The Effects of Transit Systems on International Trade*

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Abstract

In this paper, we estimate the trade effects of a transit system upgrading that streamlines border processing in developing countries. Our empirical approach combines transaction level export data from El Salvador with unique data that distinguishes export flows that were processed on the transit system. Our results indicate that the new transit system lowered regulatory border costs and raised exports. At the low end, our back-of-the-envelope estimate of the return to investment is US$ 3-to-1. This evidence informs a policy covered by the 2013 WTO Agreement of Trade Facilitation.

Keywords: Trade Facilitation, Transit Systems, Border Effects, Exports

JEL-Codes: F10, F13, F14

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1. Introduction

The design of administrative procedures determines how regulations affect transaction costs and economic outcomes. In this paper, we provide evidence from an international trade perspective. We use a unique dataset to examine the trade effects of a policy reform that harmonized and substantially simplified clearance processes across borders: an upgrade of a transit system.

Shipments in transit flow across borders and countries under customs control, but without being cleared by customs (Arvis et al., 2007).[1] More precisely, customs clearance and payment of all cross-border related charges are delayed until the shipment reaches the final destination. In their most basic and common variants, transit systems require separate controls on each side of the border and submission of paper documents to complete procedures. In the most advanced versions, transit systems involve unified border transit controls along with the use of a common electronic document and modern information technology to comply with all relevant transit border formalities, decentralizing the administrative burden away from entry points. This is for instance the case with the European TIR (*Transports Internationaux Routiers*) that is used by more than 50 countries (Arvis et al., 2011 and EC, 2001). In contrast, well working transit systems are virtually absent in the developing world.[2]

We examine the implementation of one of the few operating regional transit systems in the developing world, the Central American International Transit of Goods (hereafter TIM for its name in Spanish –*Tránsito Internacional de Mercancías*), to investigate whether and how policies that simplify administrative border frictions affect trade. More specifically, we estimate the TIM's effects on exports and also explore the mechanisms thereof guided by existing theoretical and empirical literature. The main challenges in doing so are to determine which export flows are affected by the system and exporters' self-selection into the regime based on unobserved export ability.

Addressing the first challenge is not straightforward. Although TIM operates within Cen-

[1] Without simplifying transit provisions, repetitive paper-based procedures including the loading and unloading of trucks are expected to create substantial transaction costs (Arvis et al., 2008).

[2] The reasons for the virtual absence of well-functioning transit regimes in developing countries include both inappropriate design due to lack of cooperation between relevant public and private parties and pressure from interest groups (e.g., TRIE in Western Africa) and inability of implementation due to institutional weakness (e.g., Sub-Saharan Africa) (Arvis et al., 2008). The picture does not differ much among partners of trade agreements. Only 36.4% of the agreements notified to the GATT/WTO by June 2013 -that typically involve neighboring countries- had provisions to facilitate transit (Neufeld, 2014).

tral America, exporters may use TIM at least partially for export flows to destinations anywhere in the world, including multi-modal exports overseas. Therefore, it is not possible to establish which trade flows are affected by TIM based on the participating countries and the timing of TIM alone. To solve this problem, we merge detailed transaction level export data from El Salvador including information on exporters' location, the customs office through which shipments exit El Salvador, and the export destination, with transaction level data on shipments that were processed on TIM obtained from TIM's own electronic information system. As a result, we observe which export flows used TIM at the firm-product-custom-destination-time unit of observation.

To address the second challenge, we estimate specifications that include fixed effects to absorb unobserved variables that may determine selection. In addition, we take advantage of the fact that TIM was sequentially introduced across regions in El Salvador, customs offices, and export destinations. This inadvertently resulted in variation in the availability of TIM across the routes that exporters take to deliver their shipments. Parallel trends and placebo tests provide evidence that the availability of TIM across export routes is not systematically related to pre-existing differences in exports and export growth. Therefore, conditional on fixed effects, variation in the availability of TIM across export-routes –which are defined by municipality-custom-destination triplets– allows us to use two identification strategies. First, at the policy implementation level, we regress exports at the export-route level on TIM availability to estimate its effects on aggregate exports. Second, at the unit of observation where we observe firms' actual adoption of TIM (i.e. firm-product-custom-destination-time), we present intention-to-treat and instrumental variable estimates of the effect of TIM on export outcomes. In addition, we report OLS estimates for completeness and comparison purposes.

We find that export values increased due to TIM. On export routes where TIM was available, it raised route-level export flows by about 44 percent. This effect was due to an increase in the number of exporters, product scope, and average export values. At the unit where we observe TIM adoption, intention-to-treat (ITT) estimates indicate that export flows within the firm-product-custom-destination-semester unit of observation increased by about 7.5 percent.[3]

[3]Semesters are defined by 6 month intervals from January to June and July to December.

To be clear, this estimate captures all TIM-related processes that simplified trade, takes into account that many export flows did not take advantage of TIM, and emphasizes intensive margin adjustments of export values. Overall, these results are consistent with the interpretation that TIM reduced regulatory transaction costs to increase exports. A cost benefit analysis also shows that TIM has been cost-effective. Based on our ITT estimates, the additional tax revenue associated with the increase in export flows outweighs implementation and maintenance costs by a ratio of US$ 3.3 to 1.

Multiple robustness checks address several potential concerns including the non-random implementation of TIM, self-selection, exporters' switching of export routes in anticipation of TIM, trade diversion, and alternative definitions of the instrument as well as export routes. The results show that these concerns do not affect our conclusions.

Our results generate new insights on the border effect (e.g., McCallum, 1995; Anderson and van Wincoop, 2003). Borders are important determinants of trade flows, but the sources of associated frictions have remained unclear.[4] Existing estimates of the border effects are, at least to some extent, a statistical artifact (Nitsch and Wolf, 2013); subject to aggregation bias (Coughlin and Novy, 2016); difficult to separate from distance, agglomeration, and network effects (e.g., Head and Mayer, 2010; Hillberry and Hummels, 2008; and Wrona, 2018); and could specifically be biased due to markup differences and measurement errors in distance (Coşar et al., 2015b). The evidence we present indicates that regulatory barriers impose relevant border frictions that can be mitigated with trade facilitation policies. Furthermore, while the existing literature relies on comparing trade with and without borders due to the lack of a policy experiment, the magnitudes of our estimates provide guidance on how much trade policy can actually achieve in lowering border costs.

Our findings also complement recent studies that stress the importance of shipping frequency in international trade and buyer-seller relationships (e.g., Huang and Whalley, 2008; Alessandria et al., 2010; Békes et al., 2014; Kropf and Sauré, 2014; Hornok and Koren, 2015; Bernard et al., 2018; and Carballo et al., 2018). With the caveat that mechanisms are difficult to identify with intention-to-treat (and instrumental-variable) estimates, our results suggest that

[4]Head and Meyer (2000) and Chen (2004) find little evidence that a reduction of industry level non-tariff barriers increase European integration.

both are important to understand how trade facilitation policies operate.

Finally, Goldberg and Pavcnik (2016) argue that the existing literature falls short on examining non-tariff related trade policy. They explain that measurement challenges are a major reason for this. This is also true for trade facilitation policies such as TIM. Without additional information from the transit system, it would be virtually impossible to determine which export flows were subject to the policy change. By employing detailed micro data to overcome this empirical challenge, we deliver evidence for one of the policy goals covered by the 2013 WTO Trade Facilitation Agreement (WTO, 2014).[5]

The remainder of this paper is organized as follows. Section 2 describes TIM, its implementation, the implications of this implementation for the identification of its trade effects along with the data used for that purpose, and presents event-study estimates of TIM's trade effects. Section 3 explains the baseline empirical strategies and the main estimation results. Section 4 discusses robustness checks, Section 5 examines mechanisms, and Section 6 concludes.

2. Background and Implementation of TIM

In this section, we provide background information for TIM. We then introduce our export data and TIM system data to discuss how the implementation of TIM affected its availability across export routes. We finish with event studies to examine if the policy-driven roll-out of TIM was associated with pre-existing differences in export performance.

2.1. What is TIM?

Until a decade ago, within Central America, exporters with shipments in transit had to clear customs at each side of the bilateral borders and sequentially present various country-specific paper documents to multiple intervening agencies. According to a survey conducted at El Amatillo in 2006, a border crossing between El Salvador and Honduras, 12 sets of copies of generally the same declaration and complementary documents had to be prepared and distributed

[5]Countries invest in the trade infrastructure assisted by initiatives such as the WTO-led *Aid for Trade* program. According to data from the OECD, Official Development Assistance for trade facilitation purposes amounted to approximately US$ 3,000 million over the period 2013-2019. However, little evidence exists regarding these trade policies (Cadot and de Melo, 2014). There is only a limited number of rigorous evaluations of their impacts including a few recent studies that estimate the effects of customs processes on firms' exports and imports (Volpe Martincus et al., 2015; and Fernandes et al., 2019; Hayakawa et al., 2019; and Laajaj et al., 2019). Unlike these papers, we focus on a policy intervention that covers all border procedures (i.e., not only customs but also those related to migration and quarantine) and, crucially, implies a two-sided reduction in trade costs (i.e., on both sides of the borders instead of just one side as in the papers above).

among officials of the intervening agencies (Sarmiento, 2013). Transit of goods in Central America was characterized by lack of coordination between border agencies, cumbersome and slow customs and administrative procedures, and limited use of information technology.

