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Article

Import Uncertainty and Export Dynamics

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Abstract

A supply chain is only as strong as its weakest link. Firms are constantly managing uncertainties, including unexpected delays in the provision of a critical input that can slow down or halt the production process, possibly making the manufacturer miss a delivery deadline. As most exporters are also importers of intermediate goods, supply chain unreliability related to import processing times at the border could impact downstream export dynamics. The role of unpredictability in border-clearance times for imports in manufacturing firms' entry, exit, and survival in export markets is investigated using the PPML estimator on a rich dataset built on firm-level information for 48 developing countries over 2006–2014. Uncertainty in the time to clear imported inputs impacts neither the entry nor the exit rate, but translates into lower survival rates for new exporters, reducing the number of firms that continue serving the foreign market beyond their first year of entry. This effect grows larger over time, owing to rising reputational costs to input-importing exporters and is mainly driven by South-North trade, possibly reflecting the time-sensitivity of buyers in developed countries. Results also reveal heterogeneous effects across export industries, and the mediating role of sunk costs of entry in foreign markets, which attenuate the negative effect of uncertainty on survival rates as firms delay exiting the export market.

JEL classification: F14, L25, O1

Keywords: export dynamics, import uncertainty, supply chain unreliability, Customs, trade costs, firms

1. Introduction

The business literature has extensively analyzed how delays and unpredictable delivery times influence firms' supply-chain management decisions (Arviset al. 2011; Kunaka and Carruthers 2014). With the fragmentation of production across the world and the development of lean retailing and just-in-time manufacturing practices, timeliness and reliability have become the watchwords of firms involved in supply-chain trade. Import and export activities have grown increasingly intertwined, with foreign inputs typically

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imported and incorporated in the production of final goods or transformed and exported to other countries where they may further enter as intermediate inputs in the value-added exported to third countries (Koopman et al. 2010, Koopman, Wang, and Wei 2014). Against this background, unexpected factors such as late shipment arrivals or uncertainty over the time required to clear the consignment after it has reached destination, owing for instance to cumbersome formalities and physical inspections by border authorities, can lead to postponed delivery of key inputs, thereby disrupting the supply chain. Such uncertainty carries reputational costs for the importing firm, undermining its ability to meet buyer quality requirements and delivery deadlines, and exposing it to the risk of losing sales contracts, market shares, and valued customer relationships. Unexpected delays in delivery and associated potential snowball effect across the supply chain (Harrigan and Venables 2006) prompt importers to adopt costly hedging strategies, such as switching to more reliable but expensive transportation modes (Hummels 2001) or maintaining safety stocks. Evidence suggests that inventory holding to guard against uncertainty generates costs that can vary from 15 percent of the cost of goods per year to as much as 50 percent, reaching on average 27 percent of the goods value in the case of the United States (Clark, Kozlova, and Schaur 2016).

Several studies have formally quantified the effect of timeliness on trade volumes. Based on disaggregated import data for the United States, Hummels (2001) finds that each day in transit reduces the probability that the United States imports manufactured goods from a given country by 1.5 percent and is equivalent to an ad valorem tariff rate of 0.8 percent, later updated to range between 0.6 and 2.3 percent in Hummels and Schaur (2013). Using similar data, Clark, Kozlova, and Schaur (2016) show that unexpected delays in the arrival date of shipments at U.S. ports, captured by the difference between the actual and expected dates of arrival, reduce imports by 1 to 2 percent. Time costs also impede exports, both at the extensive and intensive margins. Using a sample of 98 countries, Djankov, Freund, and Pham (2010) argue that each additional day required to move products from the factory gate and onto the ship reduces the volume of exports by more than 1 percent, while Li and Wilson (2009) find that it decreases the probability to export and the share of exports in total sales in developing countries. Freund and Rocha (2011) convey a similar message in the case of African countries and find inland transit delays to matter more than those related to documentation processing and Customs clearance. Likewise, Volpe Martincus, Carballo, and Graziano (2015) show that a 10 percent increase in Customs-driven delays in the time to export leads to a 3.8 percent decline in firms' exports in Uruguay, with additional negative consequences for export market diversification. Most of these studies concur that the negative effects that delays have on trade are particularly exacerbated for time-sensitive goods such as perishable agricultural products or parts and components (Hummels and Schaur 2013). As a result, countries with better ability to export on time are found to be more likely to develop comparative advantage in time-sensitive industries and more likely to export intermediate inputs than final goods (Gamberoni, Lanz, and Piermartini 2010).

In this paper, uncertainty in the time required to complete Customs procedures and other border processes and formalities for imported inputs is shown to affect importing firms' export dynamics. A large body of literature has documented the positive impact of foreign intermediate goods or input tariff liberalization on productivity by providing firms access to a larger array of intermediate inputs and to the foreign technology embodied in imported inputs.[1] Since only the most productive firms self-select into exporting (Melitz 2003), imports of intermediate inputs matter for export performance. A number of papers have also demonstrated the direct relationship between imports and export outcomes. For instance, van der Marel (2017) shows that nontariff barriers that hinder the import of intermediate manufactured products reduce total trade values, the average export per firm, and the number of exporting firms. Using data on Argentinian firms, Bas (2012) finds that input tariff liberalization raises the probability of firm

1 See for instance Schor (2004); Amiti and Konings (2007); Kasahara and Rodrigue (2008); Topalova and Khandelwal (2011); Halpern, Koren, and Szeidl (2015) and Bas et al. (2016).

entry into export markets, while Bas and Strauss-Kahn (2014) evidence a positive impact on the number of products exported by French manufacturing firms. By the same token, input-importing firms in South Africa (Edwards, Sanfilippo, and Sundaram 2017) and China (Feng, Li, and Swenson 2016) exhibit both higher export volume and scope. In addition to supporting the export diversification of importing firms at the intensive and extensive margins, foreign inputs also have a bearing on how long they operate in export markets. Lopez (2006) argues that importing intermediate inputs increases the probability of export survival of Chilean firms, whereas Wagner (2013) finds that importing firms in Germany are less likely to exit the export market. Access to foreign inputs also seems to enhance the quality of the export bundle (Kugler and Verhoogen 2009; 2012; Manova and Zhang 2012; Bas and Strauss-Kahn 2015; Fan, Li, and Yeaple 2015; Bastos, Silva, and Verhoogen 2018). In line with these studies, Pierola, Fernandes, and Farole (2018) show that Peruvian firms that use imported intermediate inputs not only export and grow more, but they also export high-quality goods and are more geographically diversified.

Increasing access to Customs transaction-level data has also enabled emerging evidence on the drivers of export dynamics (exporter entry, exit, and survival). In an environment with incomplete information, information uncertainty related to contract enforcement and export experience has been shown to shape Belgian firm export dynamics in Araujo, Mion, and Ornelas (2016). Uncertainty about supplier-buyer match quality induces developed country buyers to start small with a trial order to gain information about the ability of the developing-country supplier to successfully fill a large order in Rauch and Watson (2003). The duration of this relationship also depends on search costs for new suppliers and their required training. Uncertainty about future profitability and sunk costs of entry in a destination related to building a customer base and knowledge of a market also affect exporter dynamics patterns for Colombian shipments to the United States in Eaton et al. (2021).

Drawing on these three strands of literature on the trade effects of border-clearance times, the role of imported inputs in export outcomes and uncertainty as a driver of export dynamics, the role of upstream uncertainty faced by firms in border-clearance times for imported inputs in shaping downstream export dynamics is investigated in this paper. The approach is twofold and includes (1) exploring whether unpredictability in the time required to complete Customs and other border processes and formalities for imported inputs deters manufacturing firms from entering new export markets; and (2) whether it influences the export survival of firms already serving foreign markets based on the export exit rate of incumbents and entrants, and the share of firms that are still in operation in the foreign market one, two, or three years after they started exporting.

The paper's contributions to the existing literature are as follows. First, predictability in imported inputs delivery times is found to be more important than actual observed times, departing from the cross- country studies using single-value, average-type country-level indicators of time-related trade costs such as the Doing Business Indicators. Instead, a novel measure of import uncertainty is computed, taking advantage of the time-varying within-country distribution of Customs clearance times across manufacturing firms sourced from the World Bank Enterprise Surveys (WBES) to account for the heterogeneity in border times at the country-sector-firm-year level (Volpe Martincus 2016). Specifically, the within-country-sector-year interquartile range of the days elapsed between the time of arrival of imported inputs at the destination port of entry and the time of release from Customs is considered for a sample of 48 developing countries over 2006–2014. Second, matching this dataset with information on firm export dynamics at the origin-destination-sector-year level obtained from the World Bank's Exporter Dynamics Database (EDD) makes it possible to shed light on how uncertainty in the time to import affects the decision of (1) nonexporters to enter foreign markets; (2) both new and incumbent exporters to exit foreign markets, and (3) firms to keep exporting one, two, and three years after the date they started serving the foreign market. As such, the granular origins of aggregate trade performance are highlighted by exploiting firm-level information to derive country-sector level indicators of export dynamics. Export outcomes at the macro level are driven by the activities of individual firms operating in different sectors across the country, with sometimes only

a handful of them—dubbed export superstars—accounting for the lion's share of total exports (Freund and Pierola 2015).

Constructing a new measure of uncertainty in border-clearance times for imports allows quantifying a new source of trade costs. Trade costs are traditionally captured by a wide range of variables, including standard gravity-type measures such as bilateral distance, tariffs, contiguity, common language, and participation in trade agreements. They also relate to a country's legal and regulatory framework, as well as the availability of quality infrastructure and other trade-facilitation measures aimed at reducing administrative red tape. Abundant research highlights the sizeable impact of trade costs on aggregate export volumes,[2] the intensive and extensive margins of trade,[3] and export survival[4] on the one hand, and their large growth and welfare implications on the other (Anderson and Van Wincoop 2004).[5]

In this paper, uncertainty in the time required to clear imported inputs at the border is found to impact neither the entry nor the exit rate of manufacturing firms in developing countries. However, it translates into lower survival rates for new exporters, with a smaller number of firms continuing to serve the foreign market beyond their first year of entry. Interestingly, this effect grows larger over time as input-importing exporters bear the increasing reputational costs associated with missed delivery deadlines and appears to be driven by South-North trade, possibly reflecting the time sensitivity of buyers in developed countries. These export dynamics-effects of import uncertainty are heterogeneous across export industries. Also, sunk costs of entry in foreign markets attenuate the negative effect of import uncertainty on survival rates as firms delay exiting the export market. Additionally, this novel measure of uncertainty is shown to have a distinct impact on export survival. The findings are robust to using alternative dependent variables and to including other measures of domestic trade costs associated with the import process, such as cumbersome formalities to import, ease of access to finance, and corrupt practices at the border. The results suggest that developing countries seeking to promote the survival of newly-exporting firms in foreign markets should consider policies targeted at reducing the uncertainty these firms face when importing their production inputs.

