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The Heterogeneous Costs of Port-of-Entry Delays

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Abstract

Time delays in international transactions impose trade costs. We examine transaction level Peruvian import data to show that firms are subject to significant costs of port-of-entry delays. At the airport an additional day of delay raises costs by about 1.6 percent for all firms. At the seaport, an additional day of delay raises costs for small firms by about 0.7 percent and by 0.9 percent for large firms. The higher costs at the airport are partially offset by a clearance time that is on average about 5 days faster than at the seaport. These estimates inform policy where limited public resources realize the highest bang for the buck to mitigate trade costs. We also find that median delays are heterogeneous across importers and importer-exporter relationships. Therefore, firm specific trade facilitation that improves shipment and document handling to reduce delays is an alternative to policy action that reduces average delays.

Keywords: Trade Costs, Port Efficiency, Trade Facilitation
JEL Codes: F1

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Introduction

Imports from foreign countries that arrive at their destination port must be unloaded, moved to customs, inspected, cleared and finally picked up by the importer. These procedures take time and long delays impose a cost. Lengthy clearance times raise inventory and financing costs, impact a firm's ability to respond to market fluctuations and make it more difficult to plan. We use detailed transaction-level data of Peruvian imports including the date of unloading, the date of arrival at customs and the custom's clearance date to quantify the cost of port-of-entry delays.

Peruvian firms import products from foreign markets and hire domestic inputs to supply the domestic market. Total trade costs consist of two parts, observable transportation costs and unobservable costs related to observable delays at the port of entry. An additional day of delay raises trade costs. The importer's demand elasticity translates this cost increase into a reduced demand. In theory, the importer's demand elasticity with respect to transportation costs depends on the intensity of domestic inputs versus foreign products that a firm employs to supply the domestic market. Based on this theory we derive a firm-level empirical model that identifies unobserved costs of delay and allows demand elasticities to vary across different types of firms.

Peruvian transaction level data for 2011 from Peru's tax agency SUNAT provide rich variation to examine the impact of port-of-arrival delays on imports. We estimate the impact of the median delay at the importer-exporter-product level on annual import values. If importers make purchasing decisions based on their experience about delays and the median delay reflects this information, then we expect that an increase in the median delay lowers import values.[1]

[1] There are many ways to generate an expectation for the port of entry delay. The median is easy to implement, interpretable and robust with respect to outliers. We observe thousands of importer-exporter-product combinations and the question of how these importers use past information about delays is a research topic in itself. We will experiment with variations on this assumption in the future.

Observing detailed firm-level information on delays and imports has several identification advantages. We directly account for unobserved firm level heterogeneity such as productivity differences and exporter-by-product quality variation in addition to observed transportation costs, tariffs and unit values. This solves unobserved variable bias due to productivity differences and aggregation issues due to firm level heterogeneity present in aggregate data.

We find that longer median delays at the port of entry reduce trade. Pooled over the whole sample, an additional day of delay raises ad valorem trade costs by about .9 percent. We find heterogeneity in these costs across ports. At the seaport the costs are similar to the pooled estimate. At the airport, the cost of an additional day of delay increases to about 1.6 percent. At the airport the impact of an additional day of delay is similar for small and large firms. At the seaport the impact of an additional day of delay on trade costs is about 30 percent higher in magnitude for large firms. This suggest that firms using the airport and large firms using the seaport have highly fine tuned supply chains that are especially sensitive to port of entry delays.

These estimates help to sharpen trade policy. Heterogeneity across firms in the costs of delay suggest that there is room for trade promotion at the firm level to reduce these costs and lower delays possibly due to shipment and document handling by the exporter and importer. Across all firms the estimates identify the benefits of port and customs infrastructure that will lower delays for all importers. This detailed information allows policy makers to maximize bang for the buck of trade facilitation when policy action is constrained by limited resources. This information is not identifiable from aggregate delays or import data.

Our estimates are comparable to time cost estimates based on U.S. data (Hummels and Schaur, 2013) and they relate to a growing literature that examines trade costs driven by time (Evans and Harrigan, 2010; Djankov et al, 2010). We provide cost estimates of port-of-entry procedures that are directly subject to import policy and investment into infrastructure. We provide cost estimates for a small developing economy where reducing trade costs to raise international integration is often considered an important engine of growth. Our estimates are applicable to similar small economies and we can compare our estimates to existing estimates driven by United States data to learn if those estimates are applicable across countries.

Our work relates broadly to a literature that identifies trade costs (Hummels, 2007; Anderson and Neary, 2005; Anderson and Yotov, 2008; ; Jacks, Meissner and Novy, 2008), but especially with respect to frictions related to crossing borders (Anderson and van Wincoop 2003; McCallum, 1995). The advantage of our dataset is that instead of estimating a catch all border effect, we can examine the impact of detailed port-of-entry procedures. Blonigen and Wilson (2006) develop a method to examine port efficiency and a growing literature examines the impact of customs procedures on international trade.[2] Volpe, Carballo and Graziano (2013) examine the impact of customs procedures with Uruguayan firm level data. Our model separates import demand elasticities from the trade cost elasticity with respect to port of entry delays. In addition, our data provide information on all port-of-entry procedures including unloading from the vessel and customs inspections resulting in more comprehensive trade cost estimates.

