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The Border Labyrinth:

Information Technologies and Trade in the Presence of Multiple Agencies

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Inter-American Development Bank
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The Border Labyrinth: Information Technologies and Trade in the Presence of Multiple Agencies♦

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Abstract

Firms selling products abroad usually have to interact with several border agencies that develop multiple trade regulations and oversee their compliance. These regulations establish the procedures that these firms have to follow and the documents that they have to obtain, fill in, and submit for their exports to be authorized. In this paper, we estimate the effects of introducing information technologies as a new means to complete such trade-related procedures. In particular, we use highly disaggregated firm-level export data from Costa Rica over the period 2007-2013 and exploit the gradual phase-in of an electronic trade single window scheme across groups of products and ports. Results suggest that this new system has been associated with both an expansion in the number of exporting firms and increased firms' exports along the shipment extensive margin and the buyer extensive and intensive margins.

Keyword: Border Agencies, Information Technologies, Exports, Costa Rica
JEL-Code: F10, F13, F14

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1 Introduction

Both theoretical models and empirical analyses typically assume a dimensionless line-type of border. The real border, though, is thick. It is not merely a line but a zone populated by agencies that develop and administer regulations firms have to comply with when engaging in international trade. Information technology promises to eliminate the need to physically complete and move paper documents through the adoption of digitized forms and makes possible their simultaneous electronic processing by the multiple border agencies. This is expected to shorten the lead times between order placements and delivery due to faster processing and to reduce firms' costs of compliance with border regulations.

It is still an open question what role information technology had in explaining the tremendous expansion in international trade and the growth in global value chains seen in recent decades. In this paper, we show the impacts of information technologies as a means to complete the administrative procedures associated with the regulations firms have to comply on their trading activities. Our theoretical background informs researchers about the sources and mechanisms of trade frictions created by these procedures in particular and borders in general and the micro channels that are most important to understand the effects of new technology adoption. In addition, the empirical evidence we present informs policymakers about the costs and benefits of investing in information technologies as a means to facilitate trade, which is relevant in the light of the 2013 WTO Trade Facilitation Agreement.

More precisely, this paper investigates whether and how changes in the technology available for submitting, processing and sharing data to comply with border regulations affects trade. In particular, we take advantage of Costa Rica's gradual policy driven change from a paper-based to an electronic trade single window that allows for streamlined administrative procedures to obtain product-specific authorizations required to export to identify the impact of information technologies on firms' exports.[1]

We carry out difference-in-differences estimations on highly disaggregated firm-level export data from Costa Rica over the period 2007-2013 that distinguish whether shipments' required documentation was processed manually and separately with each intervening agency –even when potentially presented at a single physical entry point- or electronically in a simultaneous manner for all relevant agencies. Our results indicate that the introduction of an electronic single window that simplified administrative procedures has been associated with an increase in exports from firms whose products require permits. Such increase in exports can be traced back to higher shipping frequency, buyer diversification, and greater sales per buyer. This effect has been stronger for firms that have to interact with several public

[1] More specifically, Costa Rica implemented an automated information transaction system (see van Stijn, 2011).

agencies without offices in the regions these firms are located. This points to the benefits of relaxing geographical constraints that come along with the creation of a virtual exporters-agencies interface. Also important, the number of exporters has also responded positively to the implementation of the electronic single window. This implies that streamlined trade processing thanks to information technologies reduces entry costs and significantly affects trade extensive margin.

Border agencies do not only include customs -probably the most visible entity among them- but also a relatively large number of so-called Other Government Agencies (OGA). These agencies are responsible for health, food, quarantine, safety, and consumer protection. Survey-based evidence reveals that the median number of government agencies that have a direct regulatory involvement (or require information) in cross border transactions is 15 and that their number can reach 30 or more in some cases (see Choi, 2011). For instance, in Indonesia and Nigeria there are 37 and around 50 agencies with trade regulatory compliance responsibilities, respectively (see, UNESCWA, 2011). Compliance with their border regulations takes effort, time, and resources as many of these agencies have their own procedures and specific data requests, which are frequently paper-based and overlap with those of counterparts, and even their own processing systems.[2]

This spaghetti bowl and duplication of administrative procedures is not confined to developing countries. The US Department of Homeland Security's has recently introduced an Executive Order on Streamlining the Export/Import Process for America's Businesses signed on February 19, 2014 with the following statement: *Today, traders must submit the same information to multiple agencies, multiple times through processes that are largely paper-based and manual.* Thus, firms trading across borders may have to complete as much as 40 documents involving 200 data fields of which between 60% and 70% have to be rekeyed more than once (see APEC-BAC, 1996; Sathasivam, 2009). In Costa Rica, until some years ago the main 16 intervening agencies had 44 different procedures. Most of these procedures are specific to (groups of) products.[3]

In the absence of appropriate coordination and efficient processing mechanisms, these procedures associated with regulations can be repetitive, redundant and therefore create significant trade costs, especially when paper-based.[4] Trade single windows are flagship initiatives that reduce these hurdles by

[2] For example, in the United Kingdom there are more than 60 different trade procedures targeting goods, the vehicles that move them or their operators, and concerning revenue collection and fiscal protection, public safety and security, environment and health, consumer protection, and trade policy (see Grainger, 2007).

[3] The case of meat imports into the United Kingdom is illustrative in this regard. Five categories of procedures apply in this case including: license procedures administered by the Rural Payment Agency, procedures for booking and collecting cargo from shipping lines, procedures to clear goods through port health at the port of entry's border inspection posts, and procedures to clear goods through customs. Importantly, compliance with these procedures requires 26 transactional steps related to import licensing, shipping lines, port health, customs, and the port. These transactional steps involve using at least three different electronic systems (i.e., the port community systems at the UK's main ports; the port's vehicle booking systems; and the European veterinary entry system TRACES) and potentially several additional information and communication systems, and filling in between four and six paper documents (see Grainger, 2013).

[4] The costs of complying with trade-related regulatory requirements has been estimated to be 3.5% to 7% of the value of goods and can even reach 10%-15% of this value if there are typing and other errors (see van Stijn et al., 2011).

streamlining the administrative process related to international trade transactions. They are a f*acility that allows parties involved in trade and transport to lodge standardized information with a single entry point to fulfill all import, export, and transit related regulatory requirements* (see UNECE, 2005a).[5] More than 70 countries around the world have implemented single window schemes (see ESCWA, 2011; and World Bank, 2012).[6]

Information technology, ever expanding the ability to share information and increasing computing speeds at lower costs, and interoperability enabling methods (e.g., service-oriented architectures through which disparate systems to "talk" to each other) have made it possible to develop and implement *electronic trade single windows* (see UNESCWA, 2011).[7] Instead of filling and physically move paper-based documents consecutively, these single windows allow for online application, digital document exchange among agencies dealing with trade regulations, and issuance of trade-related permits and certificates.[8]

Upgrading technology from a paper-based to an electronic single window does not primarily change the information regulators demand but how this information is submitted and processed. This likely results in lower administrative processing costs as firms can manage trade-related documentation in a more efficient way thus minimizing clerical efforts. More importantly, electronic single windows are associated with an increase in the speed, timeliness, and accuracy of information submission and processing, and a reduction in response times.[9] Firms now interact with a single virtual agency instead of having to pay physical visits to obtain the paper forms and present them filed at the various regulatory agencies. Further, submitted data can be reused multiple times, errors from rekeying identical data are eliminated and data consistency is enhanced. Moreover, systems generally allow for better tracking the progress towards completing the procedures and for more predictable decisions (see UNECE, 2003; UNECE, 2005; UNESCWA, 2011; and van Stijn et al., 2011). Whether the implied *de facto* reduction in non-tariff barriers has actually translated into increased trade and, if so, how are still open questions. A likely reason for this lack of evidence is that the adoption of information technologies has not been typically observed in relationship to individual international trade transactions.

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[5] Single windows are used in many banking and e-government processes (see UNESCWA, 2011).

[6] These schemes have varying degree of comprehensiveness ranging from partial arrangements that only cover a subset of the universe of trade procedures with or without automatic transfer of the respective approvals to the customs declaration system to fully integrated arrangements also encompassing all logistic operations (e.g., at maritime ports, airports, and international road borders) (see ESCWA, 2011; and World Bank, 2012). Overall, most active single windows are limited in scope to trade formalities (see Choi, 2011). It is also worth mentioning that some of the regulatory activities may take place while goods are under customs control, while others are independent of these controls.

[7] A well-known non-trade example of how information technologies made it possible massive electronic data exchanges is the Society for Worldwide Interbank Financial Telecommunications (SWIFT)'s messaging system established in the 1970s (see Tsen, 2011).

[8] The initial version of Singapore's Single Window TradeNet developed at the end of the 1980s used a proprietary messages' exchange technology that consisted of 1.2 million lines of assembly code (see King and Konsynski, 1990; and Teo et al., 1999, on the implications of the introduction of electronic data interchange in this country). Advances in secured messaging technologies have broadened the alternatives to handle, process, and exchange increasingly large amounts of messages, and substantially reduced the time and costs needed to design and implemented a single window (see Tsen, 2011).

[9] Single windows can result in a significant reduction in the time spent in trade document preparation. Existing evidence indicates that the number of days required to prepare these documents is 40% lower in countries with trade single windows -8 days vs. 14 days- (see World Bank, 2013).

Given the large number of (usually unconnected and uncoordinated) stakeholders and the technical complexities involved, implementing an electronic single window is a far reaching undertaking.[10] Hence, countries typically follow an incremental step-by-step approach such that groups of border agencies and their respective procedures are sequentially incorporated into the arrangement (see, e.g., van Stijn, 2011; Tsen, 2011; and UNESCAP and UNECE, 2013).[11] In general, the order in which these agencies join and their procedures are accordingly added is determined based on their organizational readiness to introduce the technological innovation.[12] This was the case with Costa Rica.[13]

In this paper we make use of such typical stepwise implementation approach for identification purposes. More precisely, we take advantage of a gradual change in how firms can obtain product-specific authorizations required to export from a manual entity-by-entity scheme to an electronic single access point to identify whether and how the streamlining of administrative procedures associated with the introduction of information technologies actually affects firms' exports.

Admittedly, the use of the electronic single window could be voluntary, which could give rise to self-selection concerns. This is for instance the case in Germany and Sweden (see UNECE, 2005b). In Costa Rica the utilization of the single window is compulsory. True, in the presence of a transitional period in which both paper-based and electronic procedures coexisted or of enforcement problems, endogeneity associated with self-selection may be still an issue. Our baseline first-differenced estimating equation therefore includes firm-year fixed effects, which control for possible time-varying firm-level determinants of electronic single window usage correlated with exports such as access to computers and internet.

Although fixed effects are likely to go far in neutralizing potential endogeneity biases, they might not be enough to entirely rule them out. This would be the case in the presence of firm-product-destination level factors related to foreign sales that drive utilization of the new permit processing mechanism. For example, firms may choose to resort to the electronic single window when shipping a product to a destination based on the respective prospective sales. To address this concern, we carry out four main robustness exercises. First, as with all differences-in-differences estimations, a key identifying assumption is that exports processed under the electronic single window and their counterparts not processed under the electronic single window followed parallel trends in the period before the adoption of the system. In order to assess the validity of this assumption, we conduct a placebo test whereby we estimate the impact of the first use of the electronic single window assuming that this first use occurred one, two, or three

[10] A single window can be seen as "*complex piece of machinery with many moving parts*" (see van Stijn et al., 2011).
[11] The implementation of the Royal Thai Customs' paperless system is a clear example in that respect. It took approximately three years to introduce the information technology parts and three additional years for this system to be fully operative at all major seaports, airports, and land border crossings (see UNESCAP and UNECE, 2013).
[12] Alternatively, border agencies responsible for regulations applied on products that account for large shares of trade values and transaction could be prioritized (see van Stijn, 2011).
[13] According to our interviews with Costa Rican single window staff at PROCOMER, how good were the working relationships with the individual agencies and the strength of the personal ties between the management teams also played a role in determining the incorporation order.

years before it was actually observed, thus considering a sample where no exports were processed under the new system. Our results show only significant effects with the actual utilization but not with the artificially imputed utilization. Second, we run an event study in which we track the evolution of firm-product-destination exports from two years before the first utilization of the computerized procedures to the two years after and obtain estimates which are similar to those produced by our benchmark specification. Third, the transition to the new arrangement could be considered the period over which it was sequentially implemented across procedures and ports. Taking into account that this period extended until early 2011, we investigate whether our main estimates are driven by potential self-selection by allowing for different effects over the sub-periods 2007-2010 and 2011-2013. According to the estimates, the effect of the new scheme on firms' exports in the non-transitional period is in line with the baseline for the entire sample period.

Finally, in addition and on top of the differences-in-differences strategy, we double-check the robustness of our findings by using an instrumental variables approach. We primarily instrument firms' actual use of the electronic single window with the availability of such permit-processing technology across their product-destination combinations. This availability is determined by the incorporation of the procedures affecting their export products into the scheme and the adoption of the new customs information system at the ports these products are shipped from – which was needed for that scheme to operate. Even in this case, it might be conceivably argued that there might have been a correlation between the order in which the individual procedure-port combinations were added to the electronic single window (and customs information system) and the respective export growth in the immediately preceding period. In particular, (groups of) products whose exports have been growing fast in specific ports in previous years could have been given priority through an early incorporation of their respective permit-ports into the new scheme. Evidence generally indicates that there was no systematic association between previous export growth and the timing of the implementation of the single window. Also in this case, estimation results are in line with the baseline.

Our paper contributes to several literatures. Firms value short lead times and moving closer to the destination market reduces the time it takes to supply it. Evans and Harrigan (2005) provide evidence on this relocation mechanism focusing on textiles. Conditional on location, electronic administration of export permits and the simultaneous processing of information by various agencies is a policy driven technology upgrade that speeds up the regulatory control process and thereby relaxes the time constraint between placement and filling the orders.

Second, a series of studies assess the impact of trade regulations on exports. Trade theory shows that a decrease in per-shipment costs, possibly due to a reduction in border formalities' processing costs, increases shipping frequency (see, e.g., Kropf and Sauré, 2014; Hornok and Koren, 2015a). Existing empirical analyses use country-level measures from the World Bank's Doing Business Indicators to proxy

for administrative barriers and time to overcome them (e.g., Freund and Rocha, 2011; and Portugal Perez and Wilson, 2012; Hornok and Koren, 2015b).[14] This literature concludes that administrative barriers are important and that their reduction should have positive effects on trade. We make several contributions to this literature. We observe a well-defined policy experiment that streamlines trade procedures through the adoption of new technologies and can therefore precisely show for the first time how big the benefits of facilitating trade's regulatory control process are. Furthermore, our data reveal that these regulations vary across products (and change over time), so that firms have to meet different changing regulatory conditions for different export products. Moreover, we examine the micro channels by which changes in technology available to comply with such regulations matter for firms' exports, including entry into the export market and expansion across product and destination markets.

