Time Barrier to Export for OECD Countries

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Abstract

Behind-the-border time delays due to administrative procedures represent a significant barrier to export. Guided by a Ricardian framework, this paper studies the effect of such delays on exports among OECD countries, and how the effect differs across manufacturing sectors. Results show that time delays hinder exports, particularly in more time-sensitive sectors. With a ten-percent export-delay reduction, sectoral exports would increase by 2.3–6.2 percent, and total manufacturing exports would increase by 4.3 percent. The magnitude of the export effect depends on sectoral time sensitivity, with more time-sensitive sectors having a larger effect.

Key words: Time barrier; Sectoral export; Gravity equation; OECD countries

JEL Codes: F11; F13; F14

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1 Introduction

While traditional trade costs such as tariffs and transportation costs are declining, delays against timely delivery remain a significant barrier to trade (Hummels and Schaur, 2013). Besides, time costs can be magnified with demand uncertainty, multi-stage global supply chains, and intermediate goods trade, which are becoming increasingly widespread.[1] For exporting, over half of time delays are due to administrative hurdles that usually occur before containers reach the port, including numerous customs and tax procedures, clearances, and cargo inspections (Djankov et al., 2010). These behind-the-border delays tend to persist over time; see Appendix Figure A1. The associated export barrier may be of greater importance for OECD countries, given their active involvement in global supply chains and relatively low tariffs in contemporary trade.[2]

This paper studies the export effect for OECD countries of behind-the-border time delays, and how the effect differs across manufacturing sectors. As Figure 1 shows, export values mostly negatively correlate with export time; for sectors with more time-sensitive products like `Transport`, `Plastic`, and `Chemicals`, the negative correlations appear more prominent.

The empirical analysis is guided by the predictions of a Ricardian model developed in Costinot et al. (2012). I parsimoniously integrate a form of time barrier to export, which is represented by the interactive effect of exporter's export time and sectoral time sensitivity. This leads to a regression specification where corrected exports are regressed on productivity and the interactive effect. I deal with the potential endogeneity of productivity, following Costinot et al. (2012). For each sector, I compute a value that translates time delays into a price-equivalent form to capture time sensitivity, following Hummels and Schaur (2013).

Estimation results show that OECD countries with longer export delays for goods prior to being shipped export less, particularly in more time-sensitive sectors. I estimate that a ten-percent reduction in export delays would increase sectoral trade volume by 2.3–6.2 percent. There exists substantial heterogeneity across sectors in such effect, with more time-sensitive ones having a larger effect. For instance, with a ten-percent delay reduction, exports of `Transport`

1. See Evans and Harrigan (2005); Hummels et al. (2001); Hummels and Schaur (2013).

2. Chen et al. (2005) find that vertical specialization (the import share of exports) had increased further in a number of OECD countries. OECD (2001) document an average tariff reduction among OECD countries of 45 percent, as compared to 30 percent among non-OECD countries.

products would increase by 5.5 percent. And total manufacturing exports would increase by 4.3 percent.

This paper contributes to the literature on time as a trade barrier, and particularly that results from administrative processing.[3] Compared to prior work, it emphasizes how the effect of behind-the-border time barrier to export varies across sectors. The sample includes 22 OECD trading partners and 12 manufacturing sectors, which almost span the whole manufacturing industry.[4] The data are internationally comparable. Trade data are disaggregated at the exporter-importer-sector level. The regressions control for exporter-importer and importer-sector fixed effects (FEs). And the estimated trade elasticity being consistent with Costinot et al. (2012) validates the results.

2 Method

2.1 Model and predictions

Costinot et al. (2012) develop a Ricardian model with multiple countries ($i, n \in N$), multiple sectors ($k \in K$), and one factor of production—labor. Technological differences across countries and sectors depend on both fundamental productivity z_i^k and intra-sector heterogeneity θ. The former captures factors like climate, infrastructure, and institutions, which affect all producers in a country-sector pair. The latter is productivity-to-exports elasticity.