In the next section we give some background about Peru to put our estimates in context. We then develop a model that will guide our empirical approach and help interpret the coefficient estimates. In the empirical section we discuss the data, identification problems and summarize the estimation results. Finally we conclude with a

[2] On aggregate bilateral trade (e.g., Djankov et al., 2010; Freund and Rocha, 2011; and Hornok, 2011), sectoral bilateral trade (e.g., Martínez-Zarzoso and Márquez-Ramos, 2008; Bourdet and Persson, 2010; and Zaki, 2010), the product extensive margin (e.g., Persson, 2010), the destination extensive margin (e.g., Nordas, 2006), and the frequency and size of shipments (Hornok and Koren, 2011) firm-level trade (Dollar et al., 2006; Yoshino, 2008)

short discussion about the policy relevance of our estimates and how future work can sharpen these conclusions.

Background

This section explains why Peru is a good country to examine the impact of customs procedures in developing countries and shows detailed descriptive statistics that identify the source of variation in median entry delays. Identifying the source of variation in entry delays is important to understand at what level policy needs to operate to reduce these costs.

Peru is a small open developing economy. In purchasing power parity, Peru's GDP is $332 billion based on 2012 estimates which ranks Peru number 40 in the World. GDP per capita is $10,900 in PPP units and ranks Peru at 111. Of Peru's 29.9 mil people 77 percent are considered urban with about 8.8 mil people or 38 percent of the urban population concentrated in Lima. Of the 16.2 million labor force participants, .7 percent are employed in agriculture, 23.8 percent in industry and 75.5 percent in services.[3]

Peru is in trade agreements with major trading economies such as the U.S., the European Free Trade Association and China. The United Nation's trade profile shows an increase of Peruvian imports by an average of 16.7 percent per year to 37.7 bln US$ from 2007 to 2011. The import composition is machinery and transport equipment (34.7 percent), manufactured goods chiefly classified by materials (15.8 percent) and mineral fuels, lubricants and related materials (15.7 percent) and other products. In 2011, 15 major trade partners accounted for 80 percent of Peru's imports.[4] This is consistent with our data.

[3]CIA Factbook.
[4]http://data.un.org/CountryProfile.aspx?crName=PERU

Digging deeper into the data we find that Peruvian importers use 21 customs offices, but the average firm uses only 1.03 customs offices and does not use multiple ports of entry in response to long queues at customs, port back congestion or other delays. In addition, Peruvian importers purchase a given HS10 product from an average of 1.43 exporters overall and 1.279 exporters within a given country of origin. The median number of exporters is 1 and less than 2 up to the 90th percentile. At the 99th percentile firms use about 3 exporters within origins and 4.6 across all origins. In summary, most products are imported through one port of entry by a given importer using one exporter. The air and ocean ports of entry at Callao/Lima account for about 95 percent of these transactions and 88 percent of Peru's import value. Fort the remainder we focus on Callao/Lima, because the import delay information we observe is limited to those two ports of entry.

This import pattern has several advantages for identification. The concentration of business activity around Lima mitigates concerns that heterogeneity in inland transportation costs impact the results. The sourcing pattern suggests that firms are not using various importers to hedge against uncertainty. Therefore, we develop a simple model of import demand to interpret our estimates.

Peru is small and most importers are relatively small. Table 1 shows the firms size distribution by number of imported products and origins of imports. Comparing the numbers to Bernard et al (2005), across most categories Peruvian firms are less than a quarter of the size of U.S. firms. However, on average the value of the imports per worker is on average greater than that of U.S. firms. This suggests that Peruvian importers are much smaller than U.S. firms but they source a higher value of inputs per worker.

After unloading from the ship or airplane and possible holding delays in shipyards, the shipments are moved to customs. Shipments are "randomly" allocated to document inspection (orange channel) and document and physical inspection (red channel) conditional on firms and product-origins (risk-based procedure). We define port-of-entry delay as the difference between the clearance date of the shipment at customs and the date of unloading from the vessel. Table 2 shows that the average delay from unloading to clearance at customs is about 8.5 days. This compares to the duration reported by the Doing Business data reported by the World Bank, which reports a customs clearance and technical control duration of about 3 days and Ports and terminal handling duration of 5 days.[5] In addition, Table 2 also shows a significant amount of heterogeneity. At the seaport, the average delay of about 10 days is about twice as high as the delay at the airport. Measuring firm size by total imports, the data shows that for large firms delays are on average about 4 days shorter at the mean and 3 days shorter at the median. Based on these unconditional averages and existing estimates in the literature, if going through the airport saves 5 days and being large saves another 4, then large firms that clear at airports save a tariff equivalent of 9 percent compared to small firms that clear at the seaport. For individual firms the disadvantages from long delays are even more severe, noting that at the extreme small firms can experience delays of 37 days.