Third, we add to a number of papers that explore how internet and communication technologies affect international trade. Overall, this body of research conveys a consistent message: both internet and communication technologies are associated with increased trade. Thus, Freund and Weinhold (2002, 2004) find that the use of internet as proxied by the number of web hosts in a country enhances growth of both service and merchandise trade, respectively, while Fink et al. (2005) present evidence suggesting that communication costs matter for trade, particularly when differentiated goods are involved.[15] An important methodological challenge in this literature is that new technologies such as the internet affect firms, regulators, and policy through multiple channels. Our advantage is that we precisely observe the introduction of a particular information technology as a means to implement an explicit trade facilitation policy combined with comprehensive firm-level data.[16] This allows us to investigate why and how this technology influences exports. Importantly, from an economic policy point of view, adoption of information technologies for trade processing purposes is costly. The key question then becomes, what is the return to this investment? By combining export effects of the electronic single window with detailed information on its implementation and development costs, we compute a return of US$16 per each dollar spent on the new technology.

The remainder of this paper is organized as follows. Section 2 introduces the dataset. Section 3 describes the export regulations and the single window program in Costa Rica and presents basic statistics and preliminary evidence. Section 4 explains the empirical strategy. Section 5 discusses the estimation results, and Section 6 concludes.

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[14] In a related literature, some studies have explored the effects of non-tariff barriers in general and on specific groups of products on trade and welfare (e.g., Nogués et al., 1986; Leamer, 1990; Harrigan, 1993; Otsuki et al., 2001; Bradford, 2003; Deal et al., 2006; Moenius, 2006; Disdier et al., 2008; Kee et al., 2009; Beghin et al., 2012; and WTO, 2012, for a useful review).

[15] Choi (2010) also finds that internet stimulates service trade using a larger sample of countries and a longer time series. Blum and Goldfarb (2006) conclude that gravity holds in the case of digital products consumed over the internet without trading costs based on their analysis of internet activities in a sample of US households,whereas Lendle et al. (2012) show that the effect of distance –as proxy for trade costs- is smaller on eBay than on traditional offline trade.

[16] Timmis (2013) reports that internet access favors direct trade but has no discernible effect on intermediated trade using data from the World Bank's Enterprise Surveys.

2 Data

Our main dataset consists of three databases that were kindly provided by the Costa Rican customs DGA (*Dirección General de Aduanas)* and the Costa Rican national trade promotion organization PROCOMER (*Promotora del Comercio Exterior de Costa Rica*). The first database includes export data from 2007 to 2013. Each record includes the firm's ID, the product code (10-digit HS), the destination country, the foreign buyer, the export value in US dollars, and the quantity (weight) in kilograms. For 2010-2013 we additionally have transaction-level data. These data also inform the port, airport or land border (hereafter, generically "port") through which the shipment exits Costa Rica, the transport mode, the date in which the customs-processing of the shipment was requested (channel request) and date in which the shipment was authorized to leave the customs (release date), i.e., the customs clearance times (see Volpe Martincus et al., 2015). This database also reports the month in which the new customs information system started to operate in each port.

The second database informs, for each product of the tariff schedule and each year of the period 2007-2013, the permits that firms had to obtain in order to export these products. The third database covers all export transactions processed through the electronic trade single window since its establishment until 2013. It shares several fields with the customs database, which makes it possible to merge them. The electronic single window database therefore allows for identifying which specific transactions were actually processed under this new scheme and when and which not. This latter database also includes information on the date in which each permit (and specifically products) could start to be processed with that single window in each port.

3 Export Regulations, Electronic Single Window, and Trade Theory

This section describes export regulations and how single windows substantially simplify the compliance procedures based on the Costa Rican case and then explains how the change of processing technology from paper-based to computerized affects trade according to trade theory.

3.1 Export Regulations in Costa Rica

As discussed above, several public agencies intervene in the processing of trade flows. The operative counterpart is that several –even thousands- of specific products, uniquely codified by the Harmonized System Classification, are subject to controls (see UNESCAW, 2011). Costa Rica is not an exception in this regard. Export of various products requires prior permits, authorizations or certifications (hereafter

generically permits). More precisely, in addition to being registered as exporters with PROCOMER, firms intending to export these products have to obtain permits from the relevant agencies for their respective shipments to be releasable by the customs. These permits, which are known as *Notas Técnicas - NT* (Technical Notes), are essentially non-tariffs measures adopted by the country primarily to protect public health and safety as well as the environment and address information problems.

Table 1 shows the relative importance of permits in Costa Rican exports and their users. In particular, the upper panel reports the country's total exports and key aggregate extensive margin indicators (left) along with the share accounted for those requiring permits from 2008 to 2013 (right). Around 4,000 exporters sold almost 5,000 products to 151 countries for a total of 11.5 billion in 2013. Exports under permits account for approximately 30% of total Costa Rican exports, 37% of the total number of exporters, 21% of the total number of products exported, and 80% of the total number of destinations.

The lower panel of Table 1 characterizes both the overall average Costa Rican exporter in these years and the average exporter whose exports is subject to permits in terms of their total foreign sales, number of exported products, and number of destinations. On average, in 2013 exporting firms sold 9 products to 3 countries for approximately 2.8 million US dollars. The average exporter requiring permits is larger along these dimensions – this firm exports 13 products to 3.7 destinations for 5.4 million US dollars.[17]

Table 2 focuses on the specific regulations and lists the individual permits required in Costa Rica over the period 2008-2013 along with information on the agency responsible for their processing, the year in which the requirement was established, the products covered according to the HS 2-digit classification, and the joint share of these products in country's total exports in 2013. The NT 265 and 266 (and 273 and 274) are the phytosanitary and sanitary certificates for export and related procedures, respectively, which jointly account for a relatively large share of Costa Rica's aggregate foreign sales. These export permits are issued by national authorities in agreement with international practices and standards in this area. Take, for instance, the case of products whose trade requires a sanitary certificate. In this case, for Costa Rican exports of these products to be cleared in the destination country, a valid official sanitary certificate from the relevant Costa Rican agency must be submitted along with the respective import declaration. The same holds vice versa: imports of these products can only enter Costa Rica if accompanied with the sanitary certificate provided by the counterpart in the origin country. In order of importance, coffee and textile products follow among the goods whose exports are subject to regulations. These regulations have different rationales. While NT 134 has been primarily used to manage the textile quotas established in the framework of the multilateral and preferential trade agreements signed by Costa Rica (e.g., the free trade agreement with Mexico), NT 80 aims to ensure that the coffee sold abroad meets certain quality standards

[17] In fact, the t-test for differences in means suggests that the mean export indicators of the exporters requiring permits and those of their counterparts whose sales are not subject to these permits are significantly different from each other. The same holds when firms are compared based on the median values instead of the mean values of these indicators. A set of tables with these tests is available from the authors upon request.

set by the Costa Rican Coffee Institute (*Instituto del Café)* –a public-private organization- and thereby to protect the country's reputation as a provider. Most other permits involve products that are relatively insignificant in terms of the share of exports they are responsible for and legally derive from international agreements or norms.[18] From this point of view, the streamlined procedures associated with the electronic single window can be seen as a means to reduce the non-tariff barriers faced by a country's exporters.

Figure 1 presents on the x-axis the permits according to their introduction date from the earliest to the latest and on the y-axis the average annual growth rate of the exports of the products subject to each of these permit (either in the first year of their appearance or in at least one year in the period in which they have been in place) over the three years prior to their introduction. These graphs indicate that in principle there has been no systematic relationship between the timing of the permits and the growth of the exports of the goods these permits apply to.

3.2 The Costa Rican Electronic Trade Single Window (VUCE)

In Costa Rica, 16 entities issuing 20 authorizations in addition to the national customs intervene in the export process. Until the mid-1990s all these entities used different documents, which had to be presented in person in their respective different locations throughout the country's capital, San Jose. After being processed, these documents had to be delivered also in person at the corresponding customs office (see Figure 2). As a consequence, completing the formalities of the export process rarely took less than five days and often much longer (see Salas, 2010).

A first single window arrangement was established by the Law 7638 (article 8, incise c) passed in November 1996, which also created the Ministry of Foreign Trade and the public organization responsible to administer it, the national trade promotion organization, PROCOMER. This single window scheme primarily consisted of the harmonization of previous multiple heterogeneous forms with a non-negligible degree of overlapping in terms of information fields into a single and comprehensive document that gathered all data required by the intervening agencies. This single document could be presented in person at the main office of the single window in San Jose –in which officials of two of the agencies (responsible for health and agriculture) were also located, the regional offices of the single window –where no agencies were represented- (Santamaría, Caldera, Limón, Peñas Blancas y Paso Canoas), and the offices of the respective agencies. Except in the first case and for the authorizations

[18] This is the case with the NT 38, which is based on the Montreal Protocol on substances that deplete the ozone layer; the NT 51 whose product coverage reproduces the list of narcotics defined by the International Narcotics Control Board (INCB); the NT 52 which applies on those chemical substances that should be controlled according to the United Nations Convention on the Prohibition, Development, Production, Stockpiling, and Use of Chemical Weapons and on their Destruction; the NT 60, 71, and 72, whose legal basis is the Inter-American Convention against Ammunition, Explosives, and other Related Material and the International Convention for Suppression of Terrorist Bombings; the NT 81 which is associated with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); and the NT 269 which implements the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

handled by these two agencies, these documents had to be physically submitted for approval to the relevant entities.

Starting in the mid-2000s, PROCOMER moved to an electronic trade single window. The aforementioned single document was then required to be filled in just once online and the system automatically distributed it among the entities that, according to the norms, had to issue permits –thus without the need to go to a physical office or physically submit the form to these entities-. These permits were then submitted electronically to the customs systems to be added to the respective customs declaration (see Figure 3). From the point of view of the exporting firms, this allowed for a significant streamlining of the procedures and specifically for a reduction in the resources (and potentially the time) spent in dealing with the formalities associated with trade activities and, crucially, a shorter response time in the handling of their authorization requests.

The upper panel of Table 3 reports the share of exports and their main margins subject to permits that was actually processed through the electronic single window over our sample period. These shares increased over time to reach 90% or more in 2013.[19] The lower panel of Table 3 characterizes the average single window exporter, which, as expected, is very similar to the average exporter whose foreign sales are subject to permits. While the former average exporter is accordingly also larger than the exporting firms that do not have to use the electronic single window, these differences are then driven by the regulations rather by the actual use of this scheme.

Figures in Table 3 suggest that the implementation of electronic single window in Costa Ria followed the typical gradual approach observed in other countries. As shown in Table 4 for the two main technical notes in terms of the share of exports they account for, such stepwise introduction has two main sources. First, procedures (NT) were sequentially incorporated into the scheme, with the sequence being determined by the technological readiness of the respective agencies and the strength of the pre-existing working relationship between PROCOMER as the single window's coordinating unit and these agencies. As pointed out above, this generated variation in the use of the electronic single window across (groups of) products. Second, the new customs' information system TICA (Information Technology for Customs Control Scheme) was phased in to process export shipments throughout the ports in the country.[20] The TICA centralizes all the formalities and information necessary for customs control of merchandise trade. Once this system was in place, article 107 of General Law of Customs 7557, which requires all agencies to submit their permits electronically to the customs, became enforceable and actually mandatory. In this regard, it is worth noting that exports of given products to different destinations tend to be shipped from

[19] Trade regulations may change within a year. This explains –at least partially- why these shares were not 100% in 2013.
[20] Implementation of TICA was also sequenced across trade regimes. Thus, TICA was gradually put in place for transactions under special trade regime such as those by firms in free trade zones after it was completely operative for regular exports.

different ports (e.g., cocoa powder and maize starch are shipped through Peñas Blancas when the destination is Nicaragua and through Puerto Limón when the destination is the United States).

Importantly, Figure 4, which follows the same logic as Figure 1, reveal that neither permits affecting groups of products in specific ports nor even groups of products themselves in specific destinations –to allow for possible differential sectoral treatment within these combinations- with fast growing exports in the previous period were privileged in terms of the timing of their incorporation into the electronic single window and the TICA.[21] This is more formally confirmed by the estimates of regressions of a binary indicator that takes a value of one if exports of products subject to a given permit (or a given product subject to a permit) could be already processed under the electronic single window in the port in question (when shipped to the destination in question) in 2008 (or in 2008 or 2009) and zero otherwise on the respective average annual export growth rate over the previous three-year period.[22] The conclusion is the same when regressing the ranking of the permit-port or the product-destination combinations as determined based on the first date the respective shipments could be channeled through the new permit-processing mechanism on the aforementioned average annual export growth rates.[23]

Finally, note that, depending on their specific product-destination combinations, a given firm may use different ports in shipping abroad. Similarly, depending on their location, the ports utilized by firms may differ across them, even within product-destination combinations (e.g., firms closer to the Pacific Ocean frequently use Puerto Caldera to ship a given product to a given destination, while their counterparts closer to the Atlantic Ocean tend to resort to Puerto Limón to ship the same product to the same destination).[24] Hence, the gradual implementation of the electronic single window across products and that of the TICA for export transactions creates a variation in the processing mechanism of permits both across firm-product-destinations export flows in a given point in time and within such triples over time. Crucially for our identification purposes, descriptive evidence presented above suggests that such variation can be considered primarily exogenous from the point of view of the firms. We will come back to this more formally in the next section.

[21] This has been confirmed based on extensive interviews with the management of the single window at PROCOMER. More specifically, previous export performance or potential for export performance were definitely not among the criteria considered in deciding the order in which the agencies actually joined the arrangement.
[22] Table A1 in the Appendix presents the estimation results. Simple rank correlations are also consistent with the evidence presented therein. These results are available from the authors upon request.
[23] Estimations results are the same regardless of whether we estimate the relationship by Poisson or ordinary least squares (in which the ranking is expressed in natural logarithms).
[24] Over our sample period, more than 95% of the exports by firms located in the Atlantic coast were shipped abroad from Puerto Limón and less than 1% from Puerto Caldera, whereas almost 50% of those by peers located in the provinces on the Pacific coast exited through Puerto Caldera and only 15% through Puerto Limón.