I make parsimonious changes to their model. Specifically, I impose an iceberg form of trade costs (Samuelson, 1954): For each unit of good k shipped from country i to n, only $1/d_{ni}^k$ units arrive,

$$d_{ni}^k = d_{ni} * d_n^k * d_i^k, \quad \text{for all } k \text{ and } n \neq i, \tag{1}$$

where d_{ni} is exporter-importer-specific trade costs, including physical distance, colonial ties, common languages, monetary unions participation, etc.; d_n^k is importer-sector-specific trade costs, including tariffs and standards imposed by the importer on different goods, etc.; d_i^k is

3. See Alessandria et al. (2010); Carballo et al. (2018); Clark et al. (2018); Djankov et al. (2010); Evans and Harrigan (2005); Fernandes et al. (2015); Hummels and Schaur (2013); Nordås et al. (2006). In particular, Carballo et al. (2018) show that transit systems that streamline administrative processing increase firms' exports.

4. Trade costs not only reduce trade volumes, but lower the probability of trading certain products at all. Thus, relying on positive trade volumes might underestimate any effects of trade costs. But such concern is not of importance in this study: Focusing on 22 OECD trading partners and 12 manufacturing sectors, only 0.5 percent of the exporter-importer-sector combinations (31 out of 5,808 observations) have zero trade volumes. Or at least, the estimates in this paper can be regarded as lower bounds of the export effect.

exporter-sector-specific trade costs, which I discuss below.

Let x_{ni}^k denote exports from country i to n in sector k. Then the share of exports from country i in country n, sector k is $\pi_{ni}^k \equiv x_{ni}^k / \sum_{i'=1}^N x_{ni'}^k$. The model predicts that, for any importer n, any pair of exporters i and i', and any pair of goods k and k',

$$\ln\left(\frac{\widetilde{x}_{ni}^k \widetilde{x}_{ni'}^{k'}}{\widetilde{x}_{ni}^{k'} \widetilde{x}_{ni'}^k}\right) = \theta \ln\left(\frac{\widetilde{z}_i^k \widetilde{z}_{i'}^{k'}}{\widetilde{z}_i^{k'} \widetilde{z}_{i'}^k}\right) - \theta \ln\left(\frac{d_i^k d_{i'}^{k'}}{d_i^{k'} d_{i'}^k}\right), \tag{2}$$

where $\widetilde{x}_{ni}^k \equiv x_{ni}^k / \pi_{ii}^k$ is corrected exports; $\widetilde{z}_i^k$ is observed productivity. Trade-driven selection that creates a wedge between fundamental and observed productivity is corrected by $z_i^k / z_{i'}^k = \left(\widetilde{z}_i^k / \widetilde{z}_{i'}^k\right) * \left(\pi_{ii}^k / \pi_{i'i'}^k\right)^{1/\theta}$. This cross-sectional prediction describes how productivity and trade costs differences affect trade patterns in a trading equilibrium. The proof is similar to Costinot et al. (2012).

Note that the exporter-sector-level trade barrier d_i^k is preserved in equation (2), while the other two elements, d_{ni} and d_n^k, are differenced out. I further assume

$$d_i^k = \exp\left(\lambda Day_i * \tau^k\right) * \nu_i^k, \quad \text{for all } k \text{ and } i, \tag{3}$$

where Day_i is the time needed in country i to complete compulsory administrative stages for exporting, measured in days; τ^k is sector k's time sensitivity; ν_i^k is a residual term; and λ is a parameter.

2.2 Regression specification

I derive a reduced-form gravity equation from equations (2) and (3),

$$\ln \widetilde{x}_{ni}^k = \theta \ln \widetilde{z}_i^k + \beta Day_i * \tau^k + \delta_{ni} + \delta_n^k + \varepsilon_{ni}^k, \tag{4}$$

where δ_{ni} is an exporter-importer FE; δ_n^k is an importer-sector FE; and ε_{ni}^k is an error term. Trade elasticity θ governs the relationship between observed productivity and exports. And β measures the interactive effect of export delays and time sensitivity of traded goods.