What is driving the variation in these port of entry delays? Take the median entry delay over all shipments for each importer-product-exporter combination. Then regress the median delay on country fixed effects. Next augment the specification with port of entry effects, product effects and importer effects.[6] Based on R^2 measures Table 3 shows that country of origin effects explain only about 4 percent of the variation in median port of entry delays. Port of entry fixed effects explain an additional 3 percentage points as delays at the seaport are significantly greater. Prod-

[5] http://www.doingbusiness.org/data/exploreeconomies/peru/#trading-across-borders. The World Bank also reports Documents Preparation of 7 days and Inland transportation and handling of 2 days.

[6] Limiting the sample to only those firm-product-port-origin combinations with more than 1 observation does not impact these statistics.

uct information explains another 4-5 percentage points of variation. The majority of variation is explained by adding importer effects for about an additional 50 percentage points of variation. This suggests that aside from infrastructure investments and policies that shorten average entry delays, policy action on the importer side such as explaining forms and entry procedures to firms with longest delays may be an effective policy action.

Theory

This section develops a model for the import demand of Peruvian firms. The descriptive statistics show that Peruvian firms tend to import a given product from a given exporter clearing a given port of entry. With this in mind we consider the Peruvian firm a downstream monopolist that purchases a product from a foreign upstream exporter to supply the domestic market.

Let $p_i = Eq_i^{-1/\sigma}$ be the demand importer i faces on the domestic market, where p_i denotes the price, q_i denotes quantity, E is a demand shifter and $\sigma > 1$ determines the elasticity of substitution. To simplify notation we suppress exporter and product subscripts but will reintroduce them later when necessary.

Importer i imports quantity M_i of the foreign product and L_i units of the domestic input to produce and sell $q_i = \alpha_i M_i^{\beta_i} L^{1-\beta_1}$ on the domestic market. Let w be the price of the domestic input hired from a competitive market, let m_i be the FOB price for the imported input and let t_i denote ad valorem transport costs. The downstream firm's objective is to maximize profits

$$\underset{M_i, L_i}{max} \left[\left(a_i M_i^{\beta_i} L_i^{1-\beta_i} \right)^{1-1/\sigma} - t_i m_i M_i - w L_i \right] \tag{1}$$

with the optimal import demand

$$
\begin{aligned}
M_i^* &= \frac{w^{(\sigma-1)(-1+\beta_i)}\sigma^{-\sigma}\left(\sigma-1\right)^{\sigma}\left(\left(1-\beta_i\right)^{-1}\right)^{\sigma\,\beta_i-\beta_i-\sigma}{t_i}^{-\sigma\,\beta_i+\beta_i-1}{\beta_i}^{\sigma\,\beta_i-\beta_i+1}{m_i}^{-\sigma\,\beta_i+\beta_i-1}{a_i}^{\sigma-1}}{1-\beta_i} \\
&= K_i w^{(\sigma-1)(-1+\beta_i)}(t_i m_i)^{-\sigma\,\beta_i+\beta_i-1} \\
&= K_i w^{-\sigma+\rho_i}(t_i m_i)^{-\rho_i} \qquad (2)
\end{aligned}
$$

where $K_i = \frac{\sigma^{-\sigma}(\sigma-1)^{\sigma}\left((1-\beta_i)^{-1}\right)^{\sigma\,\beta_i-\beta_i-\sigma}{\beta_i}^{\sigma\,\beta_i-\beta_i+1}a^{\sigma-1}}{1-\beta_i}$, $-\sigma+\rho_i<0$ and $\rho_i>1$.

An increase in the price of the imported input lowers the demand for the input. The elasticity of demand with respect to the import price is determined by the factor intensity β_i and the demand elasticity for the final product σ. The factor intensity β_i translates the increase in the import price into a cost increase. This leads importers to raise the price of their final product. The consumer's demand elasticity σ then determines the magnitude of the price increase and corresponding drop in the quantity produced and purchased.

A greater imported input intensity increases the importer's demand elasticity with respect to the import price because $\partial\rho_i/\partial\beta_1>0$. The elasticity of the marginal cost of production with respect to a change in the import price increases in the imported input intensity.[7] Therefore, a percentage change in the import price results in a greater percentage increase in the marginal cost of production which translates into a percentage decrease in demand according to σ.[8]

Multiply the import demand M_i^* with the FOB price of the intermediate input to obtain the FOB expenditure on imported inputs by firm i

$$v_i(m_i) = K_i w_i^{-\sigma+\rho_i} t_i^{-\rho_i} m_i^{1-\rho_i}. \qquad (3)$$

[7]The Cobb-Douglas cost in our setup is $c=\beta^{-\beta}(1-\beta)^{\beta-1}m^{\beta}w^{1-\beta}q$ (see for example Varian (1992) page 55). The elasticity of the marginal cost w.r.t. to m equals β.

