand

[30] Additionally, even if we were to omit prices to the disturbance, as long as the instruments and trade costs are not systematically correlated with f.o.b. export prices, we still identify the parameters of interest.

[31] We perform several robustness checks regarding the clustering of standard errors. Results are the same across all alternative clustering. Tables are available in the online appendix.

by 0.049 percent. As outlined in the identification section, the OLS estimate is subject to considerable attenuation bias due to measurement error combined with the specification of high dimensional fixed effects. Consequently, the elasticity based on our instrumental variable approach, reported in columns IV1, is almost five times greater in magnitude. A one percent increase in the processing time lowers imports by 0.236 percent. The first stage results provide evidence that our two instruments based on port congestion and assignment to inspection channels are valid. As expected, congestion and a higher likelihood of inspection predict greater median processing times. F statistics suggest that the instruments are not weak. Hansen's test statistic provides evidence that after conditioning on fixed effects, overidentifying restrictions cannot be rejected.[32]

The empirical model reported in column IV2 augments the specification with ad-valorem freight, tariff and insurance charges. This has two reasons. First, the theory maintains that tariffs, transportation and insurance markets are independent of processing times. If transportation providers' quality depends on processing speed and higher quality providers charge higher rates, then this may result in omitted variable bias. Results reported in column IV2 show that this is not a concern. Time cost elasticities are nearly identical to the estimates in IV1. Second, the coefficient estimate on transportation costs provides an estimate for the import demand elasticity, $\hat{\gamma} = 1.541$, useful to recover structural parameters of interest.

Next consider elasticities based on total border times. Import elasticities with respect to total border time are greater than elasticities based on processing time. The theory reconciles this difference. Total border times include storage and are therefore a closer proxy to the optimal buffer time t^*. Comparing Equations (3) and (4), the theory shows that elasticities based on optimal buffer time are greater than elasticities based on processing times. The reason is that firms use storage time to smooth processing shocks. This lowers variation in total border times compared to processing times. With the same variation in import demand this leads to greater estimates.[33]

Next compare OLS to instrumental variable estimates of total border time elasticities. IV estimates are almost ten times greater than OLS estimates. Therefore, attenuation bias is even more of a concern for OLS estimates based on total border time than for estimates based on processing time. Our theory explains this result with greater sources of endogeneity of total border times, because firms can actively manage storage decisions in the import process.

Consistent with our theory, the results show that the definition of the time measure, processing time versus total-border time, has important implications for the magnitude and interpretation of elasticity estimates. We prefer estimates based on processing times, because results based on total-border times are ambiguous. Firms may use storage facilities after

[32]To check robustness of our results, we varied the time window for the congestion instrument and experimented with assignment only to the physical inspection channel for the customs instrument. Conclusions remain the same. See appendix online.

[33]We confirmed that he variance of total time dominates the variance for processing time. This is additional evidence for the buffer-time theory.

clearing customs, which is not observed in customs-level data sets. If firms use both, port and out-of-port facilities, the total-border times are mismeasured in a non-random way leading to biased elasticity estimates. If firms use only out-of-port facilities, then total-border time is actually the same as processing time and elasticity estimates should be interpreted based on equation (3) instead of equation (4). These ambiguities complicate testing theories or policy evaluation, because it is not clear whether heterogeneity in estimates across, for example, small and large firms is due to economic fundamentals or measurement differences. The benefit of processing times is that they can be directly observed and monitored by policy makers from customs and port statistics. Our results also confirm that OLS estimates based on both measures of border time are attenuated and attenuation bias is more severe for estimates based on total border times. However, our results are useful to interpret OLS estimates based on total border times when processing times and instrumental variables are not available.

The bottom panel of Table 5 reports structural parameters we back out from our estimation results. The specification in IV1 does not identify an import demand elasticity, γ. Instead we report a median elasticity based on Soderbery (2015). In IV2 the import demand elasticity is the elasticity on trade costs estimated jointly with border time elasticities. Dividing the processing time elasticity by γ, we obtain a time cost elasticity $\chi = \frac{\varphi\vartheta}{\varphi+\vartheta}$ between 0.079 and 0.152. Standard errors are bootstrapped and both estimates are significant.

To examine the economic relevance of the elasticity estimates, we can consider a policy experiment within our framework. The WTO agreement on trade facilitation includes provisions to simplify, standardize and streamline document processing. Table 1 shows that document inspection by customs increases processing times from 2 days (green channel) to 5 days (orange channel). Our time-cost elasticity estimates for χ predict that eliminating document inspection reduces processing-time costs between 7 and 13 percent, or, between 2.3 and 4.3 percent for each day cut by trade facilitation policy.

To clearly understand the impact of processing-time costs it is not enough to evaluate elasticities. We need to know the level of time related border costs according to Equation (3) and how they compare to other costs like tariffs. To do this, we compute the lower bound of the cost multiplier, $\underline{\lambda} = \frac{\vartheta+\varphi}{\varphi}/2^{\frac{\vartheta}{\vartheta+\varphi}}$, as defined in the theory and compare it to a calibrated value of λ as explained in Appendix 9.2. Both approaches require estimates of additional structural parameters.

To estimate φ the Pareto distribution provides $t_{med,ihxy} = 2^{\frac{1}{\varphi}} \times t_{min,ihxy}$, where $t_{min,ihxy}$ is the minimum observed clearance time. Taking logs we estimate the auxiliary regression $lnt_{med,ihxy} = b_0 + b_1 lnt_{min,ihxy} + u_{ihxy}$ and obtain $\hat{\varphi} = \frac{ln(2)}{\hat{b}_0}$.[34] Second, with $\hat{\chi}$ and $\hat{\varphi}$ we estimate $\hat{\vartheta}$ between 0.082 and 0.164 depending on whether we use estimates from columns IV1 or IV2. Substituting $\hat{\varphi}$ and $\hat{\vartheta}$ into $\underline{\lambda}$ provides an estimate for the lower bound cost multiplier $\hat{\underline{\lambda}}$.

[34]The intuition is that the location of the median relative to the minimum depends on the shape of the distribution. The flatter the distribution, the greater the median relative to the minimum. We estimate $b_1 = .87$ with standard error of 0.002.

Based on results in column IV1, $\hat{\underline{\lambda}}$ equals about 1.013. Therefore, even if processing times are cut to one day, the minimum cost multiplier implies a markup of 1.3 percent. The intuition is that firms incur some cost of clearing the port and customs even if they do not experience delays. This markup increase to 2.6 percent based on the estimates in IV2. Appendix 9.2 provides two back of the envelope calculations for λ. Based on estimates in IV1, moments from our own data and outside information, these calibrations suggest a λ between 1.03 and 1.06. As expected, these calibrated values for λ are greater than the lower bound.

Finally, substituting $\hat{\chi}$, $\hat{\underline{\lambda}}$ and the average median processing time of 6 days into the cost function (3), we find a lower bound border processing tariff estimate between 17 and 35 percent of the total import value.[35] For comparison, the average tariff is about 9 percent on imports excluded from free trade agreements and 2 percent including trade agreements. Again, these estimates are significant and standard errors are bootstrapped. Instead of finding a lower-bound multiplier, applying our calibrated numbers for the cost multiplier (see Appendix 9.2), these processing tariffs increase to 19 and 42 percent respectively.

