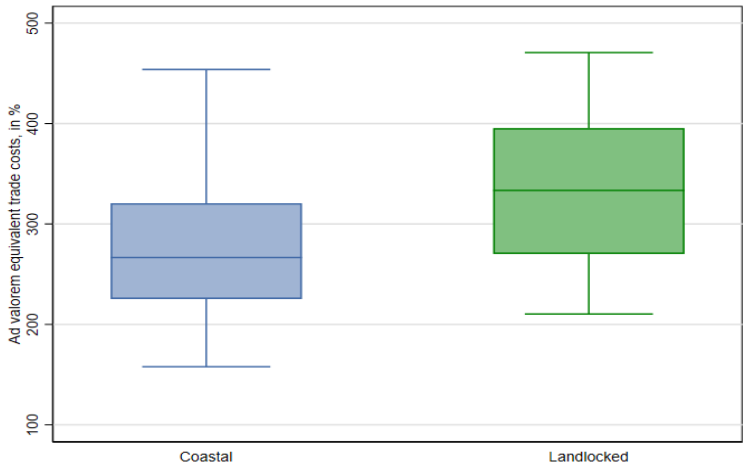
Trade costs for Landlocked and Costal Economies:

Estimates based on GTAP data[1]

Without direct access to a sea or an ocean, landlocked economies face higher costs to trade internationally than costal economies. The possibility to choose only between two modes of transport (air or road) rather than three is a factor behind higher transportation costs. In addition, landlocked countries need to cross at least one additional frontier to export. This lengthens the time to process goods at the border and generates more uncertainty about delivery times or treatment of goods in transit, especially with respect to SPS.

Relying on the methodology used to calculate the WTO Trade Cost Index,[2] this note calculates international trade costs for landlocked and costal economies based on a sample of 118 countries covering 25 landlocked economies. Estimates show that trade costs are higher for landlocked economies than for coastal economies (see Figure 1).[3] While coastal economies face an average trade costs equivalent of 278 per cent, landlocked economies average trade costs equivalent reaches 333 per cent.[4]

Figure 1: Total trade costs of coastal and landlocked economies, 2017



[1] The note has been developed by Roberta Piermartini, Katharina Laengle and Federica Maggi.

[2] This note follows Egger et al. (2021) and recovers trade costs as directional, bilateral pair fixed effects, τ, which are transformed into (partial equilibrium) trade costs, *PETC*, using sector specific elasticities, θ, as $PETC = \tau^{-1/\theta}$. For computation purposes, sector specific trade cost elasticities, θ, from WTO (2021 a) based on the World Input Output database (WIOD) were aggregated to the main industry level and take the following values: 4.8 for Agriculture, 5 for Mining, 4.7 for Manufacturing and 4.5 for Services. See WTO (2021 a) and Egger et al. (2021) for details on the methodology underlying the computation of bilateral directional trade costs.