3.3 Single Windows and Trade Theory

Short lead times are valuable. Focusing on textiles trade between the Caribbean and the U.S., Evans and Harrigan (2005) show both theoretically and empirically that firms are willing to pay a premium in order to locate close to the destination market where wages are high, but lead times are short. Exporters accept to pay the wage premium, because short lead times allow them the flexibility to respond to demand shocks and supply the market just-in-time when demand is realized. Based on this intuition, if lead times are a constraint for Costa Rican exporters and the implementation of the electronic single window reduces these lead times, then we would expect an increase in shipping frequencies and thereby exports, particularly for products with high demand volatility.

Related to this, Hornok and Koren (2015a) argue that consumers have a preferred arrival date for their shipment and that they value shipments that arrive closer to their arrival date more than shipments that deviate from their preferred arrival date. They demonstrate that a decrease in per-shipment costs due to a reduction of administrative border barriers leads firms to increase their shipping frequency. The reason is that with a lower per shipment cost firms make more shipments to reach consumers closer to their time of their preferred arrival. In their CES set-up this does not affect factory gate prices, but increases exports. This again delivers predictions regarding how the electronic single window can affect export outcomes. If the former reduces administrative barriers such that lowers per-shipment costs, then we would expect an increase in exports and shipping frequency, but no change in prices.

As for prices, there are two intuitive alternatives to the null hypothesis. On one hand, combining ideas from Harrigan and Evans (2005) and Hornok and Koren (2015a), if lead times are a constraint to get products to the market fast, then a reduction in these lead times and the ability to flexibly deliver when buyers most prefer these products is an upgrade in their quality that can induce an increase in prices. On the other hand, simple inventory models highlight that a reduction in administrative barriers and the resulting higher shipping frequency lower storage costs and accordingly prices. Assuming that consumer prices increase in the time between arrival and purchase due to storage costs and that demand arrives continuously, Kropf and Sauré (2014) establish that more frequent shipments lead to lower prices.

In summary, trade theory provides us with two main testable predictions. First, the introduction of the electronic single window should increase both exports and the number of shipments. Second, the effect on prices is undetermined. If the costs associated with compliance with border regulations decrease and firms pass these cost savings to consumers, then factory gate prices will decreases. If the reduction in lead times made it possible by the new arrangement allows for a more timely delivery close to the buyers preferred date, then factory gate prices will remain unchanged or even increase if the implied quality upgrade affects the exporters' optimal pricing rule. Thus, this is an open empirical question. Our estimates below will help establish which of these two forces prevails.

4 Empirical Methodology

As explained above, only a subset of products are subject to permits. In the analysis below, we therefore restrict our baseline sample to these products, thereby focusing exclusively on those targeted by public policy and that are potentially directly affected by the change in the technology available to complete the relevant procedures. Moreover, as discussed above, the staggered introduction of the electronic single window generated variation in the usage of the mechanism both across firm-product-destinations in a given year and over time within these combinations. In our estimations we exploit such variation to quantify the impact of the electronic single window on firms' exports by estimating the following equation on disaggregated firm-level export data:

$$lnX_{fpct} = \alpha SW_{fpct} + \lambda_{fpc} + \delta_{ft} + \rho_{\tilde{p}ct} + \varepsilon_{fpct} \quad (1)$$

where f denotes firm, p ($\tilde{p}$)stands for product at the HS-10 (HS-2) digit-level, c indicates country, and t indexes year. The main variables are X and SW. The former represents export value (or other export outcomes). The latter is a binary indicator that takes the value of 1 if firm f's exports of product p to destination country c in year t were processed through the electronic single window and 0 otherwise.[25] The coefficient on *SW*, α, is accordingly our parameter of interest. If $\alpha > 0$ ($\alpha = 0$), then reduced administrative processing costs associated with this new regime have a positive (no) impact on exports. The remaining terms of Equation (1) correspond to fixed effects that isolate the influence of potential confounders. Thus, λ_{fpc} is a set of firm-product-destination fixed effects that captures, for instance, the firm's knowledge of the market for a given product in a given country; δ_{ft} is a set of firm-year fixed effects that accounts for time-varying firm characteristics (e.g., size), competences (e.g., delivery of goods according to the specifications agreed upon), overall performance (e.g., productivity), and firm-level public policies (e.g., export promotion) as well as the companies' changing abilities to comply with border agencies' regulations; $\rho_{\tilde{p}ct}$ is a set of HS 2-digit product-destination-year fixed effects that controls for product-destination shocks such as changes in international transport costs across product groups and importing countries and fluctuations in demand for these groups of goods across markets; and for time-varying trade costs associated with customs and other administrative procedures in the various destinations; and ε is the error term.

[25] True, given that agencies (ports) could and actually did join the electronic single window (TICA) at different times within a year, it might be possible that some of the transactions making up an annual firm-product-destination export flow were subject to the old processing technology, whereas others were channeled through the electronic single window. Regrettably, we lack transaction-level data over the period 2007-2009 and hence we cannot determine to what extent this holds in the data. In any case, if anything, such potential mismeasurement would work against us because we would be considering flows partially processed under the new arrangement as fully processed through it. Further, for the sub-period 2010-2013 for which we do have transaction-by-transaction data, the share of the electronic single window transactions in the total number of transactions for a given firm-product-destination-year export flow is overwhelmingly zero or one. As shown below in Table 7, the estimated impact of the electronic single window is also positive and significant in this sub-period.

In estimating Equation (1), we use first-differencing to eliminate the firm-product-destination fixed effects. Note that, as typically the case when using this strategy to evaluate programs on more than two periods, the SW indicator has to be differenced along all other covariates (see Wooldridge, 2002).[26] The baseline equation we estimate is therefore as follows:

$$\Delta lnX_{fpct} = \alpha \Delta \mathrm{SW}_{fpct} + \delta'_{ft} + \rho'_{\tilde{p}ct} + \varepsilon'_{fpct} \quad (2)$$

where $\Delta \mathrm{SW}_{fpct} = SW_{fpct} - SW_{fpct-1}$; $\delta'_{ft} = \delta_{ft} - \delta_{ft-1}$ accounts for firm heterogeneity; $\rho'_{\tilde{p}ct} = \rho_{\tilde{p}ct} - \rho_{\tilde{p}ct-1}$ absorbs all product-destination shocks; and $\varepsilon'_{fpct} = \varepsilon_{fpct} - \varepsilon_{fpct-1}$.

By comparing changes over time in exports under the electronic single window and thus with streamlined procedures and those for exports that have not been processed under the regime and thus with no change in their procedures, we are controlling for observed and unobserved time-invariant factors as well as time-varying ones common to both groups that might be correlated with both use of the electronic single window and exports. In addition, Equation (2) includes fixed effects that account for systematic differences across firms and product-destination shocks, thus substantially reducing the risk of omitted variable biases and particularly of heterogeneity in export dynamics.

Estimation of Equation (2) can be potentially affected by serial correlation because it relies on non-trivial time series. In our baseline estimation, we therefore allow for an unrestricted covariance structure over time within firm-product-destinations, which may differ across them (see Bertrand et al., 2004).

The baseline equation assumes that the effect of the electronic single window on exports is symmetric across firms, products, and destinations. However, these effects may differ among groups of companies, goods, and countries, in which case such a restriction would not hold. Thus, for instance, impacts can be larger for firms that have to interact with more agencies or are located in regions where these agencies lack an office. Hence, we also generalize this equation to explore the existence of heterogeneous effects across those groups as follows:

$$\Delta lnX_{fpct} = \sum_{i=1}^{I} \alpha_i \Theta_i \Delta \mathrm{SW}_{fpct} + \delta'_{ft} + \rho'_{\tilde{p}ct} + \varepsilon'_{fpc} \quad (3)$$

where i indexes the groups of firms, products, or countries; and Θ is the corresponding group indicator.[27] These potentially asymmetric effects can inform how border procedures impact on exports.

5 Estimation Results

5.1 Baseline Results

The first column in the upper panel of Table 5 presents OLS estimates of Equation (2) for our main estimating sample: firm-product-destination-year observations that correspond to products subject to

[26] Keeping the program indicator in levels would lead to misleading results (see Wooldridge, 2002).
[27] The non-conditional effects of the variables that form the interaction terms are already accounted for by the sets of fixed effects.

permits. According to this baseline specification which controls for time-varying firm and HS 2 digit product-destination factors, the single window has been associated with 71.1% higher export growth.[28] The sample average (logarithm) annual growth rate of firm-product-destination exports is 2%, so this would imply that those processed under the electronic single window would have a rate 1.4 percentage points higher than those subject to the non-computerized procedures.

It is worth mentioning that this estimated impact broadly coincides with that of the first use of the scheme. This can be seen by estimating Equation (2) on the "First SW" subsample. This latter subsample creates a common "before treatment" period for both "treated" and "control" observations. It includes all exports that never used the SW before.[29] Estimates of Equation (2) based on this sample, which are reported in the second column in the upper panel of Table 5, are similar to that obtained from the whole sample. The same holds when, instead of restricting the sample to products whose export requires permits, all products are considered (see Columns 3 and 4 of Table 5).

We cluster standard errors by firm-product-destination in our baseline specification. Exports may be potentially correlated across other dimensions, though. In particular, given that the electronic single window was implemented by procedures-(groups of) products and customs branches-destinations (see Section 3), there may be correlation of exports flows across (groups of) products and destinations.[30] Hence, we have also re-estimated Equation (2) using alternative clustered errors to account for these potential correlations. More specifically, we also consider standard errors clustered at the (10 digit- and 2 digit-) product-, destination-, and firm-levels as well as all their possible combinations. The results are robust to these alternative clusterings.[31]

Admittedly, estimates shown in Table 5 cannot be automatically taken as a measure of the effect on total exports. The reason is that they might be driven by the granularity of trade flows (see, e.g., Eaton et al., 2012; di Giovanni and Levchenko, 2013; Gaubert and Itskhoki, 2015; Freund and Pierola, 2015; Bernard et al., 2015). More precisely, these flows generally tend to have a heavy-tailed distribution. Although not important from an aggregate point of view, small flows are likely to be markedly predominant and experience stronger export growth rate responses than their larger counterparts, thus being able to substantially influence our estimated average impact. We therefore re-estimate Equation (2) using WLS, whereby the weights are alternatively the size of the export flows at the firm-product-

[28] We have also directly estimated the fixed effect model given by Equation (1) using a procedure that handles multiple large sets of fixed effects. Results are in line with those reported here. These results are available from the authors upon request.
[29] Thus, for 2009 we only include exports that were not processed under the electronic single window in 2008; for 2010 we consider exports that were not processed under the electronic single window in 2008 and 2009; and so successively. The number of observations accordingly differs between the first column (entire sample) and the second column (first SW) of Table 5.
[30] In the same line, Bernard et al. (2015) show that margins of firms' exports tend to co-move together.
[31] Year-specific data on exiting customs are only consistently available for the period 2010-2013. Table A2 in the Appendix reports estimates of Equation (2) for this period along with all variants of standard errors presented in Table 5 and, in addition, those involving ports and these and permits. The significance of our estimates remains the same with the latter. The same holds when standard errors are clustered by the main dimensions considered in Table 5 combined with year. These latter estimates are available from the authors upon request.

destination level as proxied by their values in the first sample year (2007) –i.e., the year before the introduction of the electronic single window- or in the initial year of the variation (t-1).[32] The estimation results are presented in the lower panel of Table 5. These are perfectly in line with the baseline. Thus, granularity does not seem to be a major concern in this case.

We then use our baseline estimates to carry out a back-of-the-envelope calculation to quantify the impact of the establishment of the electronic single window on total Costa Rican exports. Taking into account that foreign sales subject to permits amount to approximately 30% of the total, this calculation reveals that, in the absence of such arrangement, aggregate exports would have been on average 2% smaller than they actually were over the period 2008-2013, which roughly amounts to 0.5% of the country's GDP. Given the prorated platform's development costs, its annual maintenance costs, and the annual operative budget of PROCOMER's Single Window Unit, this implies a benefit/cost ratio of approximately 16 US dollars per each dollar spent in the scheme.[33]

5.2 Robustness

While we have included comprehensive sets of fixed effects that allow us to control for unobserved firm and product-destination shocks, there might potentially be space for other factors that may have influenced firms' exports. For instance, tariffs or transport costs may have caused heterogeneous demand shifts across countries at narrower product levels than those accounted for by our HS 2-digit product-destination-year fixed effects that might be correlated with changes in permits' processing technologies. Similarly, firms using the single electronic window may have received support from PROCOMER to sell abroad and this might have resulted in increased foreign sales in specific sectors or destinations, in which case we would be overestimating the effect of interest. Moreover, there might have occurred shocks to input provision that might have differential effects on production across goods or changes in firms' competencies across them or specifically firms may have used the electronic single window to import certain inputs thus favoring the production and foreign sales of specific goods. Furthermore, firm-product-destination exports (first) processed under the electronic single window might have different average growth rate than their counterparts not (later) processed through this scheme in the absence of changes in the technology used to complete trade procedures. We have therefore also estimated alternative specifications of Equation (2) in which product-destination-year fixed effects are defined at the

[32] When we use the 2007 weights, the number of observations decreases substantially because we are implicitly requiring the firm-product-destination triples to be present in all sample years.

[33] PROCOMER roughly invested 1.15 million US dollars to develop the platform for both exports and imports. Maintenance costs are covered through usage fees of 3 US dollars per transaction. Over our sample period, an average of 163,000 export transactions was processed through the electronic single window per year. The average total annual operative budget of PROCOMER's Single Window Unit over our sample period was about 570,000 US dollars. The benefits used to compute the benefit/cost ratio reported in the text do not include the savings for the public administration associated with the reduction in the number of officials that have to be assigned to handle permits. If these savings were included, such ratio would be around 20.

HS 4-digit and 6-digit levels, firm-destination-year or firm-product-year fixed effects are included instead of merely firm-year fixed effects, or firm-HS 2 digit product-destination fixed effects are added. Estimates of these alternative specifications along with that not including fixed effects are reported in the upper panel of Table 6.[34] These estimates essentially corroborate our main initial findings.[35]

Unfortunately, these estimations do not control for a key time varying firm-product-destination factor that might be correlated with the utilization of the new computerized procedures, the customs delays.[36] Hence, we have also estimated the previous alternative specifications of Equation (2) augmented to include the change in the median number of days that the respective firm-product-destination spent in customs as a control variable over the period 2010-2013 (see Volpe Martincus et al., 2015). The estimates of this equation are presented in the lower panel of Table 6. These estimates confirm our baseline results.[37]

One key assumption in our difference-in-differences-type of estimation is that exports processed under the electronic single window and their counterparts without changes in the processing technology had parallel trends before the establishment of the electronic single window. In order to assess the plausibility of this assumption, we first carry out a falsification exercise which implies regressing current export changes in future permit processing mechanism changes. More specifically, we artificially assumed that the first use of the electronic single window has taken place one, two, or three years before it actually occurs and re-estimate Equation (2) on the sample of firm-product-destination export not using such arrangement. These placebo estimates are shown in the upper panel of Table 7 along with those for the respective real first utilization of the new computerized procedures as obtained from the same firm-product-destination combinations.[38] Reassuringly, the latter estimated coefficients are significantly different from zero but none of the former are, which points to the inexistence of pre-electronic single window differences in export trajectories.