In recent years, countries in Central America, including El Salvador starting in 2011, adopted TIM, a new electronic transit system to manage and control the movement of goods in transit.[6] This system involved a stronger within and across country inter-agency cooperation; a new process with a single and harmonized comprehensive document to comply with customs, migration, and phytosanitary agencies requirements; and the use of information technology to connect all participating agencies to manage and track the international transit process (Sarmiento et al., 2010).[7]

The introduction of TIM implied both the creation of single unified border transit controls, which reduced the number of necessary border stops, and a simplification of the procedures at each of the borders. Figure 1 illustrates an example of the former. Before TIM, a shipment from El Salvador to Panama had to clear customs procedures on each side of the border for a total of eight processing stops. TIM reduced the number of these stops to four.

Figure 2 shows the second change, TIM's streamlining of administrative procedures at each unified border control. Before TIM, crossing a border required sequential and repetitive paper-based procedures initiated at the border (Panel A). After TIM (Panel B), firms complete a single electronic document (DUT for its name in Spanish – *Documento Único de Transporte*) and start their shipments' transit at their closest customs office. Border controls are carried out by scanning a barcode which provides intervening officials all relevant data on the shipment in the transit information system, eliminating the presentation of multiple paper documents to multiple agencies.[8]

The changes to transit procedures introduced through TIM are in line with stipulations of

[6] Transit trade could be applied to re-exports or in entrepôt trade. Unfortunately, we do not have the data to make this distinction. For a discussion of re-exports and entrepôt trade in the context of China see, e.g., Feenstra et al. (1999) and Feenstra and Hanson (2004).

[7] Recent literature has examined import tariff evasion (Fisman and Wei, 2004; Demir and Javorcik, 2020). We do not expect that this significantly affects our conclusions. The literature's focus is on import evasion while we focus on exports. Furthermore, tariffs within Central America are low due to CAFTA. In particular, the average tariff for El Salvador's exports to TIM partners is 0.5% according to TRAINS data in 2011. An additional effect that might be implicit in the TIM provisions is that it mitigates other sources of corruption. However, we do not have data or explicit information to verify that this is the case.

[8] More specifically, shipments in transit are processed under the logic of an electronic single window, whereby firms interact simultaneously and in the same place with all border agencies –customs, migration, and quarantine- without using printed copies of documents.

Article 11, Freedom of Transit, of the WTO Trade Facilitation Agreement. This article asks member countries to avoid regulations that restrict trade in transit and to introduce practices that facilitate international transactions. These include the simplification of documents, streamlining of customs controls, advance filing of documents, avoidance of customs charges, and unnecessary delays or restrictions. The expectation is that this new process significantly expedited and lowered the costs of border crossings (Sarmiento et al., 2010). Our estimates of TIM's effects on export flows capture all of these mechanisms.

In examining these effects, it is crucial to consider that, even though the transit on TIM may end in Central America, the actual trade flow may continue to other extra-regional destinations, including multi-modal exports to the U.S. or economies in the European Union. Any firm in El Salvador can potentially use TIM, at least partially, to export to countries everywhere in the world. Hence, while TIM operates locally, its trade effects may go far beyond Central America. This makes it difficult to measure which export flows are affected and thus to estimate the trade effects of the associated changes in trade costs. Measuring how a policy action impacts trade flows is a common problem that limits empirical examination of trade policy related to non-tariff barriers (Goldberg and Pavcnik, 2016). To solve this problem, we take advantage of detailed data from the TIM information system.

Our detailed data on the timing of the implementation and firms' adoption of TIM across regions in El Salvador, customs offices, and export destinations provides variation to estimate its trade impacts. The main question that arises is whether variation along these dimensions is useful from an identification perspective. We address this question after introducing two unique databases that report detailed information on the use of TIM and export activities.

2.2. TIM System Data and Customs Export Data

To examine the implementation of TIM and assess its effects on export outcomes, we combine two databases. The first database includes transaction-level records from the TIM information system and covers all shipments processed under TIM starting in El Salvador since its inception in 2011.[9] In particular, for each shipment, these data report the firm, the product, and

[9]Unfortunately, we do not have data on TIM transactions finishing in El Salvador, so that we cannot assess the impact of the new transit system on imports.

the sequence of customs offices each shipment followed on the TIM system including the last customs office on TIM where the transit ended, but not the destination where the shipment was delivered.

The second database consists of the entire universe of export transactions from 2007 to 2013, kindly provided by the Salvadoran customs DGA (by its name in Spanish *Dirección General de Aduanas*). Each record includes the firm's tax ID, the product code (8-digit of Harmonized System), the exiting customs, the destination country, the foreign buyer, the transport mode, the export value in US dollars, and the quantity (weight) in kilograms. In addition, we have data on the municipality where exporting firms are located from the national business register and El Salvador's national trade and investment promotion organization PROESA. Because TIM applies to road-based exports, from here on, we focus on exports delivered by trucks and multi-modal exports that include road based transportation for example to reach a seaport.[10]

Both databases share several fields, which makes it possible to merge them. The combined dataset allows us to observe where shipments originated in El Salvador, which customs office they used to exit El Salvador, the destination of the shipment, and whether a shipment was processed under TIM. Figure **??** in the online appendix shows that the total export value in transit (red line) using TIM increases from its implementation in the second semester of 2011 to the end of 2013. We achieve to merge 97% of this value (blue line) with the customs export data.[11]

Table 1 presents El Salvador's aggregate exports and key extensive margin indicators from the first semester of 2010 to the last one of 2013. Exports grew 25% over the period to reach $US 5 billion in 2013, 45% of which goes to the Central American partners. Approximately 1,800 exporters made more than 200,000 shipments to sell 2,826 products to about 6,600 buyers in the second semester of 2013.

Table 1 also reports the extent of TIM adoption across various export outcomes. Almost

[10] Our data suggests that there is little switching in transport modes and customs offices. Moreover, the switching does not appear to be related to TIM.

[11] In our empirical analysis we use export values only from the customs system and not from the TIM information system. This mitigates concerns that differences in reporting requirements across customs and the TIM system affect the estimates. Based on our interactions with customs officials we do not have evidence that TIM led to differences in the collecting or reporting of export flows.

30% of the total export value and export transactions were channeled through TIM in 2013.[12] Moreover, around 37% of the exporters used TIM to ship about 57 percent of the products. Most importantly, these summary statistics reveal an ample opportunity to compare exports completed using TIM to exports not channeled through TIM to evaluate the effectiveness of the policy. We will discuss this in the following section.

2.3. TIM's Implementation and the Implications for the Identification of Its Trade Effects

To minimize transport costs, firms ship goods along specific routes. From a trade processing point of view, these routes can be seen as trade corridors consisting of a sequence of customs offices connected by a system of highways or roads going from the origin to the ultimate export destination. TIM facilitated export flows in a subset of these trade corridors. In this subsection, we define export-routes using our customs export (and business register) data and we establish which routes were affected by the implementation of TIM using the TIM system data.

We start by defining routes that exports follow based on the unique location, customs, and destination information we observe in our export data. More precisely, let the *export-route* of a shipment be defined by the municipality where the firm is located, the customs office where the shipment exits El Salvador, and the destination country of the export. Based on this definition, we observe 478 export-routes in our export data among the signatories of TIM.[13]

TIM was introduced gradually over the period 2011-2013 for overland shipments based on sequences of customs offices connecting regions in El Salvador to destinations in Central America.[14] To establish in which pre-existing export routes transit was facilitated by TIM and estimate the trade effects of its implementation at the route-level, we consider the fact that shipments processed on TIM first need to be transported a certain distance by truck from firms' facilities to the nearest internal customs office linked to TIM. Thus, we define a *fiscal-route* as a trade corridor that involves a sequence that starts with a municipality located within 50km of an inland TIM-enabled customs office, continues with a border customs office connected to TIM, and finishes with the last transit destination in Central America also on TIM.[15]

[12] These shares increase to around two thirds when only considering sales to other Central American without immediate neighbors (Honduras and Guatemala).

[13] Including the rest of the world raises the number of export routes to about 1,500.

[14] El Salvador was the first country to adhere to TIM as a transit territory.