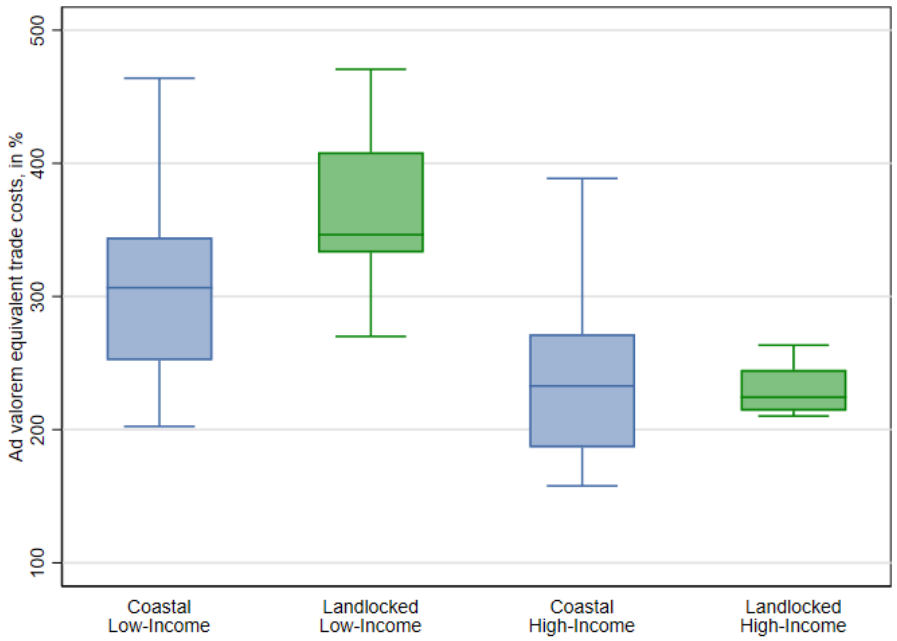
3 This analysis is based on data from the Global Trade Analysis Project (GTAP), a global database describing bilateral trade patterns, production, consumption and intermediate use of commodities and services (https://www.jgea.org/ojs/index.php/jgea/article/view/77). It covers 118 countries including the following 25 landlocked economies: (low-income) Armenia, Azerbaijan, Burkina Faso, Belarus, Bolivia, Botswana, Ethiopia, Kazakhstan, Kyrgyzstan, Lao People's Democratic Republic, Mongolia, Malawi, Nepal, Paraguay, Rwanda, Tajikistan, Uganda, Zambia, Zimbabwe; (high income) Austria, Czech Republic, Hungary, Luxembourg, Slovakia and Switzerland. For details about countries' classification see Appendix 1.

[4] Note that these are weighted trade cost. They differ from the trade costs reported in WTO (2021 b) where trade costs are computed as simple average over bilateral directional trade costs in the manufacturing sector. See technical notes in Appendix 2 for a comparison of weighted and unweighted trade costs estimations.

Note: Boxes represent the interquartile range of average ad valorem equivalent trade costs for landlocked and coastal country groups. The line inside the box shows the median.

Trade costs are particularly high for low-income landlocked economies.[5] Facing average international trade costs equivalent to a tariff of 366 per cent, low-income landlocked economies' trade costs exceed those of coastal low-income economies by 58 percentage points (see Figure 2).

Figure 2: Total trade costs of coastal and landlocked economies, by income level, 2017