[34] On the other hand, larger set of fixed effects impose larger restrictions on the estimation sample. However, this does not seem to drive our results. Estimates based on specifications that do not include fixed effects confirm that the new permit processing mechanism has had a significant positive impact on exports although smaller in absolute value. Alternative specifications that just include firm(-year) fixed effects, product(-year) fixed effects, destination(-year) effects or their alternative pairwise combination at a time yield similar results. These alternative results are available from the authors upon request.

[35] The same holds for estimates of a modified version of Equation (2) that includes firm-year and product HS 2 digit-main port-year fixed effects as obtained from data at the firm-product-destination-year level and those of another variant that incorporates firm-year and product HS 2 digit-port-destination-year fixed effects based on data at the firm-product-port-destination-year level. Further, a similar conclusion is reached when we estimate another version of Equation (2) with firm-product-destination-year and semester fixed effects on semester frequency data. These estimates are available from the authors upon request.

[36] If goods are ordered in advance, trade can respond sluggishly to changes in the technology available to comply with the procedures established by export regulations. In short, adoption of the electronic single window can potentially have lagged effects on exports. We have therefore also controlled for these effects by expanding Equation (2) with up to three lags of the electronic single window indicator. The estimation results do not differ from the baseline and are available from the authors upon request.

[37] While the estimated coefficients on the electronic single window are smaller when customs delays appear as an additional covariate (third panel) than when this variable is not included (second panel), they are not significantly different from each other.

[38] The number of observations differs because in the latter we restrict the sample to non-electronic single window observations, thus excluding the year in which the first use was observed.

In addition, we conduct an event analysis (see, e.g., McCrary, 2007). In particular, we track the behavior of firm-product-destination export flows that adopted the electronic single window in a given year two years before and two years after that adoption year. More formally, we estimate the following equation

$$\Delta lnX_{fpct} = \sum_{j=-2}^{2} \alpha^{j} \, \Delta \mathrm{SW}_{fpct} + \delta'_{ft} + \rho'_{\tilde{p}ct} + \varepsilon'_{fpct}$$

The estimates of this equation are shown in lower left panel of Table 7. In accordance with a causal interpretation of the findings reported so far, these estimates are not significant before the first use of the electronic single window and become significant once this permit processing mechanism is utilized. Furthermore, while positive impacts are observed even two years after adoption, their strength appears to decline over time. More precisely, the effects in the two initial years are clearly larger than that after two years.

Even though they are seemingly convincing, previous estimation results might not be enough to establish causality if, as discussed in the Introduction, both the paper-based and the paperless systems were allowed to be used during a transition period or there were delays in enforcing the mandatory use of the electronic single window. In this case, firms could self-select into the use of the latter which could lead to biased estimates. Thus, firms with computers and access to internet would be more likely to submit their permit requests through the electronic single window from the very beginning while their peers lacking these technological means may have joined later on, and both computers and internet could be directly associated with increased foreign sales. While the firm-year fixed effects should account for such factors creating differences in the propensity to utilize the scheme across firms over time, it is arguably possible that firms could decide on the technology with which they process the permits required by their different products based on their specific export growth prospect across destinations. In order to account for the potential endogeneity bias derived from this particular type of self-selection, we follow two strategies. First, we make use of the aforementioned transitional period, which can be considered to correspond to that over which the new scheme was gradually implemented across procedures and ports. According to the TICA implementation schedule, this period extended until early 2011 (see DGA, 2011). This seems to be confirmed by figures reported in the upper panel of Table 2, which shows that the share of exports accounted for by the electronic single window jumped to over 90% between 2011 and 2012. We therefore estimate a variant of Equation (2) whereby we allow for different effects over the transitional, potentially voluntary period 2007-2010 and the established, mandatory period 2011-2013. Estimates of this equation are presented in the second lower panel of Table 7. The

estimated impact for the latter sub-period is still positive and significant, so our baseline does not appear to originate from self-selection.[39]

Second, we estimate Equation (2) by instrumental variables whereby we instrument the actual use of the electronic single window ("demand") with a year-specific binary indicator that takes the value of one if the product in question subject to permit could be processed through the electronic single window in the main port from which it is normally shipped to each destination and zero otherwise ("supply") or its interaction with the share of that main port in the firms' exports in the respective product-destination combination. Given that firms can use different ports in shipping their product to the different destinations and that the system was gradually rolled out across permits and ports, this instrument can account for why some firms use it and others do not for a given product-destination in a given year (see Section 3). Further in this regard, recall that we do not find any systematic relationship between the timing of the implementation of the electronic single window across permit-product-port combinations and their respective (previous) average export growth rates (see Section 3).[40]

The instrumental variables estimates of Equation (2) along with those of the respective first stage and reduced-form equations and the F-test statistics, are shown in the lower right panel of Table 7. The F test statistics indicates that the availability of the electronic single window to request the permit needed to export a given product to a given destination through the main port (and when this port is important for the firm) is indeed correlated with its actual use after conditioning by firm-year and HS 2-digit product-destination-year fixed effects. As for the exclusion restriction, while it cannot be formally tested because there is only one instrument for the endogenous variable, it is likely to be fulfilled by definition. The reason is that, conditional on our fixed effects, the possibility to use the electronic single window could in principle not affect foreign sales through channels other than its actual use.[41] These instrumental variables and reduced-form equations estimates also concur in suggesting that the electronic single window has favored an increase in firms' exports. We should mention herein that the same is true when

[39] It might be argued that compositional effects could play a role here. However, this does not seem to be the case. Results are virtually identical when we restrict the sample to products subject to permit in every single year of our sample period and to these products conditionally on being exported all years. Furthermore, the length of the transitional period might have differed across product-destination combinations depending on the initial readiness of regulatory agencies and ports to absorb the technological innovation. Hence, we alternatively define asymmetric transitional phases across these combinations. In so doing, we assume that the use of the electronic single window became mandatory in a given product-destination the year in which its share in the respective total exports exceeded 90% and identify as the mandatory phase for the sake of the estimation that extending from the previous year to the end of the sample period. We accordingly estimate a modified version of Equation (2) which allows for different impacts over such mandatory phase and the respective preceding transitional phase. Estimates of this equation are also consistent with those reported in Table 7. These alternative estimation results are available from the authors upon request.

[40] Port relative importance can be considered predetermined since, if anything at all, port switching is marginal.

[41] We could conceivably think that launching the electronic single window to process the permits required to export a given product in a given port could favor exports from users at the expense of those from non-users. For instance, fewer resources could have been devoted to process non-computerized permit applications. We assess whether this could be a serious threat to our identification approach by estimating Equation (2) on a sample in which the control group is restricted to HS 4-digit products encompassing HS 10-digit products using and not using the electronic single window and on a sample in which the control group is restricted to HS 4-digit products without HS-10 digit products using the electronic single window. These estimates do not differ from the baseline and henceforth indicate that such potential cross-effects are not major concern. These estimation results are available from the authors upon request.

we alternatively use a location-based instrument, namely, a binary indicator that takes the value of one if the product whose foreign sales requires a permit could be processed under the new scheme in a port within the same province in which the firm is located and zero otherwise or its interaction with the share of this port in the respective product-destination combination.[42]

Finally, in order to account for the presence of zero trade flows, we estimated a modified version of Equation (2) where the dependent variable is the mid-point growth rate (i.e., the ratio of the difference between the two absolute consecutive values to their average), which allows us to include the initial zeroes for new exports and the final zeroes for the disappearing counterparts. Estimates of this alternative equation corroborate our main findings.[43]

5.3 Channels

In this subsection we explore the channels through which the electronic single window affects exports. In disentangling these channels, we estimate the effects of the new technology to carry out the border procedures on the quantity (weight) shipped, the unit values, the number of buyers, the average value and quantity per buyer, and, for the period 2010-2013, on the number of shipments and the average value and quantity per shipment, based on Equation (2). Estimation results are presented in Table 8. These results reveal that the streamlined administrative procedures thanks to the incorporation of information technologies have positively affected the number of buyers firms sell to, the average sales to these buyers in terms of both value and quantity, and thereby the quantity shipped. Thus, the new permit processing mechanism has been associated with an increase in the number of buyers of 22.4% and the average export per buyers of 43.5%, respectively.

Importantly, the electronic single window has had a significant positive impact on the number of shipments. In fact, increased shipping frequency appears to be the main driving force behind the observed export expansion. However, there is no effect on the shipment size neither overall (i.e., across buyers) nor for specific exporter-importer relationships (i.e., within buyers). If anything, quantity per shipment decreases within seller-buyer relationships. This is exactly what one would expect of the implementation of this new system made it possible a reduction in the per-shipment fixed costs. It is worth pointing out that these results are in line with the trade theory reviewed in Subsection 3.3. More precisely, they indicate that, thanks to such cost reduction, firms are able to place smaller shipments at higher frequency, which is what we would expect if sellers are trying to hit customers' preferred arrival date or if they supply the market multiple times under demand uncertainty.

[42] These alternative estimation results are available from the authors upon request.
[43] These estimation results are available from the authors upon request.

Moreover, there is a positive and marginally significant effect on prices in the two samples we consider. Overall, the pattern of the coefficient estimates suggests customers' value the shorter lead times and sellers are able to absorb some of the implied quality improvement with higher prices.

5.4 Mechanisms

We next investigate the underlying mechanisms of observed effects. In particular, we assess whether there are heterogeneous effects along various dimensions by estimating alternative specifications of Equation (3), in which we primarily allow for different impacts across groups of firms, products, and destinations.

First, we allow for different effects depending on whether firms have to get permits from regulatory agencies that are o not located in the same region (i.e., *canton*) in which they are established. Online application and obtaining of permits through the electronic single window is likely to have had a stronger impact on exports from firms located in regions without offices of the issuing organizations, since they experienced larger savings in the costs and time associated with visiting these offices. This is precisely what the respective estimates of Equation (3) shown Columns 2 and 3 of Table 9 indicate. Further, such effect could be expected to have been more pronounced if, due to their export portfolios, the public entities located in other regions from which firms have to get their permits are many and not just one. Estimates of this variant of Equation (3) presented in Columns 4 and 5 of Table 9 suggest that this has been indeed the case. Moreover, estimation results reveal that the electronic single window has had a positive and significant impact on unit values of exports from firms that do not collocate with border agencies (especially when these are multiple) but a negative albeit insignificant effect on those from peers that do not suffer from that locational disadvantage. This would suggest that, thanks to the decentralization of administrative procedures associated with information technology, firms with longer times to obtain and present permits could reduce their lead times and exploit consumers' valuation of these shorter time leads by increasing prices.

Second, we distinguish between small exporters (i.e., firm with up 100) and large exporters (i.e., firms whose number of employees is above this threshold) and between experienced exporters (i.e., firms systematically exporting since 2005) and inexperienced exporters (i.e., firms that started to export after 2007).[44] Estimates are reported in the upper panel of Table 10. These estimates indicate that larger firms seem to have benefited slightly more than their smaller counterparts from the computerized procedures

[44] Employment data come from CCSS (*Caja Costarricense de Seguro Social*). The number of observations is smaller than in previous tables because information on number of employees is not available for all exporting firms. We therefore also report for reference estimates of our baseline equation on this restricted sample. These estimates are in line with those shown in Table 5.

and, interestingly, new-to-export firms gained significantly more than experienced exporters.[45] In this regard, it should be noted that so far the analysis has focused in the effects of streamlined border procedures on the export intensive margin (i.e., continuing flows). The change in the permit processing mechanism can have additionally induced new firms to venture in foreign markets for the first time. We have therefore also examined the impact of this new scheme on the firm extensive margin. More specifically, we have estimated modified versions of Equation (2) at the product-destination-year level and at the product-year level in which the main dependent variable is the change in the number of firms registering exports in the product-destination or the product in question and the main explanatory variable is change in the electronic single window indicator at the respective level along with HS 2 digit product-destination-year fixed effects or HS 2 digit product-year fixed effects, respectively. By aggregating away firms, this strategy also has the advantage that estimates are less prone to be affected by the potential self-selection and granularity problems discussed above. These estimates are shown in the lower left panel of Table 10. According to them, the actual simplification of procedures made it possible by the introduction of the electronic single window has had a significant positive impact on the firm extensive margin and thus it seems to have indeed helped new firms enter into export markets.[46] In fact, when the growth of export values associated with the new arrangement is decomposed into those related to the firm intensive and extensive margins, we observe that the increase in the number of exporting firms accounts for between 44% and 48% of the export expansion at the product-destination and the product levels, respectively. It is also noteworthy that the scheme seems to have favored export diversification across destinations.[47]

Third, we assess the existence of heterogeneous effects across products. More specifically, we discriminate across good categories following Hummels and Schaur (2013). The estimation results, which are presented in Table 11, reveal that the effects are consistently larger on exports of food and textile

[45] The employment threshold corresponds to the classification used by the CCSS (2007). In particular, firms with up 100 employees are considered small and medium-sized whereas those with more than 100 employees are considered large. We should note herein that results do not change if we use different break points to classify firms in terms of their size (i.e., 50 employees or 200 employees) or impose the condition that small and large firms export in the same product-destination combinations. These results are available from the authors upon request.

[46] Moreover, estimates of variants of the previous equation on data at the product-destination-firm size category-year level and at the product-firm size category-year level that additionally allow for different impacts on small and large firms reveal that the new permit processing mechanism has been effective in helping smaller firms penetrate foreign markets. These estimates are available from the authors upon request.

