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Container shipping trade and real GDP growth: A panel vector autoregressive approach

Nektarios A. Michail
Central Bank of Cyprus

Konstantinos D. Melas
Metropolitan College

Dimitris Batzilis
American College of Greece – Deree, Greece

Abstract

By employing a panel vector autoregressive approach, we show that containership trade is an important determinant of GDP growth. Using the full sample of sea-transported container boxes of 135 countries for ten years, we provide evidence that the amount of TEUs transported, both contemporaneously as well as in the previous year, has a significant positive effect on economic growth. This can be explained via the fact that TEUs have a positive effect on trade flows between countries and trade flows have long been shown to have a strong positive impact on real GDP growth.

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Contact: Nektarios A. Michail - nektariosmichail@centralbank.cy, Konstantinos D. Melas - mkonstantinos@mitropolitiko.edu.gr, Dimitris Batzilis - batzilis@protonmail.com.
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1. Introduction

Krugman et al. (1995) have provided evidence that the increase of world trade the last 50 years can mainly be attributed to the liberalization of trade policies and also to the minimization of transportation costs. More precisely, trade as a percentage of global GDP has fascinatingly increased from 27.34% in the early 1960's to 60% in 2019, as we can observe in Figure 1. This rise in world trade has been a key factor for the vast changes that have occurred in the shipping industry.

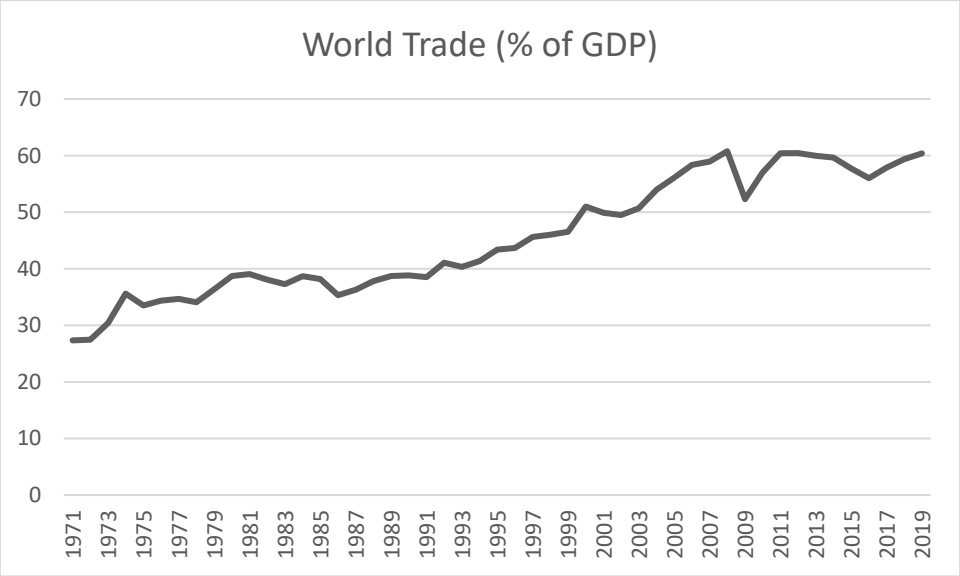

Figure 1 - Source: World Development Indicators - World Bank

Shipping has a predominant role in the world economy since approximately 85% of transported goods will be shipped at some point through vessels (UNCTAD, 2019) and thus the maritime industry in strongly related with economic growth. Park et al. (2019) show that maritime transportation is positively correlated with the economic growth of OECD and non-OECD countries alike, while air and land transportation have either a zero or a negative effect on economic growth. Therefore, it is only logical that the shipping industry will have a strong connection with world trade and with real GDP. Despite this, only a few studies have documented this relationship, and only at the global level (Strandenes and Thanopoulou, 2020; Michail, 2020).

From a shipping perspective, technological advancements that are evident in the industry since the 1950s have improved both the supply chain connectivity and the cost effectiveness of the maritime sector (Stopford, 2013). However, of all the changes that the industry has gone through, the most significant one is the containerization of parcels. Since the first voyage of Ideal-X on the 26th of April, 1956, between New Jersey to Houston, the shipping transportation has been revolutionized (Levinson, 2016). The latter innovation has led to the creation of the twenty-foot equivalent units (TEUs thereafter) and forty-foot equivalent units (FEUs thereafter) that are currently in use.

The standardization of transportation decreased logistic costs significantly. Containers have increased dock productivity by 16 times when compared to the previous state of bulk transportation when it was enacted in 1970s (Bernhofen, El-Sahli and Kneller, 2016). In addition to the standardization of sizes, which has eased logistic costs, sea-going container vessels have also benefited from economies of scale. More precisely, Coşar & Demir (2018) show that container transportation has a higher first-

mile cost and a lower distance elasticity, making it a more cost-effective way for longer distances. Similarly, Fugazza & Hoffmann (2017) show that the non-existence of liner container shipping connectivity between countries can affect negatively the values of exports.

