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The Effects of Transit Systems on International Trade

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. The estimation results also suggest that existing frameworks that emphasize shipping frequency and the formation of new trade relationships are important to interpret trade facilitation policy. This evidence informs an important policy covered by the 2013 WTO Agreement of Trade Facilitation.

JEL-Codes: F100, F130, F140.

Keywords: transit trade, border effects, shipping frequency.

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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. In so doing, we inform a relevant policy covered by the 2013 WTO Trade Facilitation Agreement.

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.[2] 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 regimes involve unified border transit controls along with the use of a common electronic document and modern information technology to simultaneously 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, 2021[3]). In contrast, well working transit systems are virtually absent in the developing world.[4]

In this paper, 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. We answer two main questions. First, does the establishment of a transit system such as TIM affect exports?

[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]Transit can take place in the country of destination/origin of the goods (national transit) or in a third country where the products are carried out from an entry post to an exit post (international transit). Thus, a complete transit operation consists of a sequence of national and international transit links (Arvis et al., 2007). Furthermore, international transit encompasses all shipments crossing two different customs territories, including exports to immediate neighbor countries when originated in internal customs.

[3]`https://ec.europa.eu/taxation_customs/business/customs-procedures/what-is-customs-transit/tir-transports-internationaux-routiers-international-road-transport_en#heading_5`

[4]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- have provisions to facilitate transit (Neufeld, 2014).

Second, guided by existing theoretical and empirical literature, how does a transit system affect export mechanisms? The main challenges to answer these questions are determining which export flows are affected by the system and exporters' self-selection into the regime based on unobserved export performance.

Addressing the first challenge is not straightforward. Although TIM operates within Central America, exporters may use TIM at least partially to complete export flows anywhere in the world, including multi-modal exports overseas. Therefore, based on the participating countries and the timing of TIM alone, it is not possible to establish which trade flows are affected by TIM. 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 use TIM at the firm-product-custom-destination-time unit of observation.

To address the second challenge, we employ panel-data methods and identification strategies from the treatment literature. In particular, 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. Conditional on fixed effects, exogenous variation in the availability of TIM across export-routes –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, the firm-product-custom-destination-time unit observation, we provide OLS, intention-to-treat, and instrumental variable estimates of the effect of TIM on export outcomes.

We find that export values increased due to TIM. On export routes where TIM is available, it raised route-level export flows by about 44 percent. This effect is 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. To be clear, this estimate captures all TIM related processes that simplify trade, takes into account that many export flows do not take advantage of TIM, and emphasizes intensive margin adjustments of export values. Overall, these results are consistent with the interpretation that TIM reduces regulatory transaction costs to increase exports.

TIM also has been cost-effective. Based on our ITT estimates, the tax income associated with the increase in export flows outweighs implementation and maintenance costs by a ratio of US$ 3.3 to 1. Based on instrumental variable estimates, on average, export flows that are processed on TIM increase by about 54 percent, resulting in a benefit/cost ratio of US$ 14.2 to 1.

Multiple robustness checks address the non-random implementation of TIM, self-selection, and trade diversion. First, our analysis reveals that only a very small share of firms switched transport modes or export routes and that this switching is not significantly related to TIM. This evidence mitigates concerns that the best performing firms switch export routes to self-select into TIM. Second, firms may systematically choose to process high-value shipments, or small emergency shipments that require seamless processing, on TIM. Our data shows that, once TIM is used in an export flow, it remains used for 90 percent of the transactions of the same flow after its first use. This alleviates concerns that firms' selective use of TIM across transactions within existing export flows affect the results. We provide evidence that both the use of TIM and the availability of TIM across export routes are not related to pre-existing differences in exports and exports growth. Finally, following Redding and Turner (2015), we consider whether TIM may have induced firms to simply redistribute exports across markets (i.e., product-destination combinations) or export routes. The results show that this does 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 remain unclear.[5] 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

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

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). Our results show 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). With the caveat that mechanisms are difficult to identify with intention-to-treat (and instrumental-variable) estimates, our findings suggest that 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 lack of evidence. This is also true for TIM. Without additional information from the transit system, it would be challenging to determine which export flows are subject to the policy change. By employing detailed micro data to overcome this empirical challenge, we deliver evidence for policy goals covered by the 2013 WTO Trade Facilitation Agreement (WTO, 2014).[6]

The remainder of this paper is organized as follows. Section 2 describes TIM, its implementation, and 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, and Section 5 concludes.

[6]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).

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 will 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, 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 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.[7] This system involves (1) stronger within and across country inter-agency cooperation; (2) a new process with a single and harmonized comprehensive document to comply with customs, migration, and phytosanitary agencies requirements; and (3) the use of information technology to connect all participating agencies to manage and track the international transit process (Sarmiento et al., 2010).[8]

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

[7]Transit trade could be applied to re-exports or in entrepôt trade. In other words, transit trade could be applied to facilitate trade in intermediate products within value chains and final products. 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 (Feenstra and Hanson,2004; and Feenstra et al., 1999).

[8]"Recent literature considers 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 Salvadoran exports to Mexico, Guatemala, Honduras, Nicaragua and Costa Rica, and Panama were 0.3%, 0%, 0.01%, 0.03%, 0.02%, 0.92% according to WITS data in 2019. 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."

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 shows intervening officials all relevant data on the shipment in the transit information system, eliminating the presentation of multiple paper documents to multiple agencies.[9] 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. In other words, 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 affects 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.

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. From an identification perspective, the main question that arises is whether variation along these dimensions can be considered plausibly exogenous. We address this ques-

[9]More specifically, shipments in transit are now 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.

tion 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.[10] In particular, for each shipment, these data report the firm, the product, and 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 concluded.

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 HS), 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 the 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.[11]

Both databases share several fields, which makes it possible to merge them. Merged, our main database allows us to observe where shipments originated in El Salvador, which customs office they use to exit El Salvador, the destination of the shipment, and whether a shipment used TIM. Appendix Figure A1 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.[12]

[10] 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.

[11] Based on our data there is little switching in transport modes and customs offices and the switching does not appear to be related to TIM.

[12] For our empirical approach 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.

Table 1 reports El Salvador's exports and key aggregate 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 performance measures. Almost 30% of the total export value and export transactions were channeled through TIM in 2013.[13] By 2013 we also observe that 37% of the exporters use TIM shipping 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.[14]

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

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.

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

[14]Including the rest of the world raises the number of export routes to about 1500.

America.[15] 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.[16]

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.[17] 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-

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

[16] 50km is the 30th percentile in the distribution of driving distances to the nearest customs office with TIM. At the 25th percentile the distance decreases to 40km, whereas at the median increases to about 77km. The maximum is 300km.

[17] 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

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 can be taken as exogenous, in general, and not associated with pre-existing differences in export performance, in particular. We address this question in the following subsection.