[47] We have also assessed the impact of the electronic single window on the destination margin for firms' exports of given products. More specifically, we estimate a variant of Equation (2) where the dependent variable is the change in a binary indicator that takes the value of one if a firm-product-destination flow is present in a given year and zero otherwise and the main explanatory variable is the change in the electronic single window status indicator between two consecutive years, on the sample of all firm-product-destination triples that did not register exports in 2007 conditional on the firms exporting the products in question to at least one destination. Alternatively, we have estimated another modified version of Equation (2) at the firm-product-year level where the dependent variable is the change in the (natural logarithm of the) number of destinations and the main explanatory variable is the same as above on the sample of firm-product combinations existing in 2007. Estimates of these two equations also consistently suggest that the new permit processing mechanism has facilitated destination diversification.

products.[48] As evident from Section 3, these are precisely the products whose exports are more heavily subject to permits.[49] These results are consistent with those obtained when looking at the electronic single window impact from the angle of the permits these products are subject to (see the lower panel of Table 11).[50]

Finally, heterogeneous effects can also arise across destinations. In Table 12 we explore whether this holds in our data by distinguishing between developed (OECD) countries and developing (non-OECD) countries and between close and distant destinations as determined based on whether their distances to Costa Rica are up to or above the median of the respective distribution. We do so with and without imposing the common product constraint across these groups. Evidence presented in this table indicates that the positive response of foreign sales to computerized border procedures has been stronger in the developed countries' markets, where competition tends to be more intense and demand for quality higher. Interestingly, this differential impact is larger along the buyer extensive margin. Estimates reported in the right panel of the table suggest that this seems to be at least partially related to the distance to the different destinations. In addition, the electronic single window seems to have resulted in increased unit values in close-by destination but no changes in far-away destinations. Shorter lead times can therefore be seen as akin to quality upgrade that allows firms to raise prices in particular to nearby markets. This is consistent with Evans and Harrigan (2005) and Hornok and Koren (2015a), who precisely highlight that time sensitive products, where short lead times are important, are imported from close by locations and consumers value their timely arrival.

6 Concluding Remarks

Getting products out of the country can be more laborious than normally assumed. It is not only about reaching the border and how this is influenced by the availability and quality of transport infrastructure. It is about the borders themselves. The border agencies and the regulations firms have to comply with when exporting may create a formalities' labyrinth, which can be hard to go across.

Streamlined procedures thus narrow the borders thereby facilitating the movements of goods across them. Information and communication technologies can be a key element for these trade facilitation initiatives to be effective. While available anecdotal evidence seems to indicate trade facilitation programs

[48] These two product categories accounted for more than 20% of total Costa Rican exports and approximately 60% of those subject to permits in recent years.

[49] In fact, we do observe that products requiring more permits have experienced larger export gains with the introduction of the electronic single window.

[50] Note, however, that we do not find any effect on exports subject to NT 80, which correspond to coffee. Several reasons can explain this result. First, the characteristics of the good are likely to matter. For example, coffee is not perishable as other food products. Second, NT 80 aims to ensure that exports meet preset quality standards and thereby protect Costa Rica's reputation as a producer and supplier. As such, its nature is different from those of most of its counterparts. Third, the relative level of efficiency with which permits were processed before the electronic single window could also play a role.

making use of these technologies allow for increased trade, our understanding of how procedures associated with border regulations are accomplished and how technologies available to do so affect trade in particular has been so far limited due to absence of appropriate data.

In this paper we fill this gap in the empirical literature by exploiting the gradual adoption of an electronic trade single window scheme in Costa Rica to identify the effects of an information technology-driven simplification of trade formalities on firms' exports. In so doing, we use highly detailed export data that inform the scheme under which exports were processed to carry out differences-in-differences estimations along with placebo tests and instrumental variables estimations to check the robustness of our results. These results suggest that the electronic single window has indeed facilitated trade. In particular, the number of exporters increased and firms' exports processed under this new arrangement grew faster than their counterparts without changes in their respective administrative procedures primarily in terms of the number of shipments and the number of and average sales per buyer.

However, caution should be exercised when moving towards computerization. Poorly designed procedures, which result in a cumbersome process of compliance with trade regulations, will not become mechanically efficient with the introduction of information technologies. A careful redesign of procedures is a pre-condition for the adoption of these technologies to yield trade gains. Costa Rica is a clear example in this regard. The country first streamlined procedures with the establishment of the paper-based single window in the mid-1990s and then further simplified them with the launching of the paperless electronic single window in the mid-2000s.

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Table 1

Aggregate Export Indicators and Average Exporter:
All Exports and Exports Under Permits, 2008-2013

Year	Total Exports (Values)				Exports Subject to Permits (Shares)			
	Exports	Firms	Products	Destinations	Exports	Firms	Products	Destinations
2008	9,091	2,858	4,209	143	0.280	0.477	0.227	0.804
2009	8,673	2,840	4,566	135	0.258	0.401	0.190	0.830
2010	9,471	3,919	4,685	143	0.293	0.378	0.192	0.846
2011	10,502	4,062	4,769	142	0.305	0.392	0.204	0.838
2012	11,343	4,123	4,999	146	0.301	0.384	0.213	0.808
2013	11,543	4,111	4,925	151	0.291	0.366	0.213	0.801

Average Exporter

Year	All Firms			Exporters Requiring Permits		
	Exports	Products	Destinations	Exports	Products	Destinations
2008	3.2	6.5	3.2	5.2	8.9	3.7
2009	3.1	8.2	3.4	4.1	11.6	4.2
2010	2.4	8.1	2.9	4.6	12.1	3.7
2011	2.6	8.8	2.9	4.7	12.6	3.6
2012	2.8	9.3	2.9	5.1	13.0	3.6
2013	2.8	8.9	2.9	5.4	13.0	3.7

Source: Authors' calculations based on data from DGA and PROCOMER.
Export values are expressed in millions of US dollars (upper panel) and thousands of US dollars (bottom panel). The upper right panel of the table presents the share of the respective aggregate export figures subject to permits.

Table 2

Technical Notes: Year of Introduction, Responsible Agency, Product Coverage, and Relative Importance in Exports

Technical Note	Description	Year	Agency	Product HS2-Digits	Share in Exports	Share in Products	Share in Destinations
265	Vegetables	2007	MAG	06, 07, 08, 09, 10, 12, 14, 18, 23, 24, 44	0.199	0.041	0.728
266	Livestock	1950	MAG	01, 02, 03, 04, 05, 15, 16, 19, 21, 22, 23, 31, 38, 41	0.038	0.045	0.318
80	Coffee	2005	ICAFE	09	0.026	0.002	0.351
134	Textile and Apparel Products	2007	CCT	39, 42, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 87, 88, 94, 95, 96	0.018	0.089	0.437
50*	Food Dewarehouse	2006	MS	09, 11, 17, 18, 20, 21	0.014	0.004	0.333
267	Chemical and Biological Substances and Equipment	2005	MAG	15, 25, 27, 28, 29, 31, 34, 38, 84	0.009	0.015	0.185
270	Precursors and Chemical Substances	2006	MS	22, 27, 28, 29, 38	0.006	0.004	0.086
38	Ozone	2003	MINAE	29, 38, 84	0.005	0.005	0.126
45	Seeds	2007	ONS	06, 10, 12	0.004	0.003	0.351
269	Hazardous Wastes	2008	MS	72, 78, 84, 85	0.003	0.006	0.159
36	Species of Wildlife Flora and Fauna	2003	MINAE	01, 03, 05, 06	0.002	0.003	0.232
60	Explosives	2006	MSP	28, 32, 36	0.001	0.001	0.066
276	Veterinary Drugs	2009	MAG	29, 30, 33, 38, 49	0.001	0.006	0.093
68	Fish, Mollusk, and Crustacean	2003	INCOPESCA	03	0.000	0.001	0.060
57*	Medicines, Cosmetics, and Medical Equipment	2003	MS	30, 33	0.000	0.000	0.067
273*	Original Archeological Pieces	2008	CPN	97	0.000	0.000	0.007
81*	Endangered Specied of Wild Fauna and Flora	2004	MINAE	01, 03, 44	0.000	0.001	0.021
52	Chemical Weapons	2003	MS	29	0.000	0.000	0.020
51	Drugs and Narcotics	2003	MS	29	0.000	0.000	0.007
72	Ammunitions	2002	MSP	93	0.000	0.000	0.007
70	Weapons	2005	MSP	93	0.000	0.000	0.007
71	Ammunitions	2005	MSP	93	0.000	0.000	0.007

Source: Authors' calculations based on data from DGA and PROCOMER.

Shares in exports correspond to 2013 except for those technical notes marked with *, in which case data correspond to the last year in which products covered jointly registered positive exports. Technical notes are ordered based on their share in total export values. The column "Product HS 2-Digits" reports the HS Chapters affected by each technical note. This does not mean that all HS-10 digit products of a given HS Chapter are subject to permits.

Agencies

MINAE: *Ministerio de Ambiente y Energías* – Ministry of Environment and Energy (several dependencies: SNAC, OTO, DSE, GGCA)

ONS: *Oficina Nacional de Semillas* – National Seeds Office

MS: *Ministerio de Salud* – Ministry of Health (several dependencies: ANAQ, DAC)

MSP: *Ministerio de Seguridad Pública* – Ministry of Public Security

INCOPESCA: *Instituto Costarricense de Pesca y Acuicultura* – Costa Rican Institute for Phishing and Aquaculture

ICAFE: *Instituto del Café de Costa Rica* – Costa Rican Institute for Coffee

ANEIT: *Asociación Nacional de Exportadores de la Industria Textil* -

MAG: *Ministerio de Agricultura y Ganadería* – Ministry of Agriculture and Livestock (several dependencies: SFE, SENASA,

MN-DPPC: *Museo Nacional – Departamento de Protección del Patrimonio Cultural* – National Museum – Department of Cultural Heritage Protection

Table 3

Aggregate Export Indicators and Average Exporter: Exports Processed through the Electronic Single Window, 2008-2013

Aggregate Export Indicators

Year	Share of Electronic Single Window in Exports Requiring Permits			
	Exports	**Firms**	**Products**	**Destinations**
2008	0.024	0.039	0.071	0.139
2009	0.405	0.563	0.459	0.759
2010	0.530	0.655	0.642	0.793
2011	0.553	0.731	0.669	0.807
2012	0.922	0.887	0.833	0.958
2013	0.933	0.911	0.853	0.926

Average Exporter

Year	Average User of the Electronic Single Window		
	Exports	**Products**	**Destinations**
2008	8.0	25.2	7.4
2009	3.3	11.9	4.5
2010	5.6	13.4	4.0
2011	5.4	13.9	3.8
2012	5.5	13.4	3.8
2013	5.7	13.1	3.8

Source: Authors' calculations based on data from DGA and PROCOMER.

Table 4

Technical Notes and their Incorporation into the Electronic Single Window
Two Main Technical Notes in Terms of Export Shares

Technical Note	Port	Year SW	Date SW	Year	Share in		
					Exports	Products	Destinations
265	Caldera	2008	November 14	2008	0.033	0.167	0.125
265	Caldera	2008	November 14	2013	0.874	0.957	1.000
265	Peñas Blancas	2008	August 22	2009	0.600	0.504	0.800
265	Peñas Blancas	2008	August 22	2013	0.923	0.909	1.000
265	Santamaría	2008	December 2	2008	0.001	0.018	0.032
265	Santamaría	2008	December 2	2013	0.991	0.913	0.933
265	Limón	2008	July 16	2008	0.022	0.013	0.122
265	Limón	2008	July 16	2013	0.987	0.935	0.843
265	Paso Canoas	2009	January 29	2009	0.087	0.394	0.500
265	Paso Canoas	2009	January 29	2013	1.000	1.000	1.000
266	Central	2011	February 23	2011	0.808	0.250	0.909
266	Central	2011	February 23	2013	1.000	1.000	1.000
266	Caldera	2008	August 6	2008	0.056	0.048	0.182
266	Caldera	2008	August 6	2013	0.987	0.962	0.957
266	Peñas Blancas	2008	September 8	2008	0.181	0.126	0.833
266	Peñas Blancas	2008	September 8	2013	0.923	0.826	1.000
266	Santamaría	2009	March 24	2009	0.280	0.500	0.939
266	Santamaría	2009	March 24	2013	0.948	0.913	0.808
266	Limón	2008	June 3	2008	0.002	0.013	0.037
266	Limón	2008	June 3	2013	0.994	0.911	0.917
266	Paso Canoas	2008	October 21	2008	0.352	0.123	0.500
266	Paso Canoas	2008	October 21	2013	0.976	0.944	1.000
266	La Anexión	2010	December 14	2012	0.992	0.625	0.500
266	La Anexión	2010	December 14	2013	0.999	0.972	0.818

Source: Authors' calculations based on data from DGA and PROCOMER.
The table reports the date and year in which the electronic single window became available to process the Technical Note 265 and the Technical Note 2006 in the different Costa Rican ports along with the share in export values, number of products, and number of destinations that the electronic single window accounted for in the introduction and the most recent years.

Table 5

The Impact of SW on Firms' Exports				
Baseline Specification and First SW				
	Products Subject to Permits		**All Products**	
	Baseline	**First SW**	**Baseline**	**First SW**
SW	0.537	0.472	0.489	0.399
Heteroscedasticity-Consistent	(0.047)***	(0.075)***	(0.046)***	(0.062)***
Cluster Firm-Product-Destination	(0.068)***	(0.104)***	(0.053)***	(0.065)***
Cluster Product	(0.083)***	(0.119)***	(0.071)***	(0.090)***
Cluster Product HS 2 Digit	(0.063)***	(0.084)***	(0.064)***	(0.094)***
Cluster Destination	(0.060)***	(0.063)***	(0.054)***	(0.061)***
Cluster Product-Destination	(0.069)***	(0.117)***	(0.056)***	(0.076)***
Cluster Product HS 2 Digit-Destination	(0.061)***	(0.092)***	(0.059)***	(0.085)***
Cluster Product- Destination	(0.069)***	(0.058)***	(0.066)***	(0.073)***
Cluster Product HS 2 Digit- Destination	(0.050)***	(0.034)***	(0.059)***	(0.069)***
Cluster Firm	(0.082)***	(0.124)***	(0.073)***	(0.091)***
Firm-Year Fixed Effect	Yes	Yes	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	No	Yes	Yes
Observations	20,778	9,631	108,514	97,364
Estimates Weighted by Initial Export Flow Size				
	Products Subject to Permits		**All Products**	
	Weight:		**Weight:**	
	t-1	**2007**	**t-1**	**2007**
SW	0.454	0.489	0.556	0.569
Heteroscedasticity-Consistent	(0.103)***	(0.246)**	(0.093)***	(0.163)***
Cluster Firm-Product-Destination	(0.107)***	(0.227)***	(0.093)***	(0.153)***
Cluster Product	(0.106)***	(0.232)***	(0.086)***	(0.156)***
Cluster Product HS 2 Digit	(0.060)***	(0.179)***	(0.066)***	(0.14)***
Cluster Destination	(0.077)***	(0.149)***	(0.068)***	(0.157)***
Cluster Product-Destination	(0.112)***	(0.229)***	(0.095)***	(0.154)***
Cluster Product HS 2 Digit-Destination	(0.090)***	(0.164)***	(0.091)***	(0.135)***
Cluster Product- Destination	(0.069)***	(0.153)***	(0.056)***	(0.159)***
Cluster Product HS 2 Digit- Destination	(0.035)***	(0.164)***	(0.023)***	(0.160)***
Cluster Firm	(0.115)***	(0.210)***	(0.113)***	(0.150)***
Firm-Year Fixed Effect	Yes	Yes	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	No	Yes	Yes
Observations	20,778	5,190	108,514	46,666

Source: Authors' calculations based on data from DGA and PROCOMER.