[8]The firm's domestic input demand is $L_i^* = \left({a_i}^{-1}\right)^{-\sigma}\left(-\frac{w\sigma}{(\sigma-1)(-1+\beta_i)}\right)^{\sigma\,\beta_i-\beta_i-\sigma}\left(\frac{t_i m_i\sigma}{\beta_i\,(\sigma-1)}\right)^{-\beta_i\,(\sigma-1)}{a_i}^{-1}$.

Let c_j be the upstream firm's constant marginal cost of production. With perfect competition in the export market, the optimal price equals marginal costs such that the price importer i pays exporter j is $m_{ij} = c_j$. On the other extreme, suppose that the upstream firm is a monopolist. Knowing the importer's expenditure the upstream exporter sets the price to maximize profits

$$\underset{m_{ij}}{max} \left[K_i w^{-\sigma+\rho_i} (t_i m_i)^{-\rho_i} m_{ij} - c_j K_i w^{-\sigma+\rho_i} (t_i m_i)^{-\rho_i} \right]. \tag{4}$$

The profit maximizing price is $m_{ij} = \frac{c\rho_i}{\rho_i - 1}$. This is constant markup over marginal cost because exporter faces a constant elasticity import demand from the downstream importer.[9]

To derive the empirical model we next specify the transportation costs and introduce notation to distinguish the dimensions of variation in the variables. To import product k from exporter j in year t importer i pays the trade cost

$$t_{ijkt} = exp(\delta Delay_{ijkt}) \tau_{ijkt}. \tag{5}$$

τ_{ijkt} is the ad valorem transport cost and $exp(\delta Delay_{ijkt})$ captures additional costs because of port of entry procedures. For a one percent increase in the ad valorem transport cost, trade costs increase by 1 percent. If there are no delays at the port of entry, then $Delay_{ijkt} = 0$ and $exp(\delta Delay_{ijkt}) = 1$. In this case, transportation costs determine the variation in trade costs.

For a given transport cost τ_{ijkt}, a day of delay raises trade costs by $(exp(a) - 1) \times 100$

[9] Note that we have not modeled how the importer chooses the optimal exporters. A standard way to solve this issue is to assume a CES production function such that importer are subject to the usual love of variety and demand a little bit of everything. Given our summary statistics this is not consistent with the data. An alternative is to approach the selection as a discrete choice problem. In this set up firm's choose the profit maximizing exporter based on observable characteristics and an unobserved shock. One can think of this shock as an unobserved match quality. Under type 2 extreme value distributions this results in the standard logit model. Feenstra (2004) shows how one can use this setup to derive a constant elasticity demand model similar to our setup.

percent. To simplify the interpretation linearize the cost of delay and evaluate the costs at a delay of zero to obtain $exp(\delta Delay_{ijkt}) \approx 1 + \delta Delay_{ijkt}$. Each day of delay is then approximately equal to a tariff or ad valorem trade cost of $(\delta \times 100)$ percent.

Substituting the trade costs (5) into the importers expenditures (3), taking logs and adding classical regression error u_{ijkt} we obtain the estimation equation

$$ln(v_{ijkt}) = ln(K_i w_i^{-\sigma+\rho_i}) - \rho_i \delta Delay_{ijkt} - \rho_i ln(\tau_{ijkt}) + (1-\rho_i) ln(m_{ijkt}) + u_{ijkt}. \quad (6)$$

ρ_i determines how responsive firms are with respect to increases in costs. Once we have an estimate for this elasticity, we can split the import response with respect to an increase in delays into two parts. The impact of the delay on trade costs determined by δ and the impact of the change in trade costs on imports determined by ρ_i. Letting elasticities vary in theory makes explicit the constraints the regression model imposes in specific subsamples of the data. The elasticity ρ_i depends on potentially firm specific factor intensities. Therefore, when comparing various subsamples of firms, we do not just simply compare them based on firm size based on employment, but also based on total imports. The idea is that larger importers produce with a greater import intensity and are therefore more elastic with respect to trade costs and import prices.

Empirics

Dataset and Import Procedure

Our dataset consists of two main databases. First, we have highly disaggregated import data for 2011 from Peru's National Tax Agency (Superintendencia Nacional de Administracion Tributaria -SUNAT). These data are reported at the transaction level and cover all transactions entering Peru through the customs in Callao (both airport and port) in this year. These customs accounted for 88% of the total import value and 95% of all import transactions in 2011. Specifically, each record includes the importing firm's tax ID, the origin country of the flow, the product code (10-digit HS), the port or airport through which the good enters Peru, the import value in US dollars, the quantity (weight) in kilograms, and the freight and insurance charges. The data also inform the date in which the ship or airplane arrived and the date in which the customs declaration was registered. Port-of-entry delays are measured here as the time elapsed between these two dates. Second, we have data on employment, sector of activity, and starting date also from the SUNAT. Firms are also identified by their tax ID in this case, so that the two datasets could be easily merged.