The remainder of the paper is organized as follows. Section 2 describes the import process, introduces the dataset, and provides stylized facts. Section 3 specifies the econometric model and presents the results. Section 4 discusses robustness checks. Section 5 concludes.

2. Data

Import Uncertainty

Following harmonization efforts promoted by international organizations, including the World Customs Organization (WCO) and the Word Trade Organization (WTO), the import process from the moment the cargo arrives at the border post until it is cleared by Customs is relatively standard across countries (fig. 1). This standardization was key to reducing the complexity of the process, as close to 100 steps must be performed by multiple public and private stakeholders, with each step being a potential source of delay. Taking the maritime transport case as an example,[6] the first step is the arrival of the vessel at the port of

2 See for example Limao and Venables (2001); Coulibaly and Fontagné (2006); Blonigen and Wilson (2008), and Volpe Martincus, Carballo, and Cusolito (2017).

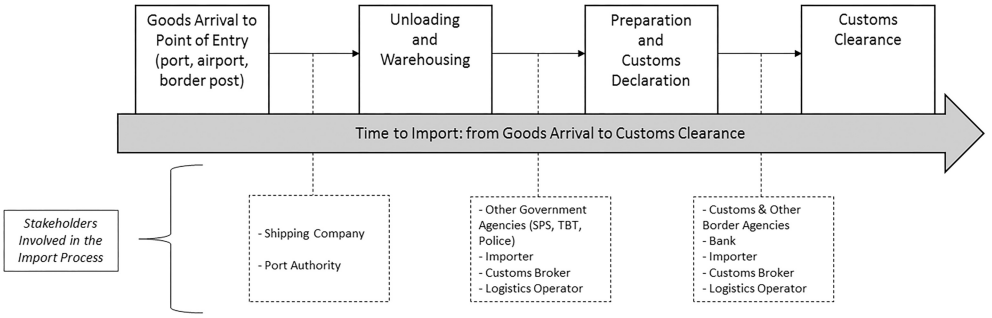
3 See for instance Debaere and Mostashari (2010); Shepherd (2010); Dennis and Shepherd (2011); Albornozet al. (2012); Regolo (2013); Feenstra and Ma (2014) and Beverelli, Neumueller, and Teh (2015).

4 See, for instance, Brenton, Saborowski, and Von Uexkull (2010); and Brenton, Cadot, and Pierola (2012); Cadot et al. (2013); Araujo, Mion, and Ornelas (2016); Fugazza and Molina (2016), and Carrère and Strauss-Kahn (2017).

5 Since the seminal work of Romer and Frankel (1999) who show that trade increases income, the literature has burgeoned with studies aimed at identifying the positive relationship between trade and economic growth. Winters (2004) provides an extensive overview of the literature.

6 The import process remains similar for other transport modes.

Figure 1. Stages of the Import Process: from Goods Arrival to Customs Clearance



Source: Authors' elaboration.
Note: SPS: Sanitary and Phytosanitary; TBT: Technical Barrier to Trade.

entry. At this stage, congestion at port terminals can lead to berthing delays with vessels waiting hours or sometimes even days in the queue, and with delays being charged by the shipping company to the importer through higher shipping rates. After berthing, port operators unload the vessel and place its cargo in a shipyard or warehouse while the importing firm or its representative—the Customs broker—verifies the content of the cargo and prepares Customs documents, import licenses, Sanitary and Phytosanitary (SPS) certificates, and permits if applicable.[7] These are filled in electronic or paper form depending on Customs and other border control agencies' use of Information Technology (IT) systems. In many countries, SPS agencies and Customs require separate declarations, with significant data gathering and task duplication for the importer or its delegate that can be a source of delays. Insufficient container placement capacity or insufficient gantry cranes, poor efficiency of port operators during cargo movement, or the slow processing of the paperwork by the importer or Customs broker can also generate delays.[8]

Once the import declaration is submitted with the corresponding paperwork as well as the auto- declared taxes and Customs duties payable on the imported good, Customs authorities validate the import transaction by assigning a number and date to the declaration. Delays could arise at this stage owing to low Customs efficiency, for instance due to limited use of IT systems, or to the type of product imported.[9] Likewise, the time taken by the Customs broker or the importer to pay the duties and fees also determines the occurrence of delays.[10] Upon payment (or warranty of it), the shipment is assigned to a verification channel based on the Customs risk management system, which can be either the green (no inspection), orange (documentary inspection), or red (documentary and physical inspection) channel.[11] Other border control agencies (e.g., SPS agency or Antinarcotic Police) also assign the shipment to their own verification channel, but in practice few of them use a risk-based model and tend to perform partial or full physical inspections.[12]

7 Import licenses are required for goods subject to import quotas, import prohibition (e.g., arms, chemicals), or sanitary and phytosanitary measures (e.g., agricultural goods, food, forestry, cosmetics, pharmaceuticals, etc.).
8 The importer may also prefer to take advantage of port storage facilities.
9 Imported products are classified based on the Harmonized System (HS) goods nomenclature in view of determining the applicable Customs tariff, which is not always straightforward depending on the composition and degree of transformation of the imported good. In addition, the computation of the total amount of duties and taxes payable on imported goods also hinges on the verification of unit values (goods valuation), which can also turn out to be highly technical.
10 For instance, the importer may not have sufficient liquidity to pay or may not be able to access its bank due to closure over the weekend and the absence of online payment options.
11 In some countries, the inspection channel is determined once the import declaration is accepted by Customs authorities and the tax and duties are paid after the execution of the verification channel decision.
12 For instance, SPS agencies collect samples to send to a laboratory or perform on-site tests.

This step tends to generate most of the uncertainty in delays arising during the import process, as it is influenced by the channel of inspection and the number of agencies involved in the clearance process. It is especially exacerbated by poor interagency coordination and time-consuming sequential process (McLinden et al. 2011). For products subject to physical inspection by Customs authorities or any other border control agency, the cargo is usually transferred to a bonded warehouse for inspection. Containers must be moved to the warehouse, opened, unloaded, reloaded, and closed, sometimes multiple times depending on the number of inspections, with direct costs charged to the importer and higher risks of deterioration for perishable goods. As in previous steps, the poor quality of port infrastructure and low efficiency of port operators in moving the cargo, as well as their limited use of IT systems to efficiently allocate containers, can generate delays, even for nonintrusive inspections methods based on X-rays. In addition, delays can occur as the importer or its representative must be physically present during any physical inspection. Rent-seeking practices, including informal payments to obtain a modification of the Customs classification or valuation of the imported good, or to limit or avoid altogether sample testing, can occur at this stage considering the multiple stakeholders involved in the clearance process. In a final step,[13] Customs authorities clear the shipment once all border control agencies have provided their clearance and the importer has paid any outstanding balance, marking the end of the import process as defined in this paper. The importing firm can claim the shipment immediately upon release or take advantage of port storage facilities.

In this paper, a new measure of uncertainty in import clearance times is constructed using the World Bank Enterprise Surveys (WBES) database over 2006–2016. The measure captures unpredictable delays arising at any stage of the import process as discussed above, from vessel berthing to Customs clearance.[14] The WBES database provides quantitative and qualitative information on the characteristics of firms operating in the manufacturing and services sectors in developing countries, as well as their business environment (e.g., access to finance, regulations, taxes and trade costs). Surveys are administered to nationally representative samples of formal firms with at least five workers. The standardized version of the database, which compiles only those surveys following the WBES Global methodology, is used as it provides information that is comparable across countries and years. The analysis is restricted to manufacturing firms identified through ISIC codes 15 to 36 (see also table S1.1 in the supplementary online appendix, available at *The World Bank Economic Review* website).[15] Since, in most low-income countries, only a very limited number of firms operate in selected manufacturing sectors defined at the 2-digit ISIC level, the 22 ISIC manufacturing divisions are aggregated into five sectors of interest: (1) manufacture of food, beverage, and tobacco products (ISIC codes 15–16); (2) manufacture of textile and leather-related products (ISIC codes 17–19); (3) manufacture of wood-related products (ISIC codes 20–22); (4) manufacture of minerals, metals, and chemicals (ISIC codes 23–28); and (5) manufacture of advanced products (ISIC codes 29–36).[16] This yields a sample of 16,475 firms.[17] Thirty percent of manufacturing firms are direct exporters, and, among these, 74 percent import the inputs that enter their production process. In contrast, only one third of firms that exclusively sell in the domestic market are also direct importers. In line with

13 For example, in the orange or red channel, the inspector assesses the appropriate value and taxes and duties to be paid.

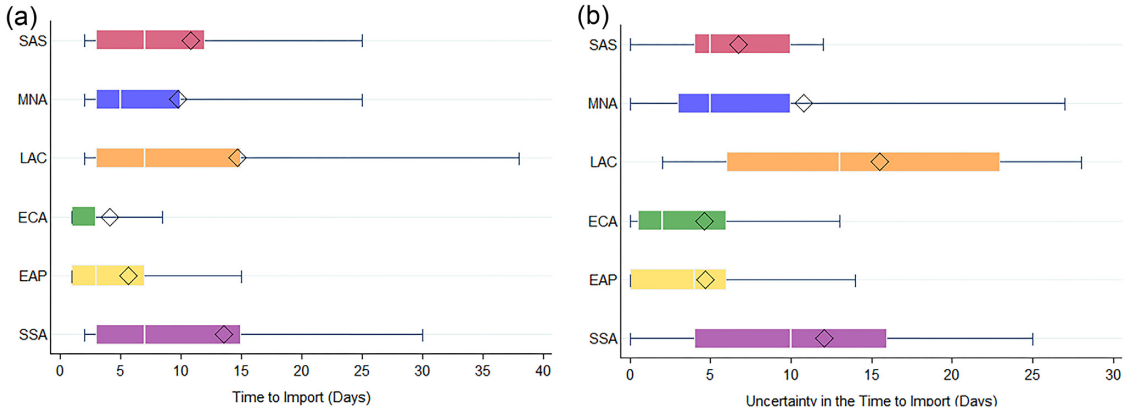
14 The WBES database was accessed in August 2017.