2.4. Can TIM Availability be Considered Exogenous? 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 (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 unit of observation. 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. Each estimate for 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 $\tau < -2$ 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 see 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.[18]

3. The Effect of TIM on Exports

In this section, we first examine the effect of TIM on aggregate exports at the export-route level (i.e., the municipality-customs-destination-year-semester unit of observation) and then explore how it affects the respective extensive and intensive margin. In addition, the section reports OLS, intention-to-treat and instrumental variable estimates at the firm-product-custom-destination-year-semester level. To estimate our model, we focus on data between 2010 to 2013.[19]

Our baseline specification is as follows:

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

where, as before, m denotes a municipality, c stands for customs office, d indicates destination country, and s indexes semesters within years t.[20]

[18] Appendix Figure A2 reports an event study at annual frequency that confirms our results. Furthermore, recent developments in methodology 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 A3 and A4. The conclusions remain the same.

[19] 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.

[20] We aggregate the transaction level data to the municipality-customs-destination-semester-year unit of observation.

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 α, 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, α is most appropriately interpreted as a reduced-form effect of TIM that encompasses all these channels.[21]

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

Equation (2) includes municipality-customs-destination fixed effects, λ_{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 specification combined with the TIM policy experiment employs a novel 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 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

[21] 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).

multiple possible confounding factors along these dimensions.

We estimate the above specifications with OLS and cluster standard errors at the 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).[22] Across all specifications, availability of TIM increases exports. The effect of TIM on exports ranges from 18.9 log points (Column 1) to about 36.7 log points (Column 4). All estimates are statistically significant at the 1 percent level. According to our preferred specification (Column 4), TIM raises exports by 36.7 log points or about 44 percent.

Based on the policy details explained in Section 2 we expect that TIM predominantly affects the intensive margin of trade via reduced administrative processing costs. Then, 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 components, i.e., the export variety extensive and intensive margins. To do so, we replace $\ln \text{Exports}_{mcdts}$ 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, respectively, 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 slightly more than half of the TIM's total export effect of 36.7 log points (Column 1) can be traced back to changes along the extensive margin: entry of new exporters accounting for 13.4 log points and entry of new

[22]The top panel of Appendix Table A1 reports associated summary statistics for export values.

products accounting for an additional 6.2 log points. The intensive margin effect is positive, but represents less than half of the impact on total exports and is estimated with less precision. In this regard, it worth noting that entry of small exporters and new products may dampen intensive margin effects. Hence, we next disaggregate the data to examine the intensive margin mechanism more in detail.

We specifically focus on the firm-product-customs-destination-semester unit of observation.[23] Our baseline specification is the following:

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

The main variable of interest, $\text{TIM}_{\text{fpcdts}}$, equals one if firm f exports at least one shipment of a HS8 product p via customs office c to destination d in semester s of year t using TIM, and zero otherwise. Again, our focus is on parameter α which captures the 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, λ_{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).[24]

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 δ_{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, ρ_{pdt}, account for destination-specific

[23]The bottom panel of Appendix Table A1 reports associated summary statistics for export values.

[24]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.

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.[25] 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 φ_{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.

Admittedly, a main concern is that firms that benefit the most from TIM could choose to adopt TIM to deliver products to their destination. We address this concern by providing two additional sets of estimates.

First, 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 contained in a municipality m and firms do not switch municipalities within our sample. We then estimate the following specification:

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

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 rate of take up of TIM. From an identification point of view,

[25] 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. Further, given that, unlike these policy changes, TIM is a customs-destination specific intervention, we can and do include in a robustness check exercise a set of firm-product-destination-year fixed effects which controls for potential heterogeneous effects of these modifications in tariffs and the origin regime as well as others such as country-specific sectoral investment rules across firms.

the idea is that TIM availability is determined by firms location relative to TIM fiscal-routes.[26]

Second, we present 2SLS estimates. In this case, 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 2SLS 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 range from 0.187 at the low end to 0.321 at the high end and are always statistically significant at the 1% level. The most notable change in the coefficient estimates appears when we control for customs-year and product-destination-year fixed effects (Column 2). Then, taking into account standard errors, estimates in Columns 2, 3, and 4 are similar. According to our preferred specification (Column 4), the estimated TIM effect is economically relevant and implies a 37.8 percent increase in exports.[27] Therefore, based on the OLS estimates, borders impose important administrative trade costs that can be addressed with appropriate trade facilitation policies.

When interpreting the magnitude of that 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$5,000 (Appendix Table A1), so our results imply an extra US$ 1,890 worth of exports. Therefore, while in percentage terms the TIM effect is high, the asso-

[26]We will examine this in the robustness section.

[27]$(e^{0.321} - 1)x100 = 37.8$

ciated 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.

The second row of Table 4 (ITT) 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 6.4 to 7.2 log points, or between 6.6 to 7.5 percent. These coefficients are estimated with similar standard errors as the OLS estimates and they are significant at the 5% level.

Finally, the third row of Table 4 (IV) presents 2SLS 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 significantly predicts treatment. 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). For the main effect, we focus again on Columns 2 to 4. This effect ranges between 39.1 and 43.2 log points. In our preferred empirical model (Column 4), the estimate implies that TIM raises exports by about 43.2 log points or about 54 percent. Comparing IV estimates to OLS estimates, IV estimates are slightly higher in magnitude, but given the standard errors, this difference is likely not significant.

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 5.9 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 overall compensation of officials supervising transits and inspecting the respective shipments at each customs office throughout the country and roughly amounts to US$ 2 million.[28] 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. Repeating the exercise based on the OLS and IV estimates in Column 4 of Table 4, the benefit to cost ratios increase to 8.1 and 14.2, respectively.

4. Robustness

4.1. Robustness with Respect to Selection Concerns

The main identification concern for the evaluation of TIM is selection: policymakers may have implemented TIM or exporters may have self-selected into using 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-semester unit of observation. Sec-

[28]There are 72 officials in charge of the transport control with an average annual compensation of US$ 8,500; 20 officials who perform non-intrusive inspections with an average annual compensation of US$ 11,000; 24 officials who conduct 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. 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.

tion 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, exports 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 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, $\text{Artifical}_{\text{mcdy-1}} = 1$ and $\text{Artifical}_{\text{mcdy-2}} = 1$. 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 $\text{TIM}_{\text{mcdt}} = 1$. 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 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 at the Firm-Product-Customs-Destination Level

We next examine identification concerns for OLS estimates based on Equation (3). These estimates are obtained conditionally comparing TIM-treated export flows to untreated export flows at the firm-product-customs-destination-semester unit of observation. In this case, the main estimation issue is that firms' self-selection to use TIM across their various export flows can lead to upward biased estimates.

Again, fixed effects reduce the scope for self-selection based on unobserved information that also determines export outcomes. For instance, our firm-year fixed effects control for all time-varying firm-level factors that might drive potential endogenous selection into the new transit system (e.g., larger or more productive firms might be more likely to use it). To check if our fixed effects are enough to account for pre-existing differences in export performance that may be correlated with firms' adoption of TIM in Equation (3), we provide direct evidence based on our detailed micro data, conduct placebo tests, and explore whether there were systematic differences in previous export growth.