Prior work points out that using the ordinary least squares (OLS) method when productivity is a regressor may yield biased estimates. I therefore follow the literature to estimate equation

(4) using the instrumental variable (IV) method, where observed productivity is instrumented with research and development (RD) intensity (Costinot et al., 2012; Griffith et al., 2004).

2.3 Data

I construct a sample of 22 OECD countries and 12 manufacturing sectors. The countries include the US, Canada, Japan, Korea, Mexico, and 17 European Union (EU) member countries. A sector corresponds to a two-digit International Standard Industrial Classification (ISIC) Revision 3.1 unit; see Table 1.

Exports (x_{ni}^k) data are from the OECD STructural ANalysis (STAN) Bilateral Trade Database. The share of total expenditure that is sourced domestically (π_{ii}^k) equals one minus import penetration ratio, data on which are from the OECD STAN Indicators. Productivity is measured by the inverse of producer price indices, data on which are from the Groningen Growth and Development Centre Productivity Level Database. Costinot et al. (2012) provide theoretical foundations that productivity is fully reflected by producer prices, and show that this database is of high quality.[5] Export time (Day_i) data are from the World Bank Doing Business Survey. Appendix A provides details about this survey, and Appendix Figure A2 presents days to export for each county in the sample. RD intensity data are from the OECD STAN Indicators.

2.4 Computing time sensitivity

Hummels and Schaur (2013) develop an approach to measure the value of time in trade, which translates days of delay into a price-equivalent form. To obtain sectoral values, I extract from their extensive dataset 12 subsamples, each corresponding to one ISIC manufacturing sector. This process is based on mappings of nomenclature provided by the World Integrated Trade Solution. I then apply Hummels and Schaur's approach on each subsample to get the value of time for each sector. Time sensitivity (τ^k) in this paper is computed by scaling these values by 100; see Table 1.

Time sensitivity is specific to the traded goods in nature. Larger values indicate goods being more time-sensitive. I find that, among manufacturing sectors, `Transport` and `Plastic`

5. See Appendix Table A1 for productivity data. See also Inklaar and Timmer (2014).

appear more time-sensitive—perhaps because they contain more parts and components,[6] while `Footwear` and `Minerals` appear less so.

3 Results

3.1 Estimation results

Table 2 presents estimation results, with robust standard errors in parentheses.[7] Columns (1) and (2) report OLS estimates. Columns (3) and (4) report IV estimates, in which productivity is instrumented with RD intensity. Post-estimation test statistics (robust score Chi-squared) show the endogeneity of productivity. And first-stage statistics (R-squared and robust F-statistics) indicate the strong predictive power of the instrument. The coefficient on the instrument is estimated to be significantly positive, in line with the notion that RD activities improve productivity.

Columns (2) and (4) control for the interaction term, the estimated coefficients on which are negative and statistically significant. This implies that time delays hinder exports, and the adverse effect is larger in more time-sensitive sectors. In all columns, the estimate of productivity-to-exports elasticity θ is positive and significant, consistent with the prediction of the Ricardian theory that countries export more in more productive sectors.

Note that the IV estimates of both trade elasticity θ and interaction-term coefficient β are larger in magnitude and statistically more significant than the corresponding OLS estimates. Note also that the estimated θ does not significantly change after adding the interaction term into the regression. Therefore, productivity for a country-sector combination is unlikely to be correlated with time costs in the country's exporting process for that sector.

Column (4) represents the preferred estimation. The estimated trade elasticity θ is well in line with prior literature, which can justify the results. See Appendix Table A2 for descriptive statistics of the main variables. See Appendix B for robustness analyses.

6. `Transport` category includes manufacture of diverse accessories for motor vehicles, such as brakes, gearboxes, and airbags. `Plastic` category includes manufacture of rubber tyres for vehicles, equipment, and other uses.