Given these findings, the literature has investigated the relationship between imports and exports and their economic effects. In their work, Bottasso et al. (2014) provide evidence that the ports' throughput capacity is an indicator of GDP growth at the country level. However, the authors do not focus on the amount of container boxes transported but they account for the total products carried. In a more recent study, Pham & Sim (2020) have studied how the transportation costs derived from containers affect the development of land-locked developing countries. By using a novel dataset of 372 country-year observations, they show that the HarpexCost variable (a variable that represents the containers costs and it is derived by the Harper Index of Harper Petersen & Co. Ltd.) is negatively correlated with GDP and light intensity at night (a widely used alternative measure of development).

Nevertheless, while there is a rich literature in the field concerning the dry bulk segment (see Kilian, 2009; Kilian and Zhou, 2018; Hamilton, 2019; Funashima, 2020), there is lack of studies regarding the container segment. Containerization has already been documented to positively influence bilateral trade flows (Bernhofen, El-Sahli and Kneller, 2016) and additionally a lower transportation cost of container boxes leads to countries' economic growth (Pham and Sim, 2020). Hence, the current paper comes to fill the gap by studying the impact of container imports and exports on real growth. By employing a dataset of 135 countries, we show how containership trade is positively related with national GDP and can also be interpreted as a leading indicator.

Apart from their practical implications, our findings contribute to the existing bibliography regarding the relationship between trade policy and economic growth. Many papers in the field suggest a link between trade restrictions and low growth rates (see Dollar, 1992; Sachs *et al.*, 1995; Edwards, 1998 inter alia), but overall, the results are ambiguous (Rodriguez and Rodrik, 2000). Since trade barriers disrupt international trade only to the extent they are stronger than the benefits of trade, it is perhaps not surprising that their effect is hard to diagnose. In our study we focus directly on the variable of interest, actual trade, and conclude that it has a positive correlation with GDP growth.

Our results have significant implications for policy-making and investment, public or private. Port authorities play a vital role and should capitalize on their importance as growth factors, since boosting container trade will be beneficial for regional and national economic development. Policy makers should also focus on increasing trade flows in their jurisdiction, by adopting policies that will augment the economic and social significance of their ports. Last but not least, private and institutional investors may employ the container trade flows as a leading indicator to project economic growth in the near future.

Following this introduction, the remainder of this paper is organized as follows: section 2 describes the methodology and data used, section 3 discusses the empirical results obtained, and section 4 concludes on the findings.

2. Methodology and Data

Previous studies have mainly focused on specific regions to establish the potential relationship that exists between the ocean-going trade and the Gross Domestic Product of countries. In our paper, we explore the relationship between growth and containership trade using a panel regression model, as usual in the literature. In particular, we specify equation (1) such that:

$$\Delta GDP_{i,t} = \alpha_i + \beta_C\, \Delta TEU_{i,t} + \beta_{EX}\, \Delta EX_{i,t} + \beta_{HC}\, \Delta HC_{i,t} + \beta_I\, \Delta I_{i,t} + \beta_O \Delta O_{i,t} + \beta_{Pop} \Delta Pop_{i,t} + \beta_G \Delta Gov_{i,t} + \varepsilon_{i,t} \quad (1)$$

where $GDP_{i,t}$ is the real GDP per capita of country *i* at time *t* and $TEU_{i,t}$ is the log-change in the number of TEUs transported to and from country *i* in containerships. As per the literature, we also include $EX_{i,t}$ which denotes the exchange rate of country *i* against the US Dollar at time *t*, $I_{i,t}$ which is the investment share of GDP, and $O_{i,t}$ that shows the trade openness of the country. $Pop_{i,t}$ which denotes population, $Gov_{i,t}$ is the change in the government's share of GDP, while $HC_{i,t}$ as the human capital index of a country at time *t*. To avoid possible endogeneity issues as they are directly related to GDP changes, the first lag of $EX_{i,t}$, $Gov_{i,t}$ and $I_{i,t}$ is used. All variables are in log-difference form, excluding percentages, which are in first difference form, with Δ being the first difference operator. Table 3 in the appendix shows the variable definitions and transformations.

Despite the importance of sea transport via containerships (TEUs), to the best of our knowledge, this is the first study that employs TEUs as a variable to capture international trade. While the multiplier of TEUs-to-GDP is widely used as a proxy for the benefits that the container trading brings to countries, this ratio has not been statistically examined in the past. In particular, the ratio is primarily employed as a rule of thumb, since it is based on graphical representations (Saxon and Stone, 2017; Srića, et al., 2019; Rodrigue, 2020; Notteboom and Haralambides, 2020). Even though some countries may not have ports at sea, the vast majority of consumer products that arrive in these countries have likely been afloat at some point during the final part of their supply chain voyage. This makes the use of TEUs indispensable for measuring movements in international trade given that consumer goods purchases are the first to decline in a recession, while dry bulk or oil products, which usually have longer-term contracts, are not equally affected.