The customs broker completes an electronic Single Customs Document (Declaracion Unica de Aduanas-DUA) and sends it to the customs -SUNAT-, which validates the DUA, sends back a message containing the number assigned to the DUA and the date, and informs the associated tax and customs payments that are due. Once the respective payments have been made (or warranted), the system allocates the shipment to a verification channel using risk-based control procedures. More specifically, conditional on firms and product-origins, the customs system randomly assigns it to no verification (green channel), verification of documents (orange channel), and verification of documents and merchandise (red channel).[10] No more than 15% of the DUAs numbered in a given month in Callao can be subject to material control (see SUNAT, 2010a).[11] After the verification, if any, has taken place, the customs sends the DUA with the clearance of the shipment. The merchandise can then be taken to its

[10]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, nature, tariff classification, and value of the goods as well as tax and customs payments.

[11]When a shipment is allocated to the red channel, the customs agent chooses randomly and inspects no 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).

final destination within the country.

Table A1 reports summary statistics for the regressions variables. The only caveat to point out is that to examine heterogeneity in time costs by firm size we use firm level employment. In those regressions we lose about 5 percent of the observations because we do observe total employment for all firms in the sample.

Identification Issues

Under classical assumptions, pooled ordinary least squares estimates of (6) are consistent. We exploit the rich variation across the importer-product-exporter dimensions to absorb unobserved variables to satisfy the identification assumptions. We impose constraints for the elasticities across subsamples of the data to examine heterogeneity in the costs of delay an import elasticities.[12]

Unobserved importer characteristics create an identification problem if they are correlated with the independent variables in our regression model. We use importer specific fixed effects to absorb the unobserved importer specific constants K_i and price of the domestic input w as well as all other unobserved importer specific variables that do not change over time. This mitigates concerns that port of entry delays are determined by importer performance or importer level ability to fill out customs forms or follow port procedures, a good track record that leads to preferential treatment in the form of separate expedited lines or priority or the ability to work with more efficient freight-forwarders.

Using importer fixed effects imposes limits. The parameters are identified by the variation in import delays a firm experiences from transactions with multiple exporters or importing several products. As alternative approach we proxy for firm performance

[12] If we would observe factor intensities then they could be directly included as data or related to elasticity estimates based on subsamples of firms that likely have similar production structures. Unfortunately, at this point, we do not have this information available.

with observable firm characteristics in particular firm size. This approach is not as robust with respect to unobserved variable bias as employing high dimensional fixed effects, but it exploits variation across and within firms to identify the coefficients of interest.

To estimate the parameters we constrain the elasticities in (6) within firms and across firms. For example, if we pool over the entire sample, this implies that all firms produce all products with the same factor intensities. Within a firm, this means that several inputs are imported and matched with the local factor with the same factor intensities. Given that we do not observe data on factor shares in production across products, we examine heterogeneity in the elasticities with respect to firm size and port of entry.

The prices that importers pay for the imported input are determined in equilibrium. In the extreme case where these prices are determined in perfect competition prices equal marginal costs of production. If the marginal cost of production is constant, then the prices are not subject to the usual simultaneity bias because they are determined by exogenous supply shocks. Similarly, if the exporter is a monopolist and markups are constant, then price variation is driven by exogenous supply shifters. Furthermore, the background section compares the size of Peruvian firms to firms in the United States. Peruvian firms are small which mitigates concerns that these firms impact prices for imports on international markets. This implies that our estimation approach is less prone to endogeneity concerns present in applications that examine for example United States firms and import behavior.

In our particular set-up the markup an exporter charges depends on the importer specific demand elasticity. Without data on variables that determine this elasticity, we examine this heterogeneity by examining various subsamples of the data.

Conditional on importer characteristics, product characteristics and prices, transport cost must be exogenous with respect to demand shocks. This abstracts from such issues as containers being only half full or quantity discounts. Without directly observing this information, we can examine heterogeneity in importer size on the impact of ad valorem freight charges on expenditures. If large importers or some importers who are particularly good with logistics always enjoy lower transportation costs, then this information is modeled by the importer specific effect.

We measure $delay_{ijkt}$ by the median delay a firm experiences importing product k from exporter j. If importers cannot respond with prices to delays on the spot, then they incorporate the central tendency of the delay in the form of some expectation. The uncertainty in the port of entry delay enters through the trade cost $t = exp(\delta \times delay)\tau$. A Taylor approximation then gives $t \approx exp(\delta \times \overline{delay}) + exp(\delta \times \overline{delay})\delta(delay - \overline{delay}))$. Taking expectations this gives $E(t) \approx exp(\delta \times \overline{delay}) \times \tau$. We model the cost of delay as a function of the median delay because it is more robust with respect to extreme observations. Because we only observe 1 year of data it is difficult to use more sophisticated techniques to generate a measure of expectations based on potential few transactions between and importer-exporter-product pair.