7. We naturally follow the practice of Costinot et al. (2012) whose specification is quite similar to the one in this study, to use robust standard errors. This avoids the substantive question of looking for formal justification for clustering. Note that in both Costinot et al. (2012) and this study, standard errors are boosted when clustered at the exporter-sector level; in this study, they are boosted to an extent that renders the estimated coefficient statistically insignificant at standard levels.

3.2 Heterogeneity across sectors in export effect of a delay reduction

Based on column (4) of Table 2, I can estimate the effect on bilateral exports in a particular sector if there was a reduction in exporters' behind-the-border export delays. I consider a ten-percent as well as a one-day exogenous reduction in such delays among OECD countries in the sample. At the sector level, I add up hypothetical after-reduction exports, and calculate the percentage increase to actual exports.

Columns (1) and (2) of Table 3 report the export effect following a ten-percent and a one-day reduction in export time, respectively. I find that exports in more time-sensitive sectors—such as `Transport` and `Plastic`—tend to increase more after a delay reduction than exports in time-insensitive sectors—such as `Footwear` and `Minerals`. Specifically, if the 22 OECD countries managed to reduce export time by ten percent, exports in `Transport` products would increase by 5.5 percent. This large responsiveness is possibly due to the well developed vertical fragmentation and global supply chains for this sector. The export effect demonstrates large heterogeneity across sectors, with a standard deviation of 1.2 percent and a mean of 4.1 percent following a ten-percent reduction. Overall, a ten-percent reduction would enhance total manufacturing exports by 4.3 percent among these OECD countries.

4 Conclusion

Using OECD trade data, I find that export-time delays related to administrative procedures reduce exports by more in time-sensitive sectors than in time-insensitive sectors. This suggests that time delays depress exports, partly due to a compositional effect (Djankov et al., 2010): Countries with lengthy export time are discouraged from exporting more time-sensitive goods, which tend to be higher value-added. As a broad range of products are becoming more time-sensitive with the proliferation of multi-stage global supply chains in manufacturing, releasing regulatory restrictions and enhancing port efficiency to improve timeliness behind the border are of fundamental importance for each country.

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Table 1 ISIC manufacturing sectors and time sensitivity

Sector	Description	Code	Time sensitivity
Textiles	Textiles, textile products, and leather	17–18	0.8
Footwear	Luggage, handbags, saddlery, harness and footwear	19	0.47
Wood	Wood and products of wood and cork	20	0.87
Paper	Pulp, paper, paper products, printing and publishing	21–22	1.15
Chemicals	Chemicals and chemical products	24	1.16
Plastic	Rubber and plastics products	25	1.32
Minerals	Other non-metallic mineral products	26	0.54
Metals	Basic metals and fabricated metal products, except machinery and equipment	27–28	0.85
Machinery	Machinery and equipment not elsewhere classified	29	1.07
Electrical	Electrical and optical equipment	30–33	0.55
Transport	Transport equipment	34–35	1.26
Misc. Manuf.	Manufacturing not elsewhere classified	36–37	0.72
All Manuf.		15–37	0.75

Table 2 Estimation results

Dependent variable	Log(corrected exports)			
	(1)	(2)	(3)	(4)
Log(productivity)	2.059***	2.081***	6.486***	6.955***
	(0.173)	(0.172)	(1.379)	(1.452)
Export delay * Time sensitivity		-2.446**		-3.987***
		(1.139)		(1.287)
Method	OLS	OLS	IV	IV
Exporter × importer FE	YES	YES	YES	YES
Importer × sector FE	YES	YES	YES	YES
Observations	5,733	5,733	5,319	5,319
R-squared	0.858	0.858	0.849	0.845
Test of endogeneity:				
Robust score Chi-squared			12.75***	14.17***
	First stage: dependent variable is Log(productivity)			
RD intensity			0.011***	0.011***
			(0.001)	(0.001)
First-stage R-squared			0.778	0.778
First-stage robust F-statistic			87.02***	79.89***

