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EXTENDED ABSTRACT

Does product heterogeneity influence the relationship between shipping connectivity and maritime trade? An application to coastal EU countries

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Abstract

We investigate the effect of shipping bilateral connectivity on maritime exports using the European Comext database, which provides information on bilateral trade flows between EU and non-EU countries disclosed by transport mode, type of product and the use of containers. Over the period 2010-2018 we find that shipping connectivity stimulates positively seaborne containerised exports. However, the magnitude of the impact depends on the nature of the shipped product. No impact is found for non-manufactured products and some manufactured products such as transport equipment or

chemicals. The large positive impact is found in textile and clothing and industrial machinery.

Introduction

The majority of all cargo delivered in the world is transported by sea. The value of world's trade merchandise using maritime transport reached 75% in 2020, with 60% of that packed in large steel containers (UNCTAD, 2021). This clearly shows how dependent companies are on shipping services. In this regard, the industries integrated into global value chains are dependent of shipping services and, consequently, the level of connectivity determines their access to international markets in a reliable and flexible way. So, better connectivity is deemed essential to facilitate bilateral trade and to help companies and countries integrate into global value chains (Mohamed-Chérif and Ducruet, 2016; Fugazza and Hoffmann, 2017; Saeed et al., 2020). Not only does this connectivity reduce maritime transport costs, but it also improves the competitiveness of products and their access to international markets (Wilmsmeier et al., 2006; Wilmsmeier and Hoffmann, 2008).

Therefore, given the growing importance of said variable, for countries with access to the sea, the UNCTAD has developed an indicator of the countries' position within the global liner shipping network: the Liner Shipping Connectivity index (LSCI), using information about the world container shipping fleet (UNCTAD, 2017). More recently, the UNCTAD also developed a bilateral version of the LSCI, the Liner Shipping Bilateral Connectivity Index (LSBCI) (Fugazza and Hoffmann, 2016), an indicator of the bilateral connectivity of a coastal country with every other coastal country.

However, there is very little research to date exploring the relationship between trade flows and said connectivity indicators. In this regard, Fugazza and Hoffmann (2017) finds that not controlling for bilateral liner shipping connectivity leads to an overestimation of the distance effect on international trade. Hoffmann et al. (2020) find a positive impact of bilateral liner shipping connectivity on bilateral South African trade flows. Analysing the maritime trade of coastal EU countries with the Rest-of-the World (ROW) countries, del Rosal and Moura (2022) find that bilateral liner shipping connectivity impacts positively on maritime containerised exports and (surprisingly) negatively on maritime non-containerised ones.

So far, the few studies published centre on identifying the effect of connectivity on trade. Indeed, most of the existing studies have undertaken a generic analysis of trade flows, treating the container as a homogeneous box without specifically incorporating information regarding the type of product transported. However, there can be a large degree of heterogeneity because of the potentially different characteristics and needs of each product, giving rise to different results in the valuation of connectivity by industry.

Therefore, in an effort to fill this gap, in this paper we explore the impact of shipping connectivity on maritime trade between EU countries and non-EU countries using the Eurostat's Comext database, which provides information product-by-product on the transport mode and the container mode (i.e. whether the cargo is containerised or not). According to Comext data for the
study period 2010-18, 51% of the value of EU countries' trade with the rest of the world was transported by sea and about 42% of this maritime trade was containerised cargo. As del Rosal and Moura (2022) discovered, the use of maritime containerised bilateral trade flows is fundamental to investigate the impact of shipping connectivity on maritime trade flows.

Reverse causality concerns when studying the impact of transport mode on international trade is controlled in our study using panel data techniques (Baier et al., 2018).

Empirical approach

We use the gravity equation to investigate the impact of connectivity on maritime trade. Taking into account that our variables of interest are time-variant dyadic, we formulate the following specification

$$X_{ijt} = exp\left(\alpha_{it} + \alpha_{jt} + \alpha_{ij} + \beta LSBCI_{ijt}\right)u_{ijt} \tag{1}$$

Where X_{ijt} denotes maritime (containerised or not) exports from country *i* to country *j* in year *t*, measured in nominal values. $LSBCI_{ijt}$ is our variable of interest, the Liner Shipping Bilateral Connectivity Index. α_{it} and α_{jt} are exporter-year and importer-year fixed effects and capture the multilateral resistance terms (third-country trade cost effects). α_{ij} are country-pair fixed effects and capture observed and unobserved heterogeneity for each pair of countries. Finally, u_{ijt} is an error term.

We estimate the gravity equation using the Poisson Pseudo Maximum Likelihood (PPML) estimator because the regressors enter exponentially in Eq. (1). Following Santos Silva and Tenreyro (2006), the PPML estimator is robust to different patterns of heteroscedasticity and provides a convenient way of dealing with zero bilateral trade flows.