15 The survey question that makes it possible to identify input-importing firms applies to manufacturing firms only, hence dictating the sample choice. The Enterprise Surveys classify firms based on the International Standard Industrial Classification (ISIC), Revision 3.1.

16 Recycling (code 37) is excluded from the analysis due to poor data coverage.

17 This figure was arrived at by restricting the sample to those firms that reported positive direct exports as a share of total sales and that also provided an indication on whether they import material inputs or supplies. Only manufacturing firms located in the 48 developing countries retained in the econometric analysis are considered (see table S2 in the supplementary online appendix).

Figure 2. Regional Distribution of the Time to Import and Uncertainty in the Time to Import. (a) Time to Import. (b) Uncertainty in the Time to Import



Source: Authors' elaboration based on the World Bank Enterprise Surveys (WBES).

Note: The horizontal box plots are for the median and interquartile range of the time to import across regions. Whiskers extend to 10 percent and 90 percent points of the distribution. Diamonds indicate means. Included manufacturing firms are those located in the 48 developing countries retained in the empirical analysis. ECA: Europe and Central Asia; SAS: South Asia; LAC: Latin America and the Caribbean; SSA: Sub-Saharan Africa; MNA: Middle East and North Africa; EAP: East Asia and Pacific. The countries included in each region are shown in table S1.1 in the supplementary online appendix.

the literature, exporting firms present specific characteristics that distinguish them from their nonexporting counterparts. In particular, they tend to be older, larger, and more productive, and this is also broadly verified across all five export industries.[18]

The explanatory variable of interest is captured by the interquartile range of the average number of days to clear imported material inputs or supplies through Customs and other border control agencies, computed over a representative population of manufacturing firms at the country-sector-year level.[19] The interquartile range is chosen over other measures of dispersion such as the standard deviation or the coefficient of variation, which are more sensitive to outliers and difficult to interpret in the face of non-normal distributions.[20] This seems particularly relevant, as the distribution of the time to clear imported goods at the border is asymmetric and broad-tailed. Following Arvis, Raballand, and Marteau (2010), it can be described by a log-normal distribution built on two components: (1) the minimum feasible time considering current infrastructure, procedures, and services as a baseline; and (2) the broad tail of the curve that illustrates the not-so-rare occurrences of the time to clear imported goods through Customs, largely in excess of the median or even the mean.

An examination of the regional distribution of both the number of days required to clear goods at the border and uncertainty in import clearance times based on the WBES geographical breakdown finds that import clearance times are lowest in Europe and Central Asia at less than 5 days on average, while being more than three times higher in Latin America and Sub-Saharan Africa (fig. 2). There are large differences

18 See, for example, the discussion by Bernard and Jensen (2007). Details on firm characteristics are provided in table S3 in the supplementary online appendix.

19 More precisely, question D.14 from the Manufacturing Module of the WBES reads "*In [the last] fiscal year, when this establishment imported material inputs or supplies, how many days did it take on average from the time these goods arrived to their point of entry (e.g., port, airport) until the time these goods could be claimed from Customs?*"

20 This approach is similar to Fernandes, Hillberry, and Mendoza Alcántara (2021)'s, who proxy uncertainty over Customs clearance times with the interquartile range of the time spent in Customs. As an additional caution, observations that lie below (above) the first (99th) percentile of the distribution are removed to guard against the effect of extreme delays at Customs.

across countries, even within the same region, as shown by the varying length of the horizontal box plot representing the range between the 25th and 75th percentiles. Furthermore, while import clearance times are fairly heterogeneous across regions, it is also the case for uncertainty. For an importer operating in a particular sector and in a specific region, for example, Latin America and the Caribbean, the effective clearance time might be significantly longer than suggested by a simple average. As shown in fig. S1.1 in the supplementary online appendix, there are significant differences in the distribution of import clearance times, with countries such as Albania or Romania displaying close-to-zero interquartile ranges, whereas 50 percent of Ivorian importing firms reported experiencing 13 to 60 days of delay in clearing imported inputs through Customs. This is consistent with Volpe Martincus (2016), who argues that using distributions rather than point estimates allows improvements to the measurement of border-clearance times given the heterogeneity in border times across observations; these stylized facts clearly suggest that relying on a single, average-type measure of time to import is not appropriate to fully grasp the uncertainty that firms face when importing inputs.

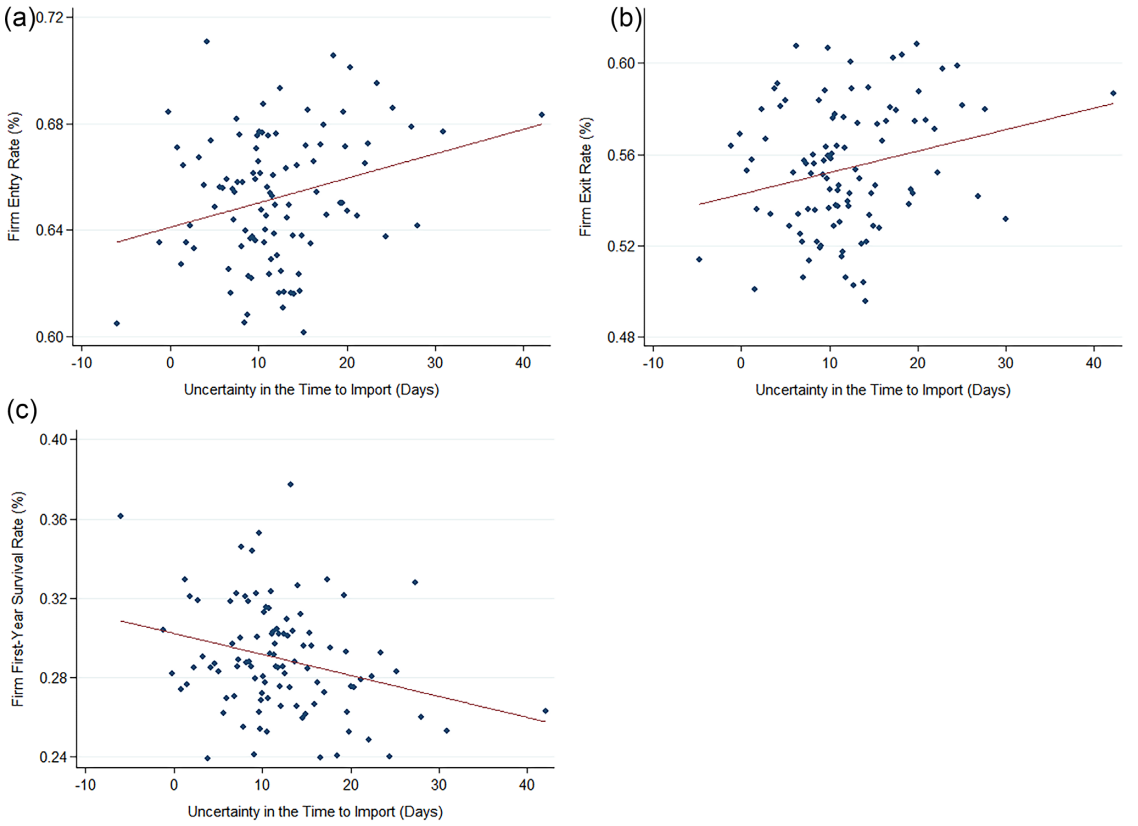
Export Dynamics

Next, the WBES is matched with a rich array of variables drawn from the World Bank's Exporter Dynamics Database (EDD). The latter contains measures of the degree of product and market export diversification, firm dynamics in terms of entry, exit, and survival in export markets, as well as the average unit prices of the products they export over the period 1997–2014 (Fernandes, Freund, and Pierola 2016). The analysis in this paper focuses on the export dynamics of manufacturing firms at the country-destination-sector-year level. More specifically, the role of uncertainty in import clearance times in affecting firm entry, exit, and first-, second- and third-year survival rates in export markets is investigated. Out of the 72 developing countries originally present in EDD, 48 were successfully matched with the WBES. Since the latter are conducted every four to six years and data collection takes over a year, EDD is matched with up to three years backward or forward relative to the WBES to enhance the size of the final dataset.[21]

Preliminary evidence of the relationship between uncertainty in the duration of the import process and firms' export dynamics in developing countries is presented in fig. 3. Once country, destination, sector, and year fixed effects are accounted for, increases in import uncertainty appear to be significantly associated with higher exit rates of exporters and lower probability of entering exporters to survive past the first year of exports, thereby hinting at a potential adverse effect on firms' exporting status. However, there also seems to be a positive correlation between import uncertainty and firm entry rates in export markets. Taken together, these scatter plots are suggestive of export experimentation and failure leading to a substantial turnover rate or churning as firms enter and exit export markets, yielding low survival rates (Brenton, Saborowski, and Von Uexkull 2010; and Pierola 2012).In this paper, such dynamics are assumed to be driven by uncertainty in the time to import, with unpredictability in border-clearance times for key inputs disrupting the production process, making the importing exporter likely to miss delivery deadlines. If such incident is frequent, exporting firms risk losing their credibility as reliable suppliers, and time-sensitive buyers may decide to terminate the export relationship. The next section offers a formal analysis of the relationship between import uncertainty and export dynamics.

21 The list of countries included in the analysis along with the corresponding time adjustments, where applicable, are displayed in table S1.2 in the supplementary online appendix.