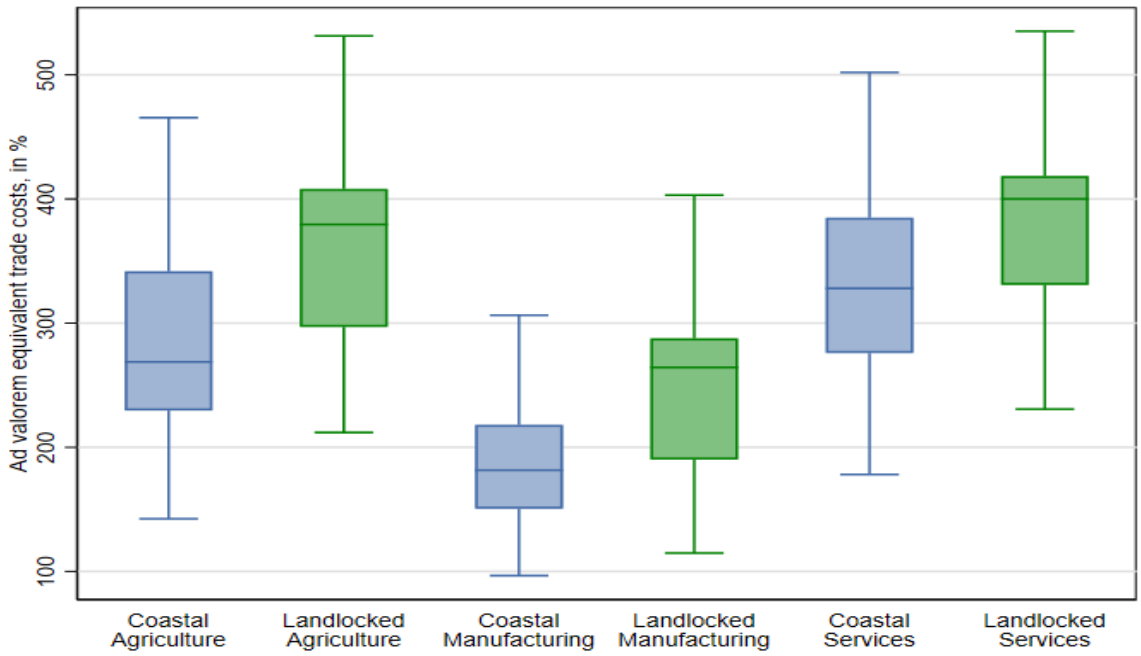


Note: Boxes represent the interquartile range of average ad valorem equivalent trade costs for landlocked and coastal country groups, by income level. The line inside the box shows the median.

Average trade costs for landlock economies are higher than those of costal economies across all sectors. They are highest in services (386 per cent tariff equivalent), followed by agriculture (360 per cent tariff equivalent) and lowest in manufacturing (243 per cent tariff equivalent), where for coastal economies trade costs are 337, 284 and 188 per cent, respectively (Figure 3).

[5] Economies are grouped into low and high-income economies based on their gross national product and income thresholds of 2016 from the World Bank, 2021. In particular, all economies with a gross national income of more than 12,235 USD in 2016 are classified as high-income economy.

Figure 3: Total trade costs of coastal and landlocked economies across sectors, 2017



Note: Boxes represent the interquartile range of average ad valorem equivalent trade costs for landlocked and coastal economies in different sectors. The line inside the box shows the median.

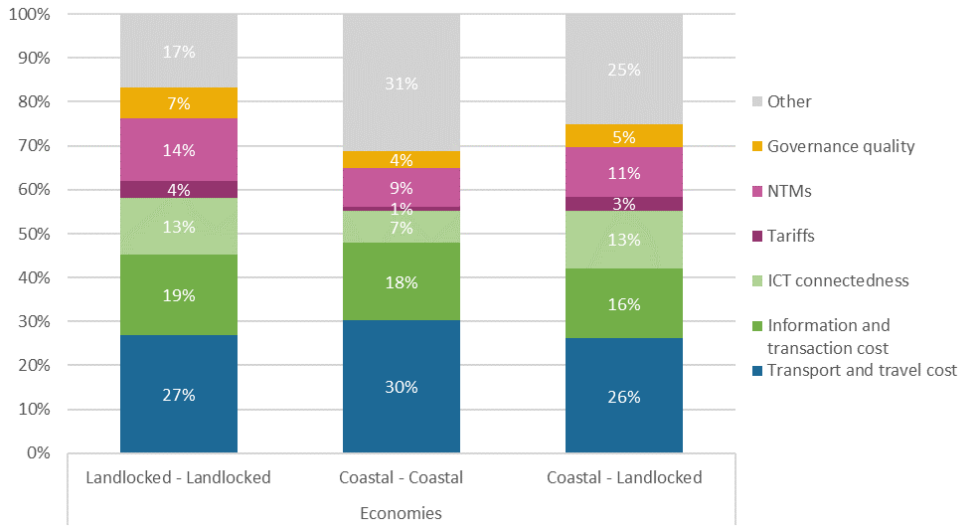
Various factors determine heterogenous trade costs among trade partners. The WTO trade cost index accounts for factors that relate to (i) transport and travel cost, (ii) information and transaction cost, (iii) ICT connectedness, trade policy and regulatory differences such as (iv) tariffs, (v) non-tariff measures (NTMs) as well as (vi) governance quality (see technical details of the decomposition in Appendix 2b).

