

The Border Labyrinth: Information Technology and Trade

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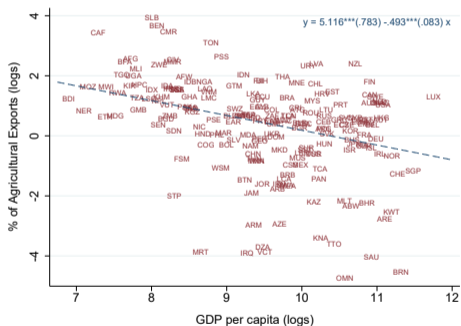
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- This is especially important for developing countries, which tend to specialize in agricultural products.
- Agricultural products are heavily regulated by sanitary and phytosanitary measures (SPS).
 - *SPS measures are adopted by governments to ensure that food is safe for consumers, and to prevent the spread of pests or diseases among animals and plants.* (World Trade Organization, SPS Information Management System)

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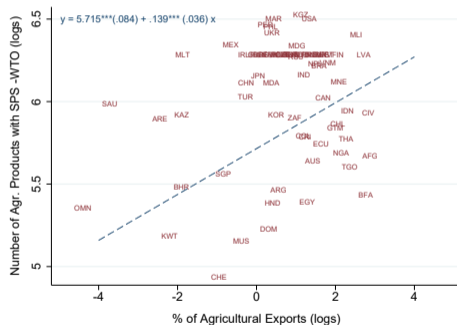
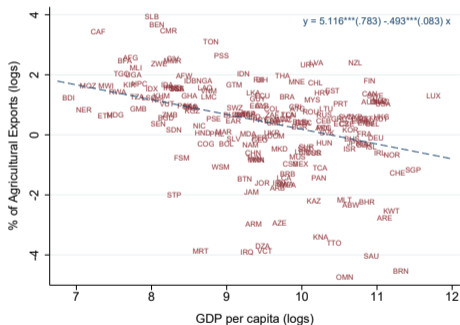
Figure: GDP per capita, Share of Agricultural Exports, and Number of Products with SPSs (2011).



Data from WDI (WB) and SPS Information Management System (WTO)

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⇒ the so-called **Electronic Single Windows** (ESW).
- ESWs reduce the time spent at the border required to export.
- While all developed countries have ESWs, only 35% of developing countries have initiated the implementation (WTO TFA database).

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- To do so, we use highly disaggregated firm-level export data from Costa Rica for 2007-2016 and exploit the gradual phase-in of the scheme across products, customs and destinations.
- Results suggest that computerization has been associated with:
 - ⇒ An increase in exports,
 - ⇒ the number of exporters, and
 - ⇒ the frequency of exporting of firms.

Electronic Single Window

- **What is an Electronic Single Window (ESW)?**
- Information technologies (ICTs) and particularly the internet and interoperability enabling methods made it possible to carry out the administrative process electronically.
- Some countries have developed and implemented electronic trade single windows.
- Instead of filling and physically move paper-based documents consecutively, these single windows allow for:
 - Online application,
 - digital document exchange among agencies dealing with trade regulations, and
 - issuance of trade-related permits and certificates.

What May an ESW Imply for Firms?

- Upgrading technology from a paper-based to a ESW does not change the information regulators demand but how this information is submitted and processed.
- This change may result in lower administrative processing costs as firms can manage trade-related documentation in a more efficient manner.
- ESW are associated with an increase in the speed, timeliness, and accuracy of information submission and processing, and a reduction in response times:
 - Submitted data can be reused multiple times, errors from rekeying identical data are eliminated and data consistency is enhanced.
 - Systems generally allow for better tracking the progress towards completing the procedures and for more predictable decisions.

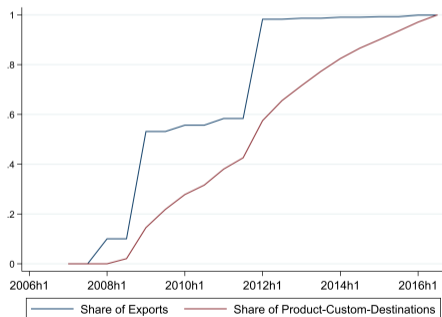
Data

- Monthly export data from 2007 to 2016, with firm's ID, the product code (6-digit HS), the destination country, the custom through which is exported, the export value in US dollars, and the quantity (weight) in kilograms.
- Permits data, which informs for each product of the tariff schedule and each year, the permits that firms had to obtain in order to export them.
- Exports processed through ESW, with firm's ID, the product code (6-digit HS), the destination country, and the custom through which is exported.