Figure 3. Binned Scatter Plots of the Relationship between Uncertainty in the Time to Import and Export Dynamics. (a) Firm Entry Rate. (b) Firm Exit Rate. (c) Entrant First-Year Survival Rate



Source: Authors' elaboration based on the World Bank Enterprise Surveys (WBES) and Exporter Dynamics Database (EDD).
Note: The data are binned according to percentiles of uncertainty in the time to import. Both x and y-axis variables are residualized on origin, destination, sector, and year fixed effects. The description and source of variables are provided in table S1.3 in the supplementary online appendix.

3. Empirical Methodology

Econometric Model

The relationship between uncertainty in import clearance times and firm export dynamics is formally examined by estimating the following baseline model:

$$FirmDynamics_{ijkt} = \delta_0 \ln(Uncertainty_{ikt}) + \delta_1 X_{ikt} + \sum_s \delta_{2s} W_{ij} + \delta_3 EIA_{ijt} + \delta_4 Tariff_{ijkt} + \delta_5 F_{it} + \delta_6 P_{jt}$$
$$+ \sum (\alpha_i O_i + \beta_j D_j + \gamma_k S_k + \theta_t T_t) + \epsilon_{ijkt}$$

The dependent variable $FirmDynamics_{ijkt}$ is the entry, exit, or survival rate of manufacturing firms in sector k of country i and exporting to destination j. $Uncertainty_{ikt}$ is the interquartile range of the time to clear imports at the border for firms in sector k, and varies across time by exporting country i and sector k. Vector X_{ikt} is included to control for time-varying exporting firm characteristics taken from the WBES and averaged at the country-sector-year level. It comprises (1) firm export intensity defined as direct exports as a fraction of total sales, (2) import penetration, captured by the proportion of firms that import material inputs or supplies, (3) the number of years since the firm first started to export as a proxy for average export experience, (4) the natural logarithm of the number of permanent,

full-time employees as a proxy for firm size, and (5) firm total factor productivity (TFP). Consistent with the literature on export dynamics, W_{ij} is a vector of standard time-invariant bilateral gravity variables such as contiguity, distance, and a binary variable for colonial relationship taken from CEPII. EIA_{ijt} is a time-variant dummy provided at Jeffrey Bergstrand's website and indicating whether the pair is involved in an economic integration agreement. $Tariff_{ijkt}$ refers to bilateral applied tariffs derived from WITS.[22] Vectors F_{it} and P_{it} are also included to control for country-specific characteristics such as GDP per capita and the cost of procedures to start a business as a share of GNI per capita drawn from CEPII to account for the level of development and the average quality of the business environment, respectively. Finally, O_i, D_j, S_k and T_t refer to exporter-, importer-, sector- and year-specific effects respectively.

A detailed description of the variables is provided in table S1.4 in the supplementary online appendix, while associated summary statistics are presented in table 1. Given the preponderance of zeros for the dependent variables of interest, the baseline model is estimated by Poisson Pseudo-Maximum Likelihood (PPML) following Santos Silva and Tenreyro (2006, 2010). Standard errors are clustered by exporter-importer pair.

Results

Baseline Results

PPML estimates of the baseline model for each dependent variable of interest are presented in table 2.[23] The results are twofold. First, uncertainty in the number of days required to clear imports at the border impacts neither the entry nor the exit rate of manufacturing firms in developing countries (columns 1 and 2). However, it reduces the survival rate of new exporters by resulting in a lower number of entrant firms that continue serving the foreign market beyond their first year of entry (columns 3–5). As the effect is significant only with respect to the export survival of entrants as opposed to the exit rate that pertains to both entrants and incumbents, that is, any firm that stops serving the foreign market in t despite having exported in $t-1$, regardless of the date of entry, these results suggest that newly-exporting firms are more affected by the detrimental impact of uncertainty than incumbents. Second, the adverse effect on export survival is economically meaningful and grows larger over time, with a doubling of import uncertainty leading to a decrease in the export survival rate of entrants of 4 percent the first year, 6 percent the second year, and 7 percent the third year. In other words, if uncertainty in border-clearance times for imports fell from 25 days (90^{th} percentile) to 3 days (10^{th} percentile), new exporters would see their probability of continuing to serve foreign markets one, two and three years after they started operations improve by 8.5, 12.5 and 15.3 percent respectively, *ceteris paribus*.[24] Furthermore, at the median value of the interquartile range of the number of days required to clear imports through Customs (10 days), an increase in uncertainty of one standard deviation (about nine days) implies a decrease in the first-year survival rate of exporting firms of 3.6 percent, in the second-year survival rate by 5.4 percent and in the third-year survival rate by 6.6 percent. Drawing from the estimated elasticity of tariffs derived from table

22 WITS uses the concept of effectively applied tariff, which is defined as the lowest available tariff. If a preferential tariff exists, it is used as the effectively applied tariff. Otherwise, the Most-Favored Nation (MFN) applied tariff is used.

23 The Exporter Dynamics Database (EDD) is constructed from exporter-level raw customs transaction level data provided by country authorities, that is, at the country-firm-product-destination-year level. Even after aggregating export flows at the country-destination-sector-year, there is a significant amount of zero-export flows. However, no export flows were filled in before calculating the export rates. A zero-export rate means a zero value at the nominator but not at the denominator, while a zero at the denominator would translate into a missing value for the export rate. For the core results (column 3 in table 2), there are 4,069 zeros out of 11,834 observations, that is, 34 percent. As discussed by Santos Silva and Tenreyro (2011), the analysis considers that the Poisson-pseudo maximum likelihood (PPML) estimator is best used in this context and leads to better estimates of elasticities than running ordinary least squares (OLS) regressions. Results obtained with OLS are consistent with this paper's core results and are available upon request.

24 These magnitudes are obtained as the product of the difference between the 90^{th} and 10^{th} percentile of import uncertainty and the corresponding coefficient in columns 3–5 of table 2.

Table 1. Summary Statistics

	Mean	Median	Std. Dev.	Min.	Max.	Obs.
Firm entry rate (%)	0.597	0.574	0.306	0	1	14,476
Firm exit rate (%)	0.524	0.500	0.292	0	1	12,744
Entrant 1st year survival rate (%)	0.286	0.250	0.294	0	1	12,654
Entrant 2nd year survival rate (%)	0.151	0	0.228	0	1	11,343
Entrant 3rd year survival rate (%)	0.110	0	0.194	0	1	5,966
Number of exporters	40.70	6	231.1	1	12,816	14,476
Number of entrants	18.56	3	87.96	0	4,952	14,476
Number of exiters	20.07	4	96.75	0	5,454	12,744
Number of surviving entrants	5.569	1	26.26	0	1641	13,896
Log import uncertainty	2.195	2.303	0.845	0	3.970	14,476
Log time to import (days)	2.422	2.466	0.527	0.916	3.713	14,476
Log median time to import (days)	2.035	1.946	0.653	0.693	4.094	14,476
Log maximum time to import	3.584	3.807	0.662	1.099	4.443	14,476
Common border	0.052	0	0.222	0	1	14,476
Colony	0.008	0	0.087	0	1	14,476
Log distance	8.573	8.819	0.901	5.089	9.886	14,476
Trade agreement	0.536	1	0.499	0	1	14,476
Log tariffs	1.311	1.281	1.249	0	5.972	14,476
Log exporter GDP cap.	8.086	8.383	1.062	5.840	9.673	14,476
Log importer GDP cap.	8.975	9.077	1.532	5.065	11.64	14,476
Log exporter entry cost (% GNI)	3.190	3.437	1.063	0.405	5.308	14,476
Log importer entry cost (% GNI)	2.300	2.389	1.669	-2.303	7.181	14,476
Log documents to import	1.947	1.946	0.333	1.099	3.045	14,390
Log LPI timeliness	1.178	1.203	0.135	0.756	1.379	13,338
High-income destination	0.716	1	0.451	0	1	14,476
Sector 1	0.223	0	0.416	0	1	14,476
Sector 2	0.194	0	0.396	0	1	14,476
Sector 3	0.115	0	0.318	0	1	14,476
Sector 4	0.264	0	0.441	0	1	14,476
Sector 5	0.204	0	0.403	0	1	14,476
Log export uncertainty	1.555	1.609	0.960	0	3.738	11,888
Log time to export (days)	1.879	1.852	0.569	0.693	3.689	13,836
Log median time to export (days)	1.607	1.386	0.647	0.693	3.689	13,836
Panel A: All Firms						
Log direct exports (% sales)	1.675	1.761	1.141	−3.818	3.838	14,476
Log direct imports (%)	−0.744	−0.634	0.504	−2.711	0	14,476
Log experience	2.457	2.510	0.414	0.348	3.570	14,476
Log number of employees	4.041	3.955	0.649	2.180	6.073	14,476
Log total factor productivity	0.495	0.511	0.228	-0.780	1.155	14,476
Log collateral (%)	−0.323	−0.220	0.340	−1.871	0	14,456
Log no loan application (%)	−1.076	−0.950	0.679	−4.343	−0.033	14,405
Log bribes (% annual sales)	0.737	0.475	0.724	0	3.024	14,098
Log licensing obstacle (%)	−2.203	−2.066	0.924	−6.335	−0.114	13,469
Log days of inventory	3.442	3.427	0.520	1.883	5.074	14,351
Panel B: Exporting Firms						
Log direct exports (% sales)	3.448	3.478	0.610	0.692	4.605	14,476
Log direct imports (%)	−0.303	−0.189	0.388	−2.549	0	14,274
Log experience	2.497	2.550	0.450	0.423	3.871	14,410
Log number of employees	4.890	4.930	0.899	1.609	7.436	14,463
Log total factor productivity	0.572	0.618	0.313	-0.667	1.433	13,798
Log collateral (%)	−0.287	−0.154	0.400	−3.042	0	13,475

Table 1. Continued

	Mean	Median	Std. Dev.	Min.	Max.	Obs.
Log no loan application (%)	−1.254	−1.151	0.850	−3.836	0	11,203
Log bribes (% annual sales)	0.502	0.187	0.699	0	3.857	13,148
Log licensing obstacle (%)	−2.079	−1.976	1.031	−5.105	0	10,835
Log days of inventory	3.661	3.697	0.631	0	5.704	14,294

Source: Authors' calculations based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, World Integrated Trade Solution (WITS), Doing Business, and Logistics Performance Index (LPI). *Note*: Descriptive statistics are computed using the sample in column 1 of table 2. Std Dev: standard deviation; Min: minimum; Max: maximum; GDP: gross domestic product; GNI: gross national income; LPI: Logistics Performance Index. Variables from WBES are calculated over the entire population of firms (panel A) or the sample of exporting firms only (panel B). The description and source of variables are provided in table S1.4 in the supplementary online appendix.