[15] 50km is the 30th percentile in the distribution of driving distances to the nearest customs office with TIM. At the 25th

In this regard, it is worth mentioning that Salvadoran customs authorities initially made TIM available in all trade corridors under their control, provided these corridors were also enabled by partner countries at the time. Therefore, partner countries' adoption of TIM determined which trade corridors were subject to TIM, mitigating concerns that El Salvador may have prioritized trade corridors and firms that could benefit most from TIM. Over time, TIM expanded as other countries joined the system and new corridors were incorporated.

Figure 3 illustrates the roll-out of TIM active fiscal-routes by semester (red line) according to the system's data. TIM's implementation began in the second semester of 2011 and its adoption increased steadily through the end of 2013.[16] This figure also shows the availability of TIM across export-routes (blue line), such that TIM is considered available on a given export-route if at least one transaction was completed using the system on that route. While the number of export-routes in which TIM is used can differ from the number of fiscal-routes if firms in municipalities outside the 50km radius use fiscal-routes to export under TIM, together, the blue line and red line suggest that the increasing availability of TIM across export-routes closely resembles the implementation of TIM fiscal-routes.

There are several reasons for such geographic pattern of actual availability of TIM within El Salvador. For example, for some exporters, it may simply not be feasible or cost-effective to ship goods across regions to use TIM due to potential traffic congestion on highways passing through densely populated areas. Alternatively, exporters may be close enough to use a TIM-enabled customs office, but these firms may serve destinations that do not correspond to TIM fiscal-routes.

In summary, the way TIM was implemented resulted in variation in the availability of TIM in export-routes over time. The question is whether this variation was associated with pre-existing differences in export performance. We address this question in the following subsection.

percentile the distance decreases to 40km, whereas at the median increases to about 77km. The maximum distance is 300km.

[16]Using our 50km radius, we observe 179 fiscal routes by the end of 2013. For comparison, at the 25th percentile of the distance distribution, the number of fiscal routes decreases to 173, while at the the median of the distance distribution the number of fiscal routes increases to 186.

2.4. Evidence from an Event Study

In this section, we examine whether TIM availability in export-routes was associated with increased exports and whether TIM export-routes experienced greater export growth before TIM became available on them.

To do so, we formally estimate the following equation that includes lags and leads of the TIM treatment (see e.g., Fajgelbaum et al., 2020):

$$\ln \text{Exports}_{mcdts} = \sum_{\substack{\tau=-13 \\ \tau\neq-1}}^{4} \beta_\tau I(st - st^*_{mcd} = \tau) + \delta_{mcd} + \rho_{mt} + \mu_{ct} + \phi_{dt} + \gamma_{ts} + u_{mcdts} \quad (1)$$

where m stands for municipality, c represents customs office, d denotes destination, and t and s correspond to year and semester, respectively. We focus on semesters instead of years, because the roll-out of TIM is more consistent with that time frequency. st^*_{mcd} is the semester s in year t when a municipality m first uses TIM to deliver an export to destination d via customs office c. For treated routes, the indicators $I(st - st^*_{mcd} = \tau)$ measure the number of semesters relative to the time of the first implementation, st^*_{mcd}, of TIM. These indicators equal zero for all time periods on export routes that never use TIM. The omitted period $\tau = -1$ is the semester prior to the introduction of TIM. Hence, each estimate of β_τ captures the change in exports on routes that use TIM relative to non-TIM routes in semester s of year t, as measured from the semester immediately prior to the roll-out of TIM. If exports were following similar trends before the roll-out of TIM, then we expect that the coefficient estimates for $\tau \leq -2$ will be statistically insignificant.

The fixed effects δ_{mcd} and γ_{ts} absorb unobserved differences across export routes that may predict routes' selection into TIM and overall trends in exports. Municipality-year fixed effects, ρ_{mt} , customs-year fixed effects, μ_{ct}, and destination-year fixed effects, ϕ_{dt}, account for differences in prices and industrial structures across regions in El Salvador, heterogeneity in performance across customs offices, and average prices and multilateral resistance across export destinations.

Figure 4 presents the results. All estimated TIM pre-treatment effects are insignificant. Hence, there seems to be no evidence that TIM-treated export routes were already experiencing improving export performance before the implementation of the system. Importantly, the event study also reveals that TIM has been associated with increased foreign sales after its introduction: export routes that use TIM registered greater exports in the year of adoption and afterwards. The following sections carefully examine this result and the underlying mechanisms using a standard estimation approach.[17]

3. The Effect of TIM on Exports

In this section, we first examine the effect of TIM on aggregate exports at the export-route by time level (i.e., municipality-custom-destination-year-semester level) and then explore how it affects the respective extensive and intensive margin. In addition, we report OLS, intention-to-treat and instrumental variable estimates at the firm-product-custom-destination-year-semester level. In all cases, we focus on data between 2010 to 2013.[18]

Our baseline specification is as follows:

$$\ln \text{Exports}_{\text{mcdts}} = \beta \text{TIM}_{\text{mcdts}} + \delta_{mcd} + \rho_{mt} + \mu_{ct} + \phi_{dt} + \gamma_{ts} + \varepsilon_{mcdts} \quad (2)$$

where, as before, m denotes a municipality, c stands for customs office, d indicates destination country, and s indexes semesters within year t.

The main variable of interest, TIM_{mcdts}, measures availability of TIM across and within export-routes. This indicator variable equals one for all semesters after the first adoption of TIM on a given route in semester st^{*}_{mcd} and zero otherwise.

The coefficient β, captures the effect of TIM on exports and is therefore the main parameter of interest. As discussed in Section 2, TIM can be seen as a policy regime change that simultaneously addressed multiple sources of trade costs affecting firms' export outcomes through various channels. Hence, β is most appropriately interpreted as a reduced-form effect of TIM that encompasses all these channels.[19]

[17]Figure **??** in the online appendix reports an event study at annual frequency that confirms our results. Furthermore, recent methodological developments provide alternative solutions to deal with potential issues arising due to the differential timing of the policy implementation. These approaches tend to focus on models with fixed effects that are less demanding than our specification and balanced panels. Nevertheless, for completeness, we report event studies based on Sun and Abraham (2021) in Figures **??** and **??** in the online appendix. The conclusions remain the same.

[18]The reason for this restriction is the 2007 to 2009 financial crisis. We also estimated the regressions for the entire period of 2007 to 2013. The results are qualitatively similar.

[19]More precisely, TIM has likely affected per unit, ad valorem, and per shipment costs all at once. The effects of these variables are not separable across trade margins. See the theoretical model in the old working paper version of this study (Carballo et al., 2016).

If TIM actually reduced trade costs due to streamlined customs clearance, then, based on standard trade models, we would expect $\beta > 0$. However, according to the border-effect literature we reviewed in the introduction, there are multiple sources for border effects that are not related to administrative procedures. Therefore, $\beta > 0$ is far from a foregone conclusion. The magnitude of β is also relevant. It informs the literature by providing a measure of the trade expansions that can be achieved by actual trade policies in comparison to a theoretical counterpart implied by a counterfactual that simply sets border costs to zero.

Equation (2) includes municipality-customs-destination fixed effects, δ_{mcd}, to account for unobserved trade costs and any other time invariant variables that determine trade flows across export-routes that may be correlated with the roll-out of TIM. Using such fixed effects avoids *ad-hoc* definitions of distance measures that could potentially bias our estimates (Head and Mayer, 2010; Coşar et al., 2015a). Furthermore, our estimation strategy employs unique identifying variation. We estimate the effect of TIM based on changes in border costs associated with the implementation of TIM within export routes. Existing approaches in the border effect literature rely on differences in domestic versus export flows with fixed border costs. Equation (2) also includes municipality-year fixed effects, ρ_{mt}, customs-year fixed effects, μ_{ct} destination-year fixed effects, ϕ_{dt}, which allow us to account for regional policies, heterogeneity in customs performance, and differences in average prices across export destinations, multilateral resistance (Anderson and van Wincoop, 2003) over time among other multiple possible confounding factors along these dimensions.

We first estimate the above specification with OLS and cluster standard errors at the export-route level determined by municipality-customs-destination triplets. These standard errors allow for an unrestricted covariance structure over time within export-routes, thus also accounting for serial correlation.

Table 2 reports OLS estimates of Equation (2) starting with a standard two-way fixed effect panel specification (Column 1) and sequentially introducing additional fixed effects to estimate the baseline specification (Column 4).[20] Across all specifications, availability of TIM increases exports. The effect of TIM on exports ranges from 20.8 percent (Column 1) to 44.3 percent in

[20]The top panel of Table **??** in the online appendix reports associated summary statistics for export values.

our preferred specification (Column 4). All estimates are statistically significant at the 1 percent level.