Concerns about endogeneity may arise in the case of our variable of interest $LSBCI_{ijt}$, an indicator that is intended to reflect maritime connectivity. Maritime connectivity may influence export flows, but export flows could also influence maritime connectivity. Baier et al. (2018) warn that “reverse causality concerns would apply to transportation channels, which are built to facilitate trade but are often in response to an already strong and demanding existing trade relationship”. To treat the endogeneity of any regressor in the gravity equation, Baier and Bergstrand (2007) advocate the inclusion of country-pair fixed effects, which control for all observable and unobservable time-invariant bilateral factors that simultaneously influence liner shipping connectivity and trade flows.[1]

Data

We use two main databases. First, our dependent variable comes from Eurostat’s Comext database which reports trade flows for every reporting EU country with its respective partner since 1988. We select the database that uses the “Transport NST/R” classification of products (Nomenclature uniforme des marchandises pour les Statistiques de Transport, Revisée) and splits trade flows by mode of transport and whether the goods are containerised. The limitation of the database is that only reports trade flows between EU countries and non-EU countries. The sample period is 2010-2018. After eliminating small (less than 1 million population) countries or countries

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[1] del Rosal and Moura (2022) showed that the impact of sea distance on maritime trade was upward biased if $LSBCIijt$ was omitted and the impact of $LSBCIijt$ on maritime trade was upward biased if the estimation did not include country-pair fixed effects

without access to the sea, the final sample includes 24 EU countries and 132 non-EU countries. See Table A1 in Appendix A for the final list of countries.

In value terms, 51.01% of EU countries' trade with third countries in 2010-2018 was transported by sea, but in volume terms the share is considerable larger, accounting for 78.3% of total volume handled in the same period.

The NSTR product classification relates to the EU Statistical Classification of Economic Activities (NACE), so we can calculate the value and volume of total trade flows for different types of goods separating by transport and container modes.

LSBCI data were retrieved from the UNCTADstat (2021) platform. This bilateral indicator, available since 2006, can be considered an extension of the UNCTAD's already existing country-level LSCI. The LSBCI is computed at the country-pair level using information about the number of transhipments between a pair of countries, the number of direct connections of both countries, the number of direct connections common to both countries, the level of competition in services that connect the pair of countries and the size of the largest ships on the weakest route connecting both countries as a proxy of port infrastructure and economies of scale 1 (Fugazza and Hoffmann, 2016).

Results

We perform the PPML estimation procedure, including and excluding zero trade flows (e.g., 14.0% of observations of the benchmark dependent variable). With 20 EU coastal countries and 86 non-EU coastal countries for the 2010-2018 period, the maximum number of observations is 30,960 (20x81x2x9). We will see that the number of included observations differs across estimations due to the presence of 'singleton' groups, i.e., fixed effect groups with only one observation. Regarding statistical inference, recent papers (Egger and Tarlea, 2015; Larch et al., 2019) emphasise the importance of accounting for multi-way clustering of errors in panel-data gravity models. Multi-way clustering along the lines of Cameron et al. (2011) usually leads to a more conservative inference. We follow this advice, and all standard errors are three-way, clustered by exporter, importer and year.

Regarding the results, Table 1 provides estimates of the three dependent variables (total trade (columns 1 and 4), seaborne trade (columns 2 and 5) and seaborne containerised trade (columns 3 and 6)) measured in nominal value (columns 1 to 3) and quantity in tonnes (columns 4 to 6). So far, quantity as dependent variable had not been explored in previous studies, however, it is especially relevant for transportation activities. Turning to the variable of interest, the LSBCI (called indexmean in Table 1, 2 and 3) is included to estimate the impact of shipping container connectivity on trade flows.

As expected, results show that only the LSBCI estimates in column (3) is positive and statistically significant for seaborne containerised trade measured in nominal value. This can be explained by the type of bilateral connectivity captured in the LSBCI, which is restricted to container traffic. So, an increase in the LSBCI would have a positive effect on seaborne containerised trade flows between EU and ROW coastal countries.

Regarding the seaborne containerised trade measured in quantity, the coefficient in column (6) turned out not statistically significant, which may easily be explained by the quality of the data collected. Since quantity information related to the shipment is not mandatory to be filled in by exporting and importing companies, this information may contain some mistakes.

Therefore, we take the seaborne containerised trade measured in value as a benchmarking dependent variable from now on.

Table 1. Baseline results.

	(1) tot v	(2) sea v	(3) cont v	(4) tot q	(5) sea q	(6) cont q
PANEL A: Zero trade flows included						
indexmean	0.186	-0.0449	0.858***	-0.531	-0.660	0.331
	(0.204)	(0.247)	(0.308)	(0.532)	(0.553)	(0.298)
N	27703	27435	26733	27694	27417	26723
pseudo-R2	0.994	0.991	0.992	0.986	0.982	0.979
PANEL A: Zero trade flows excluded						
indexmean	0.185	-0.0450	0.857***	-0.531	-0.666	0.332
	(0.203)	(0.246)	(0.308)	(0.532)	(0.553)	(0.298)
N	27197	26048	24917	27197	26048	24917
pseudo-R2	0.994	0.991	0.992	0.986	0.982	0.978

All the regressions include exporter-year dummies, importer-year dummies and country pair dummies. Three-way standard errors clustered by exporter, importer and year in parentheses.
Level of significance: *10%, **5%, ***1%.