The comparison between landlocked and costal economies shows that trade policy and regulatory differences, ICT connectedness and governance quality explain a higher share of variations of trade costs among landlocked economies than among costal economies (see Figure 4). NTMs are particularly important drivers of heterogenous bilateral trade costs of landlocked countries. Together with tariffs, NTMs account for about 18 per cent of bilateral trade costs among landlocked economies while such differences account for 10 per cent of trade costs of coastal economies.

While ICT connectedness accounts for 13 per cent of landlocked economies, its explanatory power merely accounts for 7 per cent of trade costs among economies with direct access to the sea. Governance quality is also more relevant for landlocked economies than for economies with direct access to the sea. Accordingly, governance quality accounts for around 7 per cent of trade cost differences of landlocked economies whereas it accounts for 4 per cent of trade cost differences of coastal economies.

Further analysis of the determinants of trade costs in landlocked economies should better account for quality of transport infrastructure of transit countries, as well as transit corridors and regulatory measure for transit of goods in place.

Figure 4: Trade cost determinants of coastal and landlocked economies, 2017



Note: Bilateral directional trade costs at the sector level in 2017 are decomposed into six categories plus a residual category. The sample includes Armenia, Austria, Azerbaijan, Bolivia, Czech Republic, Ethiopia, Hungary, Kazakhstan, Kyrgyzstan, Luxembourg, Mongolia, Paraguay, Rwanda, Slovakia, Switzerland, Tajikistan, Uganda and Zambia as landlocked economies. In line with Rubinova and Sebti (2021), Tariffs, SPS and TBTs are sector specific in goods regressions and country averages in services regressions. "Total" represents the variance weighted average across Agriculture, Manufacturing and Services. *Transport* comprises distance, common border, distance weighted exporter/importer infrastructure; *Information & Transaction* comprise common language, colonial relationship, common religion, previously same country, migrants from exporter to importer and vice versa; *ICT* comprises mobile and broadband coverage; *Tariffs* comprise tariffs imposed by the importer; *NTM* comprise RTA, EU, common currency, (cumulative) SPS, (cumulative) TBT; *Governance Quality* comprises distance weighted governance quality of exporter/importer and difference in governance quality. See Rubinova and Sebti (2021) for further details on variables and respective sources. Technical details of the decomposition are provided in the Technical Notes in Appendix 2b.

References

Egger, P., Larch, M., Nigai, S. and Yotov, Y., 2021. Trade costs in the global economy: Measurement, aggregation and decomposition (No. ERSD-2021-2). WTO Staff Working Paper.

Huettner, F. and Sunder, M., 2012. Axiomatic arguments for decomposing goodness of fit according to Shapley and Owen values. Electronic Journal of Statistics, 6, pp.1239-1250.

Rubinova, S. and Sebti, M., 2021. The WTO Global Trade Costs Index and its determinants (No. ERSD-2021-6). WTO Staff Working Paper.

World Bank, 2021. World Bank Country and Lending Groups, historical classification. Online Source: World Bank Country and Lending Groups – World Bank Data Help Desk [last accessed 09/03/2022]]

World Trade Organization, 2021 a, WTO Trade Cost Index: Evolution, Incidence and Determinants. WTO Background Note.

World Trade Organization, 2021 b, Easing Trade Bottlenecks in Landlocked Developing Countries. WTO Publication.