Given the procedural changes introduced through the policy (see Section 2), we expect that TIM affects the intensive margin of trade via reduced administrative processing costs. By raising profits from exporting due to lower trade costs, TIM may also lead to entry of new exporters and products (Helpman et al., 2008). We examine this with the baseline specification, Equation (2), but we decompose the total export effect into the respective intensive and extensive margins (e.g., Hummels and Klenow, 2005; Dutt et al., 2013). More precisely, we examine the impact of TIM on the firm extensive margin and the firm intensive margin and on the latter's components, i.e., the export variety extensive and intensive margins. To do so, we replace ln Exports$_{mcdts}$ with the log of the number of exporters, the log of average export value per exporter, the log of the number of exporter-product combinations, and the log of average export value per product-exporter combination, all at the municipality-customs-destination-year-semester level.

Table 3 reports the estimated effects of TIM on these extensive and intensive margins based on the baseline specification Equation (2). Estimates indicate that about half of TIM's total export effect of 44.3 percent (Column 1) can be traced back to the entry of new exporters (Column 2) and the entry of new firm-product combinations (Column 4). By construction, the remaining part is then explained by the intensive margin, an increase in the average exports per firm-product (Column 5). It is worth noting that entry of small exporters or new products may dampen intensive margin effects and we next disaggregate the data to examine the intensive margin mechanism in more detail.

We specifically focus on the firm-product-customs-destination-year-semester unit of observation.[21] Our baseline specification is the following:

$$\ln \text{Exports}_{\text{fpcdts}} = \alpha \text{TIM}_{\text{fpcdts}} + \delta_{\text{fpcd}} + \rho_{\text{ft}} + \mu_{\text{ct}} + \phi_{\text{pdt}} + \gamma_{\text{ts}} + \varepsilon_{\text{fpcdts}} \tag{3}$$

The main variable of interest, $\text{TIM}_{\text{fpcdts}}$, equals one if firm f exports at least one shipment of a Harmonized System 8-digit (HS8) product p via customs office c to destination d in semester s of year t using TIM, and zero otherwise. Again, we focus on parameter α, which captures the

[21] Semesters are defined from January to June and July to December. The bottom panel of Table **??** in the online appendix reports associated summary statistics for export values.

effect of TIM on exports. Compared to Equation (2), this specification has some advantages in identifying the effect of TIM on the export intensive margin. Thus, Equation (3) includes firm-product-customs-destination fixed effects, δ_{fpcd}. Hence, identification of the effect of interest comes from the variation in TIM status within export-routes used by firms before and after their use of TIM to ship goods from their facilities to the destinations in question. In addition, this identification strategy allows us to avoid aggregation and agglomeration biases affecting typical border effect estimates (e.g., Coughlin and Novy, 2016; Wrona, 2018).[22]

Equation (3) also encompasses three additional sets of fixed effects that account for several time-varying unobserved variables that are likely to be systematically related to export performance and potentially related to the use of TIM. Firm-year fixed effects ρ_{ft} control 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, the customs regime -free trade zones or regular customs territory-) as well as the firms' changing abilities to comply with customs' and other border agencies' regulations. The product-destination-year fixed effects, ϕ_{pdt}, account for destination-specific institutional and policy differences such as changes in tariffs across products and importing countries (e.g., the Unified Trade Agreement between Mexico and Central America) and fluctuations in demand for goods across markets.[23] From a theory point of view, this set of fixed effects also controls for average price levels across destination markets and multilateral resistance terms. The customs-year effects μ_{ct} absorb average differences in customs performance over time. Finally, ε is the residual error term.

We estimate Equation (3) with OLS and, as in the previous section, we use standard errors clustered at the municipality-custom-destination level (i.e, the level at which the policy was implemented) for inference purposes. It is important to stress that these estimates only serve as

[22] Coşar et al (2015a) also use micro data to circumvent several sources of bias in the estimation of border effects. Unlike our approach, they a apply a structural estimation technique to determine the magnitude of these effects focusing on the wind turbine industry.

[23] The Unified Trade Agreement between Mexico and Central America covers and consolidates the trade agreements between Mexico and Costa Rica, Mexico and Nicaragua, and Mexico and El Salvador, Honduras and Guatemala. It was signed in November 2011 and entered into force in September 2012 for El Salvador and Mexico, thus over our sample period, but it is not related to TIM. The two main changes introduced through this agreement were the extension of preferences to products not reached in the previous arrangements and the possibility of regional accumulation (i.e., imports from other member countries became considered domestic to establish origin and access to preferences). Given that preferential tariffs and rules of origin are product-specific, our product-destination-year fixed effects should account for the aforementioned trade policy changes.

a starting point and benchmark, because, despite the comprehensive set of fixed effects, a main concern is that exporters that benefit the most from TIM could choose to adopt TIM to deliver products to their destination. We therefore report intention-to-treat and instrumental variable estimates, which help address this concern and hence are our main results of interest at this level of aggregation.

We carry out intention-to-treat estimations based on the availability of TIM across export routes. In this case, we replace the TIM indicator in Equation (3) with the TIM availability indicator from Equation (2), $\text{TIM}_{\text{mcdts}}$. Note that each firm f is located in a municipality m and firms do not switch municipalities within our sample. We then estimate the following specification:

$$\ln \text{Exports}_{\text{fpcdts}} = \alpha \text{TIM}_{\text{mcdts}} + \delta_{\text{fpcd}} + \rho_{\text{ft}} + \mu_{\text{ct}} + \phi_{\text{pdt}} + \gamma_{\text{ts}} + \varepsilon_{\text{fpcdts}} \tag{4}$$

OLS estimation of this specification delivers intention-to-treat effects, because it considers that TIM is available to all exporters located close to customs offices that process TIM shipments serving destinations via export routes that are connected to TIM even though not all exporters actually use the system. Therefore, in this case, the estimate of interest, $\hat{\alpha}$, takes into account the effect of TIM on exports and the TIM take-up rate. From an identification point of view, the assumption is that TIM availability is determined by firms location relative to TIM fiscal-routes.

Next, to implement the IV estimator we use the TIM availability indicator from Equation (2), $\text{TIM}_{\text{mcdts}}$, as instrument for the TIM indicator in Equation (3), $\text{TIM}_{\text{fpcdts}}$. Based on the existing literature, the resulting IV estimate can be interpreted as the effect of TIM on exports for those exporters whose treatment status has changed as a consequence of their proximity to TIM fiscal routes, i.e., the IV estimate identifies a local average treatment effect (e.g., Imbens and Angrist, 1994; Bhuller et al., 2020).

Table 4 reports the results based on several alternative specifications of Equation (3) and (4). Thus, Column 1 presents estimates obtained with a standard two-way fixed effect panel specification. In Column 2, we extend the empirical model with customs-year fixed effects and product-destination-year fixed effects to account for evolving customs performance and product specific changes in trade policy across destinations, among other factors. In Column 3, we add municipality-year effects to control for local policy developments. Finally, in Column 4 we incorporate firm-year effects to account for changes in firm size and productivity.

We start by discussing OLS effect of TIM on firms' exports based on Equation (3). The estimates are always statistically significant at the 1% level. According to our preferred specification (Column 4), the estimated TIM effect is economically relevant and implies a 37.8 percent increase in exports.

The row labeled ITT of Table 4 reports intention-to-treat effects based on Equation (4). Not surprisingly, taking into account that firms do not take up TIM even though it is available, these estimates are substantially lower than their OLS counterparts. Similar to what we observe for these latter estimates, accounting for customs-year and product-destination-year fixed effects (Column 2) raises the estimated impact compared to that based on the simple two-way fixed effect panel model (Column 1). After that, in Columns 3 and 4, the estimated coefficients are similar and imply that TIM raises exports between 6.6 to 7.5 percent. These coefficients are significant at the 5% level. Therefore, based on the ITT estimates, we conclude that borders impose important administrative trade costs that can be addressed with appropriate trade facilitation policies.

Finally, the row labeled IV of Table 4 presents instrumental variable estimates of Equation (3) (top panel) along with the respective first-stage statistics (bottom panel). Across all specifications, the results show that the instrument is significantly correlated with policy adoption. Furthermore, the effective F statistics presented in Table 4 confirm that our instrument is not weak and the instrument indeed predicts the uptake of TIM (Montiel Olea and Pflueger, 2013). In our preferred empirical model (Column 4), the 2SLS estimate implies that TIM raises exports by about 54 percent.

When interpreting the magnitude of the IV estimate, it should be kept in mind, first, that TIM was a regime change that substantially modified the administrative processing of cross-border shipments through a major redesign of procedures and their digitization. Second, the median export shipment is about US$5,000 (Table **??** in the online appendix), so our results imply an extra US$ 2,700 worth of exports. Therefore, while in percentage terms the TIM effect is high, the associated increase in shipment values is plausible. Third, as examined and discussed below, the so-estimated TIM effect may not only capture net trade creation, but also trade diversion, i.e., substitution of export flows across export routes.