Firms may have purposely opted to process specific export flows through TIM, perhaps even in anticipation of the system. We consider two potential margins of adjustment. First, firms may switch export routes to take advantage of TIM. Our data indicate that these events are far from relevant. Only 4.71 percent of the firm-product-destination combinations registered switches in customs offices over our sample period. Therefore, rerouting in response to TIM is unlikely to drive our results.[29]

Second, firms may use TIM only for their most important shipments within a firm-customs-product-destination combination. The direction in which this could bias our estimates is not clear. On one hand, firms may rely on TIM predominantly for high-value shipments. On the other hand, firms may resort to TIM for low value emergency shipments for which fast and seamless processing is especially important. In any case, the data reveal that, after the first use of TIM, about 90 percent observations and 92 percent of the export values are exported using

[29]We also confirmed this more formally by regressing a binary indicator that takes the value of one if there was a change in the exiting customs office and zero otherwise on the TIM indicator along with our fixed effects. The estimated coefficient on the TIM indicator is not significant in this regression.

TIM. Hence, once firms use TIM, they tend to use it for almost all shipments and not just for those with high or low values.

For the placebo exercise, we again forward the actual use of TIM by two periods like we did in Subsection 4.1.1, but at the firm-product-customs-destination-semester unit of observation.[30] As we did above, we then include these two indicators in Equation (3) and estimate their effect on the sample of exports that do not actually use TIM. Column 3 of Table 5 reports the estimates. The forwarded TIM indicators do not significantly predict export flows. Therefore, the evidence does not raise concerns that availability of TIM across export routes is associated with pre-existing differences in export performance.

To examine if the use of TIM is systematically related to past differences in export growth, as we did in Section 4.1.1, we regress the indicator $\text{TIM}_{\text{fpcdy}}$ on the first and second differences in log exports [31] including all fixed effects as in Equation (3). Table 5 Column 4 reports the estimates. We do not find evidence that TIM availability across export routes is determined by past differences in export growth.

In summary, our detailed micro data, placebo tests, and examination of past differences in export growth suggest that self-selection is not evidently affecting our OLS estimation results. This evidence is also consistent with the IV estimates of Equation (3) based on availability of TIM reported in Table 4. OLS and IV estimates are similar. This mitigates concerns that OLS estimates are substantially biased due to self-selection. Of course, this raises the question if the instrument, the availability of TIM, is systematically related to pre-existing differences in export performance. We examine this in the next subsection.

4.1.3. Selection in ITT Estimates

Finally, 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

[30]To be precise, suppose $\text{TIM}_{\text{fpcdy}} = 1$ for the first time in period y determined by semester s of year t. Then, we generate two binary indicators that equal one in the first and second semester immediately before the first use of TIM, $\text{Artifical}_{\text{fpcdy-1}} = 1$ and $\text{Artifical}_{\text{fpcdy-2}} = 1$. The indicators are zero otherwise.

[31]To be clear, the differences are $\ln \text{Exports}_{\text{fpcdy-1}} - \ln \text{Exports}_{\text{fpcdy-2}}$ and $\ln \text{Exports}_{\text{fpcdy-2}} - \ln \text{Exports}_{\text{fpcdy-3}}$

predict the availability of TIM across export-routes. Following the same procedure as in the previous two subsections, 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 over the sample of exports that does not actually use TIM.[32] 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[33] including all fixed effects as in Equation (4). Table 5 Columns 5 and 6 show the results. TIM availability immediately before the use of TIM does not systematically predict export performance, and, past differences in log export growth do not predict the availability of TIM.

For all the estimates we provide in the previous sub-sections we examined multiple additional lags and specifications. We also examined robustness for alternative specifications of fixed effects consistent with the specifications we estimate in Tables 2 and 4. Our conclusions remain the same.

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. Then, aggregate exports to the $b - c - d - t - s$ unit of observation and regress log export on $\text{TIM}_{\text{bcdts}} = 1$ including fixed effects. Columns 1 and 2 of Table A2 report the estimation results. These estimates indicate that TIM raises exports by about 54 log points. Compared to the results of Equation (2) reported in Table 2, this implies that, if anything, a broader definition of export routes is associated with greater TIM effects.

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

[33] $\ln \text{Exports}_{\text{fpcdy-1}} - \ln \text{Exports}_{\text{fpcdy-2}}$ and $\ln \text{Exports}_{\text{fpcdy-2}} - \ln \text{Exports}_{\text{fpcdy-3}}$

Next, we carry out ITT and IV estimation based on the broader definition of export routes.[34] To obtain ITT estimates we estimate (4), but we replace the TIM indicator based on municipalities, TIM_{bcdts}, 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-destination-semester specific export flows. Table A2 presents the results. ITT estimates imply that TIM raises exports between 8.9 and 10.1 log points, whereas their IV counterparts indicate that TIM increases exports between 77.3 and 87.7 log points. In both cases, the coefficient magnitudes are greater than the estimates reported in Table 4. Therefore, a broader specification of export routes would lead to even greater TIM benefits.

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. Appendix Table A3 reports 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.

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.[35]

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

[34] For clarification, we do not report OLS estimates because they would be the same as the estimates of Equation (3).
[35] As an example, products belonging to HS Chapter 84, which required a certificate from the Ministry of Labor.

involving the HS2 product on the export-route in question. We then estimate ITT effect based on Equation (4) and instrumental variable effect based on Equation (3) using the industry specific availability of TIM as instrument.

Table A4 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 38.6 log points, compared to 43.2 log points with the baseline specification of TIM availability.

To further examine this issue, we take an even more aggressive approach and 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 A4 presents the estimation results. The estimated intention-to-treat effects increase, because they now capture take up of TIM on export-routes where TIM is available within narrower product groups. The instrumental variable estimate decreases to 31 log points. 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 benefit/cost analysis– would primarily correspond to the upper bound of the program's true effect.[36]

To assess whether and to what extent such export substitution affects our results, we apply

[36] 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.

a strategy proposed by Redding and Turner (2015). We estimate a variant of Equation (3) and (4) where we drop the firm-year fixed effects to allow cross-firm variation to play a role in the identification of the effects of interest.[37] These estimates are reported in Columns 1 and 2 of Table 6. The results show that TIM raises export flows by 29.4 log points according to OLS estimates and 6.8 log points according to ITT estimates.

If export substitution is relevant, then the concern would be that the estimates in Columns 1 and 2 could be due to a decrease in export flows of non-treated firms. To examine whether this is the case, we restrict the sample to export flows from treated firms and re-estimate the specifications. Columns 3 and 4 present the OLS and ITT results. Both estimates are similar to the estimates in Columns 1 and 2, and, if anything, they are greater in magnitude. Therefore, we do not find evidence that a decrease in trade flows of non-treated firms is driving the estimates over the full sample.