Equation (1) allow us to compute the contribution of expected delay costs to total border costs. Substitute the optimal buffer time (2) into the integral of (1) to separate expected costs from total costs.[36] Evaluate this expected delay cost with $r = 0.03$ (see Appendix 9.2) and a median processing time of 6 days. Based on the parameter values of columns (2) and (3) in Table 5, we find that the expected late fee contributes 4.5 and 9.7 percentage points to the ad-valorem border costs. Therefore, expected late fees account for about a fourth of the total expected border-cost markup.

Reconsider the policy experiment of eliminating all physical document inspections, a change in the total processing time from 5 to 2 days. Based on Equation (3), this reduces the processing tariff from about 15 to 9 percent according to the estimates in IV1, and from 24 to 12 percent according to estimates in IV2. As comparison, World Bank data shows that average applied tariffs have decreased from about 10 percent to 6 percent between 1996 and 2010.[37]

Our conclusions are robust with respect to alternative specifications of fixed effects, estimators and potential identification threats. Table 6 reports results of our main specification for alternative sets of fixed effects. Across the columns, the processing time elasticity of import demand is remarkably stable and similar to the estimates we report in Table 5. We point out two highlights. First, column 2 shows that omitting importer-by-time characteristics leads to lower estimates and the instruments are more predictive. Therefore, importer heterogeneity is relevant for identification and may cause identification problems in data sets that aggregate over this heterogeneity. Second, the theory derives import demand based on a Cobb-Douglas and CES production structure. For a given importer, in the Cobb Dou-

[35]Note that the median processing time in Table 1 is not the same as the averaged median processing time. The average median processing time is the average over the regressor we generate to estimates the time cost elasticities, the simple average over $\hat{t}_{med,ihxy}$.

[36]We obtain $\frac{r\varphi t_{med}^{-\frac{\varphi\vartheta}{\varphi+\vartheta}}}{\varphi-\omega}\left(\varphi^2 r\left(2^{\frac{\varphi}{\vartheta}}\right)\left(\vartheta\left(\varphi-\omega\right)\right)\right)^{\frac{-\varphi}{\varphi+\vartheta}}$.

[37]See http://data.worldbank.org/indicator/TM.TAX.MRCH.SM.AR.ZS

glas structure imports of different products respond to an idiosyncratic demand fluctuation. Alternatively in the CES production structure, firms combine multiple imported products into one output. Therefore, within a firm, imports across multiple products respond to the same demand fluctuation. Firm-product-year fixed effects in column five allow for the more general unobserved consumption changes. In addition, these fixed effects account for the sourcing of the product from local and potentially agglomerated markets. These fixed effects limit variation to firms sourcing the same product from multiple markets, but the results are the same.[38]

The last column of Table 6 provides an additional robustness check. We clean the estimation sample of shipments that cleared under an express channel that importers can use to expedite their shipments before they arrive at the port. Results show that there are no systematic differences in the estimates. We conclude that either firms cannot take action to affect processing times, or, our fixed effects appropriately account for this heterogeneity.

Finally, we also dropped all shipments of products that required additional import permits that may delay the progress of shipments (Bowen and Crowley, 2016). This does not affect our estimates. There are two potential reasons for this. First, our fixed effects may already account for differences in licensing and permit requirmeents. Second, lincensing and permits may hold up shipments before they even arrive that the border.[39]

5.1. Heterogeneity

Trade theory highlights the importance of firm heterogeneity on the exporter side (e.g. Melitz, 2003) and the importer side (Antràs et al., 2014). Recent research combines both sources of heterogeneity in one framework and provide empirical evidence (Bernard et al., 2017). For theoretical convenience, it is common to assume that trade costs are iceberg and homogeneous across firms. From a border cost and trade facilitation point of view, this assumption mutes policy consequences and conceals firms' optimal response to trade barriers such as the adoption of different supply chain technologies. Therefore, we examine next the empirical relevance of border cost heterogeneity across firm and product dimensions.

We start by interacting the median processing time in our main empirical model with an indicator that distinguishes large importing firms (LF) from small importing firms (SF) according to their labor force. Table 7 reports the estimates.[40] Imports of large firms

[38]As further robustness checks not reported in this Table but available in the online appendix, we estimated the main empirical model for two alternative levels of aggregation, allowing for variation across carriers involved in transporting the the shipment and at the exporting firm level accounting for exporting-firm fixed effects. Again, elasticity estimates were remarkably similar. This alleviates concerns that importers select carriers or exporters based on unobserved information that is correlated with import values, processing times and is correlated with the instruments.

[39]We also dropped products that can be classified as light. Reassuringly, there are no systematic differences in the estimates. Product fixed effects already account for this heterogeneity. Results are available in the online appendix.

[40]For reasons of space, we focus on the more parsimonious empirical specification and apply Soderbery's elasticity to back out cost parameters. The Appendix reports estimates when we include trade costs in the model.

are more elastic with respect to processing time. A test confirms this difference, rejecting equality of the coefficients at the 1 percent level (reported in column Diff). However, the demand elasticity γ and shape parameter φ are similar across the subsamples, confirming our pooling restrictions in the overall sample. Consequently, the results imply that small firms' costs are less elastic with respect to scheduling longer supply chains as measured by a smaller ϑ and combine to a smaller border cost markup, $\lambda - 1$. A potential reason is that compared to large firms, small firms manage relatively simpler supply chains. Combining the structural parameters with observed processing times, processing tariffs are very similar across the two samples, 1.150 compared to 1.153. The heterogeneity in cost parameters suggests that larger firms deal with supply chain technology that puts them at a cost disadvantage compared to smaller firms, but they are able to offset this disadvantage with fast processing times.

Next we compare exporting to non-exporting firms. The advantage is that firms choose export status based on productivity. Therefore, export status may be a more reliable indicator distinguishing productivity than exogenously chosen size cutoffs. The coefficient pattern is similar comparing exporting (EF) to non-exporting firms (NEF). Exporting firms are at a cost disadvantage compared to nonexporting firms. But again, they make up for this with faster processing times. We conclude that firm size and export status are important to understand differences in the management of border processes, but total costs are similar across the groups of firms. The last two columns of Table 7 compare new importers (NIF) to established importers (IF). Across all parameters, new importers face greater time costs. New importers also experience much longer processing times. Combined, this leads to greater border processing costs for newly formed trade relationships, inconsistent with homogeneous iceberg costs. From a policy interpretation, the results imply that trade facilitation may especially affect the formation of new trade relationships. In summary, consistent with Holmes and Stevens (2012) we find evidence that firm heterogeneity is important in understanding border costs. While Holmes and Stevens focus on export heterogeneity, we can only measure importer heterogeneity and find that large and exporting firms have lower but very similar border costs compared to smaller and non-exporting firms. The most significant effect on heterogeneity relates to the formation of new relationships (Bernard et al., 2017ab).