Appendix

Appendix 1: List of landlocked and non-landlocked economies in GTAP by income level

country name	HI	LI	landlocked	country name	HI	LI	landlocked	country name	HI	LI	landlocked
Albania	0	1	0	Guinea	0	1	0	Nepal	0	1	1
United Arab Emirates	1	0	0	Greece	1	0	0	New Zealand	1	0	0
Argentina	0	1	0	Guatemala	0	1	0	Oman	1	0	0
Armenia	0	1	1	Hong Kong SAR, China	1	0	0	Pakistan	0	1	0
Australia	1	0	0	Honduras	0	1	0	Panama	1	0	0
Austria	1	0	1	Croatia	1	0	0	Peru	0	1	0
Azerbaijan	0	1	1	Hungary	1	0	1	Philippines	0	1	0
Belgium	1	0	0	Indonesia	0	1	0	Poland	1	0	0
Benin	0	1	0	India	0	1	0	Portugal	1	0	0
Burkina Faso	0	1	1	Ireland	1	0	0	Paraguay	0	1	1
Bangladesh	0	1	0	Iran, Islamic Rep.	0	1	0	Qatar	1	0	0
Bulgaria	0	1	0	Israel	1	0	0	Romania	0	1	0
Bahrain	1	0	0	Italy	1	0	0	Russia	0	1	0
Belarus	0	1	1	Jamaica	0	1	0	Rwanda	0	1	1
Bolivia	0	1	1	Jordan	0	1	0	Saudi Arabia	1	0	0
Brazil	0	1	0	Japan	1	0	0	Senegal	0	1	0
Brunei Darussalam	1	0	0	Kazakhstan	0	1	1	Singapore	1	0	0
Botswana	0	1	1	Kenya	0	1	0	El Salvador	0	1	0
Canada	1	0	0	Kyrgyz Republic	0	1	1	Slovak Republic	1	0	1
Switzerland	1	0	1	Cambodia	0	1	0	Slovenia	1	0	0
Chile	1	0	0	Korea, Rep.	1	0	0	Sweden	1	0	0
China	0	1	0	Kuwait	1	0	0	Togo	0	1	0
Cote d'Ivoire	0	1	0	Lao PDR	0	1	1	Thailand	0	1	0
Cameroon	0	1	0	Sri Lanka	0	1	0	Tajikistan	0	1	1
Colombia	0	1	0	Lithuania	1	0	0	Trinidad & Tobago	1	0	0
Costa Rica	0	1	0	Luxembourg	1	0	1	Tunisia	0	1	0
Cyprus	1	0	0	Latvia	1	0	0	Turkey	0	1	0
Czech Republic	1	0	1	Morocco	0	1	0	Tanzania	0	1	0
Germany	1	0	0	Madagascar	0	1	0	Uganda	0	1	1
Denmark	1	0	0	Mexico	0	1	0	Ukraine	0	1	0
Dominican Republic	0	1	0	Malta	1	0	0	Uruguay	1	0	0
Ecuador	0	1	0	Mongolia	0	1	1	United States	1	0	0
Egypt, Arab Rep.	0	1	0	Mozambique	0	1	0	Vietnam	0	1	0
Spain	1	0	0	Mauritius	0	1	0	South Africa	0	1	0
Estonia	1	0	0	Malawi	0	1	1	Zambia	0	1	1
Ethiopia	0	1	1	Malaysia	0	1	0	Zimbabwe	0	1	1
Finland	1	0	0	Namibia	0	1	0				
France	1	0	0	Nigeria	0	1	0				
United Kingdom	1	0	0	Nicaragua	0	1	0				
Georgia	0	1	0	Netherlands	1	0	0				
Ghana	0	1	0	Norway	1	0	0				

Note: In order to ensure consistency of the country sample across methodologies, Puerto Rico was aggregated to the Rest of the World given the comparably small coverage of explanatory variables required for the decomposition of trade costs. Although Venezuela and Chinese Taipei are available in GTAP data, these countries cannot be matched with World Bank income classes and are therefore not considered in the analysis of Figure 2.

Overall, the Rest of the World includes Puerto Rico as well as Rest of Oceania, Rest of East Asia, Rest of Southeast Asia, Rest of South Asia, Rest of North America, Rest of South America, Rest of Central America, Caribbean, Rest of EFTA, Rest of Eastern Europe, Rest of Europe, Rest of Former Soviet Union, Rest of Western Asia, Rest of North Africa, Rest of Western Africa, Central Africa, South Central Africa, Rest of Eastern Africa and Rest of South African Customs.