To further examine the effect of TIM on non-treated export flows, Columns 5 and 6 present estimates from a sample that only includes non-treated export flows. The estimate in Column 5 reveals how TIM affected treated firms' export flows not processed under TIM (for which the TIM indicators are set equal to one) relative to non-treated firms' export flows. According to this estimate, there is no significant difference between TIM firms' export flows not using TIM and those export flows of firms that do not use TIM. The estimate in Column 6 shows the response of treated firms' export flows that are not processed on TIM to the availability of TIM relative to non-treated firms export flows. Again, 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. Taken together, these results suggest that reallocation between treated and untreated firms does not impact the estimates in a consequential way.

Next, we also examine the possible substitution within firms. To do so, we consider a subsample that limits such a substitution. In particular, in Columns 7 and 8 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

[37] We focus on results based on Equations (3) and (4) because potential export substitution would affect our benefit/cost analysis. For completeness, Appendix Table A5 reports the comparable results based on Equation (2).

where firms could easily substitute exports across routes within a particular product.[38] When estimated on this sample, the estimated TIM effects remain similar in magnitude to the full sample estimates reported in Columns 1 and 2. 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. We expect that results based on a broader definition of export routes, i.e., the department level, are less affected by such substitution, because they identify export effects based on a broader region within El Salvador. Therefore, if export substitution across narrowly defined export-routes is relevant, then we expect that TIM effects are lower with a broader definition of export-routes. Comparing results in Table A2 to results in Table 4, the opposite is the case. At the high end, Table 4 reports that TIM increases exports by about 43.3 log points based on our narrow definition of export routes. At the low end, Table A2 reports that TIM increases exports by as much as 53.8 log points with the broader definition of export routes. This evidence mitigates concerns that our results are due to export substitution across narrow definitions of export routes.[39]

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

Finally, based on the identification strategy explained in this section, we will examine several additional export margins potentially affected 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:

$$X_{fpcdts} = \frac{X_{fpcdts}}{Q_{fpcdts}} \frac{Q_{fpcdts}}{N^S_{fpcdts}} \frac{N^S_{fpcdts}}{N^B_{fpcdts}} N^B_{fpcdts} \tag{5}$$

[38] Recall that TIM did not induce route switching (Subsection 4.1.2).

[39] We 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 Appendix Table A6.

where X_{fpcdts} is export value, Q_{fpcdts} denotes 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 examine 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 OLS, intention-to-treat, and 2SLS estimates.

Estimation results are shown in Appendix Table 7. Across the estimates we do not find evidence that TIM affects unit values. Therefore, the reduction of costs associated with TIM does not seem to be passed to buyers in terms of lower export prices.[40] Across OLS, ITT, and IV estimates we find some evidence that the number of shipments per buyer increases. 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 across the three types of estimators. Therefore, based on OLS results, this evidence is perhaps best interpreted as a descriptive exercise to understand various adjustment margins.

The estimation results in Appendix Table 7 also show that the export expansion due to TIM is 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 (see, e.g., Bernard et al 2018; and Bernard et al 2019).

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.

[40]Furthermore, TIM does not seem to affect (transfer) pricing strategies perhaps in order to evade taxes.

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 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$ 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. Recent research examines the effects of exporting on prices, productivity, markups, and product quality (e.g. Atkin et al., 2017). If exporting improves these margins, then we expect that transit trade policies have welfare benefits beyond their return to investment. On the other hand, it is often a concern that trade facilitation policy mostly helps firms with special interests and lobbying power (Rodrick, 2018). We expect that both questions could be examined with more detailed data on firm characteristics. Finally, we expect that transit policies, and their reversions, 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 Firm-Product per Firm	Exports 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

	(1)	(2)	(3)	(4)
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)
	IV - First Stage			
TIM - Availability	0.309***	0.165***	0.163***	0.167***
	(0.037)	(0.029)	(0.025)	(0.027)
F-Statistics	70.2	32.9	42.3	38.5
Fixed-Effects				
Firm-Product-Customs-Destination	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes
Product-Destination-Year	No	Yes	Yes	Yes
Customs-Year	No	Yes	Yes	Yes
Firm-Year	No	No	No	Yes
Municipality-Year	No	No	Yes	No
Observations	103,122	103,122	103,122	103,122

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

Results based on:	Equation (1)		Equation (2)		Equation (3)	
	Placebo	Growth	Placebo	Growth	Placebo	Growth
	(1)	(2)	(3)	(4)	(5)	(6)
Forward 1 Semester	0.106		-0.015		0.048	
	(0.087)		(0.079)		(0.121)	
Forward 2 Semesters	-0.124		0.126		0.091	
	(0.079)		(0.129)		(0.117)	
Lagged 1 Semester		0.002		-0.002		0.001
		(0.002)		(0.002)		(0.0010)
Lagged 2 Semesters		0.0003		-0.002		0.001
		(0.0009)		(0.002)		(0.001)
Fixed-Effects						
Municipality-Custom-Destination	Yes	Yes	No	No	No	No
Destination-Year	Yes	Yes	No	No	No	No
Custom-Year	Yes	Yes	Yes	Yes	Yes	Yes
Municipality-Year	Yes	Yes	No	No	No	No
Semester-Year	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Product-Custom-Destination	No	No	Yes	Yes	Yes	Yes
Product-Destination-Year	No	No	Yes	Yes	Yes	Yes
Firm-Year	No	No	Yes	Yes	Yes	Yes
Observations	3,395	4,427	41,971	42,202	75,782	49,856

Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS estimates for placebos 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 columns 3 and 5. 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, in columns 1 and 5, and if the exporter uses TIM to export the product to the destination through the customs in question, in column 3. 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, in columns 2 and 6, and taking the value of one if the exporter uses TIM to export the product to the destination through the customs in question, in column 4. 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 and 6. 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	
	OLS (1)	ITT (2)	OLS (3)	ITT (4)	OLS (5)	ITT (6)	OLS (7)	ITT (8)
TIM	0.294***	0.068**	0.325***	0.084**	0.014	-0.024	0.281***	0.068
	(0.036)	(0.031)	(0.049)	(0.036)	(0.042)	(0.048)	(0.039)	(0.042)
Fixed-Effects								
Firm-Product-Custom-Destination	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Product-Destination-Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Custom-Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	102,444	102,444	77,902	97,135	85,359	58,576	81,817	81,817

Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS estimates of Equation (3) (OLS columns) and (4) (ITT columns) 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. On the OLS columns, 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. On the ITT columns, 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. Standard errors clustered at municipality-customs-destination level.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