Comparing the estimates shown in the the second and third rows of Table 4 reveals that intention-to-treat estimated effects are substantially lower than the instrumental variable counterparts. The reason is that, as mentioned above, intention-to-treat estimates capture the effect of TIM on export values and the rate at which export flows adopt TIM. Dividing the intention-to-treat by the instrumental-variable estimate in Column 4 implies an average take-up rate of about 16.7 percent. This take-up rate is conditional on fixed effects and averaged over the entire sample period. The unconditional take-up rate increases to 42 percent in the last semester of 2013. This take-up rate is comparable, for example, to Latin American exporters' unconditional take-up rate of export promotion services (Volpe Martincus, 2010) or managers' unconditional take-up rate of foreign language classes (Guillouet et al., 2021).

A cost-benefit analysis provides additional context to our estimates. Using our intention-to-treat estimate from Column 4 of Table 4, it is possible to establish that Salvadoran aggregate exports increased by roughly 5.6 percent due to TIM. On the benefit side, we consider the additional tax revenues derived from the higher profits associated with these larger exports allowed for by TIM. Based on a standard heterogeneous firm model, these additional tax revenues can be expressed as follows: $Z = z(\pi_1 - \pi_0) = (z/\sigma)(r_1 - r_0)$, where Z denotes tax revenues, z is the tax rate, π corresponds to profits, σ is the elasticity of substitution across firm-products, and r stands for export revenues. An advantage of focusing on intensive margin variation is that we do not need to consider fixed costs of entry. Therefore, changes in export revenues directly translate to changes in profits. In El Salvador, the tax rate on profits is 25 percent. Assuming $\sigma = 4$ (e.g., Simonovska and Waugh, 2014) and given the 5.6 percent extra exports induced by TIM, tax revenues would have increased by US$ 15 millions.

On the cost side, TIM's total development and implementation costs, when prorated among the countries in the region according to their participation in the successive stages of the process, were US$ 2.5 millions for El Salvador. The annual operative costs correspond to the compensation of officials supervising transits and inspecting the respective shipments at each customs office throughout the country. According to figures provided by El Salvador's DNA, there were 72 officials in charge of the transport control with an average annual compensation of US$ 8,500; 20 officials who performed non-intrusive inspections with an average annual compensation of US$ 11,000; 24 officials who conducted thorough physical inspections with an average annual compensation of US$ 16,000; and 37 customs managers with an average annual compensation of US$ 20,000. Overall, these operative costs roughly amount to US$ 2 million[24] Hence, total costs add up to US$ 4.5 million. Together, these figures imply a benefit/cost ratio of approximately US$ 3.3 per US dollar invested in the system with a confidence interval between US$ 0.815 and US$ 5.971 based on our intention-to-treat point estimates of TIM's impact on exports.

4. Robustness

4.1. Selection Concerns

The main identification concern for the evaluation of TIM is selection: policymakers may have implemented TIM based on unobserved information correlated with export performance. This subsection examines the robustness of our results with respect to such identification concerns.

4.1.1. Selection at the Export-Route Level

We start with the results based on Equation (2) that estimate the effect of TIM based on the availability of TIM at the municipality-customs-destination-year-semester unit of observation. Section 2.3 shows that variation in the availability of TIM is predominantly due to the roll-out of TIM across export-routes and their proximity to customs offices that are connected to the system. Admittedly, trade flows on export-routes that allow for the use of TIM might be systematically different and these differences might be correlated with export performance. Municipality-custom-destination, municipality-year, and destination-year fixed effects included in Equation (2) precisely aim at accounting for such heterogeneity and demand growth differentials across routes. To check if these fixed effects are sufficient to account for pre-existing differences in export performance that may have been systematically related to the

[24] TIM could have potentially lead to a reduction in operating costs related to customs staff. In that case, the benefit to cost ratio would be actually higher and we would be reporting a conservative estimate.

roll-out of TIM, we perform a placebo test and we examine whether differences in past export growth predict the availability of TIM across export routes.

The placebo exercise seeks to establish whether export flows that end up using TIM already outperformed other export flows immediately before their actual take up of TIM. To do this, we start with Equation (2) and replace the actual TIM indicator with two artificial counterparts that assume that TIM was already in use in the two periods immediately before the actual first use of the system, i.e., we forward the actual use of TIM. To be precise, suppose that $\text{TIM}_{\text{mcdy}} = 1$ for the first time in period y, where period y is determined by semester s of year t. Then, we generate two binary indicators that equal one in the first and second semesters immediately before the first use of TIM, $\text{Artificial}_{\text{mcdy-1}} = 1$ and $\text{Artificial}_{\text{mcdy-2}} = 1$. The indicators are zero otherwise. We then include these two indicators in Equation (2) and estimate their effect on exports on the subsample in which there is no use of TIM, i.e., we drop all observations with $\text{TIM}_{\text{mcdy}} = 1$. Column 1 of Table 5 reports the estimates. The estimates are not significant. Hence, conditional on our fixed effects, we do not find evidence that availability of TIM across export routes is associated with past differences in export performance.

Next, we examine if export growth predicts the availability of TIM based on Equation (2). For notation, again, let period y be determined by year t and semester s. We regress the indicator TIM_{mcdy} on the differences $\ln \text{Exports}_{\text{mcdy-1}} - \ln \text{Exports}_{\text{mcdy-2}}$ and $\ln \text{Exports}_{\text{mcdy-2}} - \ln \text{Exports}_{\text{mcdy-3}}$ including all fixed effects as in Equation (2). Column 2 of Table 5 presents the estimation results. Consistent with the findings based on the placebo exercise, these estimates do not substantiate the concern that TIM availability across export routes was determined by pre-existing differences in export growth.

4.1.2. Selection in ITT Estimates

We examine if availability of TIM in Equation (4), $\text{TIM}_{\text{mcdts}}$, is determined by pre-existing differences in export performance. Note that the indicator $\text{TIM}_{\text{mcdts}}$ is also the instrument we employ for the IV estimates of Equation (3).

As before, we perform a placebo test and examine whether past differences in export growth predict the availability of TIM across export-routes. Following the same procedure as in the previous subsection, for the placebo exercise, we generate two indicators that forward the actual use of TIM by two periods, we include both indicators in Equation (4), and we estimate their effect in the sample of exports that does not actually use TIM.[25] To examine if past differences in export growth predict availability of TIM, we again regress the indicator TIM_{mcdy} on the first and second difference in log exports including all fixed effects as in Equation (4). Table 5 Columns 3 and 4 show the results. TIM availability immediately before the use of TIM is not systematically associated with improved export performance, and, past differences in export growth do not predict the availability of TIM.

In closing, we note that we have checked the robustness of the findings presented in this and the previous sub-section to using alternative specifications that either include multiple additional lags or varying sets of fixed effects that correspond to those whose estimates are shown in Tables 2 and 4. In all cases, our conclusions remain the same. Moreover, for completeness, we have also examined selection in the the OLS estimations. We did not find evidence that pre-existing differences in export performance predict exporters' adoption of TIM. For a detailed discussion see **??**.

4.2. Alternative Definition of Export Routes

In the previous sections, we focused on export-routes at the municipality-custom-destination unit of observation. It might be argued that this definition is too narrow and the availability of TIM is too closely related to the actual adoption of TIM by firms to be a valid instrument. To examine this, we consider a broader definition of TIM availability.

Let b indicate a department that includes multiple municipalities m in El Salvador and let TIM be considered available on a given department-custom-destination route in semester s of year t if TIM is used in at least one transaction at that level. To fix notation, let $\text{TIM}_{\text{bcdts}} = 1$ if TIM is available on a route and zero otherwise. We then aggregate exports to the $b-c-d-t-s$ unit of observation and regress log exports on $\text{TIM}_{\text{bcdts}} = 1$ including the relevant fixed effects at that level. Columns 1 and 2 of Table **??** in the online appendix report the OLS estimation results. These estimates indicate that TIM raises exports by about 72 percent. Compared to the estimates of Equation (2) presented in Table 2, this implies that, if anything, a broader definition

[25]The indicators take the value of one in the first and second semester immediately before the first use of TIM, $\text{Artificial}_{\text{mcdy-1}} = 1$ and $\text{Artificial}_{\text{mcdy-2}} = 1$, and zero otherwise.

of export routes is associated with greater TIM effects.