Finally, we compare product level border costs to import tariffs. Again this requires several steps. First, estimate our main empirical model within each section of the harmonized classification to obtain section specific import elasticities. Second, we back out cost parameters similar as in Table 7 to obtain section specific cost shifters $\underline{\lambda_{HSec}}$ and cost elasticities χ_{HSec}. Let m_x denote the average over the median processing times $\hat{t}_{med,ihxy}$ within a given HS product . Then, following Equation (3), we define the processing tariff equivalent $\tau_{processing} = \underline{\lambda_{HSec}} m_x^{\chi_{HSec}}$. Figure 1 plots the distribution of this processing tariff equivalent cost and the distribution of standard ad-valorem import tariffs. We draw two conclusions. First, border-processing related tariffs are larger than standard import tariffs. Therefore, streamlining import procedure does have the potential for significant cost changes compared to tariffs. Second, the distribution of the processing tariff ranges between 0 and 30 percent of the import value. Thus, heterogeneity in processing tariff equivalent is significant and needs to be incorporated into to trade facilitation discussions.

6. Conclusions

Crossing borders imposes several costs on trade flows. We focus on the role of border-handling as a source of these border costs. We model a firm's optimal time management to meet delivery schedules when processing times at the border are uncertain. The theory delivers cost functions to evaluate border-handling costs that extend and provide fundamentals for existing time-cost estimates. Functional forms consistent with empirical facts allow us to embed the cost functions in importers' demand. We employ detailed imports and processing data for Peru, develop an identification approach that takes into account omitted variables and measurement problems to estimate these cost functions and recover structural parameters. We draw several conclusions.

Border processing imposes a trade cost greater than average applied WTO tariffs. Illustrative policy examples show that trade facilitation does have the potential to substantially reduce these trade costs. Processing tariffs are dispersed across products, and especially new trade relationship suffer from high border costs. This informs current research on the formation of relationship about relevant trade cost assumptions.

Our model and data help interpret widely used aggregate measures of border-handling times. Differences in these measures are difficult to interpret as cost ranking because they combine actual processing times with optimally chosen storage times. Even actual processing times systematically vary with firms and product characteristics. Therefore, to interpret cost elasticities and rankings based on processing times, it would be useful for country level datasets to report information related to the distribution of processing times.

Several theory and empirical extensions are worth considering. Existing theory examines shipping frequencies and per-shipment costs (Hornok and Koren, 2015ab; Krop and Sauré, 2014). Future research may combine these mechanisms with our buffer time theory to obtain a more complete understanding of international supply chain management and its interactions. Finally, as trade facilitation policies are implemented, our model can be identified from policy shocks to obtain direct evaluations of actual policy provisions. Several papers work with aggregate trade facilitation indicators developed by the Organization for Economic Cooperation and Development (Fontagné et al., 2016; Möiseé et al., 2011; Möiseé and Sorescu, 2013). This evidence focuses on elasticity estimates and shows that the indicators are predictive. Given our evidence for time indicators, it would be worthwhile to understand how policy changes affect these broader trade facilitation indicators and how they translate to cost rankings or performance measures.

Finally, our theory and empirical approach extend to issues beyond trade facilitation and border processing. For example, import licensing, the requirement to purchase a license before products can be imported, may delay imports (Bowen and Crowley, 2016). In this case imports may get held up even before arriving at the border. Our theory and identification approach extend to the entire international supply chain to evaluate these issues conditional on our modeling assumptions.

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7. Tables

Table 1: Border Times: Total and Stages in 2013, by Customs Verification Channel

Stage	Channel	Mean	Percentile						
			5th	10th	25th	50th	75th	90th	95th
Total Border	All	16.5	4.0	5.0	7.5	12.0	20.0	33.0	44.0
	Green	11.6	4.0	4.5	6.0	8.0	13.0	21.0	29.5
	Orange	16.9	5.0	6.0	8.0	13.0	21.0	31.0	42.5
	Red	23.2	7.0	9.0	13.0	19.0	29.0	42.0	55.0
Port	All	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Green	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Orange	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Red	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
Storage	All	11.0	2.0	3.0	5.0	7.0	13.0	22.0	32.0
	Green	9.7	2.0	3.0	4.5	7.0	11.0	19.0	27.0
	Orange	10.7	1.0	3.0	4.5	7.0	13.0	22.0	31.0
	Red	12.5	2.0	3.0	5.0	8.0	15.0	27.0	37.0
Custom	All	5.2	1.0	1.0	1.0	2.0	7.0	13.0	18.0
	Green	1.7	1.0	1.0	1.0	1.0	2.0	3.0	4.0
	Orange	6.0	1.0	2.0	2.0	4.0	7.0	13.0	17.0
	Red	10.5	3.0	3.0	5.0	8.0	13.0	19.5	25.0
Port and Custom	All	6.4	1.0	2.0	2.0	4.0	8.0	15.0	19.0
	Green	3.8	1.0	2.0	2.0	2.0	3.0	5.0	6.0
	Orange	8.1	2.0	3.0	3.0	5.0	9.0	14.0	19.0
	Red	12.1	4.0	4.0	6.0	9.0	14.0	20.0	26.0

Source: Authors' calculations based on data from SUNAT.
The table reports the average and percentiles of the distribution of total and procedure-specific times (i.e., port times, preparation and storage times, and customs times) by customs' verification channel (i.e., green, orange, and red) for 2013. The sample corresponds to all maritime imports entering into Peru through the port of Callao.

Table 2: Border Times: Total and Stages in 2013, by Firm Types

Stage	Firm Type	Mean	Percentile						
			5th	10th	25th	50th	75th	90th	95th
Total Border	New Importers	24.7	7.0	9.0	13.0	20.0	30.5	49.0	60.0
	Incumbent	15.2	4.0	5.0	7.0	11.0	19.0	30.0	40.0
Port	New Importers	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Incumbent	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
Storage	New Importers	15.1	3.0	4.0	6.0	11.0	19.0	33.0	44.0
	Incumbent	10.4	2.0	3.0	5.0	7.0	12.0	21.0	29.0
Custom	New Importers	9.5	1.0	2.0	4.0	7.0	12.0	19.0	26.0
	Incumbent	4.6	1.0	1.0	1.0	2.0	6.0	12.0	16.0
Port and	New Importers	9.8	2.0	3.0	4.0	8.0	12.0	19.0	25.0
Custom	Incumbent	5.8	1.5	2.0	2.0	4.0	7.0	13.0	17.0
Total Border	Non-Exporters	17.2	5.0	6.0	8.0	13.0	21.0	33.0	45.0
	Exporters	13.0	4.0	4.5	6.0	9.0	15.0	26.0	37.0
Port	Non-Exporters	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Exporters	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
Storage	Non-Exporters	10.9	2.0	3.0	5.0	7.0	13.0	22.0	32.0
	Exporters	9.1	1.0	2.0	4.0	6.0	10.0	19.0	28.0
Custom	Non-Exporters	6.1	1.0	1.0	1.0	4.0	8.0	14.0	19.0
	Exporters	3.6	1.0	1.0	1.0	2.0	4.0	8.0	13.0
Port and	Non-Exporters	7.2	2.0	2.0	3.0	5.0	9.0	15.0	20.0
Custom	Exporters	4.8	1.0	2.0	2.0	3.0	5.5	10.0	14.0
Total Border	Small Firms	17.2	4.5	6.0	8.0	13.0	21.0	34.0	45.0
	Large Firms	14.6	4.0	5.0	7.0	10.0	17.0	31.0	43.0
Port	Small Firms	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
	Large Firms	2.1	1.0	1.0	2.0	2.0	2.0	3.0	4.0
Storage	Small Firms	11.1	3.0	3.0	5.0	8.0	13.0	22.0	32.0
	Large Firms	11.2	2.0	3.0	5.0	7.0	13.0	25.0	35.0
Custom	Small Firms	6.8	2.0	2.0	2.0	4.0	9.0	15.0	19.0
	Large Firms	4.7	1.0	2.0	2.0	3.0	5.0	9.0	14.0
Port and	Small Firms	5.9	1.0	1.0	1.0	3.0	8.0	14.0	19.0
Custom	Large Firms	3.1	1.0	1.0	1.0	1.0	3.0	7.0	12.0