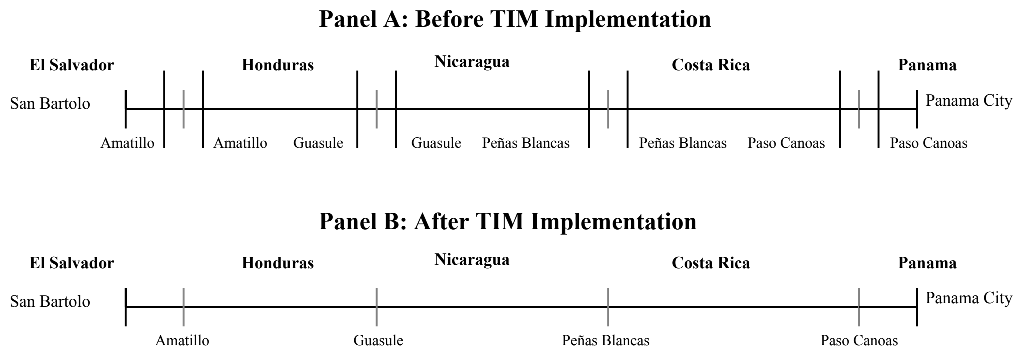
Table 7: **The Impact of TIM on Exports - Mechanisms**

	Total Exports	Unit Value	Weight per Shipment	Shipments per Buyer	Number of Buyers
	(1)	(2)	(3)	(4)	(5)
TIM - OLS	0.321***	0.010	0.070	0.165***	0.076***
	(0.042)	(0.030)	(0.045)	(0.039)	(0.013)
TIM - IV1	0.432**	-0.109	0.412*	-0.021	0.149*
	(0.219)	(0.118)	(0.230)	(0.180)	(0.088)
TIM - IV2	0.386***	0.060	0.083	0.142*	0.101***
	(0.112)	(0.065)	(0.094)	(0.084)	(0.038)
TIM - IV3	0.310***	0.022	0.055	0.167***	0.065***
	(0.048)	(0.033)	(0.046)	(0.042)	(0.014)
Fixed-Effects					
Firm-Product-Custom-Destination	Yes	Yes	Yes	Yes	Yes
Product-Destination-Year	Yes	Yes	Yes	Yes	Yes
Custom-Year	Yes	Yes	Yes	Yes	Yes
Firm-Year	Yes	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes	Yes
Observations	102,444	102,444	102,444	102,444	102,444

Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS and IV estimates of Equation (3) with different instrument definitions. The dependent variable is the natural logarithm of the variable indicated at the column label, aggregated at the firm-product-customs-destination-year-semester level. On the OLS row, 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. On the IV rows, 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. On IV1, the instrument is a binary indicator taking the value of one if TIM is available as at the municipality-custom-destination; on IV2, the instrument is a binary indicator taking the value of one if TIM is available as at the municipality-product-custom-destination; and on IV3, the instrument is a binary indicator taking the value of one if TIM is available as at the municipality-industry-custom-destination, where industry is defined at the 2-digit HS product level. Fixed effects included as noted (not reported). Standard errors clustered at municipality-customs-destination level. Standard errors clustered at municipality-customs-destination level.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

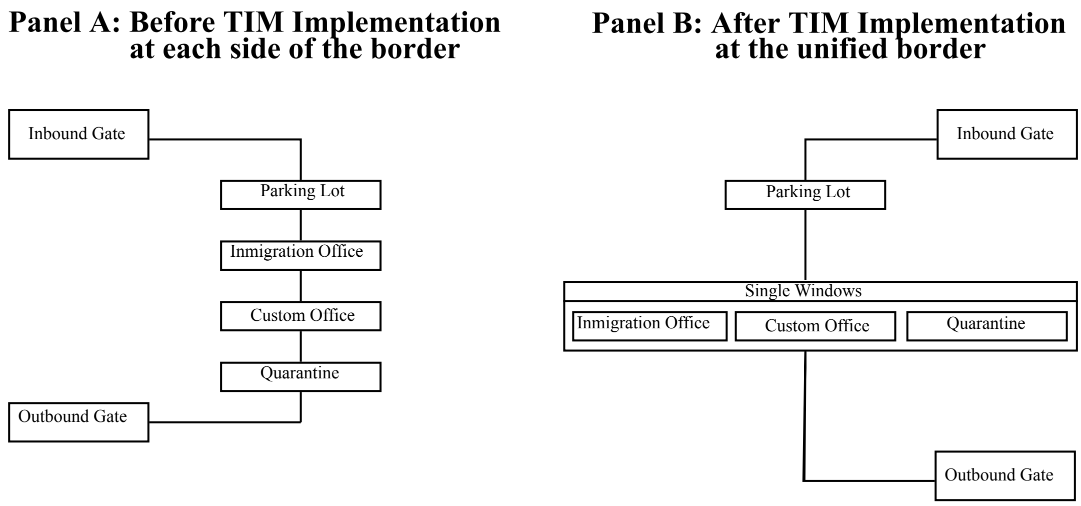
8. Figures

Figure 1: Stylized Border Crossing from El Salvador to Panama



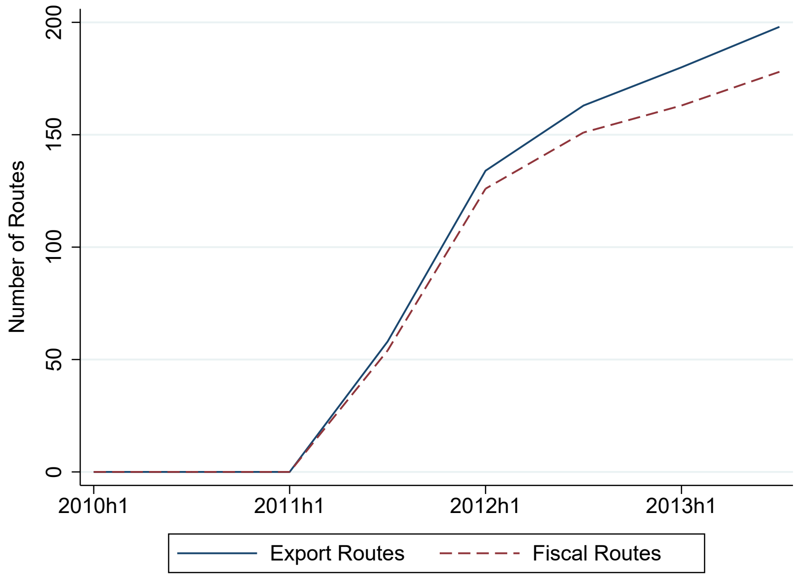
Panel A plots the sequence of customs a firm exporting from San Bartolo (El Salvador) to Panama City (Panama) needs to go through before TIM implementation. Gray short vertical lines are borders, and black long vertical lines are customs.
Panel B plots the same route after TIM implementation, where intermediate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