Next, we carry out ITT and IV estimation based on the broader definition of export routes. To obtain ITT estimates we estimate Equation (4), but we replace the TIM indicator based on municipalities, TIM_{mcdts}, with the department level indicator TIM_{bcdts}. We also re-estimate Equation (3), but we use TIM_{bcdts} to instrument for the actual use of TIM across firm-product-customs-destination-semester-year specific export flows. Table **??** in the online appendix presents the results. ITT estimates imply that TIM raises exports between 9.3 and 10.6 percent, whereas their IV counterparts indicate that TIM increases exports between 117 and 140.4 percent. In both cases, the coefficient magnitudes are greater than the respective estimates reported in Table 4. Therefore, a broader specification of export routes would lead to even greater TIM benefits.[26]

4.3. Availability of TIM by Product and Route

Table 1 reports that around 40% of the products never use TIM. In our sample, these products account for only about 9% of the export flows. Still, we reached out to customs authorities in El Salvador to look for an explanation. Based on our exchanges with these authorities, a potential reason could be that, while TIM was, in principle, made available to firms exporting any product, from a practical point of view, its actual use could have been discouraged by the need to comply with additional requirements.[27]

In this regard, it is worth noting that our preferred empirical specifications account for product-destination-year fixed effects. Hence, any potential differences in product requirements that may affect the use of TIM are accounted for. However, as specified in Equation 4, TIM availability may be arguably too broad. We accordingly adjust our indicator of TIM availability for differences across industries and products and re-estimate ITT and IV effects.

To allow for differences in TIM availability across industries, we consider that TIM is available for a given HS2 sector on a given export-route if TIM is used in at least one transaction involving the HS2 product on the export-route in question. We then estimate ITT effect based on

[26] As we did for Equations (2), (3), and (4), we also performed a placebo test and examined if differences in past export growth predict the roll-out of TIM. Table **??** in the online appendix presents the results. The estimates do not raise concerns that the roll-out of TIM at the department-custom-destination-semester unit of observation is related to differences in past export performance.

[27] For example, products belonging to HS Chapter 84 required a certificate from the Ministry of Labor.

Equation (4) and instrumental variable effect based on Equation (3) using the industry specific availability of TIM as instrument.

Table **??** in the online appendix reports the estimation results. For comparison, Column 1 reproduces the baseline ITT and IV estimates discussed in Section 3. Column 2 presents the respective estimates when TIM availability is adjusted by industry. The intention-to-treat effect in row TIM-ITT increases relative to the baseline estimates. Unlike the latter, this new estimate reflects take up of TIM on routes where TIM is available within HS2 industries where the use of TIM is feasible. The instrumental variable estimate in row TIM-IV is somewhat lower with the industry level adjustment. Using TIM now raises export flows by about 47.1 percent, compared to 54 percent with the baseline specification of TIM availability.

To further examine this issue, we make the TIM availability indicator product-specific. More precisely, we consider that TIM is available for a product on a given export-route if that product was exported at least once using TIM on the export-route in question. Column 3 of Table **??** in the online appendix presents the estimation results. The estimated intention-to-treat effects increase to 27.8 percent, whereas the instrumental variable estimate decreases to 36.3 percent. In summary, we conclude that adjusting availability of TIM for product heterogeneity results in stronger intention-to-treat effects and more conservative instrumental variable estimates.

4.4. Export Substitution Effects

The question arises of whether the estimated impacts reported in previous tables can be linearly interpreted as TIM's net contribution to El Salvador's trade. A necessary condition for this to be the case is the absence of reallocation of exports from untreated to treated export flows. If reallocation occurred, then our estimated coefficient –and our estimated benefit/cost ratio– would primarily correspond to the upper bound of the program's true effect.[28]

To assess whether and to what extent such export substitution affects our results, we apply a strategy proposed by Redding and Turner (2015). We estimate a variant of Equation (4) where we drop the firm-year fixed effects to allow cross-firm variation to play a role in the

[28] In the extreme case, firms' exports processed under TIM expanded entirely at the expense of counterparts subject to the former transit procedures and the estimated effect effect would merely correspond to trade diversion.

identification of the effects of interest.[29] This estimate is shown in Column 1 of Table 6 and suggests that TIM raises export flows by 7 percent according to ITT estimates.

If export substitution is relevant, then the concern would be that the estimates in Column 1 could be due to a decrease in export flows of non-treated firms. To determine whether this is the case, we restrict the sample to export flows from treated firms and re-estimate the specifications. Column 2 reports ITT results. If anything, the estimate is greater in magnitude. Therefore, we do not find evidence that a decrease in trade flows of non-treated firms is driving the estimates in the full sample.

To further examine the effect of TIM on non-treated export flows, Column 3 presents an estimate on a sample that only includes non-treated export flows. In particular, the estimate in Column 3 shows the response of treated firms' export flows that are not processed on TIM to the availability of TIM relative to that of non-treated firms export flows. The estimation results point to a non-significant difference between TIM firms' export flows not using TIM and those export flows of firms that do not use TIM. This suggests that reallocation between treated and untreated firms does not impact the estimates in a consequential way.

We also explore the possible substitution within firms. To do so, we consider a sub-sample that limits such a substitution. In particular, in Column 4 of Table 6, we only keep firm-product export flows that were carried along a single customs-destination route and accordingly drop all firm-product export flows using multiple customs-destination routes where firms could easily substitute exports across routes within a particular product. When estimated on this sample, the estimated TIM effect remains similar in magnitude to the full sample estimates reported in Column 1.[30] Hence, within-firm substitution does not affect coefficient magnitudes in a way that affects our conclusions.

Our results at the department-customs-destination-semester unit of observation also speak to potential substitution patterns. Exporters located in municipalities with access to TIM may absorb export opportunities from firms that are less conveniently located to use TIM. In that case, TIM simply leads to a reallocation of exports from treated to non-treated export-routes.

[29] We focus on results based on Equation (4) because potential export substitution would affect our benefit/cost analysis. For completeness, Table **??** in the online appendix reports the respective results based on Equation (2).

[30] The effect is insignificant, a potential reason for this is that we limit the sample.

We expect that results based on a broader definition of export routes, i.e., the department level, are less affected by such substitution. Therefore, if export substitution across narrowly defined export-routes is relevant, we then expect that TIM effects are lower with a broader definition of export-routes. Comparing ITT results in Table **??** in the online appendix to those in Table 4 suggests that the opposite is the case. At the high end, estimates in Table 4 indicate that TIM increases exports by about 7.5 percent based on our narrow definition of export routes. At the low end, Table **??** in the online appendix reports that TIM increases exports by as much as 9.3 percent according to ITT estimates based on the the broader definition of export routes. This evidence mitigates concerns that our results are due to export substitution across narrowly-defined export routes.[31]

5. Mechanisms: The Effects of TIM on Firms' Export Margins

Finally, we examine how several additional export margins reacted to TIM. To disentangle the channels, we first extend the standard intensive-extensive margin decomposition from the literature (e.g., Hummels and Klenow, 2005; Dutt et al., 2013) and estimate the effects of using the new transit system on each of the resulting components. More precisely, we decompose export values at the firm-product-customs-destination level in each semester as follows:

$$X_{fpcdts} = \frac{X_{fpcdts}}{Q_{fpcdts}} \frac{Q_{fpcdts}}{N^S_{fpcdts}} \frac{N^S_{fpcdts}}{N^B_{fpcdts}} N^B_{fpcdts} \quad (5)$$

where X_{fpcdts} is export value, Q_{fpcdts} is weight, X_{fpcdts}/Q_{fpcdts} is the unit value, Q_{fpcdts}/N^S_{fpcdts} is the average shipment size, $N^S_{fpcdts}/N^B_{fpcdts}$ is the average number of shipments per buyer, and N^B_{fpcdts} is the number of buyers. To assess the effect of TIM, we take the log of these various export margins and use them as dependent variables in Equation (3). Again, we will provide intention-to-treat, and 2SLS estimates.

Estimation results are shown in Table **??** in the online appendix. According to these results, there is no evidence that TIM affected unit values. Therefore, the reduction of costs associated with TIM does not seem to have been passed to buyers in the form of lower export prices.[32]

[31] We have also examined the effect of TIM on exports at the firm-custom-destination-semester level. These effects are more robust with respect to substitution across products within firms. Results are reported in Table **??** in the online appendix.

[32] Furthermore, TIM does not seem to affect (transfer) pricing strategies.

To some extent, ITT and IV estimates also suggest that the number of shipments per buyer increased. This result based on a well-defined policy experiment complements recent studies that examine the relevance and consequences of fixed per-shipment costs (Alessandria et al, 2010; Kropf and Sauré, 2014; and Hornok and Koren, 2015). Our caveat is that it is challenging to obtain significant estimates.

The estimates presented in Table **??** in the online appendix also reveal that the export expansion due to TIM was partially due to an expansion of the buyer network. This informs the effects of trade facilitation policies on the formation of new trade relationships and indicates that for buyers the seamless processing of shipments is important (e.g., Bernard et al., 2018; and Carballo et al., 2018).