Appendix 2: Technical Notes

a) Weighted vs. unweighted results

Consistent with the theoretical model of Egger et al. (2021), this note relies on aggregated trade costs at the country level using exporter and importer fixed effects from the initial gravity model as weights (see WTO, 2021 a). Qualitatively, these weights can be interpreted as market potential of respective trade partners.

Taking the perspective of country *i*, the aggregation of trade costs at the country level follows a two-step approach.[1] First, this procedure takes the geometric average of bilateral directional trade costs between country *i* and all its trade partners at the sector level using the geometric average of exporter and importer fixed effects of trade partners as weights. Accordingly, aggregated trade costs of country *i*, B_i, in a given sector can be expressed as

$B_i = \left[\sum_{j \epsilon R(i)} \frac{\sqrt{\chi_j \varphi_j}}{\sum_{k \epsilon R(i)} \sqrt{\chi_k \varphi_k}} \sqrt{\hat{d}_{ij}\, \hat{d}_{ji}}\right]^{-1/\theta}$ with $\hat{d}_{ij}$ and $\hat{d}_{ji}$ as estimated coefficients for directional country-pair dummies from the gravity estimation, χ_j and φ_j as importer *j*'s exporter and importer fixed effect (in levels) as well as a sector-specific elasticity θ.[1] Second, trade costs aggregated at the country-sector level are further aggregated to the country level applying a simple average over sectors.

This weighted average aggregation procedure leads to lower estimated values of trade costs than a simple average of ad valorem equivalent trade costs for two reasons. First, the use of exporter and importer fixed effects as weights assigns greater importance to importers with a higher market potential. As the market potential tends to be inversely correlated[1] with trade costs, the use of weights thus limits the upward bias of trade costs. Second, bilateral directional trade costs are harmonized by pair before elasticity exponents are applied. In case there are outliers, this harmonization mitigates the bias towards high numbers.

For example, the estimated *simple average* ad valorem equivalent trade costs in manufacturing for landlocked developing economies is 540 per cent (see WTO (2021 b)), while the *trade-weighted average* ad valorem trade costs of landlocked economies in manufacturing is 360 per cent.

While the weighted average procedure described above is preferrable over the use of a simple average of ad valorem equivalent trade costs due to its theoretical foundation, a simple average is often the only suitable option to compare trade costs estimations across different sources.

b) Shapley Decomposition of R-squares

In order to assess to what extent different groups of variables can explain the variation of trade costs across country pairs, the present note applies the Shapley decomposition of R-squares. This concept uses regression results and decomposes the share of explained variance, the R-square, into contributions by different groups of explanatory variables[6]. Accordingly, R-squares from regressions

[6] See Huettner and Sunder (2012) for mathematical details on the Shapley decomposition.

presented in the Table below (Table 1) are decomposed into different categories related to (i) transport and travel cost, (ii) information and transaction cost, (iii) ICT connectedness, trade policy and regulatory differences such as (iv) tariffs, (v) non-tariff measures (NTMs), (vi) sanitary and phytosanitary measures (SPS) and technical barriers to trade (TBT) as well as (vii) governance quality. In this context, Shapley decomposition results allow to conclude by how many per cent differences in trade costs between, for example, country pair A-B and country pair C-D are related to transport and travel, information and transaction costs etc.