Source: Authors' calculations based on data from SUNAT.
The table reports the average and percentiles of the distribution of total and procedure-specific times (i.e., port times, preparation and storage times, and customs times) by importer type (i.e., new importers -firms that did not import before- and incumbent importers firms that imported in previous years-) for 2013. The sample corresponds to all maritime imports entering into Peru through the port of Callao.

Table 3: Border Times: Total Time and Stages in 2013, Driving Factors

	Total Border	**Port**	**Preparation and Storage**	**Custom**	**Port and Custom**
Origin	0.034	0.071	0.015	0.049	0.036
Origin + Product	0.122	0.080	0.067	0.160	0.139
Origin + Product + Importer	0.551	0.304	0.500	0.645	0.596
		Preparation and Storage			
Port Time		-0.152***	-0.169***	-0.111***	-0.132***
		(0.011)	(0.013)	(0.011)	(0.012)
		Customs Time			
Preparation and Storage Time		-0.001	-0.009	-0.005	-0.016
		(0.007)	(0.008)	(0.006)	(0.011)
Firm Fixed Effect		Yes	No	Yes	No
Product-Origin Fixed Effect		Yes	No	Yes	No
Firm-Product-Origin Fixed Effect		No	Yes	No	Yes
Day Fixed Effects		No	No	Yes	Yes

Source: Authors' calculations based on data from SUNAT.
The upper panel of the table reports the adjusted R2 of regressions of the natural logarithm of the median total time and the median procedure-specific times (i.e., port times, preparation and storage times, and customs times) at the importing firm-product-origin country-exporting firm-year level on sequential increasing sets of fixed effects: country of origin; country of origin and product; country of origin, product, and importing firm; and country of origin, product, importing firm, and exporting firm. The lower panel of the table presents the correlation between the times at consecutive border stages after conditioning according to referenced fixed. In the first regression the dependent variable is the natural logarithm of preparation and storage time and the main explanatory variable is the natural logarithm of the port time. In the second regression the dependent variable is the natural logarithm of the customs time and the main explanatory variable is the natural logarithm of the preparation and storage time. Standard errors clustered by importing firm-product-origin are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4: Aggregate Import Indicators

Year	Import Value	Number of Importers	Number of Origins	Number of Products
		All Imports		
2007	19,100	19,290	199	6,989
2008	27,900	22,542	205	6,230
2009	20,600	23,597	201	6,174
2010	28,200	25,592	203	6,233
2011	36,100	26,804	210	6,177
2012	40,200	28,799	211	6,302
2013	41,100	30,131	209	6,303
		Percentage Share Callao		
2007	72.3	64.0	86.4	92.4
2008	72.4	65.4	87.3	92.6
2009	73.8	65.7	93.0	93.0
2010	75.5	64.8	84.7	92.9
2011	76.7	65.8	84.8	93.2
2012	75.9	65.5	90.5	93.3
2013	74.7	65.6	88.5	93.2

Source: Authors' calculations based on data from SUNAT. The table reports aggregate import indicators for each year of our sample period (2007-2013). In the first panel, all imports are considered. Import values are expressed in millions of US dollars. Number of shipments is expressed in thousands. In the second panel, only maritime imports entering into Peru through the Port of Callao are considered. Specifically, this panel shows the percentage share of total Peruvian imports accounted for by these maritime imports along the dimensions that correspond to the selected indicators

Table 5: The Impact of Border Time on Firms' Imports - Baseline Specification

	Processing Time			**Total Time**		
	OLS	IV1	IV2	OLS	IV1	IV2
Time	-0.049***	-0.236***	-0.234***	-0.057***	-0.556***	-0.551***
	(0.005)	(0.011)	(0.011)	(0.005)	(0.026)	(0.026)
Trade Costs			-1.541***			-1.540***
			(0.044)			(0.044)
First Stage				**First Stage**		
Congestion		0.028***	0.028***		0.009***	0.009***
		(0.000)	(0.000)		(0.000)	(0.000)
Channel		0.651***	0.651***		0.281	0.281***
		(0.003)	(0.003)		(0.003)	(0.003)
F-Test		33593.342	33594.833		6632.774	6633.300
		[0.000]	[0.000]		[0.000]	[0.000]
Hansen		0.562	0.570		0.949	0.934
		[0.453]	[0.450]		[0.330]	[0.334]
Firm-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Origin-Product-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	589842	589842	589842	589844	589844	589844
Lower Bound Time Cost						
γ		2.977	1.541			
χ		0.079***	0.152***			
		(0.008)	(0.008)			
φ		2.072***	2.072***			
		(0.037)	(0.037)			
ϑ		0.082***	0.164***			
		(0.007)	(0.016)			
$(\underline{\lambda} - 1)$		0.013***	0.026***			
		(0.002)	(0.004)			
(Time Cost$-$1)		0.167***	0.346***			
		(0.015)	(0.036)			

Source: Authors' calculations based on data from SUNAT.
The table reports OLS and IV estimates of alternative specifications of Equation (7) along with the first stage estimates and the F-test statistics and the Hansen test statistics for the latter. The dependent variable is the change in the natural logarithm of the import value at the importing firm-product-origin-year level. In the IV estimations, the instruments are port congestion as proxied by the median number of other vessels that arrive at the port the day before that the one carrying the firm-product-origin country import in question does in a given year and the median allocation to inspection (either documentary or physical). Importing firm-year and product-origin country-year fixed effects included (not reported). Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. In the case of the lower panel (Lower Bound Time Costs), bootstrapped standard errors with 300 replications are reported. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 6: The Impact of Border Time on Firms' Imports - Robustness Checks

	Alternative Specifications					**No Express**
	(1)	(2)	(3)	(4)	(5)	(6)
Time	-0.228***	-0.189***	-0.264***	-0.224***	-0.243***	-0.241***
	(0.011)	(0.010)	(0.015)	(0.032)	(0.018)	(0.011)
First Stage						
Congestion	0.029***	0.028***	0.030***	0.029***	0.029***	0.028***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)
Channel	0.476***	0.522***	0.452***	0.398***	0.411***	0.655***
	(0.002)	(0.002)	(0.003)	(0.005)	(0.003)	(0.001)
Test Statistics						
F-Statistics	27,698.2	28,591.8	15,606.0	3,498.4	10,070.9	32,438.3
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hansen	0.466	1.878	1.786	0.049	0.369	0.420
	[0.495]	[0.171]	[0.183]	[0.825]	[0.544]	[0.517]
Fixed Effect:						
Firm-Year	Yes	No	No	No	Yes	Yes
Product-Origin-Year	No	Yes	Yes	Yes	Yes	Yes
Firm-Origin-Year	No	No	Yes	No	No	No
Firm-Product-Year	No	No	No	Yes	No	No
Firm-Product-Origin	No	No	No	No	Yes	No
Observations	685,971	685,971	685,971	685,971	685,971	566,084