6. Concluding Remarks

The existing literature shows that borders impose large costs to trade, but it is not clear what policies will work to reduce these costs. Countries worldwide have implemented multiple major trade facilitation initiatives that simplify the processing of international shipments in the hope to reduce border-related trade costs and increase global integration. One of these initiatives is the upgrading of transit systems to streamline procedures, use modern technology, and coordinate the interventions of border agencies in both exporting and importing countries. In this paper, we provide evidence on the trade effects of such an upgrade of transit system.

Our estimates indicate that simplified border procedures within regions where trade flows often cross multiple borders lower trade costs and consequently facilitate trade. In particular, the improvement of the Central American transit system has resulted in increased exports in firm-product-custom-destination flows that use the new system, and has led to entry of exporters and product varieties within firms for those exports where the new transit system is available. Based on our estimates, these transit trade polices are cost-effective. According to our rough estimates of benefits and costs, the upgrading of the transit system has generated a return of over US$ 3 in tax income for each US$ 1 of cost associated with implementing and running the transit system.

Our results are encouraging for trade facilitation policy in general and transit trade policy in particular. This motivates several future research questions. Given that it helps determine the benefits of these policies, there is clear need to gain a better understanding of what are the factors accounting for their take-up by firms. As for the effect of these policies, recent research shows how exporting impacts prices, productivity, markups, and product quality (e.g. Atkin et al., 2017). If exporting improves these margins, then transit trade policies could have welfare benefits beyond their return to investment. We expect that both questions could be examined with more detailed data on firm characteristics. Finally, we expect that transit policies, and their reversions, can have implications beyond the developing world. For example, *Brexit* excludes British firms from access to the EU-wide e-customs system increasing regulatory burden on both sides of the UK and EU borders.

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7. Tables

Table 1: Descriptive Statistics

Year	Semester	Value/ Share TIM	Exports	Number of Shipments	Number of Exporters	Number of Products	Number of Destinations	Number of Buyers
2010	1	Value	1,925	150,953	1,726	2,650	96	6,485
		Share TIM	0.000	0.000	0.000	0.000	0.000	0.000
	2	Value	2,098	170,202	1,777	2,700	95	6,698
		Share TIM	0.000	0.000	0.000	0.000	0.000	0.000
2011	1	Value	2,470	189,347	1,800	2,759	85	6,756
		Share TIM	0.000	0.000	0.000	0.000	0.000	0.000
	2	Value	2,362	191,997	1,804	2,813	95	6,817
		Share TIM	0.033	0.048	0.048	0.167	0.221	0.055
2012	1	Value	2,563	198,483	1,780	2,759	94	6,693
		Share TIM	0.142	0.198	0.263	0.431	0.266	0.199
	2	Value	2,530	202,355	1,793	2,853	96	6,729
		Share TIM	0.200	0.259	0.359	0.578	0.313	0.268
2013	1	Value	2,585	199,694	1,817	2,816	97	6,785
		Share TIM	0.253	0.280	0.373	0.555	0.351	0.266
	2	Value	2,515	203,555	1,823	2,826	90	6,603
		Share TIM	0.266	0.276	0.366	0.573	0.456	0.274

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

Export values are expressed in millions of US dollars. Air-shipped exports are excluded.

Table 2: The Effect of TIM on Export-Route Level Exports

	(1)	(2)	(3)	(4)
TIM	0.189***	0.192***	0.334***	0.367***
	(0.055)	(0.068)	(0.075)	(0.080)
Fixed-Effects				
Municipality-Custom-Destination	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes
Destination-Year	No	Yes	Yes	Yes
Custom-Year	No	No	Yes	Yes
Municipality-Year	No	No	No	Yes
Observations	8,672	8,672	8,672	8,672

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

The table reports OLS estimates of Equation (2). The dependent variable is the natural logarithm of export value aggregated at the municipality-customs-destination-semester-year level. The main explanatory variable is a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question and zero otherwise. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 3: Decomposition of the TIM Effect at the Export-Route Level

	Total Exports	Number of Firms	Exports per Firm	Number of of Firm-Product per Firm	Exports per per Firm-Product
TIM	0.367***	0.134***	0.233**	0.062*	0.170***
	(0.080)	(0.023)	(0.077)	(0.036)	(0.073)
Fixed-Effects					
Municipality-Custom-Destination	Yes	Yes	Yes	Yes	Yes
Destination-Year	Yes	Yes	Yes	Yes	Yes
Custom-Year	Yes	Yes	Yes	Yes	Yes
Municipality-Year	Yes	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes	Yes
Observations	8,672	8,672	8,672	8,672	8,672

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

The table reports OLS estimates of Equation (2). The dependent variable is the natural logarithm of the variable indicated at the column label aggregated at the municipality-customs-destination-semester-year level. The main explanatory variable is a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question and zero otherwise. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 4: The Effect of TIM on Firm-Product Exports

	FE1	FE2	FE3	FE4
TIM - OLS	0.187***	0.294***	0.289***	0.321***
	(0.030)	(0.036)	(0.038)	(0.042)
TIM - ITT	0.036	0.069**	0.064**	0.072**
	(0.030)	(0.031)	(0.032)	(0.033)
TIM - IV	0.116	0.416*	0.391*	0.432**
	(0.099)	(0.213)	(0.219)	(0.220)
Fixed-Effects				
Firm-Product-Customs-Destination	Yes	Yes	Yes	Yes
Semester-Year	No	No	No	Yes
Product-Destination-Year	No	No	Yes	No
Customs-Year	Yes	Yes	Yes	Yes
Firm-Year	No	Yes	Yes	Yes
Municipality-Year	No	Yes	Yes	Yes
Observations	103122	103122	103122	103122

IV - First Stage

	p_tim_tfpca			
Custom-Year	No	Yes	Yes	Yes
Fixed-Effects				
Firm-Product-Customs-Destination	Yes	Yes	Yes	Yes
Semester-Year	No	No	No	Yes
Product-Destination-Year	No	No	Yes	No
Customs-Year	Yes	Yes	Yes	Yes
Firm-Year	No	Yes	Yes	Yes
Municipality-Year	No	Yes	Yes	Yes
Observations	103122	103122	103122	103122

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

The table reports OLS and IV estimates of Equation (3) at the OLS and IV rows, and OLS estimates of Equation (4) at the ITT row. The dependent variable is the natural logarithm of export value aggregated at the firm-product-customs-destination-year-semester level. For OLS and IV, the main explanatory variable is a binary indicator taking the value of one if the exporter uses TIM to export the product to the destination through the customs in question and zero otherwise. The instrument for the IV is a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question and zero otherwise. For ITT, the explanatory variable is the instrument. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 5: Placebos and Selection based on Past Export Growth

	Equation 2		Equation 4	
	Placebo	Growth	Placebo	Growth
	(1)	(2)	(3)	(4)
Forward 1 Semester	0.106		0.048	
	(0.087)		(0.047)	
Forward 2 Semesters	-0.124		0.091*	
	(0.079)		(0.053)	
Lagged 1 Semester		0.002		-0.002
		(0.002)		(0.004)
Lagged 2 Semesters		0.0003		0.004
		(0.0009)		(0.003)
Fixed-Effects				
Municipality-Custom-Destination	Yes	Yes	No	No
Destination-Year	Yes	Yes	No	No
Custom-Year	Yes	Yes	Yes	Yes
Municipality-Year	Yes	Yes	No	No
Semester-Year	Yes	Yes	Yes	Yes
Firm-Product-Custom-Destination	No	No	Yes	Yes
Product-Destination-Year	No	No	Yes	Yes
Firm-Year	No	No	Yes	Yes
Observations	3,395	4,427	75,782	32,557

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

The table reports OLS estimates for the exercises described in Section 4.1. In the Placebo columns, the dependent variable is the natural logarithm of export value aggregated at the municipality-customs-destination-year-semester level in column 1, and aggregated at the firm-product-customs-destination-year-semester level in Column 3. The explanatory variables are one and two forwards of a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question. Observations where actual TIM use is observed are excluded. In the Growth columns, the dependent variable is a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question. The explanatory variables are one and two lags of log export growth defined at the municipality-customs-destination-year-semester level in column 2, and at the firm-product-customs-destination-year-semester level in columns 4. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table 6: The Impact of TIM on Exports - Trade Diversion at Firm-Product

	Full Sample	Only Flows for Treated Firms	Only Untreated Flows	Only Single Routes Flows
	(1)	(2)	(3)	(4)
TIM	0.068**	0.084**	-0.024	0.068
	(0.031)	(0.036)	(0.048)	(0.042)
Fixed-Effects				
Firm-Product-Custom-Destination	Yes	Yes	Yes	Yes
Product-Destination-Year	Yes	Yes	Yes	Yes
Custom-Year	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes
Observations	102,444	97,135	58,576	81,817

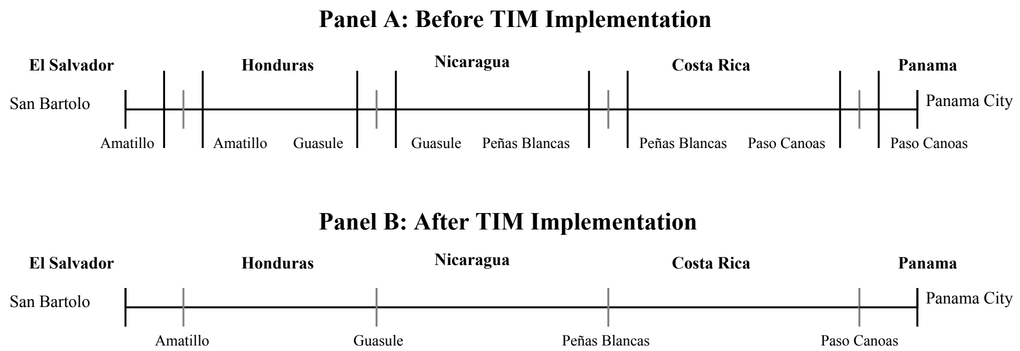
Source: Authors' calculations based on data from DGA and TIM.