We do not observe transit times between the origin and the port of arrival, quality of ports and other export related infrastructure in the export country. We absorb this information with country of origin specific fixed effects and product-by-exporter fixed effects. Conditional on exporter-product fixed effects, lengthy ocean transit times between Peru and it's trade partners, variation in economic size across trade partners and quality heterogeneity of a given product across origins does not impact our interpretation as as long as they are separable in our import specification and can therefore be absorbed with a fixed effect.

Conditioning on importer and exporter-product fixed effects concentrates the identifying variation on importer-product-export-partner specific variation. Importers match with exporters to purchase a particular product from a particular location. Across importers, delays vary across products and export partners. Data on importer and exporter characteristics would allow for a careful examination of how importers match with exporters. Not having such information available, our identification assumption is that after conditioning on importer fixed effects, and within subsamples of the data, matches between importers and exporters are random.

While some of these identification assumptions are restrictive, they are implicit in any identification approach that is based on firms importing multiple products. For example, if firms import varieties to minimize the cost of production based on a CES production function, then within firms, the elasticity with respect to the input price and trade costs captures substitutability between varieties in the production process and K_i absorbs the CES price index over imported varieties.

Results

This section presents regression results for the empirical model (6). The dependent variable in all tables is the log of expenditures on imports. The unit of observation is a importer-exporter-product triple. All specifications include origin-by-product fixed effects and the tables report clustered standard errors.

Table 4 shows the estimation results pooling over the whole sample and splitting the sample by firm size. For the pooled sample, reducing port of entry procedures by one day raises import values by about 2 percent. Also as expected an increase in freight costs or fob import prices lowers import values.

For small firms and large firms the coefficients on the freight charges identify a similar demand elasticity with respect to changes in transportation costs.[13] Based on

[13]The sample size across small and large firms is slightly small than for the pooled sample. That is because we do not observe employment for all firms. Table A1 reports the summary for the various estimation samples.

the theory this suggests that small firms and large firms produce with similar imported input intensity. The impact of an additional day of delay is almost 50 percent greater for large firms. This large difference in the impact combined with a similar elasticity of substitution across the different types of firms results in a cost-of-delay parameter δ that is about 38 percent greater for large firms. Large importers manage fine tuned supply chains with complicated sourcing patterns and management of inventory. If long time lags make this management process more difficult, then we would expect that large firms incur especially high costs from time lags.

An alternative hypothesis is that the smallest firms do not have means to substitute across different products and export partners. In that case these firms may have large time costs but we are not able to identify them because the fixed costs of supply chain management are too large for these firms to optimally adjust. We reject this alternative hypothesis because in this case we would also expect that firms are not able to seamlessly adjust their sourcing pattern with respect to transportation costs, but the demand elasticity is very similar for small and large size firms.

To identify heterogeneity in times costs estimates for firms that source products using air transport, Table 5 shows the results when we restrict the sample to the airport. An additional day of delay at the airport increases time cost by about 1.6 percent and both types of firms have very similar costs of delay. Time sensitive importers sourcing time sensitive products select to import through the airport even through the cost of air shipping is much higher than the cost of ocean transport. The cost advantage of air shipping is due to two sources. First, air shipping is much faster than ocean shipping. Second, Table 2 shows that at the airport the average clearance time is about 5 days faster than at the ocean port. This results in a cost advantage of $1.6 \times 5 = 8$ percent.

Table 6 reports results when we restrict the sample to the seaport. Compared to the estimates at the airport, the estimates are much more similar to the pooled estimates. Pooling over the vessel shipments a day of delay is worth about 0.7 percent. But the impact is slightly greater for large firms with an estimate of 0.9 percent.

Comparing the estimates of ocean to air shipped imports, the elasticity of imports with respect to an additional day of delay is similar between both modes of transportation . The larger time cost estimates at the airport are mostly due to a price elasticity of demand that is about half as much as the elasticity at the the seaport. Based on the theory this suggests that firms that use air shipment are less intensive in the imported input. Given that air imports tend to be of higher value than ocean imports, this makes sense if importers add a substantial amount of value using domestic resources. We cannot directly test this channel because we do not observe an importers production function or complete input information.

The advantage of using importer specific fixed effects is that the estimates are robust with respect to productivity differences. The disadvantage is that if small firms only import one product, then their annual import value is fully captured by the fixed effect. Table 7 examines the impact on delays without importer fixed effects. Instead, firm level employment proxies for productivity and performance differences across firms. In addition, we add tariff charges to the total transaction cost.[14] Including tariff charges is important if across importers that source the same product from a given country some firms do not claim special tariff provision due to trade agreements. In this case, there is variation in the tariff even within a given HS10-exporter combination. In magnitude and sign, 7 confirms the discussion of time cost estimates above.

[14] For completeness we also added tariff charges to the specifications estimated in the previous tables. In magnitude and sign the estimates are nearly identical.