Implementation

- The implementation over products, customs and destinations of the ESW generates a gradual phase-in through product-custom-destinations flows.

Figure: Gradual Implementation of the ESW over Treated Product-Custom-Destinations



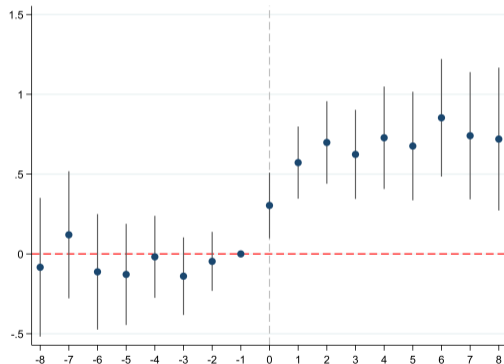
Baseline Results at the Implementation Level

	(1)	(2)	(3)	(4)	(5)
Electronic SW Availability	0.177*** (0.0668)	0.372*** (0.0867)	0.379*** (0.0895)	0.406*** (0.0888)	0.448*** (0.103)
Product-Importer-Custom F.E.	Yes	Yes	Yes	Yes	Yes
Semester-Year F.E.	Yes	Yes	Yes	Yes	Yes
Product-Year F.E.	No	Yes	Yes	Yes	Yes
Importer-Year F.E.	No	No	Yes	Yes	No
Custom-Year F.E.	No	No	No	Yes	Yes
Product (2 digits)-Importer-Year F.E.	No	No	No	No	Yes
Observations	23,554	23,263	23,090	23,090	21,964
R^2	0.758	0.794	0.807	0.814	0.856

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

Event Study Results

Figure: The Impact of ESW on Exports



Vertical lines are 95% confidence intervals

- There is no evidence of pre-trends when the ESW is implemented.

Decomposition

Dependent Variables:	Total Exports	Number of Firms	Exports per Firm
Electronic SW Availability	0.448*** (0.103)	0.132*** (0.0219)	0.315*** (0.0975)
Observations	21,964	21,964	21,964
R^2	0.856	0.845	0.848

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

- The effect is explained by both the extensive and intensive firm margin.

Baseline Results with the Firm Dimension.

	(1)	(2)	(3)	(4)	(5)	(6)
Electronic SW Use	0.199*** (0.0329)	0.463*** (0.0379)	0.459*** (0.0389)	0.469*** (0.0386)	0.472*** (0.0414)	0.478*** (0.0425)
Firm-Product-Importer-Custom F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Semester-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Product-Year F.E.	No	Yes	Yes	Yes	Yes	Yes
Importer-Year F.E.	No	No	Yes	Yes	Yes	No
Custom-Year F.E.	No	No	No	Yes	Yes	Yes
Firm-Year F.E.	No	No	No	No	Yes	Yes
Product (2 digits)-Importer-Year F.E.	No	No	No	No	No	Yes
Observations	68,449	68,193	68,054	68,054	66,413	65,607
R^2	0.823	0.835	0.839	0.840	0.873	0.881

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

- The impact of using the ESW on firms' exports is higher than at the implementation level.

Implementation as an Instrument.

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS		ITT		IV	
Electronic SW	0.494*** (0.0403)	0.478*** (0.0425)	0.0965** (0.0486)	0.112** (0.0482)	0.199** (0.0991)	0.240** (0.101)
Firm-Product-Importer-Custom F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Semester-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Product (2 digits)-Importer-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Importer-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Custom-Year F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Firm-Year F.E.	No	Yes	No	Yes	No	Yes
Observations	67,194	65,607	67,194	65,607	67,194	65,607
R^2	0.848	0.881	0.847	0.880	-	-
Fist Stage Coefficient	-	-	-	-	0.484*** (0.0310)	0.466*** (0.0337)
F-stat 1st Stage	-	-	-	-	244.6	191.1

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

- The IV estimates show that OLS results overestimate the effect (selection?)

Trade Diversion

	(1)	(3)	(5)
	Full Sample	Only Flows for Treated Firms	Only Untreated Flows
Electronic SW	0.494*** (0.0403)	0.522*** (0.0465)	0.0513 (0.0418)
Observations	67,190	42,667	32,033
R^2	0.848	0.860	0.875

- There is no evidence of exports being diverted to treated firms from non-treated.

Mechanisms I: Prices and Quantities.

	(1)	(2)	(3)	(4)	(5)	(6)
	Export Value		Export Quantity (Net Weight)		Unit Value	
	OLS	IV	OLS	IV	OLS	IV
Electronic SW	0.478*** (0.0425)	0.240** (0.101)	0.507*** (0.0429)	0.270*** (0.0963)	-0.0296** (0.0151)	-0.0297 (0.0346)
Observations	65,603	65,603	65,603	65,603	65,603	65,603
R^2	0.881	-	0.921	-	0.959	-
F-stat 1st Stage	-	191.1	-	191.1	-	191.1

- The effect is mostly explained by an increase in the quantity exported.