Figure 2: Stylized Export Processing at the Border



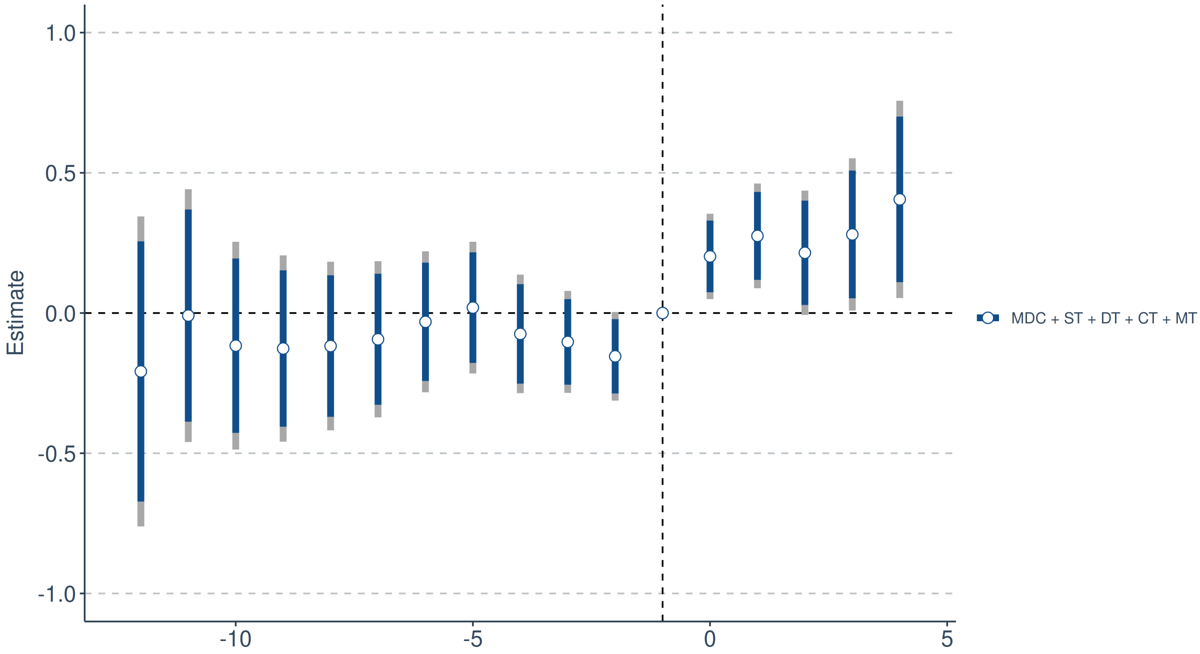
Panel A shows the process for a shipment that arrives at the border before TIM implementation. This process would take place two times at the border, in each side of the border.
Panel B shows the process for a shipment that arrives at the border after TIM implementation. This process is unified for both 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 where 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 clustered at municipality-customs-destination level. Gray bars are 95% significant confidence interval and blue bars are 90% significant confidence interval.

Online Appendix

Transit Trade

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Table A1: Export Value Summary Statistics - Estimating Samples

Year	Semester	Mean	s.d.	p 25	p 50	p 75	N
Municipality-Custom-Destination Level							
2010	1	2089	11617	32	175	908	883
	2	2178	13095	27	142	814	931
2011	1	2393	12532	30	193	1036	996
	2	2350	11563	28	147	922	979
2012	1	2487	12380	29	148	1026	1,002
	2	2633	13200	30	144	937	937
2013	1	2593	12834	30	175	1136	960
	2	2700	14446	31	162	1029	907
Full Sample		2430	12723	30	161	961	7,595
Firm-Product-Custom-Destination Level							
2010	1	160	2012	1	6	41	11,018
	2	164	2365	1	5	39	11,834
2011	1	180	2204	1	5	40	12,740
	2	161	1821	1	5	38	13,326
2012	1	177	2194	1	5	37	13,552
	2	168	2058	1	5	36	13,719
2013	1	178	2023	1	5	38	13,413
	2	183	2297	1	6	42	12,842
Full Sample		172	2126	1	5	39	102,444

Source: Authors' calculations based on data from DGA and TIM.
Export values are expressed in thousands of US dollars.

Table A2: TIM Effects Based on a Broader Definition of Export Routes

	Department		Firm-Product			
	OLS		ITT		IV	
	(1)	(2)	(3)	(4)	(5)	(6)
TIM	0.538***	0.544***	0.101**	0.089**	0.877**	0.773*
	(0.118)	(0.119)	(0.044)	(0.045)	(0.436)	(0.440)
					IV - First Stage	
TIM-Availability					0.115***	0.115***
					(0.022)	(0.024)
F-Statistics					26.3	23.7
Fixed-Effects						
Department-Custom-Destination	Yes	Yes	No	No	No	No
Destination-Year	Yes	Yes	No	No	No	No
Custom-Year	Yes	Yes	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes	Yes	Yes
Department-Year	No	Yes	No	No	No	No
Firm-Product-Custom-Destination	No	No	Yes	Yes	Yes	Yes
Product-Destination-Year	No	No	Yes	Yes	Yes	Yes
Municipality-Year	No	No	Yes	No	Yes	No
Firm-Year	No	No	No	Yes	No	Yes
Observations	3,941	3,941	102,444	102,444	102,444	102,444

Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS and IV estimates as described in section 4.2. The dependent variable is the natural logarithm of export value, aggregated at the department-customs-destination-semester-year level on the department columns (1 and 2), and at the firm-product-customs-destination-semester-year level at the firm-product columns (columns 3 to 6). On the OLS columns, the main explanatory variable is a binary indicator taking the value of one if TIM is available at the department-custom-destination in question and zero otherwise. On the IV columns, 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 department-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 A3: The Impact of TIM on Exports - Robustness Exercises at Department Level

	Department		Firm-Product	
	OLS		ITT	
	(1)	(2)	(3)	(4)
Forward 1 Semester	0.171		0.094	
	(0.140)		(0.093)	
Forward 2 Semesters	0.055		-0.011	
	(0.121)		(0.059)	
Lagged 1 Semester		-0.001		-0.002
		(0.003)		(0.003)
Lagged 2 Semesters		0.0004		0.0008
		(0.001)		(0.003)
Fixed-Effects				
Department-Custom-Destination	Yes	Yes	No	No
Destination-Year	Yes	Yes	No	No
Custom-Year	Yes	Yes	Yes	Yes
Department-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	1,475	1,932	66,451	27,957

Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS estimates for placebos described in section 4.1. In the Placebo columns, the dependent variable is the natural logarithm of export value, aggregated at the department-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 department-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 department-custom-destination in question. The explanatory variables are one and two lags of log export growth defined at the department-customs-destination-year-semester level in column 2, and at the firm-product-customs-destination-year-semester level in column 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 A4: The Impact of TIM on Exports - Alternative TIM-Availability Measures

	Municipality	Municipality - Industry	Municipality - Product
	(1)	(2)	(3)
TIM-ITT	0.072**	0.134***	0.246***
	(0.033)	(0.034)	(0.040)
TIM-IV	0.432**	0.386***	0.310***
	(0.219)	(0.112)	(0.048)
		IV - First Stage	
TIM - Availability	0.167***	0.347***	0.794***
	(0.027)	(0.042)	(0.029)
F-Statistics	38.7	68.0	723.0
Observations	102,444	102,444	102,444

Source: Authors' calculations based on data from DGA and TIM. The table reports IV estimates of Equation (3), IV row, and OLS estimates of Equation (4), ITT row, with different instrument definitions. The dependent variable is the natural logarithm of export value, aggregated at the firm-product-customs-destination-year-semester level. For 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 as indicated at the column label level and 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. Standard errors clustered at municipality-customs-destination level.
* significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