Source: Authors' calculations based on data from SUNAT.
The table reports IV estimates of alternative specifications of Equation (7) along with the first stage estimates and the F-test statistics and the Hansen test statistics. The dependent variable is the change in the natural logarithm of the import value at the importing firm-product-origin -year level. The main explanatory variable is the change in the natural logarithm of the median total processing time. The instruments are port congestion as proxied by the median number of other vessels that arrive at the port the day before that the one carrying the firm-product-origin import in question does in a given year and the median allocation to inspection. Columns (1)-(5) correspond to different sets of fixed effects as indicated in the table. In Column (6) imports processed through the expressed channel are excluded. Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

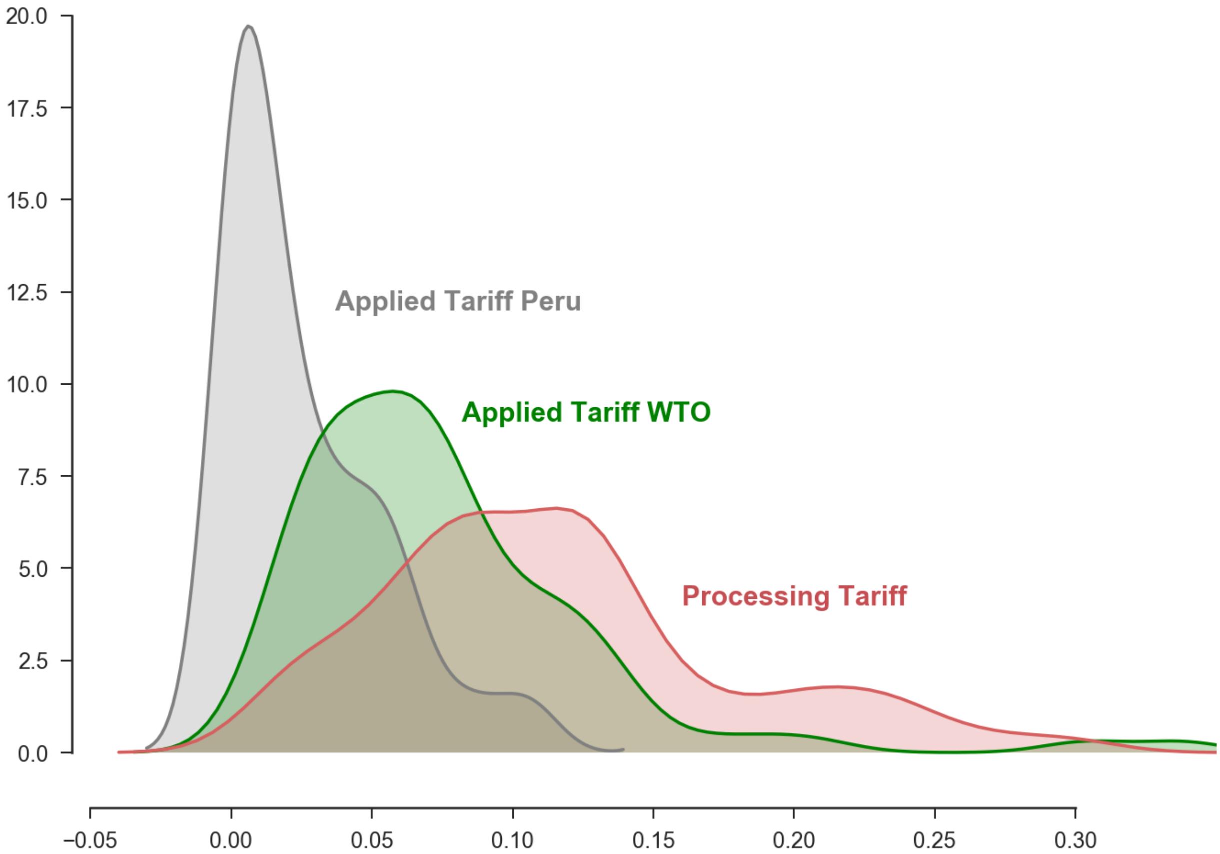
Table 7: The Impact of Border Times on Firms' Imports - Heterogeneous Effect

	Size			**Export Experience**			**Import Experience**		
	SF	LF	Diff	NEF	EF	Diff	NIF	IF	Diff
Time	-0.204***	-0.296***	***	-0.199***	-0.268***	***	-0.422***	-0.207***	***
	(0.013)	(0.026)		(0.014)	(0.019)		(0.034)	(0.012)	
Fixed Effect:									
Firm-Year	Yes	Yes		Yes	Yes		Yes	Yes	
Origin-Product-Year	Yes	Yes		Yes	Yes		Yes	Yes	
Observations	561284	561284		561284	561284		561284	561284	
Lower Bound Time Cost									
γ	2.922	3.129		2.945	3.038		2.940	2.977	
χ	0.070***	0.094***	***	0.068***	0.088***	***	0.144***	0.069***	***
	(0.005)	(0.012)		(0.006)	(0.010)		(0.016)	(0.005)	
φ	2.011***	2.128***		1.999***	2.070***		3.053***	2.037***	***
	(0.038)	(0.091)		(0.042)	(0.062)		(0.220)	(0.037)	
ϑ	0.072	0.099	**	0.070	0.092	**	0.151	0.072	***
	(0.006)	(0.014)		(0.007)	(0.012)		(0.021)	(0.006)	
$(\underline{\lambda} - 1)$	0.011***	0.015***	*	0.011***	0.014***	*	0.016***	0.011***	
	(0.001)	(0.003)		(0.002)	(0.003)		(0.006)	(0.001)	
Average Time	6.531	3.771		6.961	3.846		11.868	5.374	
(Time Cost−1)	0.153***	0.150***		0.153***	0.142***		0.449***	0.136***	***
	(0.014)	(0.024)		(0.015)	(0.020)		(0.071)	(0.013)	

Source: Authors' calculations based on data from SUNAT.
The table reports IV estimates of variants of Equation (7) that allows for different effects across types of firms: small firms (SF, with up to 200 employees) and large firms (LF, with more than 200 employees); exporting firms (EF) and non-exporting firm (NEF); for new importers (NIF, firms that never imported before) and incumbent importers (IF, firms that imported before). Importing firm-year and product-origin country-year fixed effects included (not reported). The columns Diff report the significance of the difference in the estimates across types of firms. Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. In the case of the lower panel (Lower Bound Time Costs), bootstrapped standard errors with 300 replications are reported. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