2 (column 3), this first-year impact on the survival rate is also equivalent to an increase in the median ad valorem applied tariff of 136 percent. This is equal to increasing the median ad valorem applied tariff from 2.5 percent to 5.9 percent (and to 7.5 percent for the second-year survival rate, as well as to 8.6 percent for the third-year rate).

These results can be explained in light of the initial assumption that unpredictability in border-clearance times for key inputs disrupts the production process, making the importing exporter likely to miss delivery deadlines, and to lose sales contracts with time-sensitive buyers. The detrimental effect is felt by young exporters that started operating in foreign markets one, two, and three years ago, with import uncertainty taking an increasing toll on entrants' export activities with time. This entails that some export relationships are extremely short-lived, with time-sensitive buyers ending them as soon as the very first delivery deadline is missed. This is typically the case for markets such as low-end garments featuring little product differentiation and where buyers can easily switch suppliers owing to low search costs (Brenton, Cadot, and Pierola 2012). But even when a young exporter manages to survive more than a year past its entry date, it continues incurring costs associated with the loss of credibility as a reliable supplier. These reputational costs accumulate over time as the exporter experiences postponed delivery of its imported inputs, which erodes the "patience" and "confidence" of its customers, up to a level that ultimately leads them to terminate the business relationship.

Control variables broadly display the expected sign. The average number of years since firms started exporting in the sector is positively associated with the survival rate of new exporters, suggesting that the latter benefit from lower asymmetries of information associated with the collection of information on market conditions and business opportunities in international markets, possibly through the work performed by production associations or export-promotion agencies. For instance, following evidence from Lederman, Olarreaga, and Zavala (2016) for a panel of Latin-American firms between 2006 and 2010, export promotion agencies improve firm entry and survival in export markets. This is also in line with Carrere and Strauss-Kahn (2017), who show that experience raises the survival of developing countries' exports to the OECD, and with Albornoz, Calvo Pardo, Corcos, and Ornelas (2012), who underscore the importance of learning by exporting for survival. Sectors with larger and more productive firms are more likely to enjoy higher rates of export survival and lower exit rates.[25] TFP is also positively associated with firm entry rates, consistent with Melitz (2003) and Bernard et al.(2003). Standard proxies of bilateral trade costs, including tariffs, distance, and limited participation in economic integration agreements, lower export survival and increase exit rates. High costs of starting a business in the exporting country,

25 Bilateral distance and the dummy for participation in economic-integration agreements enter with a positive and negative sign, respectively in column 1. This seems to relate to the importance of South-North trade and relatively limited intraregional trade, hence leading firms from developing countries to enter mostly rich markets. It is also worth noting that Fernandes, Freund, and Pierola (2016) find a positive association between bilateral distance and firm export entry rate.

Table 2. Import Uncertainty and Export Dynamics: Core Results

	Firm Entry Rate (1)	Firm Exit Rate (2)	First yr. Survival (3)	Second yr. Survival (4)	Third yr. Survival (5)
Log import uncertainty	0.000	0.000	−0.040***	−0.059***	−0.072**
	(0.006)	(0.007)	(0.014)	(0.021)	(0.036)
Log direct imports (%)	−0.014	−0.004	−0.026	−0.020	0.061
	(0.011)	(0.015)	(0.031)	(0.053)	(0.093)
Log direct exports (% sales)	−0.027***	−0.032***	0.105***	0.113***	0.088
	(0.005)	(0.013)	(0.028)	(0.040)	(0.062)
Log experience	0.001	−0.004	0.115***	0.157***	0.126
	(0.013)	(0.016)	(0.035)	(0.058)	(0.104)
Log number of employees	−0.020*	−0.027***	0.081***	0.117***	0.132**
	(0.010)	(0.009)	(0.019)	(0.029)	(0.057)
Log total factor productivity	0.043*	−0.045**	0.175***	0.308***	0.269***
	(0.024)	(0.019)	(0.039)	(0.063)	(0.100)
Common border	−0.033	−0.040	0.065*	0.068	−0.020
	(0.022)	(0.027)	(0.039)	(0.059)	(0.089)
Colony	−0.079*	−0.019	0.148**	0.219*	0.080
	(0.041)	(0.041)	(0.073)	(0.112)	(0.283)
Log distance	0.110***	0.037***	−0.071***	−0.109***	−0.150***
	(0.009)	(0.010)	(0.018)	(0.029)	(0.051)
Trade agreement	−0.063***	−0.035**	0.098***	0.162***	0.194**
	(0.016)	(0.018)	(0.033)	(0.051)	(0.082)
Log tariffs	0.008	0.012*	−0.027**	−0.028*	-0.030
	(0.005)	(0.006)	(0.011)	(0.017)	(0.027)
Log exporter GDP cap.	−0.075	0.056	−0.042	−0.182	2.706*
	(0.097)	(0.117)	(0.181)	(0.260)	(1.640)
Log importer GDP cap.	0.061	0.004	0.122	0.136	0.264
	(0.041)	(0.049)	(0.098)	(0.152)	(0.229)
Log exporter entry cost (% GNI)	−0.021	−0.078*	−0.141*	−0.327***	0.155
	(0.036)	(0.043)	(0.084)	(0.121)	(0.400)
Log importer entry cost (% GNI)	0.013	−0.013	−0.011	−0.021	−0.115
	(0.014)	(0.018)	(0.035)	(0.054)	(0.083)
Constant	−1.036	−1.151	−1.232	−0.556	−25.937*
	(0.863)	(1.032)	(1.642)	(2.424)	(14.823)
Observations	14,476	12,001	11,834	10,755	5,680
R^2	0.182	0.183	0.106	0.100	0.123
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Destination Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).
Note: Regression estimates are obtained from the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Robust standard errors in parentheses are clustered on exporter-importer pair. Log direct imports (percent), Log direct exports (percent sales), Log experience, Log number of employees, and Log total factor productivity are computed over the sample of exporting firms, except in column 1 (all firms). GDP: gross domestic product; GNI: gross national income; yr: year. The description and source of variables are provided in table S1.4 in the supplementary online appendix.
***Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

which reflect the extent to which the business environment is conducive to firms' activities, also deter the survival of entrants but reduce the exit rate.[26]

26 Since the pool of firms exiting the export market in t comprises firms that were identified as entrants or incumbents in $t-1$, business start-up costs seem to act as a sunk cost of entry into foreign markets that only the most productive

Table 3. Import Uncertainty and Export Dynamics: South-North vs. South-South Trade

	Firm entry rate (1)	Firm exit rate (2)	First yr. survival (3)	second yr. survival (4)	Third yr. Survival (5)
South-North Trade					
Log import uncertainty	0.009	0.011	−0.061***	−0.085***	−0.091**
	(0.007)	(0.008)	(0.016)	(0.024)	(0.041)
Observations	10,363	8,693	8,513	7,857	4,290
R^2	0.191	0.198	0.104	0.099	0.120
South-South Trade					
Log import uncertainty	−0.014	−0.022	0.020	0.029	−0.025
	(0.012)	(0.015)	(0.030)	(0.000)	(0.000)
Observations	4,113	3,308	3,317	2,894	1,390
R^2	0.205	0.192	0.139	0.131	0.168
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Destination Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).

Note: Regression estimates are obtained from the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Robust standard errors in parentheses are clustered on exporter-importer pair. Control variables are included but not reported. Full regression tables are available upon request. yr: year. The description and source of variables are provided in table S1.4 in the supplementary online appendix.

*** Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

Heterogeneity

Beyond these baseline estimates, whether the adverse effect of import uncertainty on firm survival rates is more pronounced for exports to high-income countries is investigated. The rationale behind this assumption lies in the growing share of trade flows that belong to global value chains (GVCs). Multinational firms based in high-income countries outsource part of their manufacturing process, typically labor-intensive tasks, to suppliers in developing countries. Combined with the observation that importer-exporter relationships involving developed countries tend to rely more heavily on lean supply chain strategies (Volpe Martincus 2016), this makes buyers in high-income countries particularly sensitive to delivery schedules, and hence more prone to terminating trade relationships with unreliable suppliers in developing countries. By raising importing firms' probability of missing delivery deadlines, uncertainty in the time required to clear foreign inputs through Customs could exert a stronger effect on firm survival in high-income export markets. To test this prediction, the baseline regressions are estimated using two subsamples distinguishing between high-income (South-North trade) and non-high-income (South-South trade) destinations (table 3). The impact of uncertainty in import clearance times on export survival is mainly driven by South-North trade, as coefficients on the dependent variable of interest lose statistical significance in the subsample of South-South trade.[27] In a context of GVCs where time management is critical, this confirms the distinctive sensitivity of buyers in high-income countries to timeliness.

In the same vein, one would expect exports from time-sensitive industries to be more affected by unpredictable delays to clear imported inputs at the border. Hummels (2001, 2007) and Hummels and Schaur (2013) provide a classification of goods according to their time-sensitivity, based on trading firms'

firms—presumably the incumbents—can cover. The role of sunk costs in mediating the relationship between import uncertainty and export dynamics is also explored in this paper.

27 To rule out the concern that results may be driven by sample size, alternative regressions are carried out by augmenting the baseline model with a dummy equal to 1 if the destination is a high-income country and its interaction term with import uncertainty (results are available upon request). The message remains similar.