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table 3 Export effect of a delay reduction by sector

Sector	Increase in exports (%)	
	10% reduction (1)	1-day reduction (2)
Textiles	4.25	3.26
Footwear	2.77	1.89
Wood	3.61	3.55
Paper	4.77	4.68
Chemicals	4.79	4.73
Plastic	6.18	5.42
Minerals	2.75	2.20
Metals	3.92	3.44
Machinery	4.90	4.34
Electrical	2.28	2.20
Transport	5.53	5.13
Misc. Manuf.	3.51	2.91
All Manuf.	4.27	3.94

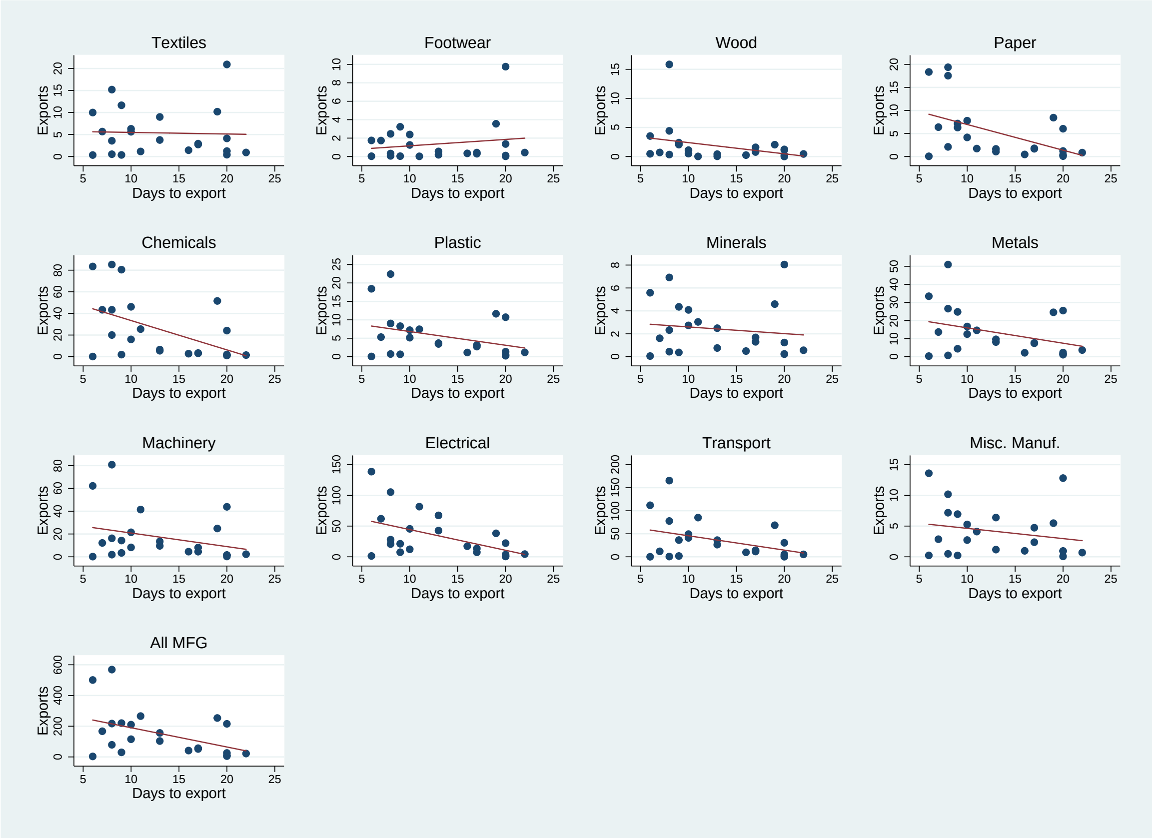

Figure 1 Export values versus export time

Notes: Export values in billion US dollars.

Appendices

Section A describes an important data source used in the paper—the World Bank Doing Business Survey. Section B conducts a number of robustness analyses for estimation results. Section C presents supplementary tables and figures.