The upper panel of table reports OLS estimates of Equation (2) for both the entire sample and when restricting the sample to exports that never used the electronic single window in the past. In the left panel, the sample is restricted to products subject to permit, whereas in the right panel all products are considered. The lower panel of the table presents WLS estimated of Equation (2) for both only products subject to permit and all products. The weights are the value of the firm-product-destination export flow in t-1 or in 2007. The dependent variable is the change in the natural logarithm of export value at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year fixed and HS 2-digit product-destination-year effects are included (not reported). Heteroscedasticity-robust standard errors are reported in parentheses below the estimated coefficients. Standard errors clustered at alternative levels are shown next. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. The significance indicator is presented along with the respective standard errors.

Table 6

The Impact of SW on Firms' Exports Alternative Specifications							
2007-2013							
SW	0.234***	0.537***	0.592***	0.599***	0.546***	0.459***	0.501***
	(0.031)	(0.068)	(0.083)	(0.108)	(0.072)	(0.099)	(0.173)
Firm-Year Fixed Effect	No	Yes	Yes	Yes	No	No	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	No	Yes	No	No	Yes	Yes	Yes
Product-HS4 Digit-Destination-Year Fixed Effect	No	No	Yes	No	No	No	No
Product-HS6 Digit-Destination-Year Fixed Effect	No	No	No	Yes	No	No	No
Firm-Product HS2 Digit-Year Fixed Effect	No	No	No	No	Yes	No	No
Firm-Destination-Year Fixed Effect	No	No	No	No	No	Yes	No
Firm-Product-Destination Fixed Effect	No	No	No	No	No	No	Yes
Observations	20,778	20,778	20,778	20,778	20,778	20,778	20,778
2010-2013, Without Control for Customs Delays							
SW	0.444***	0.702***	0.748***	0.678***	0.673***	0.732***	
	(0.079)	(0.082)	(0.076)	(0.100)	(0.091)	(0.156)	
Firm-Year Fixed Effect	No	Yes	Yes	Yes	No	No	
Product-HS2 Digit-Destination-Year Fixed Effect	No	Yes	No	No	Yes	Yes	
Product-HS4 Digit-Destination-Year Fixed Effect	No	No	Yes	No	No	No	
Product-HS6 Digit-Destination-Year Fixed Effect	No	No	No	Yes	No	No	
Firm-Product HS2 Digit-Year Fixed Effect	No	No	No	No	Yes	No	
Firm-Destination-Year Fixed Effect	No	No	No	No	No	Yes	
Firm-Product-Destination Fixed Effect	No	No	No	No	No	No	
Observations	11,986	11,986	11,986	11,986	11,986	11,986	
2010-2013, Controlling for Customs Delays							
SW	0.341***	0.603***	0.599***	0.588***	0.558***	0.657***	
	(0.075	(0.126)	(0.148)	(0.203)	(0.138)	(0.182)	
Customs Delays	-0.051***	-0.114***	-0.087**	-0.071	-0.104***	-0.070	
	(0.014)	(0.030)	(0.035)	(0.044)	(0.032)	(0.051)	
Firm-Year Fixed Effect	No	Yes	Yes	Yes	No	No	
Product-HS2 Digit-Destination-Year Fixed Effect	No	Yes	No	No	Yes	Yes	
Product-HS4 Digit-Destination-Year Fixed Effect	No	No	Yes	No	No	No	
Product-HS6 Digit-Destination-Year Fixed Effect	No	No	No	Yes	No	No	
Firm-Product HS2 Digit-Year Fixed Effect	No	No	No	No	Yes	No	
Firm-Destination-Year Fixed Effect	No	No	No	No	No	Yes	
Firm-Product-Destination Fixed Effect	No	No	No	No	No	No	
Observations	9,262	9,262	9,262	9,262	9,262	9,262	

Source: Authors' calculations based on data from DGA and PROCOMER.

The first panel of the table reports OLS estimates of alternative specifications of Equation (2). In the first panel, the sample period is 2007-2013, whereas in the second and third panels the sample period is 2010-2013. The dependent variable is the change in the natural logarithm of export value at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. In the third panel, the change in the natural logarithm of the median number of days spent in customs (as computed across shipments) at the firm-product-destination-year level is added as a control variable. First panel: No fixed effects are included in the first column; firm-year fixed effects and HS 2-digit product-destination-year fixed effects are included in the second column; firm-year fixed effects and HS 4 digit product-destination-year fixed effects are included in the third column; firm-year fixed effects and HS 6-digit product-destination-year fixed effects are included in the fourth column; firm-HS 2 digit product-year fixed effects and product HS 2-digit-destination-year fixed effects are included in the fifth column; firm-destination-year fixed effects and HS 2-digit product-destination-year fixed effects are included in the sixth column; and firm-year fixed effects, HS 2-digit product-destination-year fixed effects, and firm-product-destination fixed effects are included in the seventh column (not reported). Second and third panel: Estimates of these different specifications are presented in the same order, except for the last specification, which has not been estimated, Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficients. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 7

The Impact of SW on Firms' Exports
Placebo Exercises, Event Study, Transitional Period vs. Established Period, and Instrumental Variables Estimation

	Placebo 1	Placebo 2	Placebo 3
Placebo Exercises	**SW (t+1)**	**SW (t+2)**	**SW (t+3)**
SW (t+1) / SW (t+2) / SW (t+3)	-0.101	-0.109	-0.117
	(0.107)	(0.164)	(0.288)
Firm-Year Fixed Effect	Yes	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes	Yes
Observations	10,015	5,589	2,723
Baseline with Same Observations			
SW	0.475***	0.462***	0.489**
	(0.109)	(0.126)	(0.180)
Firm-Year Fixed Effect	Yes	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes	Yes
Observations	10,015	5,589	2,723

Event Study and Instrumental Variables Estimations	**Event Study**	**Sub-Periods**		**Instrumental Variables and Reduced Forms**			
		2007-2010	**2011-2013**	**IV1**	**RF1**	**IV2**	**RF2**
SW (τ-2)	-0.141						
	(0.128)						
SW (τ-1)	-0.111)						
	(0.127)						
SW (τ)	0.351***	0.372***	0.713***	0.566**	0.190**	0.646**	0.261**
	(0.115)	(0.094)	(0.096)	(0.275)	(0.093)	(0.282)	(0.115)
SW (τ+1)	0.432***						
	(0.092)						
SW (τ+2)	0.150**						
	(0.064)						
Firm-Year Fixed Effect	Yes	Yes		Yes	Yes	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes		Yes	Yes	Yes	Yes
Observations	21,540	20,778		19,409	19,409	17,025	17,025
First Stage Estimates							
SW Available for Technical Note/Product/Port				0.336***			
				(0.023)			
SW Available for Technical Note/Product/Port x Share of Port in Firm-Product-Destination						0.404***	
						(0.031)	
Firm-Year Fixed Effect				Yes		Yes	
Product-HS2 Digit-Destination-Year Fixed Effect				Yes		Yes	
F Statistics				206.254		171.936	
Observations				19,409		17,025	

Source: Authors' calculations based on data from DGA and PROCOMER.

The upper panel of the table reports OLS estimates of Equation (2) based on a placebo exercise whereby firm-product-destinations exports using the electronic single window for the first time over the period 2007-2013 are assumed to have used it the one year before (Column 1), two years before (Column 2), and three years before (Column 3). Estimates immediately below correspond to our baseline but when the sample is restricted to the same respective firm-product-destinations. Lower Panel: The lower left panel presents OLS estimates from an event study-type regression whereby the behavior of firm-product-destination export flows that adopted the electronic single window in a given year are tracked two years before and two years after that adoption year. The lower middle panel shows OLS estimates of a modified version of Equation (2) that allows for different effects over the period 2007-2010 (transitional, potentially voluntary) and 2011-2013 (established, mandatory). The lower right panel reports instrumental variables estimates of Equation (2) along with the estimates of the first stage equation, the F test statistics, and the estimates of the respective reduced form-equations (RF1 and RF2). The instruments are a binary indicator that takes the value of one if the product in question subject to permit could be processed through the electronic single window in the main port from which it is normally shipped to each destination and zero otherwise and its interaction with the share of this port in the firms' exports in this product-destination combination. The dependent variable is the change in the natural logarithm of export value at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product-destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 8

The Impact of SW on Firms' Exports Channels		
Export Outcomes	**SW**	
	2007-2013	**2010-2013**
Export Value	0.537***	0.702***
	(0.068)	(0.102)
Export Quantity	0.498***	0.627***
	(0.068)	(0.099)
Unit Value	0.044*	0.075**
	(0.025)	(0.035)
Number of Buyers	0.202***	0.184***
	(0.024)	(0.033)
Export Value per Buyer	0.361***	0.518***
	(0.063)	(0.095)
Export Quantity per Buyer	0.296***	0.443***
	(0.063)	(0.092)
Number of Shipments		0.595***
		(0.063)
Average Export Value per Shipment		0.106
		(0.077)
Average Export Quantity per Shipment		0.031
		(0.074)
Average Shipments per Buyer		0.411***
		(0.055)
Average Export Value per Shipment and Buyer		-0.078
		(0.082)
Average Export Quantity per Shipment and Buyer		-0.153*
		(0.079)
Firm-Year Fixed Effect	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes
Observations	20,778	11,986

Source: Authors' calculations based on data from DGA and PROCOMER.
The table reports OLS estimates of Equation (2). In the first column the sample period is 2007-2013, whereas in the second column the sample period is 2010-2013. The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, and average export quantity per buyer (first column), and, in addition, of the number of shipments, average export value per shipment, average export quantity per shipment, average shipments per buyer, average export value per shipment and buyer, and average export quantity per shipment and buyer (second column), all at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product-destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 9

The Impact of SW on Firms' Exports
Heterogeneous Effects by Firm Categories
Firms Colocated with Agencies (SL) vs. Firms Located in a Different Region (DL)
in General and from that of the Only Agency (OA) or the Many Agencies (MA) Firms Interact with

Export Outcomes	Baseline	Location		Location and Number of Agencies		
		SL	DL	DL-MA	DL-OA	Rest
Export Value	0.523***	0.407***	0.554***	0.632***	0.516***	0.408***
	(0.070)	(0.122)	(0.080)	(0.138)	(0.097)	(0.122)
Export Quantity	0.475***	0.443***	0.484***	0.477***	0.487***	0.443***
	(0.070)	(0.121)	(0.081)	(0.143)	(0.096)	(0.121)
Unit Value	0.047*	-0.035	0.070**	0.154**	0.029	-0.034
	(0.026)	(0.046)	(0.031)	(0.072)	(0.028)	(0.046)
Number of Buyers	0.200***	0.217***	0.196***	0.250***	0.169***	0.218***
	(0.025)	(0.048)	(0.028)	(0.052)	(0.032)	(0.048)
Export Value per Buyer	0.322***	0.190	0.358***	0.381***	0.347***	0.191
	(0.066)	(0.117)	(0.075)	(0.129)	(0.091)	(0.117)
Export Quantity per Buyer	0.275***	0.226**	0.288***	0.227*	0.317***	0.225**
	(0.066)	(0.114)	(0.076)	(0.135)	(0.090)	(0.114)
Firm-Year Fixed Effect	Yes	Yes			Yes	
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes			Yes	
Observations	19,445	19,445			19,445	

Source: Authors' calculations based on data from DGA and PROCOMER.

The table reports OLS estimates of specifications of Equation (3) that allow for different effects on exports from firms whose location coincides with that of at least one of the regulatory agencies they have to interact with and on exports from firms that do not share location with the regulatory agencies they have to interact with (Columns 2 and 3), and for different effects on exports from firms that have to interact with more than one regulatory agency and the offices of these agencies are located in other regions, on exports from firms that have to interact with only one regulatory agency with offices in other regions, and on export from firms that have to interact with one or many regulatory agencies that are present in their own regions (Columns 4-6). Locations (regions) are defined in terms of cantons. The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, and average export quantity per buyer at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product-destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 10

The Impact of SW on Firms' Exports
Heterogeneous Effects by Firm Categories
Small Firms (SF) vs. Large Firms (LF), Experienced Exporters (EE) vs Inexperienced Exporters (IE), and Firm and Destination Extensive Margins

Small Firms (SF) vs. Large Firms (LF) and Experienced Exporters (EE) vs. Inexperienced Exporters (IE)

Export Outcomes	Baseline	Small Firms (SF) vs. Large Firms (LF)		Experienced Exporters (EE) vs. Inexperienced Exporters (IE)	
		SF	LF	EE	IE
Export Value	0.486***	0.440***	0.544***	0.500***	0.746***
	(0.074)	(0.086)	(0.121)	(0.075)	(0.153)
Export Quantity	0.445***	0.386***	0.517***	0.464***	0.665***
	(0.074)	(0.084)	(0.124)	(0.075)	(0.147)
Unit Value	0.041	0.054*	0.026	0.037	0.081**
	(0.029)	(0.030)	(0.050)	(0.029)	(0.039)
Number of Buyers	0.193***	0.151***	0.244***	0.197***	0.224***
	(0.026)	(0.032)	(0.041)	(0.027)	(0.052)
Export Value per Buyer	0.294***	0.289***	0.300***	0.303***	0.522***
	(0.069)	(0.081)	(0.111)	(0.070)	(0.141)
Export Quantity per Buyer	0.252***	0.235***	0.273**	0.266***	0.441***
	(0.069)	(0.079)	(0.114)	(0.070)	(0.135)
Firm-Year Fixed Effect	Yes	Yes		Yes	
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes		Yes	
Observations	16,991	16,991		20,778	

The Firm and the Destination Extensive Margins
Product-Destination-Year Level Data/Product-Year Level Data

Export Outcomes	Product-Destination-Year Level Data			Product-Year Level Data	
Export Value	0.155***	0.302***	0.305***	0.271**	0.571***
	(0.060)	(0.072)	(0.086)	(0.123)	(0.138)
Export Quantity	0.163***	0.332***	0.343***	0.297**	0.615***
	(0.057)***	(0.068)	(0.082)	(0.115)	(0.124)
Unit Value	-0.007	-0.030	-0.038	-0.027	-0.044
	(0.030)	(0.035)	(0.042)	(0.046)	(0.056)
Number of Buyers	0.232***	0.223***	0.239***	0.308***	0.341***
	(0.017)	(0.020)	(0.025)	(0.047)	(0.042)
Export Value per Buyer	-0.077	0.080	0.066	-0.037	0.230*
	(0.057)	(0.069)	(0.081)	(0.117)	(0.120)
Export Quantity per Buyer	-0.070	0.110*	0.104	-0.010	0.274**
	(0.053)	(0.064)	(0.077)	(0.105)	(0.106)
Number of Exporting Firms	0.113***	0.146***	0.160***	0.226***	0.252***
	(0.013)	(0.015)	(0.018)	(0.039)	(0.035)
Export Value per Exporting Firm	0.042	0.156**	0.145*	0.045	0.319**
	(0.058)	(0.071)	(0.085)	(0.118)	(0.129)
Export Quantity per Exporting Firm	0.050	0.186***	0.183**	0.071	0.363***
	(0.055)	(0.067)	(0.081)	(0.108)	(0.116)
Number of Buyers per Exporting Firm	0.120***	0.077***	0.079***	0.050**	0.045**
	(0.014)	(0.016)	(0.021)	(0.021)	(0.018)
Number of Destinations				0.258***	0.296***
				(0.046)	(0.040)
Product-HS2 Digit-Year Fixed Effect	No	Yes	No	No	Yes
Destination-Year Fixed Effect	No	Yes	No	No	No
Product-HS2 Digit-Destination-Year Fixed Effect	No	No	Yes	No	No
Observations	11,252	11,252	11,252	4,421	4,421

Source: Authors' calculations based on data from DGA and PROCOMER.