Table 1: Results from the regressions for landlocked and coastal countries

VARIABLES	(1) Landlocked - Landlocked Agr.	(2) Coastal - Coastal Agr.	(3) Landlocked - Coastal Agr.	(4) Landlocked - Landlocked Man.	(5) Coastal - Coastal Man.	(6) Landlocked - Coastal Man.	(7) Landlocked - Landlocked Serv.	(8) Coastal - Coastal Serv.	(9) Landlocked - Coastal Serv.
Distance	0.222*	0.160***	0.186**	0.445**	0.571***	0.582***	-0.231*	0.001	-0.015
	(0.1156)	(0.0520)	(0.0749)	(0.1790)	(0.0530)	(0.0760)	(0.1105)	(0.0255)	(0.0274)
Common Border	-0.427	-0.142***	-0.231***	-0.285	-0.086***	-0.131***	-0.108	-0.114***	-0.141***
	(0.2954)	(0.0308)	(0.0296)	(0.1734)	(0.0228)	(0.0214)	(0.0632)	(0.0230)	(0.0269)
I-Infrastr x Dist (in log)	-0.047	-0.178***	-0.089	0.019	-0.272***	-0.243***	0.061	-0.004	0.022
	(0.1656)	(0.0501)	(0.0732)	(0.2208)	(0.0526)	(0.0776)	(0.0773)	(0.0225)	(0.0403)
E-Infrastr x Dist (in log)	0.379	0.076	0.139**	0.074	-0.161***	-0.083	0.092	-0.021	0.002
	(0.2804)	(0.0467)	(0.0670)	(0.1907)	(0.0475)	(0.0536)	(0.0701)	(0.0203)	(0.0273)
Common Language	0.001	-0.022	-0.043**	-0.100	-0.054***	-0.101***	-0.103*	0.000	0.004
	(0.0865)	(0.0190)	(0.0212)	(0.1181)	(0.0200)	(0.0226)	(0.0525)	(0.0068)	(0.0086)
Colonial Rel	-0.271	-0.075**	-0.059	-0.033	-0.046***	0.071	0.044	-0.019*	-0.001
	(0.3634)	(0.0286)	(0.0696)	(0.1266)	(0.0165)	(0.0624)	(0.0815)	(0.0106)	(0.0270)
Common Religion	0.039	-0.076**	0.020	-0.039	-0.048*	0.109***	-0.164*	-0.012	0.024
	(0.1406)	(0.0292)	(0.0440)	(0.1172)	(0.0246)	(0.0337)	(0.0897)	(0.0120)	(0.0151)
Prev Same Ctry	0.206	0.061	-0.177***	0.239	0.024	-0.125***	-0.055	-0.048	-0.096**
	(0.2443)	(0.0597)	(0.0618)	(0.1934)	(0.0400)	(0.0405)	(0.1113)	(0.0360)	(0.0378)
Common Legal Orig	-0.016	-0.015*	-0.011	-0.021	-0.014*	-0.011	-0.008	-0.000	0.004
	(0.0522)	(0.0087)	(0.0112)	(0.0540)	(0.0077)	(0.0118)	(0.0285)	(0.0032)	(0.0055)
Migrants from E in I	-0.009	-0.013***	-0.006*	0.004	-0.009***	-0.012***	0.002	-0.002**	0.001
	(0.0199)	(0.0023)	(0.0036)	(0.0142)	(0.0021)	(0.0027)	(0.0033)	(0.0009)	(0.0012)
Migrants from I in E	-0.001	-0.008***	-0.013***	-0.000	-0.008***	-0.010***	-0.001	-0.001	0.001
	(0.0127)	(0.0024)	(0.0035)	(0.0135)	(0.0020)	(0.0022)	(0.0043)	(0.0009)	(0.0012)
Broadband	-0.016	0.017	-0.006	0.056**	-0.011	0.004	0.024*	0.001	0.001
	(0.0311)	(0.0191)	(0.0107)	(0.0217)	(0.0179)	(0.0186)	(0.0134)	(0.0073)	(0.0095)
Mobile	0.450***	0.021	0.103	-0.142	-0.002	0.013	-0.119	0.015	-0.009
	(0.1379)	(0.0543)	(0.0721)	(0.3310)	(0.0531)	(0.0813)	(0.0998)	(0.0134)	(0.0257)