A World Bank Doing Business Survey

This survey reports the time and cost (excluding tariffs) associated with exporting and importing a standardized cargo of goods by sea transport.* Specifically, the time and cost necessary to complete four sets of procedures—document preparation, customs clearance and inspections, inland transport and handling, and port and terminal handling—are included. The waiting time that occurs in practice—such as in queues to obtain a service or during the unloading and moving of the cargo at seaport—is also included. In particular, the exporting process ranges from packing goods into the container at warehouse to their departure from port of exit. Figure A2 reports export time (in calendar days) for the 22 OECD countries in the sample.

This survey also records all documents needed by the trader to export or import across the border. Specifically, documents required by law or common practice by relevant agencies—such as government ministries, customs authorities, and port authorities—are included. For landlocked economies, documents required by authorities in the transit economies are included. Documents required by banks for the issuance or advising of a letter of credit by which payment is made, are also included.

This survey makes the data comparable across countries under certain assumptions.

B Robustness analyses

The main results in the paper are estimated using equation (4). As this empirical specification unavoidably leaves out any discretionary trade policies that are exporter-importer-sector specific, one might be concerned with potential omitted variable bias in the estimates.

*. The methodology used to collect the data was initially developed by Djankov et al. (2010). In recent years, it has been revised for improvement and expansion. See Li (2018).

I conduct two robustness analyses to address this concern. First, I estimate equation (4) based on a subsample of the 17 EU member countries, as there is less scope for discretionary trade policies among these preferential trading partners. Column (2) of Table A3 reports the results, while column (1) which replicates the preferred estimation—column (4) of Table 2, is the baseline. It shows that the pattern of results is well preserved when focusing on trade among EU member countries, despite the reduction in the sample size.

Second, instead of controlling for exporter-importer and importer-sector FEs, I control for exporter, importer, and sector FEs, and further add a vector of bilateral variables—geographical distance, contiguity, common language, and colonial ties—into the regression. Column (3) of Table A3 reports the results. It shows that the estimated coefficients on productivity and the interaction term are similar to the baseline, and those on the bilateral variables are in line with prior literature. Long bilateral distance between trading partners tends to impede trade. Sharing a border increases trade. Cultural and institutional similarities represented by common language or colonial ties also increase trade.

These two robustness analyses show that discretionary exporter-importer-sector-specific trade policies may not be an important concern in the results. The reason may be that trade costs associated with such policies are orthogonal to trade costs that this paper is interested in—time costs due to behind-the-border administrative hurdles.

Another concern that potentially leads to omitted variable bias in estimation results is that there could be other exporter-sector-specific trade costs that are not accounted for in the specification. Examples include exporter's port and road infrastructure or port efficiency that is not captured by days of delay in exporting. Yet the robustness result in column (3) of Table A3 mitigates this concern, as the regression explicitly controls for unobserved exporter-specific fixed characteristics by including exporter FEs.

In the next robustness analysis to address the above concern, I replace in the interaction term in equation (4) the number of days required to export with the number of documents, data on which are from the World Bank Doing Business Survey. More documents required indicate less port efficiency or efficiency of officials in relevant agencies, which has a larger adverse effect on exporting more time-sensitive goods. Therefore, the estimated coefficient on the interaction term is expected to be significantly negative. Column (4) of Table A3 reports the results, from which we observe the expected pattern. This robustness result shows that using alternative measures of exporter's exporting efficiency yields similar conclusions.