Table 4. Import Uncertainty and Export Dynamics: Sector-Specific Marginal Effects

	firm entry rate	firm exit rate	First yr. survival	Second yr. survival	Third yr. survival
Manufacture of food, beverage, and tobacco products	0.016	0.017	− 0.082***	− 0.104**	− 0.068
	(0.016)	(0.019)	(0.028)	(0.043)	(0.065)
Manufacture of textile and leather-related products	0.014	0.000	0.002	− 0.070*	− 0.134**
	(0.012	(0.014)	(0.027)	(0.042)	(0.063)
Manufacture of wood-related products	− 0.026*	0.024	− 0.025	− 0.042	− 0.044
	(0.015)	(0.017)	(0.034)	(0.047)	(0.094)
Manufacture of minerals, metals, and chemicals	0.032***	0.011	− 0.053**	− 0.040	0.020
	(0.011)	(0.013)	(0.025)	(0.037)	(0.068)
Manufacture of advanced products	− 0.030***	− 0.034***	− 0.039	− 0.030	− 0.155*
	(0.009)	(0.012)	(0.029)	(0.047)	(0.086)

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).

Note: Coefficients are marginal effects for cases where the export sector dummy for each manufacturing industry takes the value of 1. They are computed using parameter estimates from regressions of the baseline model augmented with an export sector dummy and its interaction with import uncertainty. Standard errors are in parentheses. yr: year. Detail on the aggregation of the five manufacturing sectors is available in table S1.1 in the supplementary online appendix. The description and source of variables are provided in table S1.4 in the supplementary online appendix.

***Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

choice between using expensive but fast air transportation versus inexpensive and slow sea shipping for their products. Time-sensitive goods include, for instance, perishable products likely to be spoiled in the event of delayed delivery, seasonal products such as garments and textiles which are subject to fashion cycles, and parts and components that are used as inputs in the production process. With this in mind, to test whether the effect of uncertainty in import clearance times on firm export dynamics varies across the five manufacturing sectors, the baseline regressions are augmented with an export sector dummy and its interaction with import uncertainty. The sector-specific marginal effects of import uncertainty on firm export entry, exit and survival rates along with their corresponding standard errors computed following Brambor, Clark, and Golder (2006) are summarized in table 4.[28] For each dependent variable of interest, the marginal effect of import uncertainty is displayed for cases where the export sector dummy takes the value of 1.

All export sectors exhibit some statistically significant effect of import uncertainty on firm-export dynamics. The negative effect of unpredictability in import clearance times on the first- and second- year survival rates of entrants in the food, beverage, and tobacco industry reflects the time-sensitivity of imported perishable goods that enter in the sector's production process. Similarly, the adverse effect of import uncertainty on firm export survival rates is verified for the textile and garment industry, as well as manufacturing of ores and chemicals. Since most developing countries are exporters of agricultural raw materials and natural resources, promoting manufacturing activities based on the transformation of these products contributes to value addition and export upgrading, paving the way to industrialization. Likewise, several studies corroborate the historical role of the garment industry in creating jobs and helping countries move up the value chain. Consequently, our results suggest that by reducing export survival, uncertainty in import processing times is an impediment to developing countries' diversification and structural transformation agenda. Last, and remarkably, import uncertainty now displays a negative effect on both firm entry and exit rates, but only in the case of advanced products exports. This could be interpreted as high-technology products such as machinery, motor vehicles and precision instruments, exhibiting high sunk costs of export entry and exit given their sophistication, translating into lower survival rates only three years after the firm's entry date into the foreign market.

28 Full regression tables are available upon request.

Table 5. Import Uncertainty and Export Dynamics: The Role of Sunk Costs

	Firm entry rate (1)	Firm exit rate (2)	First yr. survival (3)	Second yr. survival (4)	Third yr. survival (5)
Log import uncertainty	0.005	0.020*	−0.066***	−0.103***	−0.093*
	(0.009)	(0.011)	(0.021)	(0.032)	(0.056)
Log import uncertainty ×	−0.002	−0.009**	0.011*	0.020**	0.009
Log importer entry cost (% GNI)	(0.003)	(0.004)	(0.007)	(0.010)	(0.017)
Log importer entry cost (% GNI)	0.017	0.006	−0.035	−0.063	−0.134
	(0.015)	(0.019)	(0.037)	(0.058)	(0.089)
Observations	14,476	12,001	11,834	10,755	5,680
R^2	0.182	0.183	0.106	0.100	0.123
Country Fixed Effects	Yes	Yes	Yes	Yes	Yes
Destination Fixed Effects	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).
Note: Regression estimates are obtained from the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Robust standard errors in parentheses are clustered on exporter-importer pair. Control variables are included but not reported. Full regression tables are available upon request. GNI: gross national income; yr: year. The description and source of variables are provided in table S1.4 in the supplementary online appendix.
***Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

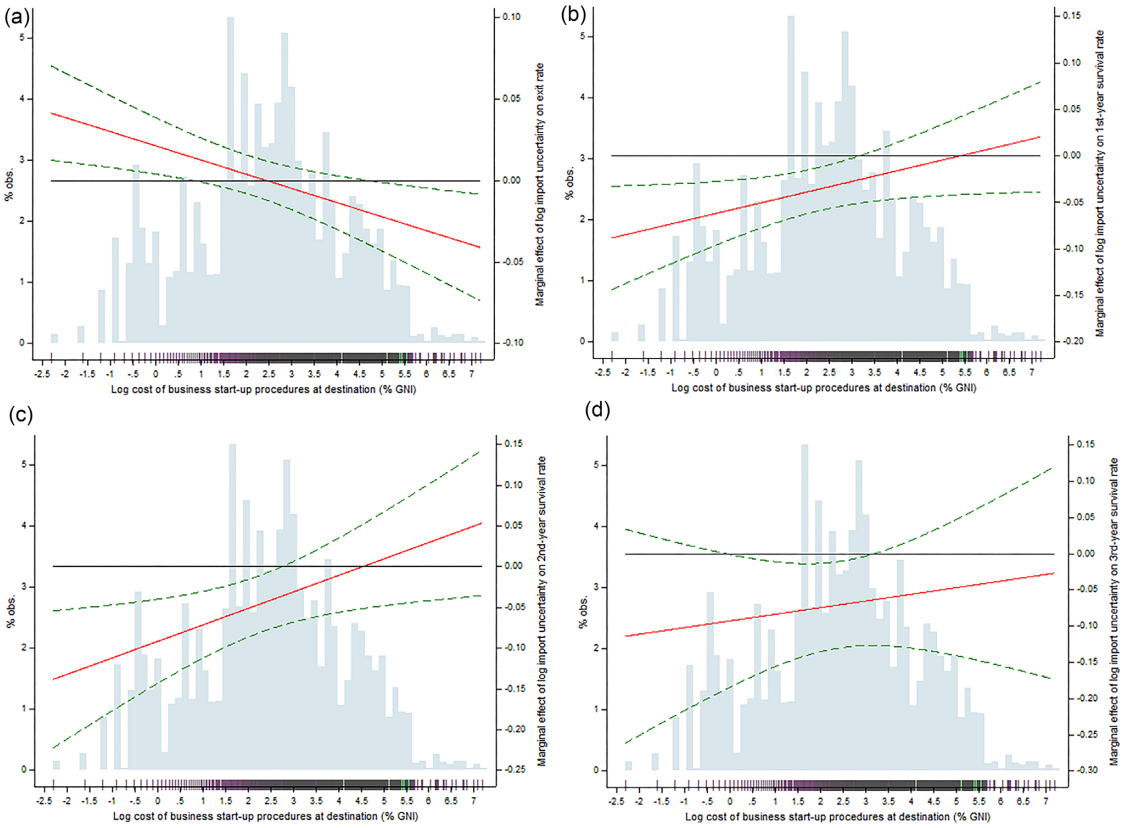
Finally, the role of sunk costs in mediating the relationship between import uncertainty and export dynamics is examined. The theoretical literature on hysteresis in international trade shows that firms must incur a sunk cost of entry to start serving foreign markets, which generates hysteresis in aggregate trade flows by inducing a high persistence in export status, hence raising export survival.[29] In a seminal paper, Roberts and Tybout (1997) find that prior export experience raises the probability of exporting by 60 percentage points for Colombian firms. In other words, sunk costs of entry induce persistence in firms' exporting status by making it hard to switch from non-exporter to exporter status, with those firms that have already incurred the sunk start-up costs to enter the foreign market more likely to remain exporters.[30] Sunk costs of entry pertain to the start-up costs faced by a firm that wants to export, such as the cost of identifying and informing potential buyers about its products, the cost of learning about the foreign market—including the prevailing regulations and standards—and the cost of setting up new distribution channels at destination (Melitz 2003). Based on a simple model of exchange rate uncertainty, Brenton, Cadot, and Pierola (2012) confirm the positive relationship between sunk costs and export survival by showing that a firm's option value of staying in the export market increases with sunk costs of reentry, even under the scenario of a negative exchange rate shock.

Against this background, the adverse impact of uncertainty in import clearance times on firms' export survival rates could be assumed to decline with increasing levels of sunk costs of reentry, leading exporting firms to wait before exiting the market as any future attempt of reentry would be costly. To test this prediction, the cost induced by procedures to start a business in the destination country (expressed as a share of GNI) is used as a proxy for the sunk costs incurred by a firm when entering that foreign market, building on Helpman et al. (2017). Regressions including the interaction term between the cost of business start-up procedures at destination and import uncertainty at origin are presented in table 5. The total marginal effect of import uncertainty on the exit rate of incumbents and entrants, as well as the

29 See the seminal work by Dixit (1989a, b); Baldwin (1988); Baldwin and Krugman (1989); Krugman (1989); and Dixit and Pindyck (1994).

30 The hysteresis effect associated with export participation has also been evidenced by Bernard and Wagner (2001) for German firms and Bernard and Jensen (2004) for U.S. firms.

Figure 4. Import Uncertainty and Export Dynamics: Marginal Effect Plots Conditional on Sunk Costs (a) Firm Exit Rate. (b) Entrant First-Year Survival Rate. (c) Entrant Second-Year Survival Rate. (d) Entrant Third-Year Survival Rate



Source: Authors' calculations based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).