Table A5: Trade Diversion at Municipality

	Full Sample	Only Flows for Treated Firms	Only Untreated Flows	Only Single Routes Flows
	(1)	(2)	(3)	(4)
TIM	0.334***	0.362***	0.091	0.209***
	(0.075)	(0.085)	(0.073)	(0.073)
Fixed-Effects				
Municipality-Custom-Destination	Yes	Yes	Yes	Yes
Destination-Year	Yes	Yes	Yes	Yes
Custom-Year	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes
Observations	8,672	6,840	7,660	3,842

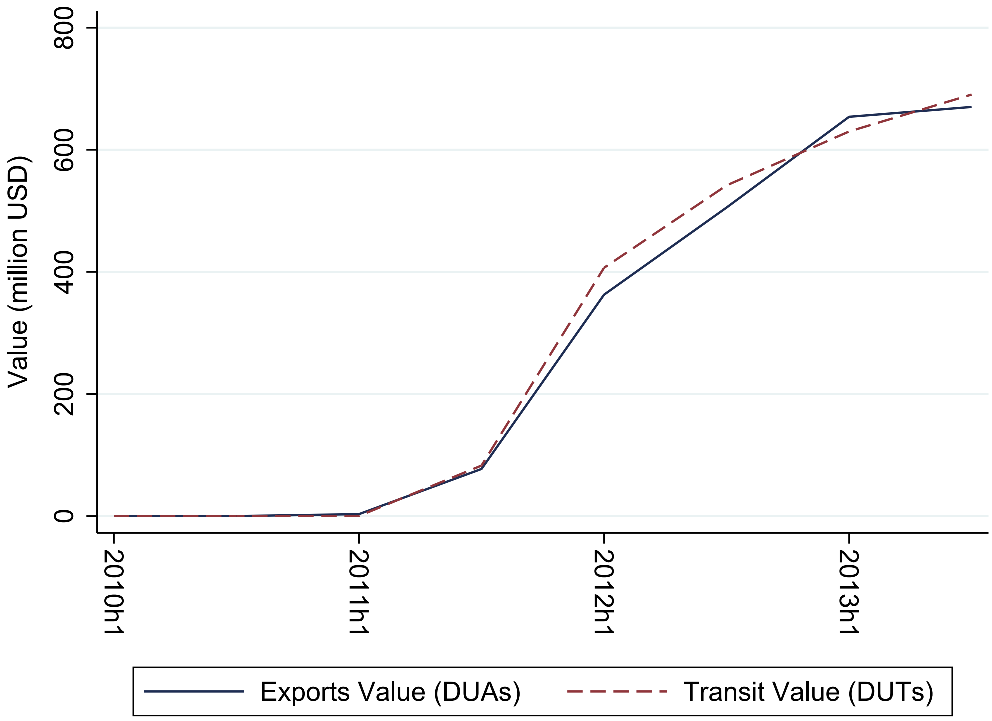
Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS estimates of Equation (2) with the sample restriction noted at the column label. The dependent variable is the natural logarithm of export value, aggregated at the municipality-customs-destination-semester-year level. 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 A6: **The Impact of TIM - Robustness - Firm-Route Level**

	(1)	(2)	(3)	(4)	(5)
TIM - OLS	0.176***	0.227***	0.242***	0.246***	0.224***
	(0.030)	(0.042)	(0.042)	(0.043)	(0.046)
TIM - ITT	0.054*	0.070**	0.079***	0.083***	0.066**
	(0.031)	(0.031)	(0.030)	(0.028)	(0.031)
TIM - IV	0.164*	0.369**	0.479***	0.494***	0.411**
	(0.089)	(0.161)	(0.177)	(0.164)	(0.194)
			IV - First Stage		
TIM - Availability	0.330***	0.190***	0.165***	0.168***	0.160***
	(0.037)	(0.020)	(0.017)	(0.015)	(0.016)
F-Statistics	80.5	92.0	93.0	124.4	103.2
Fixed-Effects					
Firm-Custom-Destination	Yes	Yes	Yes	Yes	Yes
Semester-Year	Yes	Yes	Yes	Yes	Yes
Destination-Year	No	Yes	Yes	Yes	Yes
Custom-Year	No	No	Yes	Yes	Yes
Municipality-Year	No	No	No	Yes	No
Firm-Year	No	No	No	No	Yes
Observations	34,055	34,055	34,055	34,055	34,055

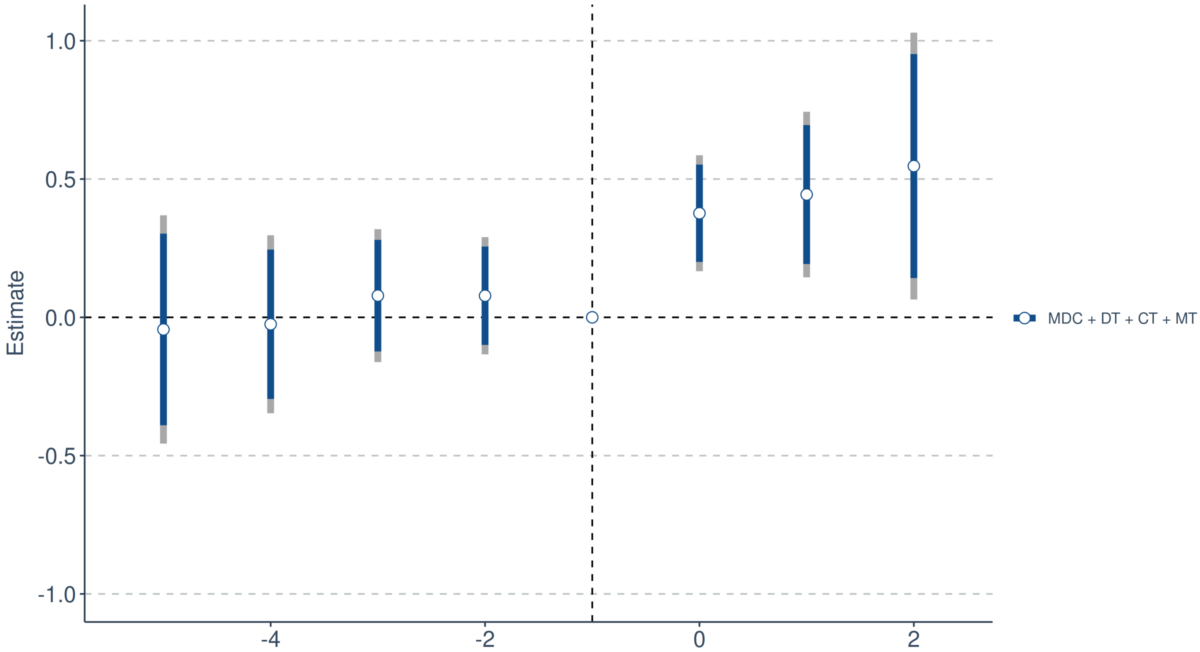
Source: Authors' calculations based on data from DGA and TIM.
The table reports OLS and IV estimates of Equation (3) at the OLS and IV rows, and OLS estimates of Equation (4) at the ITT row, at a different level of aggregation. The dependent variable is the natural logarithm of export value, aggregated at the firm-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 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.