The upper panel of table reports OLS estimates of a specification of Equation (3) that allows for different effects on exports from small and large firms and exports from experienced exporters and inexperienced exporters. Firms are classified as large (small) if their number of employees exceeds (does not exceed) 100 as experienced exporters if they systematically exported since 2005. The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, and average export quantity per buyer at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product -destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. The lower panel of the table reports OLS estimates of modified versions of Equation (2) The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, average export quantity per buyer, number of exporting firms, average export value per exporting firm, average export quantity per exporting firm, average number of buyers per exporting firm at the product-destination-year level (first to third columns) and these variables and the change in the natural logarithm of the number of destinations at the product-year level (fourth and fifth columns). When working with data at the product-year level the change in the natural logarithm of the number of destinations is included among the dependent variables (fourth and fifth columns). The main explanatory variable is the change in a binary indicator taking the value of one if the electronic single window is used in shipping the product to the destination in question (first to third columns) or simply the product in question (fourth and fifth columns) and zero otherwise. HS 2-digit product-year and destination-year fixed effects included in the first column and HS 2 digit product-destination-year fixed effects in the third column; and HS 2-digit product-year in the fifth column (not reported). Standard errors clustered by product-destination (first to third columns) and by product (fourth and fifth columns) are reported in parentheses below the estimated coefficient * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 11

The Impact of SW on Firms' Exports					
Heterogeneous Effects by Product Categories					
Export Outcomes	**Sectoral Effects**				
	Food	**Textiles**	**Other Industrial Supplies**	**Other Consumer Goods**	**Others**
Export Value	0.590***	0.530***	0.325*	0.408**	0.568***
	(0.122)	(0.143)	(0.161)	(0.154)	(0.128)
Export Quantity	0.534***	0.598***	0.236	0.337*	0.482***
	(0.121)	(0.144)	(0.166)	(0.171)	(0.126)
Unit Value	0.056	-0.060	0.089	0.071	0.086*
	(0.037)	(0.065)	(0.066)	(0.077)	(0.046)
Number of Buyers	0.201***	0.201***	0.009	0.003	0.280***
	(0.042)	(0.049)	(0.088)	(0.054)	(0.044)
Export Value per Buyer	0.389***	0.328*	0.315*	0.405**	0.288**
	(0.115)	(0.134)	(0.157)	(0.152)	(0.117)
Export Quantity per Buyer	0.332**	0.396**	0.226	0.333*	0.202*
	(0.114)	(0.130)	(0.165)	(0.166)	(0.116)
Firm-Year Fixed Effect			Yes		
Product-HS2 Digit-Destination-Year Fixed Effect			Yes		
Observations			20,778		
Heterogeneous Effects by Permit					
Export Outcomes	**Permit**				
	NT 80	**NT 134**	**NT 265**	**NT 266**	**NT Others**
Export Value	-0.303	0.544***	0.600***	0.398**	0.406***
	(0.608)	(0.138)	(0.098)	(0.162)	(0.134)
Export Quantity	-0.244	0.584***	0.541***	0.275*	0.379***
	(0.479)	(0.138)	(0.097)	(0.162)	(0.146)
Unit Value	-0.060	-0.039	0.059*	0.124*	0.028
	(0.201)	(0.063)	(0.031)	(0.066)	(0.068)
Number of Buyers	0.372	0.184***	0.239***	0.120*	0.123**
	(0.307)	(0.048)	(0.033)	(0.071)	(0.055)
Export Value per Buyer	-0.675	0.360***	0.361***	0.279*	0.284**
	(0.453)	(0.129)	(0.089)	(0.166)	(0.131)
Export Quantity per Buyer	-0.615	0.400***	0.301***	0.155	0.256*
	(0.377)	(0.125)	(0.088)	(0.167)	(0.142)
Firm-Year Fixed Effect			Yes		
Product-HS2 Digit-Destination-Year Fixed Effect			Yes		
Observations			20,778		

Source: Authors' calculations based on data from DGA and PROCOMER.

The table reports OLS estimates of alternative specifications of Equation (3) that allow for different effects on exports of different product categories (food products, textile products, other industrial supplies, other consumer goods, and other goods) (upper panel) and for different permits (NT 80, NT 134, NT 265, NT 266, and others) (lower panel). The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, and average export quantity per buyer at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product-destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 12

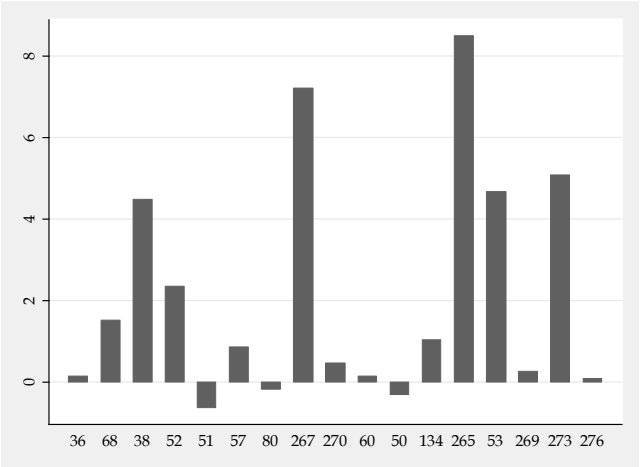
The Impact of SW on Firms' Exports Heterogeneous Effects by Destination				
OECD Destinations (OECD) vs. Non-OECD Destinations (N-OECD) and Close Destinations (CD) vs. Distant Destinations (DD)				
All Products				
Export Outcomes	**OECD**	**N-OECD**	**CD**	**DD**
Export Value	0.608***	0.474***	0.540***	0.598**
	(0.102)	(0.082)	(0.070)	(0.235)
Export Quantity	0.584***	0.408***	0.493***	0.620**
	(0.100)	(0.084)	(0.070)	(0.256)
Unit Value	0.024	0.065*	0.047*	-0.022
	(0.030)	(0.038)	(0.026)	(0.128)
Number of Buyers	0.270***	0.131***	0.197***	0.301***
	(0.035)	(0.029)	(0.024)	(0.105)
Export Value per Buyer	0.338***	0.343***	0.343***	0.297
	(0.092)	(0.080)	(0.065)	(0.222)
Export Quantity per Buyer	0.314***	0.277***	0.295***	0.319
	(0.090)	(0.082)	(0.065)	(0.233)
Firm-Year Fixed Effect	Yes		Yes	
Product-HS2 Digit-Destination-Year Fixed Effect	Yes		Yes	
Observations	20,778		20,778	
Common Products				
Export Outcomes	**OECD**	**N-OECD**	**CD**	**DD**
Export Value	0.605***	0.560***	0.569***	0.651**
	(0.117)	(0.109)	(0.108)	(0.254)
Export Quantity	0.581***	0.483***	0.515***	0.675**
	(0.116)	(0.110)	(0.106)	(0.277)
Unit Value	0.024	0.078	0.054	-0.024
	(0.032)	(0.050)	(0.036)	(0.139)
Number of Buyers	0.279***	0.181***	0.229***	0.311***
	(0.042)	(0.035)	(0.039)	(0.111)
Export Value per Buyer	0.326***	0.379***	0.340***	0.340
	(0.106)	(0.102)	(0.098)	(0.241)
Export Quantity per Buyer	0.302***	0.301***	0.286***	0.364
	(0.104)	(0.103)	(0.097)	(0.254)
Firm-Year Fixed Effect	Yes		Yes	
Product-HS2 Digit-Destination-Year Fixed Effect	Yes		Yes	
Observations	16,175		11,179	

Source: Authors' calculations based on data from DGA and PROCOMER.

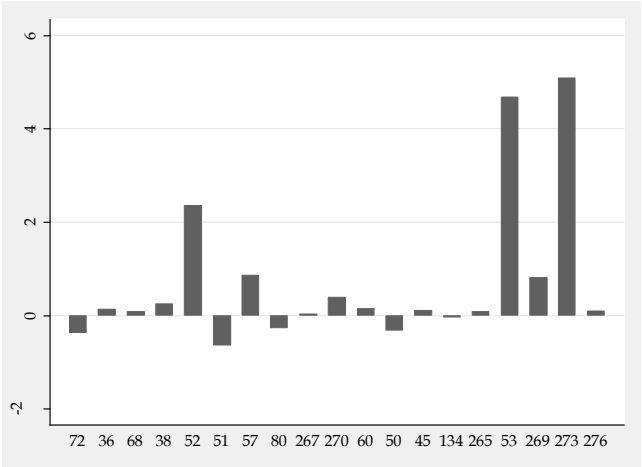
The table reports OLS estimates of alternative specifications of Equation (3) that allow for different effects across OECD destinations and non-OECD destinations and for close destinations (CD) and distant destinations (DD), both when all products are considered and when only common products across destinations are considered. The dependent variables are the change in the natural logarithm of export value, quantity (weight) shipped, unit value, number of buyers, average export value per buyer, and average export quantity per buyer at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year and HS 2-digit product-destination-year fixed effects included (not reported). Standard errors clustered by firm-product-destination are reported in parentheses below the estimated coefficient. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Figure 1
Timing of Introduction of Permits and Previous Export Growth