Note: Marginal effect plots use parameter estimates from columns 2–5 of table 5 following Brambor, Clark, and Golder (2006) and Berry, Golder, and Milton (2012). Dashed green lines pertain to 90 percent confidence intervals. The vertical axis on the right indicates the magnitude of the marginal effect; the left axis is for the histogram depicting the distribution of observations in the sample across the range of costs associated with business start-up procedures in the destination country. Underneath each marginal effect plot is a rug plot, that is, a set of tick marks indicating the precise location of individual observations for the variable on the horizontal axis. The description and source of variables are provided in table S1.3 in the supplementary online appendix.

first-, second-, and third-year survival rates of entrants across a range of possible values of entry costs at destination is displayed in fig. 4. Following Brambor, Clark, and Golder (2006) and Berry, Golder, and Milton (2012), the vertical axis on the right indicates the magnitude of the marginal effect, while the left axis is for the histogram depicting the distribution of observations in the sample across the range of costs associated with business start-up procedures in the destination country. The survival-hindering impact of import uncertainty is found to weaken and even turn insignificant as sunk costs of entry in the foreign market rise. These results support the assumption that high sunk costs of entry lead new exporters to "tough it out" and wait for better times instead of exiting the foreign market right away, despite recording lower margins due to unpredictable import clearance times. In addition, the negative and statistically significant coefficient on the interaction term in the firm exit-rate regression suggests that this pattern is not exclusive to new exporters given a diminishing positive effect of import uncertainty on the exit rate (fig. 4), which turns insignificant and even becomes negative as the option-value of waiting rises with export entry costs at destination.

4. Robustness

The robustness of baseline results is checked in various ways: first by testing the relevance of the novel measure of import uncertainty; second by using alternative dependent variables to capture export dynamics, and third, by checking whether the baseline results are sensitive to additional control variables.

Measuring Import Uncertainty

The relevance of using the interquartile range to measure uncertainty is demonstrated in table S1.5 in the supplementary online appendix. The export-dynamics effects of uncertainty in border-clearance times for imports are distinct from that of the average and median time to import commonly employed in the literature (panels A and B). Neither the mean nor the median has a consistent and statistically significant effect on export survival rates. Indeed, a major threat to the identification of an uncertainty effect would have been if first moments had mattered more than second moments, meaning that the average or mean time to import matters more than the uncertainty in the time to import. Given that the coefficient on the uncertainty measure remains robust, this rules out concerns that such measure is a proxy for some first-moment effect or shock. For example, if border-clearance times were reduced within a year through a series of reforms, the interquartile range would be high because average or median wait times would be reduced over time. Even after controlling for these first moments, the significant effect of uncertainty on survival suggests a distinct effect from the well-known relationship between average import time and exports.

Panel C tests the robustness of the baseline results to the introduction of the median time to export and the uncertainty in the time to export, the latter captured by the interquartile range of the number of days required to clear exports through Customs. In doing so, the aim is to demonstrate that the export dynamics effects of uncertainty identified on the import side are distinct from any potential effect that may arise on the export side. Neither the median nor the interquartile range from the export side influences survival rates, suggesting that uncertainty in export times does not matter for the survival of young exporters. However, while the core results on the links between import uncertainty and export survival remain broadly the same, they are less significant (although still significant at the 10 percent level for first- and third-year export survival). This is explained by nonrandom sample variations. Once export uncertainty is introduced, the sample size shrinks with about 10 percent of observations lost. Yet the computation of the interquartile range for each country-sector-year cluster requires at least four data points in line with the number of exporting firms that provided information about the time to clear their exports through Customs. For many low-income countries, the number of exporters is low (and much lower than the number of importers), and these country-sector-year clusters that are lost with the introduction of export uncertainty in the model are overwhelmingly from low-income countries with higher-than-average import uncertainty. Moreover, as the relationship between import uncertainty and export survival is mainly driven by South-North trade (table 3), dropping a significant number of country-sector-year clusters from low-income countries with higher-than-average import uncertainty mechanically weakens this relationship and leads to those relatively lower statistical significance levels.

Finally, the negative effect of import uncertainty on export survival rates is found to hold even after controlling for maximum border-clearance times (panel D) and for the size of inputs held in stock by importers (panel E). This suggests that what the measure of import uncertainty captures goes beyond the influence of extreme delays in clearing goods at the border, which can undermine export dynamics by eroding the amount of inventory carried by firms to guard against supply chain unreliability.

Alternative Dependent Variables

The sensitivity of the main findings to alternative measures of export dynamics is also assessed using the number of entrants, exiters, and surviving entrants from EDD instead of the entry, exit, and survival rates,

Table 6. Robustness: Alternative Dependent Variables

	Nb. of entrants (1)	Nb. of exiters (2)	Nb. of survivors (3)
Log import uncertainty	−0.015***	0.008	−0.022***
	(0.005)	(0.008)	(0.007)
Observations	14,476	12,001	11,834
R^2	0.995	0.987	0.990
Country Fixed Effects	Yes	Yes	Yes
Destination Fixed Effects	Yes	Yes	Yes
Sector Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, and World Integrated Trade Solution (WITS).
Note: Regression estimates are obtained from the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Robust standard errors in parentheses are clustered on exporter-importer pair. Control variables are included but not reported. Full regression tables are available upon request. Nb: number. The description and source of variables are provided in table S1.4 in the supplementary online appendix.
***Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

respectively. Results reported in table 6 confirm the adverse effect of import uncertainty on firm survival. Import uncertainty also reduces the number of manufacturing firms entering the export market.

Additional Control Variables

Whether the main findings are sensitive to including additional variables that may be correlated with both export dynamics and import uncertainty—therefore giving rise to omitted variable bias if not accounted for—is also examined. First, the number of documents required to import taken from the Doing Business database in considered. This indicator covers the documents requested by the various actors involved in the import process, including government ministries, Customs authorities, port and container terminal authorities, health and technical control agencies, and financial institutions. Failure to furnish the required documents (or failure to submit them in due time) by the importer can influence border-clearance times beyond the direct implications for export performance already documented in the literature.[31] Results displayed in panel A of table 7 evidence a negative association between the number of documents required to import and the rates of entry and third-year survival, with no impact on the baseline findings.

Second, following the same rationale, an indicator is included that is derived from the Logistics Performance Index (LPI) and measuring the timeliness of shipments in reaching their destination within the scheduled or expected delivery time. Again, the baseline estimates remain unchanged, while the LPI index influences neither the entry nor the survival rate of exporting firms (panel B). The LPI index measures the timeliness of the entire import process, including transportation from the port of origin to the port of destination as well as road transportation to deliver the imported goods to the consignee's warehouse once they have been cleared, thus blurring the specific role of ports and government border agencies in generating delays. Therefore, its lack of statistical significance seems to suggest that the efficiency of Customs and other border agencies matters more than the performance of transportation companies.

Third, firms' access to finance is controlled for. As mentioned earlier, liquidity-constrained firms are likely to face difficulties paying on time the duties and fees associated with the import process, thus leading to longer clearance times and higher uncertainty as measured by the interquartile range of the time to import. The microliterature also provides ample evidence of the detrimental impact of financial

31 See for instance Li and Wilson (2009); Djankov, Freund, and Pham (2010); and Gamberoni, Lanz, and Piermartini (2010) for studies relying on the Doing Business Indicators to show the adverse impact of delays on trade outcomes.

Table 7. Robustness: Additional Control Variables

	firm entry rate (1)	Firm exit rate (2)	First yr. survival (3)	Second yr. survival (4)	Third yr. survival (5)
Panel A					
Log import uncertainty	− 0.004	− 0.003	− 0.036**	− 0.057***	− 0.072**
	(0.006)	(0.007)	(0.014)	(0.021)	(0.036)
Log documents to import	− 0.082**	0.081	0.052	0.281	− 0.526**
	(0.041)	(0.053)	(0.116)	(0.178)	(0.238)
Panel B					
Log import uncertainty	0.007	0.000	− 0.045***	− 0.074***	− 0.090**
	(0.006)	(0.007)	(0.014)	(0.022)	(0.038)
Log LPI timeliness	0.047	− 0.145	− 0.033	− 0.530	2.018
	(0.133)	(0.168)	(0.319)	(0.488)	(1.480)
Panel C					
Log import uncertainty	− 0.000	0.003	− 0.041***	− 0.060***	− 0.079**
	(0.006)	(0.008)	(0.015)	(0.022)	(0.036)
Log collateral (%)	− 0.034**	0.016	− 0.060*	0.000	− 0.040
	(0.016)	(0.016)	(0.031)	(0.045)	(0.070)
Panel D					
Log import uncertainty	0.000	0.001	− 0.033**	− 0.037	− 0.080*
	(0.006)	(0.009)	(0.016)	(0.026)	(0.045)
Log no loan application (%)	− 0.003	0.002	− 0.023	− 0.068**	− 0.108**
	(0.008)	(0.009)	(0.018)	(0.028)	(0.051)
Panel E					
Log import uncertainty	0.004	− 0.001	− 0.039***	− 0.061***	− 0.051
	(0.006)	(0.008)	(0.015)	(0.022)	(0.037)
Log bribes (% annual sales)	− 0.008	0.020*	0.012	0.003	-0.006
	(0.009)	(0.012)	(0.027)	(0.039)	(0.065)
Panel F					
Log import uncertainty	− 0.001	− 0.010	− 0.033*	− 0.045*	− 0.105**
	(0.006)	(0.010)	(0.017)	(0.025)	(0.045)
Log licensing obstacle (%)	− 0.006	− 0.008	− 0.031**	− 0.027	− 0.073*
	(0.007)	(0.007)	(0.013)	(0.019)	(0.043)

Source: Authors' analysis based on data from the World Bank Enterprise Surveys (WBES), Exporter Dynamics Database (EDD), Centre d'études prospectives et d'informations internationales (CEPII), Jeffrey Bergstrand's website, World Integrated Trade Solution (WITS), Doing Business, and Logistics Performance Index (LPI).
Note: Regression estimates are obtained from the Poisson Pseudo-Maximum Likelihood (PPML) estimator. Robust standard errors in parentheses are clustered on exporter-importer pair. Control variables are included but not reported. Full regression tables are available upon request. LPI: Logistics Performance Index; yr: year. The description and source of variables are provided in table S1.4 in the supplementary online appendix.
***Significant at 1 percent. **Significant at 5 percent. *Significant at 10 percent.