ln_tariff	-0.242	-0.047	0.056	-1.601**	0.226	0.169	0.046	-0.011	-0.087
	(0.4738)	(0.0807)	(0.1362)	(0.6369)	(0.2814)	(0.2495)	(0.3956)	(0.0523)	(0.0615)
RTA	-0.084	-0.057***	-0.058*	-0.509***	-0.012	-0.106***	0.011	0.009	-0.004
	(0.2029)	(0.0189)	(0.0295)	(0.1040)	(0.0331)	(0.0394)	(0.0429)	(0.0064)	(0.0100)
EU	-0.196	-0.196***	-0.245***	0.037	-0.085**	-0.119***	-0.123	-0.023	-0.052***
	(0.2393)	(0.0392)	(0.0445)	(0.1328)	(0.0320)	(0.0402)	(0.0865)	(0.0143)	(0.0164)
Common Currency	0.066	0.049	0.042	-0.062	-0.032	-0.000	0.149**	0.001	0.034***
	(0.4000)	(0.0358)	(0.0429)	(0.0892)	(0.0294)	(0.0196)	(0.0615)	(0.0124)	(0.0124)
I-SPS STCs (cum.)	0.299**	0.017*	0.010	0.122	0.005	-0.000	0.167**	-0.007	-0.003
	(0.1150)	(0.0096)	(0.0144)	(0.0758)	(0.0074)	(0.0115)	(0.0739)	(0.0055)	(0.0079)
I-TBT STCs (cum.)	0.023	-0.008	-0.006	0.015	0.004	0.009	-0.015	0.006	-0.003
	(0.0348)	(0.0066)	(0.0101)	(0.0278)	(0.0054)	(0.0071)	(0.0162)	(0.0039)	(0.0057)
I-Governance quality x Dist (in log)	-0.148	0.067**	-0.062	-0.248	0.028	-0.063	0.047	0.021	0.002
	(0.1136)	(0.0335)	(0.0530)	(0.1576)	(0.0279)	(0.0491)	(0.0312)	(0.0179)	(0.0272)
E-Governance quality x Dist (in log)	-0.284	0.010	-0.106**	-0.173	0.055	-0.050	-0.003	0.012	-0.011
	(0.1625)	(0.0419)	(0.0437)	(0.0995)	(0.0409)	(0.0433)	(0.0652)	(0.0149)	(0.0132)
Dif in Governance quality	-0.307	-0.143	0.034	-0.655	-0.126	-0.091	-0.541	-0.022	-0.055
	(0.4362)	(0.2033)	(0.1531)	(0.5462)	(0.1366)	(0.1608)	(0.3140)	(0.0695)	(0.0986)
Dif in GDPpCap	0.025	-0.014	-0.055	0.001	-0.028	-0.047	0.033	0.002	0.005
	(0.1498)	(0.0382)	(0.0379)	(0.0961)	(0.0272)	(0.0453)	(0.0591)	(0.0138)	(0.0194)
Dif Tertiary Educ	-0.261	0.010	-0.118**	-0.386*	0.003	0.013	0.211	0.006	-0.034
	(0.1533)	(0.0550)	(0.0527)	(0.1989)	(0.0456)	(0.0593)	(0.1306)	(0.0155)	(0.0419)
Constant	-1.733**	0.546*	0.733*	0.901	-0.092	0.383	2.676***	1.477***	1.727***
	(0.6528)	(0.2879)	(0.4021)	(1.7239)	(0.3057)	(0.3867)	(0.7189)	(0.0802)	(0.1316)
Observations	272	6,054	2,650	272	6,054	2,650	272	6,054	2,650
R-squared	0.868	0.750	0.819	0.884	0.791	0.831	0.933	0.917	0.921

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

Note: Columns (1), (4) and (7) show the results for landlocked economies. This means that both the importer and the exporter are landlocked economies. Likewise, Column (2), (5) and (8) show the results for only coastal countries. In Column (3), (6) and (9), instead, one country is landlocked and the other the other one is coastal.