Mechanisms II: Frequency.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Export Value		Number of Months		Exports per Month		Quantity per Month	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Electronic SW	0.478*** (0.0425)	0.240** (0.101)	0.314*** (0.0157)	0.200*** (0.0348)	0.164*** (0.0349)	0.0398 (0.0863)	0.193*** (0.0353)	0.0696 (0.0810)
Observations	65,603	65,603	65,603	65,603	65,603	65,603	65,603	65,603
R^2	0.881	-	0.734	-	0.902	-	0.940	-

- The effect is mostly explained by an increase in export frequency (shipments) rather than the quantity exported.

Conclusion and Next Steps

- We exploited the gradual implementation of an Electronic Single Window that allowed exporters to simplify the export procedures at the border.
- We found that the ESW increased exports at the implementation level.
- Treated firms exported more and at a higher frequency than non-treated firms.
- Next step: Study whether the effect is heterogeneous in terms of firm sizes and location.
 - Given the agricultural nature of products needing sanitary and phytosanitary permits, we could expect a stronger effect on small, rural firms.

Related Literature

- How internet and ICTs affect trade (e.g., Freund and Weinhold, 2002, 2004; Fink et al., 2005, Akerman et al. (2015, 2021).
- Digitalization of procedures at the border (e.g. Carballo et al., 2016, 2021, Volpe Martincus, 2016, Arvis et al., 2007, 2008, Sarmiento et al., 2010).
- The export effects of regulations as measured by country-level indicators such as the number of documents to export (e.g., Portugal Perez and Wilson, 2012).
- Firms' valuation of short lead times and location decisions (e.g., Evans and Harrigan, 2005)
- Online trade platforms and how they create opportunities for firms (e.g. Carballo et al., 2020a, 2020b; Chen and Wu, 2020).

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Customs Locations

Figure: Customs Location



Source: Contraloría General de la República - Costa Rica

Empirical Approach

- We exploit the variation in the ESW availability generated by the staggered introduction of the scheme to quantify its impact on firms' exports.
- We identify the ESW availability by using the first ESW use at the product-custom-destination level.
- *Staggered diff-in-diff design:*

$$\ln X_{pcdts} = \alpha ESW_{pcdts} + \lambda_{pcd}^{PCD} + \lambda_{pt}^{PT} + \lambda_{\tilde{p}dt}^{\tilde{P}DT} + \lambda_{ct}^{CT} + \lambda_{ts}^{ts} + \varepsilon_{pcdts} \quad (1)$$

where:

- X are exports (or related dependent variables), ESW is an indicator that takes the value of one if the ESW is available.
- p (\tilde{p}) indexes 6-digit (2-digit) HS products, d destination countries, c customs, t years and s semesters.
- The λ terms are different sets of fixed effects and ε_{pcdts} is the error term.

Annual Implementation Results

	(1)	(2)	(3)	(4)	(5)
Electronic SW Availability	0.256*** (0.0766)	0.446*** (0.106)	0.426*** (0.113)	0.456*** (0.111)	0.523*** (0.144)
Product-Importer-Custom F.E.	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	Yes
Product-Year F.E.	No	Yes	Yes	Yes	Yes
Importer-Year F.E.	No	No	Yes	Yes	No
Custom-Year F.E.	No	No	No	Yes	Yes
Product (2 digits)-Importer-Year F.E.	No	No	No	No	Yes
Observations	14,538	13,918	13,621	13,621	11,233
R^2	0.764	0.805	0.821	0.832	0.877

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

Event Study Design

- The previous results do not account for potential pre-trends.
- For instance, the implementation of the ESW could have been introduced in customs where the exports of products shipped to specific destinations were growing.
- To investigate such possibility, we estimate the following event study:

$$\ln X_{pcdts} = \sum_{\tau=-8, \tau \neq -1}^8 I(ts - T_{pcd}^* = \tau) \beta_{\tau} + \lambda_{pcd}^{PCD} + \lambda_{pt}^{PT} + \lambda_{\tilde{p}dt}^{\tilde{P}DT} + \lambda_{ct}^{CT} + \lambda_{ts}^{TS} + \varepsilon_{pcdts} \quad (2)$$

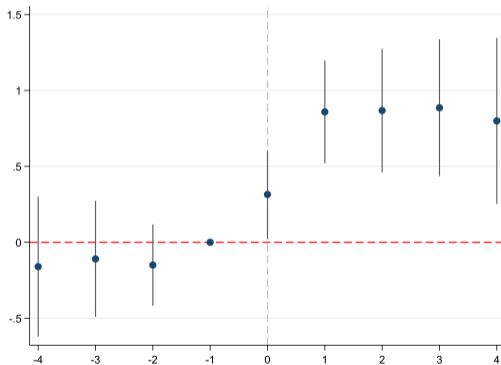
where T_{pcd}^* identifies the time period at which the ESW is implemented.