constraints on export dynamics.[32] If access to finance affects the ability of firms to enter export markets and survive while also influencing the time required to clear foreign inputs at the border, failing to properly control for its effect would yield biased estimates of the impact of import uncertainty on export dynamics. To address this concern, two variables drawn from the WBES are considered. To capture the burden imposed by loan requirements, the proportion of firms that had to provide collateral to obtain their most recent loan or line of credit is included. Alternatively, a broader indicator is used for the difficulties faced

32 Using data for Chinese firms, Manova, Wei, and Zhang (2015) show that credit-constrained firms are less likely to penetrate foreign markets, in line with findings by Minetti and Zhu (2011) and Muûls (2015) for firms in Italy and Belgium respectively. Besides preventing firms from breaking into new markets, lack of access to finance also reduces export intensity (Bellone et al. 2010; Kiendrebeogo and Minea 2017), and survival (Brenton, Cadot, and Pierola 2012). For instance, Cadot et al. (2013) find that firms operating in a foreign market with limited presence of other firms from the same origin are less likely to obtain a credit from banks if they seek to ramp up production and exports, translating into lower survival in the foreign market.

by firms to access the financing required to support their export activity, computed as the proportion of firms that needed a loan but did not apply for it owing to complex application procedures, unfavorable interest rates, excessively high collateral requirements, insufficient maturity and loan size, and anticipation of a negative decision by financial services providers. Results are displayed in panels C and D (table 7). Consistent with the literature, there is a detrimental impact of the proportion of loans requiring collateral on firm entry and first-year survival rates, with the coefficient on import uncertainty remaining unchanged across specifications. This is also broadly the case for the second variable capturing difficulties related to access to finance, which translate into depressed second- and third-year survival rates of entrants.

Fourth, the sensitivity of the baseline results to controlling for corruption is examined. As described earlier, stages of the import process could be plagued by rent-seeking and corrupt practices, with Customs officials accepting informal payments, for instance, in exchange for modifying the classification or valuation of the imported good for tax purposes. Inspectors from other government entities such as SPS agencies involved in the clearance process could also engage in kickbacks and other illegal transactions that would ultimately influence the time required to clear foreign inputs at the border.[33] Accordingly, two indicators taken from the WBES are included, namely (1) the share of annual sales spent in informal payments or gifts to public officials to "get things done" regarding Customs, taxes, licenses, regulations, and services; and (2) the proportion of firms identifying business licensing and permits as a major or very severe obstacle. The latter variable is a broad indicator of the quality of firms' interaction with public officials, and reflects firms' perception of the difficulty to obtain operating and import licenses. Panels E and F of table 7 show that overall, the core findings remain unchanged when introducing these two variables. The proportion of sales revenue forgone because of rent-seeking practices is positively associated with firm exit rates, while the share of firms reporting the incidence of hurdles faced in connection with business and import licenses reduces the survival rate of entrants.

While the robustness checks reported in this section show that the baseline results do not seem to be influenced by omitted variables bias, one may still argue about the presence of endogeneity due to reverse causality. This concern is ruled out for the following reasons. First, although one could claim that higher firm entry or survival rates in foreign markets may translate into more intense export activity leading to Customs and other border agencies overflow, and ultimately delays in the time required to export, it is difficult to see how this would also directly affect import times. Indeed, extensive data verifications and physical inspections carried out by border agencies for imports are usually not relevant for most exports. Unless the country applies Customs export duties, which few countries do nowadays and only for a limited set of products, Customs agents seldom check export values or classification (McLinden 2011).[34] This also explains why WCO guidelines to measure release times focus on import transactions (World Customs Organization 2011). Second, another potential reason for reverse causality is that, as more firms enter the

33 Based on the "efficient grease" theory, one could argue that an importing firm may find it rational to extend bribes so as to reduce the red tape it faces at the border and speed up clearance of its foreign inputs through Customs. In other words, corruption would enhance efficiency by helping lower bureaucratic burden and delay (Leff 1964 and Lui 1985). However, Kaufmann and Wei (1999) show that firms with the ability to pay more bribes to corruption-prone officials are precisely the ones that suffer more from "bureaucratic harassment" and red tape. In addition to influencing border clearance times, rent seeking has a direct bearing on firms' export decisions, as shown by Olney (2015), who finds that corruption reduces the likelihood that a firm exports directly while raising the probability of resorting to intermediaries to access foreign markets. More generally, the literature has emphasized the trade effects of institutional quality (see, for example, Levchenko 2007 and Nunn 2007).

34 Volpe Martincus, Carballo, and Graziano (2015) show that in Uruguay, some exports are subject to Customs physical inspections for the purpose of (1) collecting export taxes on a narrow set of products, (2) controlling tax reimbursement claims, and (3) fighting illegal trade. The first reason holds only for a limited list of countries and for a narrow set of products. The second reason requires the exchange of information between Customs and Tax administrations, a best practice rarely in place in most developing countries. Inspections to fight illegal trade also cover a limited set of transactions.

export market and survive, the private sector could push for Customs reforms for enhanced efficacy and reduced delays. This is also unlikely as current evidence shows a lack of coordination between the private sector and Customs and other border control authorities.[35]

5. Conclusion

As most exporters are also importers of intermediate goods, trade costs that constrain the capacity of firms to import are likely to affect their export dynamics as well, especially in the context of rising GVCs. Using trade flows, Customs transactions, and firm-level data, several studies have so far provided evidence of how the reduction of import barriers can shape export performance and diversification patterns. This paper contributes to this literature by quantifying a new source of trade costs based on a novel measure of uncertainty in import clearance times and by exploring its impact on manufacturing firms' export entry, exit, and survival decisions. Using the PPML estimator on a sample of 48 developing countries over 2006–2014, supply chain unreliability due to uncertainty in import clearance times is found to impact neither the entry nor the exit rate. However, it translates into lower survival rates for entrants, reducing the number of firms that continue serving the foreign market beyond their first year of entry. This effect grows larger over time with the accumulation of reputational costs to input-importing exporters and is mainly driven by South-North trade, possibly reflecting the time-sensitivity of importers in developed countries that tend to rely more heavily on lean supply-chain strategies. Results also reveal sectoral heterogeneity in the impact of import uncertainty, as well as the mediating role of sunk costs of entry in foreign markets that attenuate the negative effect of uncertainty on export survival rates as firms delay exiting the export market.

These findings suggest that developing countries seeking to promote the survival of newly exporting firms in foreign markets should consider implementing policies targeted at reducing the uncertainty these firms face when importing their production inputs. Predictability in border-clearance times is key to the smooth running of the supply chain, allowing firms to deliver on time to time-sensitive foreign customers. Notwithstanding the contribution of firm-specific factors such as limited financial liquidity or willingness to pay bribes in influencing the duration of the import process, the results highlight the role of external factors related to trade facilitation and the investment climate that are outside of firms' control, hence calling for policy action. Specifically, given the lion's share of Aid for Trade flows aimed at enhancing both hard and soft trade-related infrastructure and supporting border-related policies, the findings make the case for stepping up soft investments specifically designed to reduce supply chain unreliability due to unpredictable import clearance times.

First, efforts to address coordination failures among public and private actors involved in the movement of goods are key to lowering the dispersion of import times. For instance, incentivizing border control agencies, port operators, and other transport and logistics stakeholders participating in the import process to adopt IT and electronically interconnect themselves, through a Single Electronic Window for instance, would facilitate collaboration and information sharing. This would in turn avoid duplication of requirements for importers, and should bring significant gains in reducing import time unreliability. An additional low-cost initiative that could successfully reduce import uncertainty is the use of IT systems for cargo tracking and tracing by port and road freight transport operators; and nonintrusive inspection mechanisms such as scanners by Customs. Second, effectively implementing the WTO Trade Facilitation Agreement, especially provisions on advance rulings (Articles 3) and border agency and Customs cooperation (Articles 8 and 12) should significantly increase predictability and reduce the dispersion of

35 Article 23.2 of the WTO Trade Facilitation Agreement urges signatories to "establish and/or maintain a national committee on trade facilitation or designate an existing mechanism to facilitate both domestic coordination and implementation of [its] provisions" where the participation of the business community is highly recommended (International Trade Center 2015).

border-clearance times. Third, supporting the modernization of public border entities other than Customs, such as SPS agencies or the police, would significantly contribute to lowering supply chain unreliability by shortening the import process, as most import clearance delays usually originate from these agencies. In particular, incentivizing them to adopt risk-management systems aimed at reducing physical inspections for low-risk consignments without compromising their mandate of protecting the domestic market from phytosanitary threats or illegal trade is key to enhancing predictability in import times. Fourth, incentivizing the expansion of the Authorized Economic Operator (AEO) Program could open a fast-track and predictable clearance channel for compliant firms. Encouraging public agencies other than Customs to join is key for the program to be attractive to the private sector. Accepting a wide range of private stakeholders, including importers, exporters, Customs brokers, and transport and logistics services providers that comply with a list of security, tax, and Customs requirements is also key to facilitating the trade process without compromising its safety.[36]

Finally, the findings call for a revised methodology for quantifying time to trade by using transaction-level trade data. Nowadays, IT systems adopted by public and private operators involved in the trading process, such as ASYCUDA for Customs, Navis for port operators, and GPS devices for transport operators, make it possible to move away from perceptions-based indicators of time to trade—usually derived from expensive surveys administered to truckers—to transaction-based objective measures. These are usually produced at low cost based on time stamps collected from IT systems and for any container in movement along the logistics supply chain, from port arrival to cargo delivery at the importer's warehouse. Constructing measures of unreliability in trading times using Big Data opens new directions of research on trade costs and their impact on the trade performance of firms.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability

The EDD data underlying this article were provided by the World Bank by permission. Data will be shared on request to the corresponding author with permission of the Word Bank. Other datasets are publicly available and the data will be shared upon reasonable request to the corresponding author.

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36 In exchange, benefits for AEOs include lower clearance time, higher predictability, and lower logistics costs due to reduced movement of cargo within logistics terminals.

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