Figure A1: Merge Quality



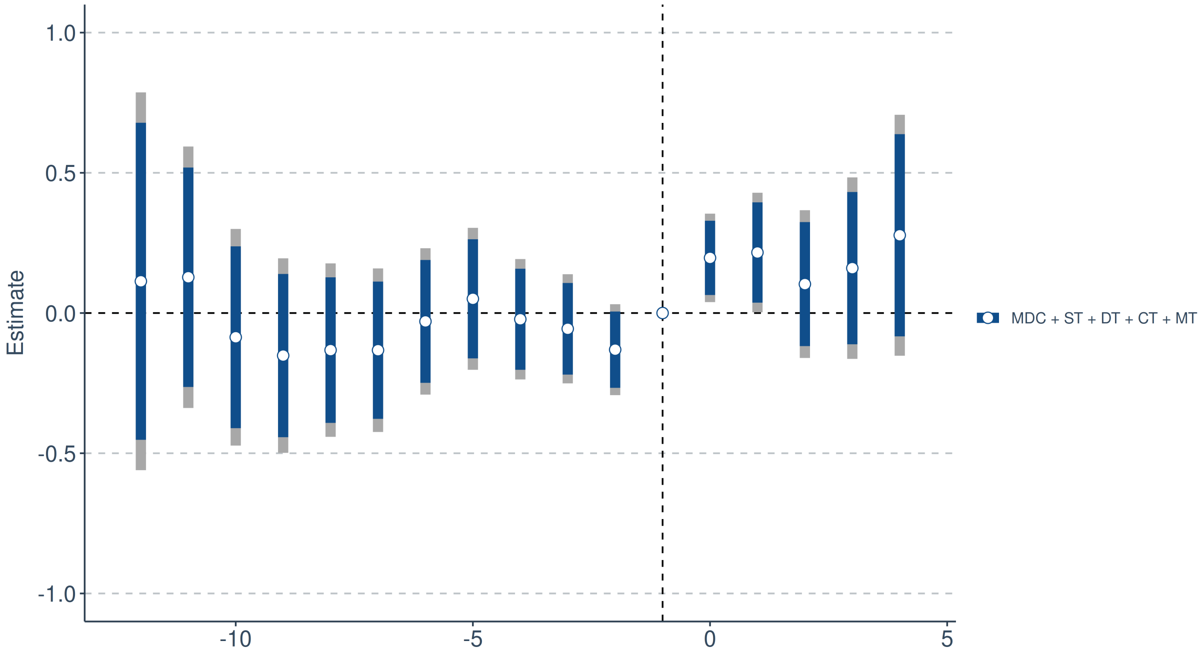
The figure identifies the total value of transits through TIM and the total export value we identified as having used TIM, by semester. Transit values taken from transport documents (DUTs for its name in Spanish – *Documento Único de Transporte*) and export values taken from custom documents (DUAs for its name in Spanish – *Documento Único Administrativo*).

Figure A2: Event Study at Annual Frequency



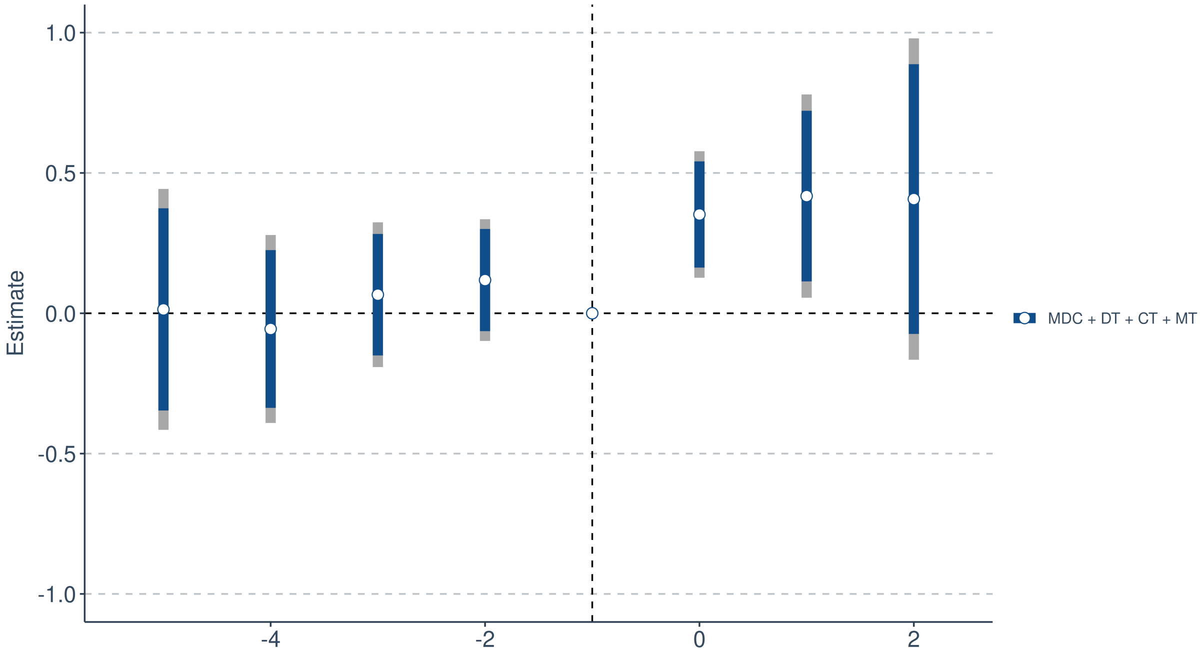
The figure plots OLS coefficient estimates of equation (1) at an yearly frequency. The dependent variable is the natural logarithm of export value, aggregated at the municipality-customs-destination-year level. Municipality-customs-destination, municipality-year, destination-year, customs-year fixed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

Figure A3: Event Study at Semester Frequency - Following Sun and Abraham (2021)



The figure plots OLS coefficient estimates of equation (1), with observations reweighted as in Sun and Abraham (2021). 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 clustered at municipality-customs-destination level. Gray bars are 95% significant confidence interval and blue bars are 90% significant confidence interval.

Figure A4: Event Study at Annual Frequency - Following Sun and Abraham (2021)



The figure plots OLS coefficient estimates of equation (1) at an yearly frequency, with observations reweighted as in Sun and Abraham (2021). The dependent variable is the natural logarithm of export value, aggregated at the municipality-customs-destination-year level. Municipality-customs-destination, municipality-year, destination-year, customs-year fixed effects included. Standard errors clustered at municipality-customs-destination level. Gray bars are 95% significant confidence interval and blue bars are 90% significant confidence interval.