C Supplementary tables and figures

Table A1 Productivity by country and sector

	Textiles 17–18	Footwear 19	Wood 20	Paper 21–22	Chemicals 24	Plastic 25	Minerals 26	Metals 27–28	Machinery 29	Electrical 30–33	Transport 34–35	Misc. Manuf. 36–37
BEL	1	1.07	0.93	0.82	1.3	1.48	0.78	0.88	0.72	1.02	0.82	1.13
CAN	1	1.1	0.95	1	1.22	1.43	0.8	0.95	0.91	1.07	0.92	1.14
CZE	1	1.07	1.01	1.15	1.55	1.6	0.92	1.04	0.78	1.04	0.91	1.16
DEU	1	1.06	0.92	0.8	1.24	1.22	0.79	0.84	0.78	0.91	0.85	0.99
ESP	1	1.01	0.98	0.84	1.51	1.61	1.03	0.79	0.83	0.94	0.93	0.97
EST	1	0.89	0.85	0.9	1.47	1.41	0.84	0.91	0.7	0.84	0.68	0.99
FIN	1	1.05	1.04	0.92	1.57	1.58	0.79	1	0.92	1.11	0.96	1.01
FRA	1	1.12	0.89	0.82	1.34	1.42	0.88	0.76	0.8	0.91	0.87	0.97
GBR	1	1.07	0.81	0.79	1.35	1.4	0.82	0.88	0.83	1.02	0.85	0.9
GRC	1	0.93	1.01	0.81	1.62	1.74	1.14	1.04	0.91	0.83	1.12	0.94
HUN	1	0.94	0.99	1.17	1.46	1.62	1.05	1.05	0.84	1.07	0.85	1.03
IRL	1	1.01	0.8	0.83	1.26	1.19	0.79	0.7	0.78	1	0.82	0.8
ITA	1	1.06	0.98	0.82	1.28	1.34	1.1	0.92	0.91	0.92	1.03	1.08
JPN	1	1.19	1.24	1.15	1.75	1.81	1.12	1.26	1.24	1.72	1.5	1.35
KOR	1	0.89	1.15	1.11	1.69	1.74	1.3	1.46	1.01	0.99	1.31	1.17
MEX	1	1.14	1.03	0.96	0.97	1.11	1.18	1.17	0.77	0.91	0.84	1.04
NLD	1	1.04	0.93	0.78	1.38	1.54	0.8	0.84	0.72	1.01	0.84	0.94
POL	1	0.84	1	1.13	1.48	1.54	0.94	0.98	0.79	0.93	0.85	1.09
PRT	1	1.02	0.87	0.85	1.28	1.34	0.95	0.92	0.78	0.94	0.79	0.89
SVK	1	1.03	1	1.15	1.45	1.61	1.03	1.01	0.76	1.1	0.84	1.14
SVN	1	1.05	1.12	0.96	1.47	1.68	0.98	1.08	0.92	1.04	0.94	1.29
USA	1	1	1	1	1	1	1	1	1	1	1	1

Notes: Productivity is normalized to reflect relative levels in the way suggested by equation (2). Specifically, within each sector, the US has productivity of one, and within each country, `Textiles` has productivity of one.

Table A2 Descriptive statistics of main variables

Variable	Mean (1)	Std. Dev. (2)	Min. (3)	Max. (4)	Observations (5)
Exports (billion US dollars)	2.154	18.29	0.000	530.3	5,319
Import penetration ratio	50.36	26.89	3.309	99.85	5,319
Productivity	0.993	0.193	0.553	1.464	5,319
Export delay (days)	13.17	5.189	6	22	5,319
Time sensitivity	0.908	0.280	0.471	1.325	5,319
RD intensity	1.166	1.917	0	11.63	5,319

Notes: For the preferred estimation, column (4) of Table 2.

Table A3 Robustness results

Dependent variable	Log(corrected exports)			
	Baseline	EU member countries	Different FEs	# Export documents
	(1)	(2)	(3)	(4)
Log(productivity)	6.955***	6.849**	7.081***	6.914***
	(1.452)	(3.276)	(1.668)	(1.517)
Export delay * Time sensitivity	-3.987***	-3.119**	-3.914**	
	(1.287)	(1.483)	(1.531)	
Export documents * Time sensitivity				-15.310**
				(7.229)
Log(distance)			-1.444***	
			(0.037)	
Contiguity			0.300***	
			(0.088)	
Common language			0.248**	
			(0.115)	
Colonial ties			0.575***	
			(0.110)	
Method	IV	IV	IV	IV
Exporter × importer FE	YES	YES		YES
Importer × sector FE	YES	YES		YES
Exporter FE			YES	
Importer FE			YES	
Sector FE			YES	
Observations	5,319	3,207	5,319	5,319
R-squared	0.845	0.859	0.788	0.845