The table reports OLS estimates of Equation (4) (ITT estimates) with the sample restriction noted at the column label. The dependent variable is the natural logarithm of export value aggregated at the firm-product-customs-destination-semester-year level. The main explanatory is a binary indicator taking the value of one if TIM is available at the municipality-custom-destination in question and zero otherwise. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level.

* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

8. Figures

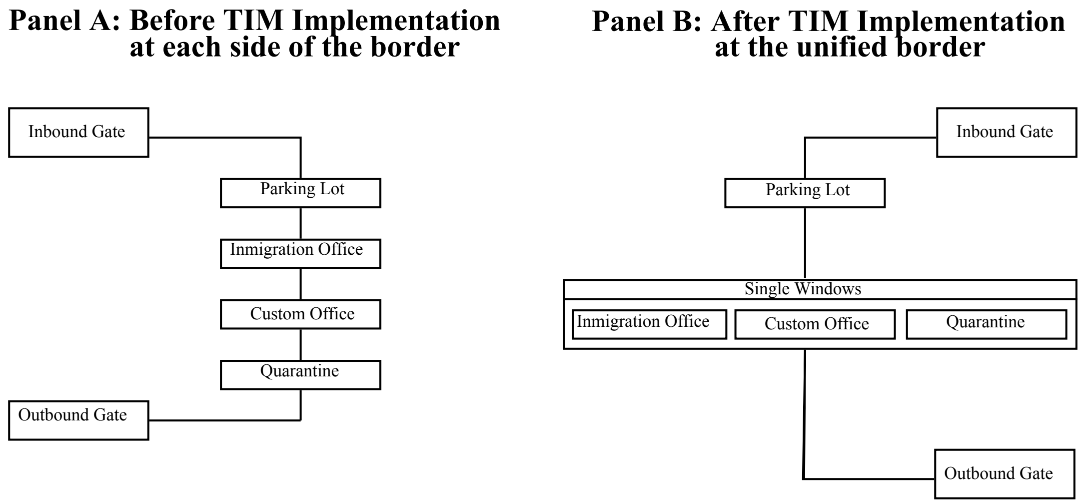
Figure 1: Stylized Border Crossing from El Salvador to Panama



Panel A plots the sequence of customs a firm exporting from San Bartolo (El Salvador) to Panama City (Panama) needs to go through before TIM implementation. Gray short vertical lines are borders, and black long vertical lines are customs.

Panel B plots the same route after TIM implementation, where intermediate customs were removed.

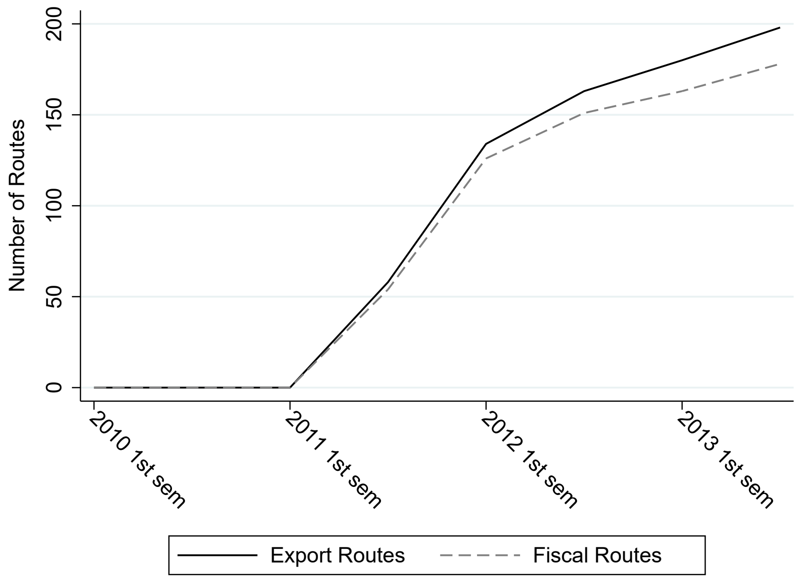
Figure 2: Stylized Export Processing at the Border



Panel A shows the process for a shipment that arrives at the border before TIM implementation. This process would take place two times at the border, in each side of the border.

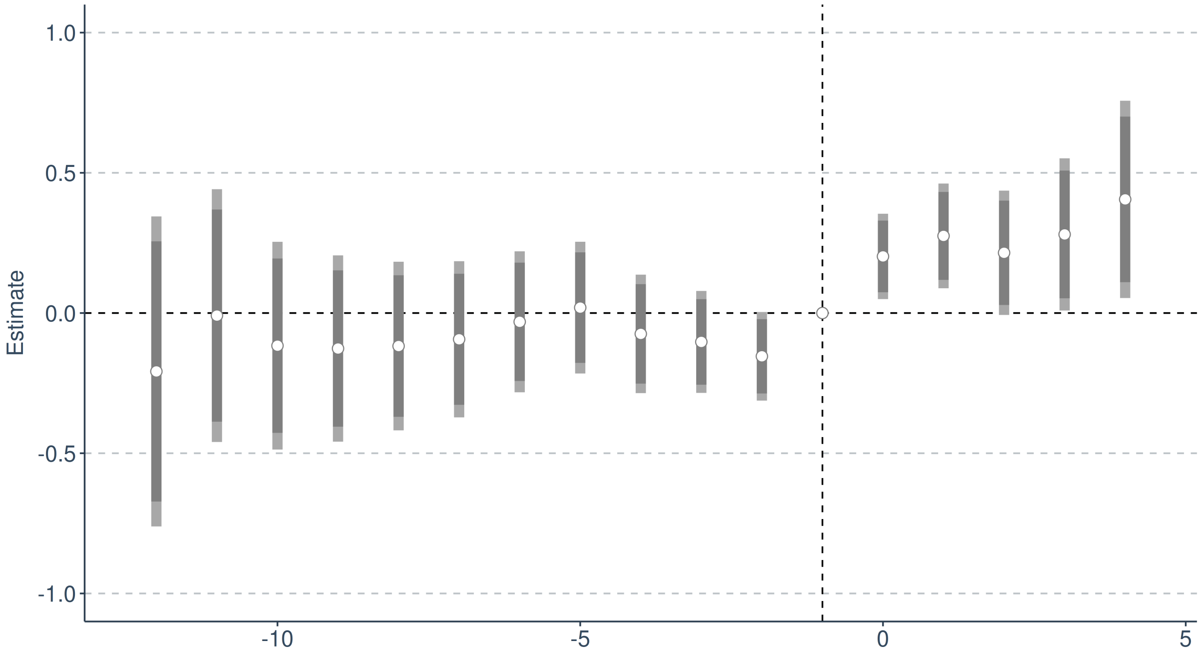
Panel B shows the process for a shipment that arrives at the border after TIM implementation. This process is unified for both sides.

Figure 3: Route Adoption



Export routes are defined by the municipalities where firms are located, customs offices where shipment exits El Salvador, and destination countries. Fiscal routes are defined as a sequence that starts with a municipality located within 50km of an inland customs office connected to TIM, a border office connected to TIM, and the last destination in Central America also on TIM, conditional on municipalities with exports through TIM.

Figure 4: Event Study



The figure plots OLS coefficient estimates of Equation (1). The dependent variable is the natural logarithm of export value, aggregated at the municipality-customs-destination-semester-year level. Municipality-customs-destination, municipality-year, destination-year, customs-year, and semester-year fixed effects included. Standard errors are clustered at municipality-customs-destination level. Light gray bars are 95% significant confidence interval and dark gray bars are 90% significant confidence interval.