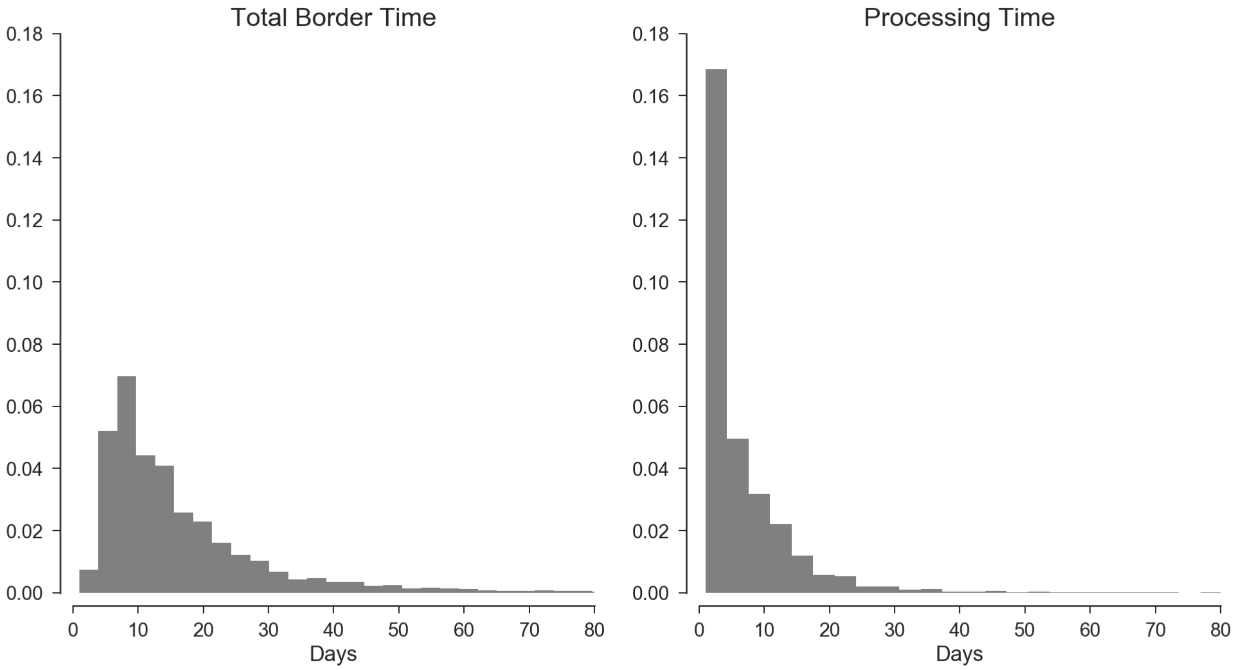
8. Figures

Figure 1: Advalorem Time Costs and Tariff Costs



Source: Authors calculations based on data from SUNAT.

Figure 2: Border Times: Distributions, 2013



Source: Authors calculations based on data from SUNAT. The figures are histograms that show the distribution of the total and processing times. Data corresponds to the year 2013.

9. Appendix

9.1. General Time Distribution

Let x be a random variable with p.d.f. $f_x(x)$. Then, the transformation $y = x + m$ has the p.d.f. $f_y(y) = f_x(y - m)$ and mean $\mu_x + m$. Suppose that y is the time it takes to clear the port. Then the expected clearance time is $\mu_x + m = \int y f_y(y)dy = \int y f_x(y - m)dy = \int (x + m) f_x(x)dx$. Therefore, we can write the expected cost of clearing the port as:

$$\int_{t_c}^{\infty} \left(\frac{y}{t_c}\right)^{\omega} rvf_y(y)dy + t_c^{\vartheta}v = \int_{t_c-m}^{\infty} \left(\frac{x+m}{t_c}\right)^{\omega} rvf_x(x)dx + t_c^{\vartheta}v \tag{8}$$

The objective is to find the cost minimizing t_c. The first order conditions is:

$$-\int_{t_c-m}^{\infty} t_c^{-\omega-1}(x+m)^{\omega}\omega rvf_x(x)dx - rvf(t_c - m) + t_c^{\vartheta}v = 0 \tag{9}$$

By the implicit function theorem we obtain

$$\frac{dt_c}{dm} = -\frac{\frac{\partial FOC}{\partial m}}{\frac{\partial FOC}{\partial t_c}} \tag{10}$$

By inspection of the first order condition we see that the first order condition decreases in m if $f_x' < 0$. This is true if the density for example is pareto or exponential. In optimum the second order condition must be positive. Therefore, as long as the distributional assumption and solution of the problem meet $f'(x) < 0$, then the opimtially scheduled clearance time increases in the mean processing time, m.

From a more general point of view we need a p.d.f. that guarantees that the marginal cost savings from increasing the buffer time diminish relative to the costs of scheduling additional lead time. An equilibrium exists and provides an minimizer with any p.d.f. where this is true. Therefore, the model applies across countries and import processes and many probability densities.

By the envelope theorem we obtain that an increase in the mean clearance time due to an increase in m raises the expected cost of clearing the port, because an increase in m raises $\left(\frac{x+m}{t_c}\right)^{\omega}$. Changes working through the optimal clearance time can be ignored according to the envelope theorem.

Next, suppose that Peruvian importers place orders according to a Poisson distribution. Then, because across importers, products and source countries, firms choose a different optimal arrival time for their shipment. Therefore, on any arrival date, shipments arrive that were placed on different order dates. However, because the Poisson distribution is additive, the sum of random orders place on different dates is again Poisson distributed. Therefore, the arrival rate of shipments at the port is Poisson. The queueing literature shows that if that arrival distribution is Poisson, and the processing distribution is exponential, then this leads to an exponential wait time and sojourn distribution.

This approach extends to all stages of the import process in the supply chain. As we add more steps in the import process, the mean processing time increases and the variance may be affected. All of these stages add to the random variable y with some general distribution function.

9.2. Back of Envelope $\hat{\lambda}$

Note that the optimal time a firm schedules for entry is

$$t^* = \left(-\frac{\vartheta\ (\omega - \varphi)}{r\varphi^2}\left(\frac{t_{median}}{2^{\varphi^{-1}}}\right)^{-\varphi}\right)^{-(\varphi+\vartheta)^{-1}} \tag{11}$$

To be conservative, suppose that firm schedule one additional day of buffer time. Then set $t_{median} = 4$ to evaluate at the median and $t_p = 5$ to allow for a day of buffer time. Let $\omega = 1$ to linearize and substituting our estimates $\vartheta = 0.082$, $\varphi = 2.07$, $\omega = 1$ and solving we obtain $r = 0.037$. Substituting all values into λ we obtain $\hat{\lambda} = 1.06$. Following similar steps with $\vartheta = 0.16$ we obtain $r = 0.082$ and $\hat{\lambda} = 1.13$.

In addition we can obtain λ based on outside information. Examples we found say that firms charge 5 percent of the value of shipment for every week of late arrival. The late fee in our model is $\left(\frac{t_p}{t_c}\right)^{\omega} rv$. To linearize let $\omega = 1$. Then, evaluating this at the average total processing time of about 6.5 days, and assuming that processing is one work week late we obtain $\left(\frac{11.5}{6.5}\right) rv = 0.05v$. Solving we obtain $r \approx 0.03$. As we exected, this level of r is smaller because it only includes late fees and does not incude reputation effects etc. Substituting our estimates into λ and applying $r = 0.03$ we obtain $\hat{\lambda} = 1.03$.