Notes: Robust standard errors in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

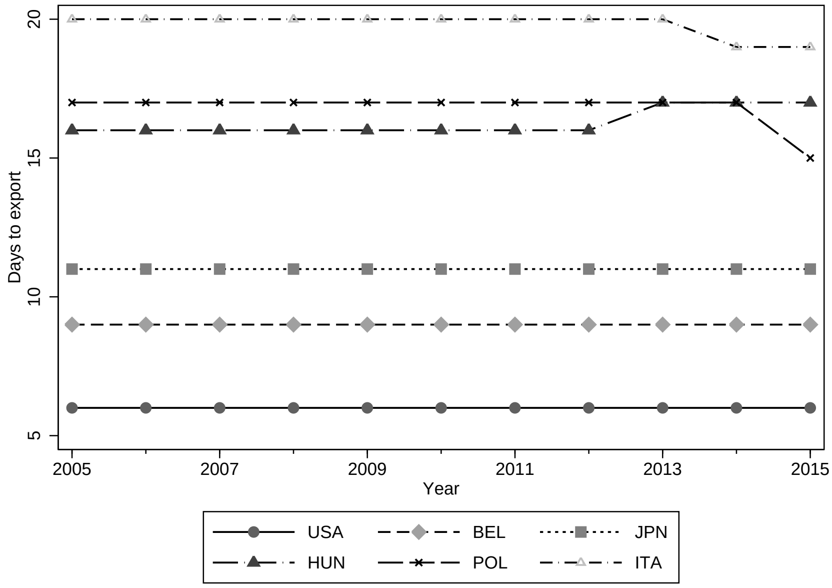

Figure A1 Trend in export time, 2005–2015

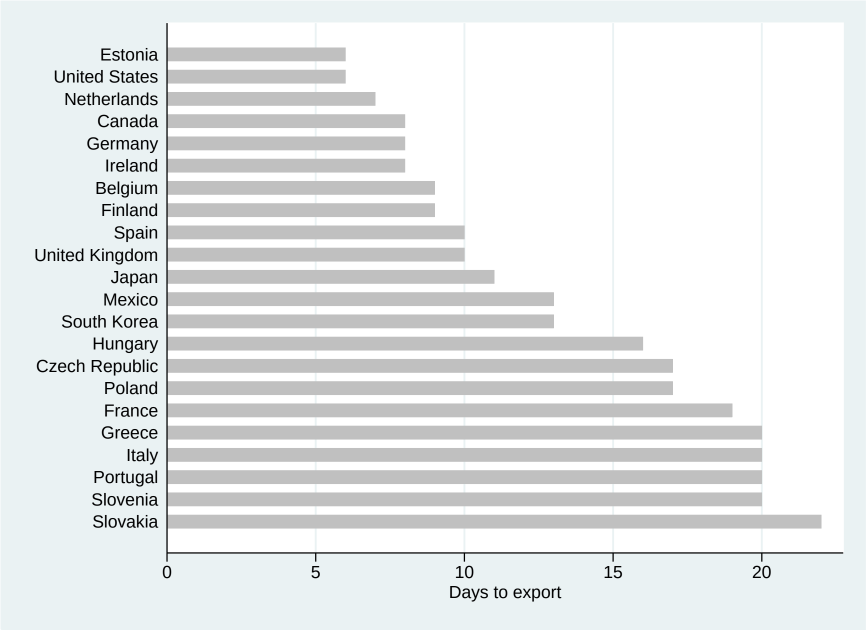

Figure A2 Export time for 22 OECD countries