For the purpose of capturing product heterogeneity, Table 2 estimates the effect of the LSBCI on seaborne containerised trade classified by one-digit NSTR/E codes. Results show that the effect of LSBCI on other manufactures (column 10) and metals (column 6) is statistically significant and with the expected sign, but negative for minerals (column 3) and building materials (column 7) and not statistically significant for the other categories under study.

The coefficient estimate for LSBCI for manufactures and metals is as expected since these kind of products are commonly transported in containers, especially manufactured goods. In the case of metals, they are classified as intermediate products that are likely to be used in the production process. Therefore, for them, the level of connectivity is crucial to meet with their delivery times in a reliable and flexible way, showing the relevant role played by the time factor in the relative competitiveness of logistics chains.

Table 2. Regression by one-digit NSTR/E codes

VARIABLES	(1) agro raw	(2) food	(3) minerals	(4) petroleum	(5) ores	(6) metals	(7) building mat.	(8) fertilizers	(9) chemicals	(10) other manuf.
indexmean	-0.443	-0.622	-1.681**	-1.304	0.0847	1.475***	-0.957*	1.440	0.861	1.359***
	(0.345)	(0.418)	(0.820)	(0.971)	(2.190)	(0.570)	(0.572)	(0.881)	(0.702)	(0.337)
N	18074	20877	3519	8762	7553	13438	13461	6405	18383	22819
pseudo-R2	0.923	0.962	0.674	0.860	0.918	0.926	0.927	0.697	0.978	0.992

Zero trade flows are excluded. All the regressions include exporter-year dummies, importer-year dummies and country pair dummies. Three-way standard errors clustered by exporter, importer and year in parentheses. Level of significance: *10%, **5%, ***1%.

Since the effect of connectivity is more significant for manufactured goods, Table 3 provides the estimates of this category by two-digit NSTR/E codes. Only the coefficients of textile and clothing (column 6) and industrial machinery (column 3) turned out statistically significant and with the expected positive sign. In the case of textile and clothing trade flows, this industry requires quick and reliable supplies and accurate transportation as crucial elements in its supply chain management (Wen et al., 2019). In this regard, connectivity increases the flexibility in the management and planning of the shipment: high connectivity allows companies to adjust their shipments to the desired days, thus optimising the efficiency of operations. Besides, in the event of significant delays or cancellations of ship calls, a high connectivity reduces the waiting time until the next service arrives at the port, meaning the goods can be loaded in the shortest possible time (Martinez-Moya and Feo-Valero, 2022).

It is worth highlighting that transport equipment (column 1) and tractors, agricultural machinery and equipment (column 2) turned out not statistically significant. This kind of products are commonly transported in specialized vessels, called car carriers.

Table 3. Regression by two-digit NSTR/E codes of group 9: Other manufactures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
VARIABLES	transport	agr mach	ind mach	mat. constr	glass/ceramic	textil clothing	semi-finished
indexmean	2.190	0.678	1.647***	0.822	0.0291	2.223**	0.183
	(1.672)	(1.111)	(0.512)	(0.553)	(0.544)	(1.114)	(0.406)
N	14810	8882	19071	16480	13035	16889	20227
pseudo-R2	0.969	0.879	0.985	0.960	0.926	0.984	0.982

Zero trade flows are excluded. All the regressions include exporter-year dummies, importer-year dummies and country pair dummies. Three-way standard errors clustered by exporter, importer and year in parentheses. Level of significance: *10%, **5%, ***1%.

Conclusions

We find that liner shipping connectivity had a positive impact on maritime containerised trade.

We find the positive impact of liner shipping connectivity on maritime containerised trade of manufactured products is very strong. In contrast, del Rosal and Moura (2022) found that liner shipping connectivity had no impact on maritime containerised trade of manufactured products.

We find huge sectoral heterogeneity across products, with a negative impact for minerals and building materials, and with a positive impact for metals and other manufactures.

Among the group of “other manufactures”, the positive impact of liner shipping connectivity on bilateral trade flows is only significantly different from zero for industrial machinery and semi-finished products.

Appendix

List of countries in sample (countries with access to the sea, pop>1 million and LSBCI is available)

20 coastal EU countries

BEL CYP DEU DNK ESP EST FIN FRA GBR GRC HRV IRL ITA LTU LVA NLD POL PRT ROU SWE

81 non-EU coastal countries
ARE ARG AUS BEN BGD BGR BHR BRA CAN CHL CHN CIV CMR COD COL CRI CUB DOM DZA ECU EGY GAB GEO GHA GMB GNB GNQ GTM HKG HND HTI IDN IND ISR JPN KEN KHM KOR KWT LBN LBR LBY LKA MAR MDG MEX MMR MOZ MUS MYS NAM NGA NIC NOR NZL OMN PAK PAN PER PHL PNG QAT RUS SAU SEN SGP SLE SVN THA TTO TUN TUR TWN TZA UKR URY USA VEN VNM YEM ZAF

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