10. Appendix - Not for Publication

Table 8: Average Importer

Year	Import Value	Number of Origins	Number of Products	Number of Employees	Age
Callao					
2007	623.5	3.1	14.2	63.6	7.4
2008	785.1	3.0	13.2	60.4	7.4
2009	618.9	2.9	12.5	58.4	7.6
2010	660.8	2.9	12.7	58.1	7.7
2011	715.1	2.9	12.8	63.2	7.9
2012	700.5	2.9	12.8	64.8	8.0
2013	653.9	2.8	12.4	65.4	8.3
All Imports					
Year	**Import Value**	**Number of Origins**	**Number of Products**	**Number of Employees**	**Age**
2007	764.8	3.5	16.2	52.2	7.0
2008	1,009.3	3.3	14.8	48.4	7.0
2009	722.3	3.2	14.0	47.6	7.2
2010	904.8	3.2	14.2	47.8	7.3
2011	1,036.5	3.2	14.5	52.2	7.4
2012	1,057.4	3.2	14.4	52.2	7.5
2013	1,011.3	3.1	14.0	52.3	7.7
Excluding Minerals and Metals and Air-Shipped Import					
Year	**Import Value**	**Number of Origins**	**Number of Products**	**Number of Employees**	**Age**
2007	718.5	2.8	12.2	65.6	8.3
2008	657.1	3.1	14.1	63.6	7.4
2009	814.5	3.0	13.1	60.5	7.4
2010	629.2	2.9	12.5	57.8	7.6
2011	723.6	2.9	12.6	58.1	7.7
2012	796.3	2.8	12.6	63.2	7.9
2013	792.4	2.8	12.6	64.8	8.0

Source: Authors' calculations based on data from SUNAT. The table reports average import indicator for firms importing by sea through the Port of Callao, for all importers, and for firms that do not import minerals or metals or by air. Import values are expressed in thousands of US dollars. Markets correspond to product-origin combinations

Table 9: The Impact of Border Time on Firms' Imports - Alternative Clustering

	OLS	IV						
		Congest	**Channel**	**F-Stat**		**Hansen**		**IV**
Port and Customs Time	-0.049	0.029	0.469					-0.240
Clustered at:								
Firm-Product-Origin	(0.005)***	(0.000)***	(0.003)***	20,483.0	[0.000]	0.843	[0.359]	(0.013)***
Product	(0.004)***	(0.000)***	(0.005)***	9,765.0	[0.000]	0.696	[0.404]	(0.012)***
Product (HS2)	(0.006)***	(0.000)***	(0.013)***	6,319.0	[0.000]	0.429	[0.512]	(0.015)***
Origin	(0.004)***	(0.001)***	(0.023)***	4,130.0	[0.000]	1.659	[0.198]	(0.028)***
Firm	(0.006)***	(0.001)***	(0.007)***	2,963.0	[0.000]	0.601	[0.438]	(0.016)***
Product Origin	(0.004)***	(0.001)***	(0.023)***	3,857.0	[0.000]	1.307	[0.253]	(0.028)***
Product (HS2)	(0.005)***	(0.001)***	(0.025)***	6,836.0	[0.000]	0.560	[0.454]	(0.029)***
Firm Product	(0.005)***	(0.001)***	(0.007)***	2,838.0	[0.000]	0.526	[0.468]	(0.015)***
Firm Product (HS2)	(0.006)***	(0.001)***	(0.013)***	2,082.0	[0.000]	0.381	[0.537]	(0.017)***
Firm Origin	(0.004)***	(0.001)***	(0.022)***	2,270.0	[0.000]	1.388	[0.239]	(0.028)***
Firm Product Origin	(0.005)***	(0.001)***	(0.007)***	3,191.0	[0.000]	0.571	[0.450]	(0.016)***
Firm Product (HS2) Origin	(0.005)***	(0.001)***	(0.010)***	2,139.0	[0.000]	0.672	[0.412]	(0.017)***
Fixed Effects:								
Firm-Year	Yes	Yes						Yes
Product-Origin-Year	Yes	Yes						Yes
Observations	685,000	685,000						685,000

Source: Authors' calculations based on data from SUNAT.
The table reports OLS and IV estimates of alternative specifications of Equation (12) (Columns 1 and 6, respectively) along with the first stage estimates (Columns 2 and 3) and the F-test statistics and the Hansen test statistics (Columns 4 and 5) for the latter. The dependent variable is the change in the natural logarithm of the import value at the importing firm-product-origin country-year level. In the first panel the main explanatory variable is the change in the natural logarithm of the median total time, while in the second panel the main explanatory variable is the change in the natural logarithm of the median port and customs time. In the IV estimations, the instruments are port congestion as proxied by the median number of other vessels that arrive at the port the same date that the one carrying the firm-product-origin country import in question does in a given year and the median allocation to inspection (either documentary or physical as required in the orange and red channels, respectively). Importing firm-year and product-origin country-year fixed effects included (not reported). Standard errors clustered at alternative levels are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. The significance indicator is presented along with the respective standard errors.

Table 10: The Impact of Border Time on Firms' Imports - Alternative Instrument Definitions

	IV				
	Congest	**Channel**	**F-Stat**	**Hansen**	**IV**
Port and Customs Time					
Port Congestion - Window: 1 Day	0.029***	0.469***	20,483	0.843	-0.240***
	(0.000)	(0.003)	[0.000]	[0.359]	(0.013)
Port Congestion - Window: 2 Days	0.033***	0.469***	20,595	1.275	-0.239***
	(0.000)	(0.003)	[0.000]	[0.259]	(0.013)
Port Congestion - Window: 3 Days	0.035***	0.469***	20,416	0.746	-0.240***
	(0.000)	(0.003)	[0.000]	[0.388]	(0.013)
Port Congestion - Window: 4 Days	0.037***	0.469***	20,432	1.162	-0.239***
	(0.001)	(0.003)	[0.000]	[0.281]	(0.013)
Port Congestion - Window: 5 Days	0.038***	0.469***	20,236	0.484	-0.241***
	(0.001)	(0.003)	[0.000]	[0.487]	(0.013)
Firm-Year Fixed Effect	Yes				Yes
Product-Origin-Year Fixed Effect	Yes				Yes
Observations	685,000				685,000

Source: Authors' calculations based on data from SUNAT.
The table reports IV estimates of alternative specifications of Equation (12) along with the first stage estimates (Columns 2 and 3) and the F-test statistics and the Hansen test statistics (Columns 4 and 5). The dependent variable is the change in the natural logarithm of the import value at the importing firm-product-origin country-year level. In the first panel the main explanatory variable is the change in the natural logarithm of the median total time, while in the second panel the main explanatory variable is the change in the natural logarithm of the median port and customs time. In the IV estimations, the first instrument is port congestion as proxied by the median number of other vessels that arrive at the port the same date that the one carrying the firm-product-origin country import in question does in a given year (Rows 1 and 6); the average of that date and the previous one (Rows 2 and 7), the average of that date and the two previous ones (Rows 3 and 8), the average of that date and the three previous ones (Rows 4 and 9), and the average of that date and the four previous ones (Rows 5 and 10). The second instrument is the median allocation to inspection (either documentary or physical as required in the orange and red channels, respectively). Importing firm-year and product-origin country-year fixed effects included (not reported). Standard errors clustered at alternative levels are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. The significance indicator is presented along with the respective standard errors.