Conclusions

This paper estimates the impact of port-of-entry delays due to clearance procedures on firm level imports in Peru. Highly detailed data on imports and delays at the port of entry identify these costs accounting for heterogeneity in firm productivity and bypassing aggregation issues present in industry level data.

The data show that port-of-entry delays are costly. For a one day increase in procedures, trade costs increase by .9 percent. The average delay for imports is about 8.5 days. Combined, this results in a port-of-entry cost of about 7.65 percent. Port-of-entry delays and the costs firms incur due to an additional day of delay are heterogeneous across different types of firms and imports. Delays are more costly at the airport than at the seaport. At the seaport delays are more costly for large than for small firms.

This is important for policy. Port-of-entry delays due to clearance procedures are directly related to trade policy as well as customs and port infrastructure. Furthermore, recent initiatives focus on trade promotion for small and medium sized enterprises. Our estimates imply that all firms face significant costs of entry delays. Therefore, all firms benefit from infrastructure investments that lower average delays. However, observed port-of-entry delays are heterogeneous across importers and importer-exporter relationships. If these delays are driven by document preparation, omissions and shipment handling, then this suggests that targeted firm level trade facilitation that helps importers improve their import process has a direct cost reducing benefit. Identifying the costs of delay and how they vary across firms allows policy makers to maximize bang for the buck of infrastructure investment or trade facilitation.

High costs of delay at small firms are likely driven by different factors than the costs of delay at large firms. Small firms may find it more difficult to cover financing and inventory costs or losses related to unexpected events while shipments are hung up in long port of entry procedures. Firms that are new to importing may not yet have the experience in document and shipment handling to minimize port-or-entry delays. Large firms are likely sensitive to delays because of complicated supply chain management across multiple export partners and products. Future research with data on firm characteristics and information about the source of the port-of-entry delay will provide an opportunity to identify the source of the port-of-entry costs. This will improve our understanding of the costs that are specific to firms active on global markets and how policy can mitigate these costs to impact trade related economic growth.

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Tables

Table 1: Firm Size Distributions

Nr. of Products	Workers per Firm	Imports pre Firm ($000)	Imports per Worker ($000)	Nr. of Origins	Workers per Firm	Imports per per Firm ($000)	Imports per Worker ($000)
1	21.8	63.7	25.3	1	22.2	113.5	42.1
2	23.1	147.9	42.9	2	28.1	360.5	86.5
3-4	25.9	364.0	77.2	3-4	51.1	588.5	147.4
5-9	35.2	432.6	95.1	5-9	91.4	1325.4	122.3
+10	116.7	3994.6	156.6	+10	275.1	13708.2	250.8

Table 2: Delay Distributions

		Delay		
		Average	Median	95th Percentile
	POOL	8.5	6	22
	Seaport	10.4	8	25
	Airport	5.8	4	16
Firm Size by Employment	Small ($<$200 employees)	9	7	23
	Large ($\geq$200 employees)	7.1	5	20
	Seaport - Small Firms	10.3	8	25
	Seaport - Large Firms	10.3	8	26
	Airport - Small Firms	6.5	5	18
	Airport - Large Firms	4.8	3	14

Table 3: Dimensions of Variation in Firm-Product-Exporter-Custom Median Port of Entry Delays

Dependent Variable: ln(Delay)	R-Squared	Adjusted R-Squared
Fixed Effects:		
Country	0.020	0.020
Country+Customs	0.050	0.049
Country+Customs+Product	0.096	0.085
Country+Customs+Product+Importer	0.589	0.567

Table 4: Entry Delay Impact Pooled and by Firm Size

		Firm Size by Employment	
	All Importers	<200	≥200
Delay	-0.025	-0.021	-0.031
	(.001)[a]	(0.001)[a]	(0.001)[a]
Freight Charge	-2.638	-2.503	-2.936
	(0.035)[a]	(0.039)[a]	(0.116)[a]
Price	-0.244	-0.220	-0.280
	(0.004)[a]	(0.005)[a]	(0.008)[a]
δ	0.9%	0.8%	1.1%
Firm FE	Yes	Yes	Yes
HS10-Origin FE	Yes	Yes	Yes
N	517,256	380,681	112,814
R^2	0.561	0.599	0.619

Note: Standard errors are clustered. a, b, c reflect significance at the 1, 5 and 10 percent levels.

Table 5: Entry Delay Impact at Airport

		Firm-Size by Employment	
	All Importers	$<$200	$\geq$200
Delay	-0.027	-0.025	-0.029
	(.001)^{a}	(0.001)^{a}	(0.001)^{a}
Freight Charge	-1.622	-1.515	-1.817
	(0.026)^{a}	(0.033)^{a}	(0.060)^{a}
Price	-0.076	-0.053	-0.112
	(0.005)^{a}	(0.007)^{a}	(0.010)^{a}
δ	1.7%	1.7%	1.6%
Firm FE	Yes	Yes	Yes
HS10-Origin FE	Yes	Yes	Yes
N	265,654	185,536	71,758
R^2	0.533	0.566	0.555

Note: Standard errors are clustered. a, b, c reflect significance at the 1, 5 and 10 percent levels.