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[Event Study Design](#)

Annual Event Study

Figure: The Impact of ESW on Exports



Vertical lines are 95% confidence intervals

Average Exporter

Year	All Exporters			ESW Users		
	Exports (Th. USD)	Number of Products	Number of Destinations	Exports (Th. USD)	Number of Products	Number of Destinations
2007	2157.6	2.5	3.0	-	-	-
2008	2424.2	2.4	3.0	-	-	-
2009	2386.4	2.6	3.2	2799.7	3.1	3.8
2010	2476.1	2.1	3.0	3006.6	2.7	3.5
2011	2733.1	2.1	3.1	3057.2	2.6	3.4
2012	2702.2	2.1	3.1	3195.7	2.4	3.4
2013	2560.0	2.0	2.9	3070.1	2.3	3.4
2014	2825.7	2.0	3.0	3370.8	2.3	3.4
2015	2843.6	1.9	3.0	3350.8	2.2	3.4
2016	3335.1	2.0	3.2	3880.5	2.3	3.6

Empirical Approach using the Firm Dimension

- The study at the implementation level does not allow for more granular controls at the firm level, and does not allow us to study firm-level mechanisms and heterogeneous effects.
- We exploit the firm dimension of the data to construct ESW use by product, importer and custom. [Average Exporter and ESW User Statistics](#)
- We estimate the following equation that incorporates the firm dimension:

$$\ln X_{fpcdts} = \gamma ESW_{fpcdts} + \lambda_{fpcd}^{FPCD} + \lambda_{pt}^{PT} + \lambda_{\check{p}dt}^{\check{P}DT} + \lambda_{fpcd}^{CT} + \lambda_{ct}^{CT} + \lambda_{ft}^{FT} + \lambda_{ts}^{TS} + \varepsilon_{fpcdts} \quad (3)$$

where f indexes firms.

- Exports at the firm-product-destination-custom that start using the ESW are statistically the same as those that never use. [t-Tests](#)

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t-Test of Difference in Means

- We test the difference in means between trade flows at the firm-product-importer-custom-year level that never use ESW (control) and those that start using it (treatment).

	Value	Logs
Mean Difference (never minus entrants)	-156.5	.0605
	(109.2)	(.0758)

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

- We cannot reject the null of them being different at standard significance levels.

Placebo I: Firm and Policy Anticipation

	(1)		(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	First Use (restricted sample)		Firm Use Anticipation			Firm Availability Anticipation			Policy Level Anticipation		
ESW (t)	0.500*** (0.0774)	ESW ($t + 1$)	-0.0120 (0.0638)		-0.0308 (0.0769)	-0.0472 (0.0808)		-0.0859 (0.0822)	0.0471 (0.137)		0.0267 (0.152)
		ESW ($t + 2$)		0.0949 (0.0689)	0.0690 (0.0751)		0.0103 (0.0760)	-0.00592 (0.0771)		0.108 (0.0938)	0.0817 (0.0999)
Observations	13,470		8,429	7,921	7,413	8,668	8,565	8,380	3,701	3,447	3,236
R^2	0.898		0.908	0.910	0.911	0.904	0.904	0.903	0.903	0.915	0.917

- No evidence of firms anticipating the policy implementation or the possibility of using the ESW.

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Placebo II: Endogenous Policy

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Firm Use ESW Indicator			ESW Availability Indicator			ESW Policy Level		
log Export Growth ($t - 1$)	-0.00155 (0.00145)		-0.00396 (0.00270)	0.00213 (0.00265)		-0.00175 (0.00286)	0.000288 (0.00226)		0.000908 (0.00423)
log Export Growth ($t - 2$)		0.00374 (0.00229)	0.00176 (0.00256)		0.000269 (0.00257)	-0.000360 (0.00307)		-0.000439 (0.00346)	0.000395 (0.00387)
Observations	13,370	9,287	8,899	13,370	9,287	8,899	5,145	3,640	3,492
R^2	0.823	0.858	0.857	0.870	0.916	0.914	0.725	0.783	0.769

- Export growth does not predict implementation.

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