Average Exports Growth of Products Covered by a Permit in the Introduction Year

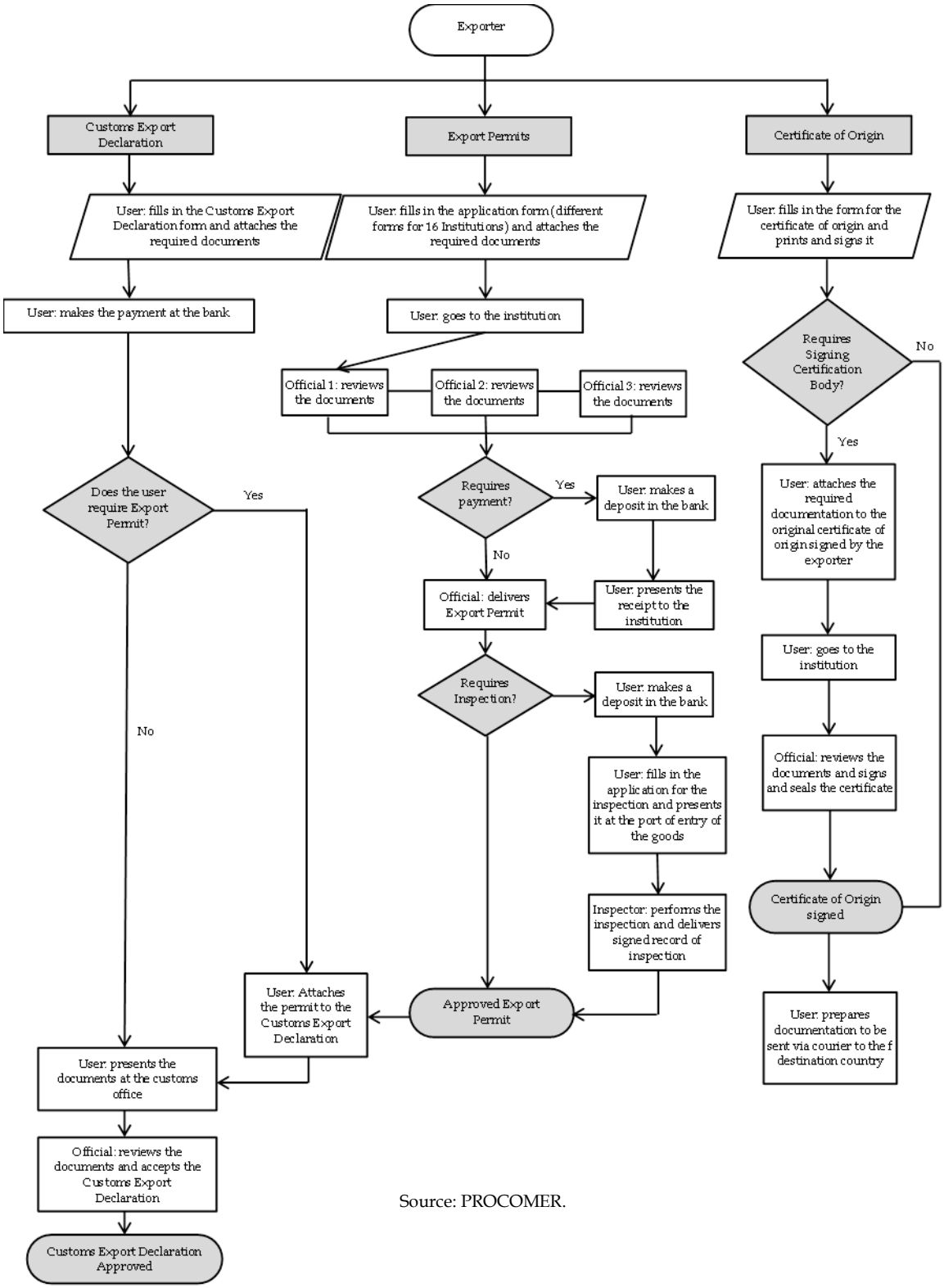


Average Exports Growth of Products Covered by a Permit over the Entire Period



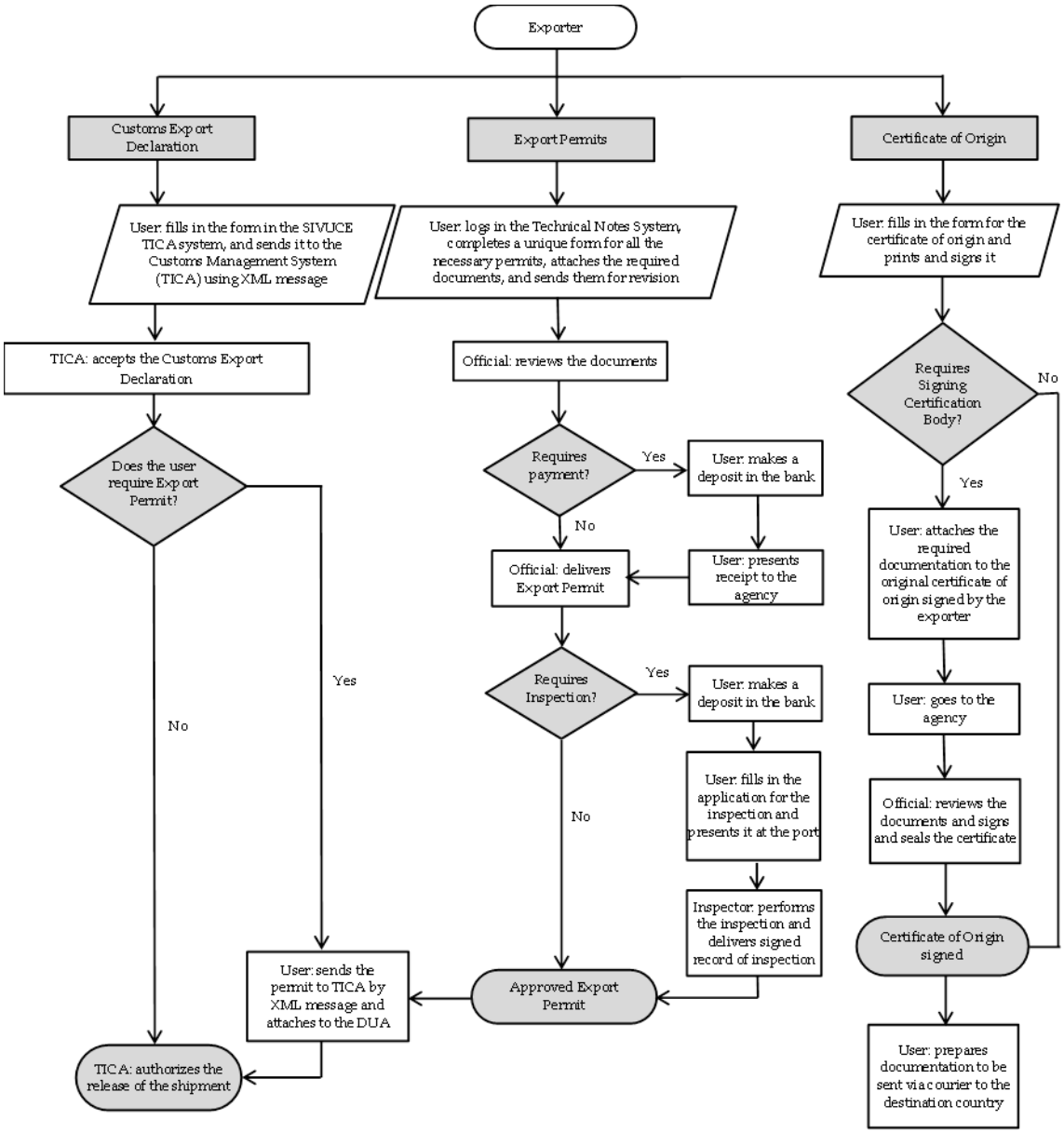
Source: Authors' calculations based on DGA and PROCOMER.
The figures show the average annual growth rate of exports of products covered by each permit the first year in which it was introduced over the previous three years (left panel) and the average annual growth rate of exports of all products covered by each permit at some point of our sample period over the three years previous to its introduction (right panel). Permits are ordered on the x-axis according to their date of introduction from the earliest to the latest.

Figure 2
Administrative Processing of Export Flows Requiring Permits before the Single Window



Source: PROCOMER.

Figure 3
Administrative Processing of Export Flows Requiring Permits under the Electronic Single Window

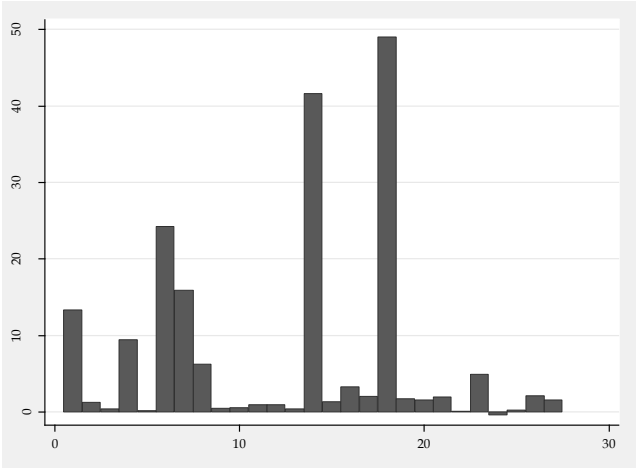


Source: PROCOMER.

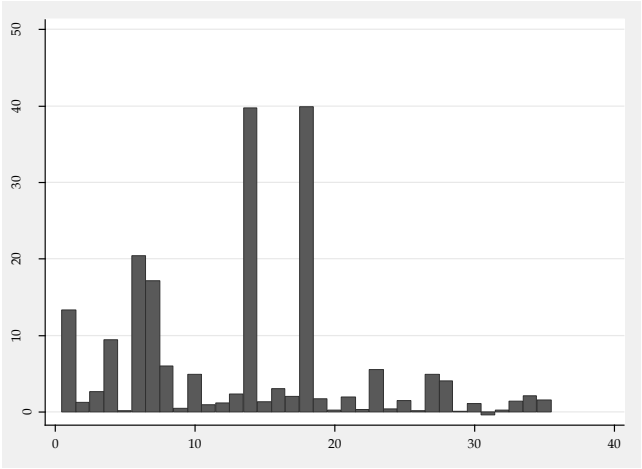
Figure 4
Timing of Adoption of the Electronic Single Window and Previous Export Growth

Permit-Port

Average Exports Growth of Products Covered by a Permit in a Given Port in the Adoption Year

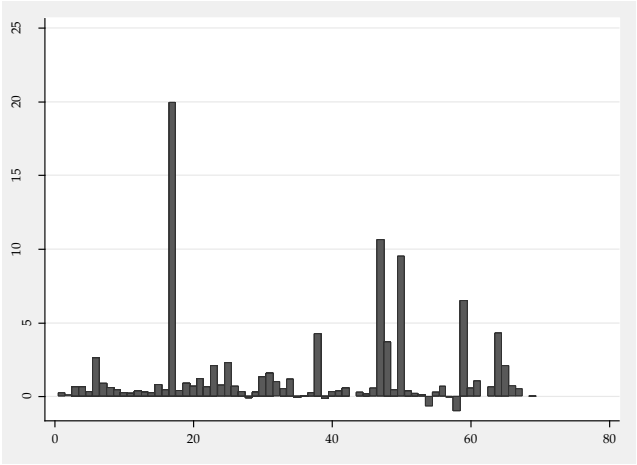


Average Exports Growth of Products Covered by a Permit in a Given Port over the Entire Period

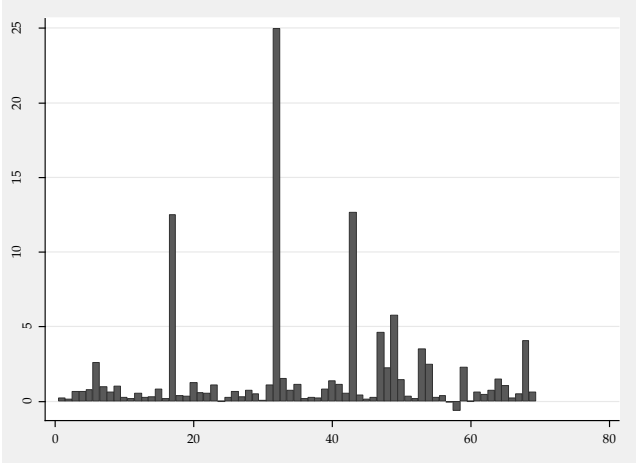


Product-Destination

Average Exports Growth of Products Covered by a Permit to Specific Destinations in the Adoption Year



Average Exports Growth of Products Covered by a Permit to Specific Destination over the Entire Period



Source: Authors' calculations based on DGA and PROCOMER.
The upper panel of the figure shows the average annual growth rate of exports of products covered by each permit the first year in which it could be processed through the electronic single window in the main port over the three previous years (left) and the average annual growth rate of the exports of all products covered by each permit at some point of our sample period over the three years previous (right). The lower panel of the figure shows the average annual growth rate of exports of each product to each destination covered by a permit the first year in which it could be processed through the electronic single window over the three previous years (left) and the average annual growth rate of exports of each product to each destination covered by a permit at some point of our sample period over the three previous years (right). Due the large number of possible combinations, product-destination combinations are grouped according to the month in which their exports started to be channeled through the electronic single window. The height of the bar corresponds to the median export growth rate of all of all product-destination combinations joining the electronic single window in the respective months. Permit-ports and product-destinations are ordered on the x-axis according to their date of introduction of the electronic single window from the earliest to the latest.

Appendix

Table A1

Timing of Adoption of the Electronic Single Window												
Permit-Ports												
	Linear Probability Model								**Ranking**			
	SW in 2008				**SW in 2008 or 2009**							
Average Export Growth - First Products	0.001		-0.009		0.006		0.006		-0.007		-0.002	
	(0.008)		(0.011)		(0.006)		(0.007)		(0.015)		(0.013)	
Average Export Growth - All Products		0.010		-0.002		0.011		0.009		-0.019		-0.001
		(0.009)		(0.014)		(0.008)		(0.009)		(0.016)		(0.012)
Permit Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Port Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Observations	31	35	31	35	31	35	31	35	31	35	31	35
Product-Destinations												
	Linear Probability Model								**Ranking**			
	SW in 2008				**SW in 2008 or 2009**							
Average Export Growth - First Products	-0.000		-0.000		0.000		-0.000		0.000		0.000	
	(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)	
Average Export Growth - All Products		-0.000		-0.000		0.000		-0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)
Product HS 2 Digit Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Destination Fixed Effect	No	No	Yes	Yes	No	No	Yes	Yes	No	No	Yes	Yes
Observations	495	812	495	812	495	812	495	812	495	812	495	812

Source: Authors' calculations based on DGA and PROCOMER.

The upper left panel of the table reports OLS estimates of an equation whose dependent variable is a binary indicator that takes the value of one if the permit could be processed through the electronic single window in the port in question in 2008 (Columns 1 and 2) or in 2008 or 2009 (Columns 3 and 4) and zero otherwise. The main explanatory variable is the average annual growth rate of exports of the products covered by these permits in the respective ports over the three previous years. The upper right panel of the table reports OLS estimates of an equation whose dependent variable is the natural logarithm of the ranking of the permit-port combination as determined based on the date on which the respective exports could be processed through the electronic single window for the first time. The lower left panel table reports OLS estimates of an equation whose dependent variable is a binary indicator that takes the value of one if the product-destination exports could be processed through the electronic single window in question in 2008 (Columns 1 and 2) or in 2008 or 2009 (Columns 3 and 4) and zero otherwise. The main explanatory variable is the average annual growth rate of exports of the respective product-destination combination covered by permits over the three previous years. The lower right panel of the table reports OLS estimates of an equation whose dependent variable is the natural logarithm of the ranking of the product-destination combination as determined based on the date on which the respective exports could be processed through the electronic single window for the first time. Both products subject to permits the adoption year and at some point in our sample period are considered. Specification that do not include fixed effects (Columns 1-2, 5-6, and 9-10) and including permit and port fixed effects or HS2 digit product and destination fixed effects are considered (Columns 3-4, 7-8, 11-12).

Table A2

The Impact of SW on Firms' Exports Baseline Specification, 2010-2013		
	Products Subject to Permits	**All Products**
SW	0.702	0.591
Heteroscedasticity-Consistent	(0.099)***	(0.080)***
Cluster Firm-Product-Destination	(0.102)***	(0.082)***
Cluster Product	(0.086)***	(0.081)***
Cluster Product HS 2 Digit	(0.084)***	(0.085)***
Cluster Destination	(0.075)***	(0.074)***
Cluster Product-Destination	(0.096)***	(0.079)***
Cluster Product HS 2 Digit-Destination	(0.090)***	(0.079)***
Cluster Product Destination	(0.063)***	(0.076)***
Cluster Product HS 2 Digit Destination	(0.068)***	(0.079)***
Cluster Firm-Product-Port	(0.104)***	(0.086)***
Cluster Port	(0.104)***	(0.090)***
Cluster Product-Port	(0.098)***	(0.087)***
Cluster Product HS 2 Digit-Port	(0.097)***	(0.094)***
Cluster Product Port	(0.085)***	(0.083)***
Cluster Product HS 2 Digit Port	(0.085)***	(0.080)***
Cluster Permit	(0.072)***	(0.120)***
Cluster Permit-Port	(0.104)***	(0.103)***
Cluster Permit Port	(0.058)***	(0.110)***
Cluster Firm	(0.106)***	(0.112)***
Firm-Year Fixed Effect	Yes	Yes
Product-HS2 Digit-Destination-Year Fixed Effect	Yes	Yes
Observations	11,986	58,691

Source: Authors' calculations based on data from DGA and PROCOMER.

The table reports OLS estimates of Equation (2) for both only products subject to permits and all products. The dependent variable is the change in the natural logarithm of export value at the firm-product-destination-year level. The main explanatory variable is the change in a binary indicator taking the value of one if the firm uses the electronic single window in shipping the product to the destination in question and zero otherwise. Firm-year fixed and HS 2-digit product-destination-year effects are included (not reported). Heteroscedasticity-robust standard errors are reported in parentheses below the estimated coefficients. Standard errors clustered at alternative levels are shown next. * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level. The significance indicator is presented along with the respective standard errors.