Table 6: Entry Delay Impact at Seaport

		Firm-Size by Employment	
	All Importers	<200	≥200
Delay	-0.023	-0.020	-0.034
	(.001)[a]	(0.001)[a]	(0.002)[a]
Freight Charge	-3.162	-2.958	-3.603
	(0.153)[a]	(0.127)[a]	(0.898)[a]
Price	-0.190	-0.155	-0.255
	(0.010)[a]	(0.011)[a]	(0.031)[a]
δ	0.7%	0.7%	0.9%
Firm FE	Yes	Yes	Yes
HS10-Origin FE	Yes	Yes	Yes
N	300,282	228,174	55,647
R^2	0.647	0.661	0.707

Note: Standard errors are clustered. a, b, c reflect significance at the 1, 5 and 10 percent levels.

Table 7: Alternative Estimates Using Labor Variable

	Pooled			Small Firms			Large Firms		
	Pooled	Airport	Seaport	Pooled	Airport	Seaport	Pooled	Airport	Seaport
Delay	-0.026	-0.022	-0.032	-0.024	-0.020	-0.030	-0.031	-0.030	-0.036
	$(0.000)^a$	$(0.001)^a$	$(0.001)^a$	$(0.000)^a$	$(0.001)^a$	$(0.001)^a$	$(0.001)^a$	$(0.001)^a$	$(0.002)^a$
log(Labor)	0.215	0.179	0.215	0.234	0.187	0.226	0.221	0.183	0.218
	$(0.002)^a$	$(0.002)^a$	$(0.003)^a$	$(0.003)^a$	$(0.004)^a$	$(0.004)^a$	$(0.010)^a$	$(0.012)^a$	$(0.016)^a$
Freight Charge +Tariff	-2.806	-1.458	-3.736	-2.751	-1.298	-3.664	-2.943	-1.865	-3.723
	$(0.035)^a$	$(0.022)^a$	$(0.153)^a$	$(0.037)^a$	$(0.027)^a$	$(0.128)^a$	$(0.110)^a$	$(0.056)^a$	$(0.832)^a$
Price	-0.186	0.006	-0.158	-0.160	0.060	-0.137	-0.258	-0.115	-0.234
	$(0.003)^a$	$(0.005)^a$	$(0.008)^a$	$(0.004)^a$	$(0.006)^a$	$(0.009)^a$	$(0.008)^a$	$(0.010)^a$	$(0.027)^a$
δ	0.9%	1.5%	0.9%	0.9%	1.5%	0.8%	1.1%	1.6%	1.0%
Firm FE	No	No	No	No	No	No	No	No	No
HS10-Origin FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	493,495	257,294	283,821	380,681	185,536	228,174	112,814	71,758	55,647
R^2	0.463	0.431	0.521	0.467	0.453	0.519	0.574	0.503	0.661

Note: Standard errors are clustered. a, b, c reflect significance at the 1, 5 and 10 percent levels.

Appendix

Table A1: Summary Statistics of Regression Variables

Variable	N	Mean	SD
All Observations			
Imports	517,256	60,204.026	2,086,833.428
Imports (log)	517,256	7.002	2.773
Median Delay	517,256	9.794	10.037
Freight Charge + Tariff	517,256	2.180	580.741
Freight Charge + Tariff (log)	517,256	0.137	0.211
Freight Charge	517,256	2.147	580.740
Freight Charge (log)	517,256	0.112	0.206
Price	517,256	401.612	15,788.159
Price (log)	517,256	3.247	1.776
Labor	493,495	343.577	1,204.478
Labor (log)	493,495	3.360	2.307
Airport			
Imports	265,654	14,650.401	424,452.412
Imports (log)	265,654	6.402	2.435
Median Delay	265,654	7.662	8.279
Freight Charge + Tariff	265,654	1.374	5.811
Freight Charge + Tariff (log)	265,654	0.182	0.284
Freight Charge	265,654	1.341	5.577
Freight Charge (log)	265,654	0.160	0.280
Price	265,654	766.783	22,020.461
Price (log)	265,654	4.384	1.422
Labor	257,294	347.464	1,070.180
Labor (log)	257,294	3.727	2.255
Seaport			
Imports	300,282	90,719.237	2,702,977.323
Imports (log)	300,282	7.412	2.904
Median Delay	300,282	11.341	10.791
Freight Charge + Tariff	300,282	2.769	762.186
Freight Charge + Tariff (log)	300,282	0.106	0.145
Freight Charge	300,282	2.737	762.186
Freight Charge (log)	300,282	0.079	0.138
Price	300,282	40.192	3,481.350
Price (log)	300,282	2.292	1.361
Labor	283,821	349.378	1,285.561
Labor (log)	283,821	3.180	2.306