Table 11: The Impact of Border Times on Firms' Imports - Alternative Specifications

	IV						
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Time	-0.184***	-0.180***	-0.167***	-0.187***	-0.156***	-0.174***	-0.153***
	(0.009)	(0.008)	(0.008)	(0.010)	(0.013)	(0.010)	(0.012)
First Stage							
Congestion	0.030***	0.030***	0.030***	0.030***	0.031***	0.030***	0.031***
	(0.0003)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0003)	(0.0004)
Channel	0.682***	0.680***	0.681***	0.685***	0.682***	0.677***	0.690***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.003)
Test Statistics							
F-Statistics	26726	31519	31207	23499	15917	19917	13088
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hansen	1.873	2.324	0.453	1.161	0.00552	0.939	1.741
	[0.171]	[0.127]	[0.501]	[0.281]	[0.941]	[0.333]	[0.187]
Fixed Effects:							
Firm-Year	Yes	Yes	No	No	No	Yes	No
Origin-Product-Year	Yes	No	Yes	Yes	Yes	Yes	Yes
Carrier-Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Exporter-Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Origin-Year	No	No	No	Yes	No	No	No
Firm-Product-Year	No	No	No	No	Yes	No	No
Firm-Origin-Product	No	No	No	No	No	Yes	No
Firm-Origin-Product-Year	No	No	No	No	No	No	Yes
Exporting Firm-Year	No	No	No	No	No	No	Yes
Observations	685,971	685,971	685,971	685,971	685,971	685,971	685,971
Lower Bound Time Cost							
χ	0.063	0.062	0.057	0.064	0.054	0.060	0.053
ϑ	0.065	0.064	0.059	0.066	0.055	0.062	0.054
$\underline{\lambda} - 1$	0.010	0.010	0.009	0.010	0.008	0.009	0.008
Time Cost -1	0.118	0.115	0.107	0.120	0.099	0.111	0.097

Source: Authors' calculations based on data from SUNAT.

The table reports IV estimates of variants of Equation (7). Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 12: The Impact of Border Time on Firms' Imports - Alternative Samples

	No Express Channel		**No Permits**		**No Light Permits**	
	IV1	IV2	IV1	IV2	IV1	IV2
Time	-0.241***	-0.238***	-0.237***	-0.237***	-0.252***	-0.248***
	(0.011)	(0.011)	(0.012)	(0.012)	(0.019)	(0.019)
Trade Costs		-1.522		-1.695		-1.443***
		(0.044)		(0.057)		(0.061)
First Stage						
Congestion	0.028***	0.028***	0.028***	0.028***	0.028***	0.028***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
Channel	0.655***	0.655***	0.643***	0.643***	0.655***	0.655***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)	(0.005)
F-Test	32438.756	32440.354	27666.986	27667.462	10630.209	10629.657
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Hansen	0.420	0.417	0.135	0.307	0.000	0.011
	[0.517]	[0.518]	[0.713]	[0.579]	[0.992]	[0.917]
Firm-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Country-Product-Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Number of observations	566082	566082	493384	493384	206973	206973
Lower Bound Time Cost						
γ	2.962	1.522	2.766	1.695	3.137	1.443
χ	0.081***	0.157***	0.086***	0.140***	0.080***	0.172***
	(0.004)	(0.008)	(0.004)	(0.008)	(0.006)	(0.015)
φ	2.140***	2.140***	2.144***	2.144***	2.081***	2.081***
	(0.037)	(0.037)	(0.042)	(0.042)	(0.035)	(0.035)
ϑ	0.085	0.169	0.089	0.150	0.084	0.187
$\underline{\lambda}$	1.012	1.026	1.013	1.022	1.013	1.029
Time Cost	1.171	1.358	1.181	1.314	1.170	1.401

Source: Authors' calculations based on data from SUNAT.
The table reports IV estimates of alternative specifications of Equation (7) along with the first stage estimates and the F-test statistics and the Hansen test statistics for the latter. The dependent variable is the change in the natural logarithm of the import value at the importing firm-product-origin country-year level. In the first panel, imports processed through the expressed channel are excluded. In the second panel, imports involving product subject to permits are removed. In the third panel, imports of light products (i.e., products with weight-to-value ratios are up to the median of their distribution across products as computed from worldwide data from COMTRADE). Importing firm-year and product-origin country-year fixed effects included (not reported). Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level

Table 13: The Impact of Border Times on Firms' Imports - Heterogeneous Effect

	Size			**Export Experience**			**Import Experience**		
	SF	LF	Diff	NEF	EF	Diff	NIF	IF	Diff
Time	-0.202***	-0.295***	0.093***	-0.197***	-0.269***	0.071***	-0.426***	-0.205***	-0.220***
	(0.013)	(0.025)	(0.028)	(0.014)	(0.019)	(0.023)	(0.034)	(0.012)	(0.035)
Trade Costs	-1.744***	-1.729***	-0.015	-1.591***	-2.012***	0.421***	-1.550***	-1.777***	0.227**
	(0.051)	(0.105)	(0.117)	(0.049)	(0.097)	(0.101)	(0.094)	(0.055)	(0.107)
Fixed Effect:									
Firm-Year	Yes	Yes		Yes	Yes		Yes	Yes	
Origin-Product-Year	Yes	Yes		Yes	Yes		Yes	Yes	
Observations	561284	561284		561284	561284		561284	561284	
Lower Bound Time Cost									
γ	1.744	1.729	0.015	1.591	2.012	0.421	1.550	1.777	0.227
χ	0.116***	0.171***	-0.055***	0.124***	0.133***	-0.009	0.275***	0.115***	0.159***
	(0.008)	(0.018)	(0.020)	(0.010)	(0.011)	(0.014)	(0.027)	(0.008)	(0.028)
φ	2.011***	2.128***	-0.117	1.999***	2.070***	-0.071	3.053***	2.037***	1.017***
	(0.038)	(0.091)	(0.099)	(0.042)	(0.062)	(0.075)	(0.220)	(0.037)	(0.223)
ϑ	0.110	0.157		0.117	0.125		0.252	0.111	
$\underline{\lambda} - 1$	0.017	0.024		0.019	0.019		0.027	0.017	
Average Time	6.531	3.771		6.961	3.846		10.868	5.374	
(Time Cost$-$1)	0.265	0.285		0.296	0.220		2.025	0.235	

Source: Authors' calculations based on data from SUNAT.

The table reports IV estimates of variants of Equation (7) that allows for different effects across types of firms (first panel): small firms (SF, with up to 200 employees) and large firms (LF, with more than 200 employees) (Columns 1 and 2); exporting firms (EF) and non-exporting firm (NEF) (Columns 3 and 4); for new importers (NIF, firms that never imported before) and incumbent importers (FF, firms that imported before) Importing firm-year and product-origin country-year fixed effects included (not reported). Standard errors clustered by importing firm are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level