While the use of the GDP per capita over the simple GDP growth is straightforward, as is the use of TEUs, the use of the exchange rate helps to account for any potential movements in GDP that have already been incorporated by the markets and are thus unrelated to the growth in trade. Furthermore, the change in the human growth index, measuring the improvement in overall school years assists in capturing the overall social and cultural developments in the economy. In general, we expect that a depreciation of the exchange rate should have a negative impact on real GDP growth, while more schooling should be positively correlated with growth. To avoid any issues with causality, we use the lag of the exchange rate in the estimations. Overall, the selection of variables is based on the existing literature, such as Barro (2003), Bassanini and Scarpetta (2003), Moral-Benito (2012), and Michail and Savvides (2018). In particular, these studies have shown that education, the investment share in GDP, population growth, the government's share in GDP, trade openness, and the exchange

rate against the USD are the most significant determinants of growth in their samples. As such, these variables are also included in our estimation.

To address the possibility that the relationship between GDP and its own past values can be dynamic, we also employ a GMM estimation of equation (1), following the approach of Arellano and Bond (1991)[1]. In what follows, the first lag of real GDP per capita was employed, a decision supported not only via the annual frequency of the data but also due to the fact that only the first lag appears to be statistically significant in the instrument specification. Further to the possible existence of a dynamic relationship, the inclusion of a lag of the dependent variable also allows us to capture any lagged impact from variables not included in the estimation but still potentially affecting GDP.

Data on TEUs were obtained from United Nations Conference on Trade and Development Data Centre, while the rest of the data were obtained from the Penn World Tables (see Feenstra et al., 2015). The sample ranges from 2010 to 2018, and includes a total of 135 countries, making a total of 1078 country-year observations. All data are in log first-difference form. The range is limited by the availability of TEU data. A list of the included countries can be found in the appendix.

3. Results

Table 1 shows the results of our panel regression model, as specified in equation (1). As the reader can observe, the difference of number of TEUs that are imported and exported nationally, across all specifications, appears to be a positive and statistically significant determinant of economic growth. More importantly, the lagged values of the difference of the TEUs transported still have a significant effect on the national GDP, as evidenced in specifications (3) to (5).

In general, it appears that trade is a determinant of economic growth, as a 1% increase in transported TEUs will lead to an approximate 1.7% increase in GDP. Interestingly, this increase has a persistent effect on GDP, given that both the previous year's growth rate and the current year's change in total TEUs transported have an impact on the countries' GDP growth. At the same time, other determinants of real GDP per capita growth appear to cause a less significant effect (e.g. investment and the exchange rate). In general, the static regression estimates are supportive of the view that international trade, as proxied by TEU volume growth, has a positive relationship with real per capita GDP growth.

[1] While not contemplated here, a more recent extension which can also be employed in such a setup would be that of Baltagi et al. (2020). However, for space purposes we do not employ this additional approach and leave its use open for future research.

Table 1 – Static Panel Estimates

	(1)	(2)	(3)	(4)	(5)
$\Delta TEU_{i,t}$	0.016**	0.017***	0.017***		0.014***
	(0.006)	(0.006)	(0.005)		(0.002)
$\Delta TEU_{i,t-1}$			0.017***	0.015***	0.011*
			(0.003)	(0.004)	(0.006)
$\Delta EX_{i,t-1}$				-0.031**	-0.019
				(0.013)	(0.013)
$\Delta Inv_{i,t-1}$					-0.085***
					(0.033)
$\Delta Gov_{i,t-1}$					0.174***
					(0.067)
$\Delta Pop_{i,t}$					-0.155
					(0.113)
$\Delta O_{i,t}$					0.006
					(0.013)
$\Delta HC_{i,t}$				-0.442	-0.067
				(0.598)	(0.108)
Constant	0.014***	0.014***	0.012***	0.014***	0.022***
	(0.002)	(0.002)	(0.000)	(0.006)	(0.004)
Observations	1078	1078	943	896	588
Chi-squared	0.02	0.00	0.00	0.00	0.00
Fixed Effects	No	Yes	Yes	Yes	Yes

Notes: Dependent variable is $\Delta GDPPC_{i,t}$parentheses are the standard errors. *,**,*** indicate significance at the 10%, 5%, and 1% level respectively. In all specifications, a robust standard error estimator was used.

In Table 2, the estimates from a dynamic panel approach (Arellano and Bond, 1991) suggest that, once the lag of GDP is included as an instrument in the specification, only the contemporaneous effect of TEU volume change appears to affect GDP growth. The result is expected, given that the use of lagged GDP incorporates any past impact from TEU growth into the equation and thus allows us to focus only on the contemporaneous effect. With regards to the macroeconomic variables, it appears that only the change in the government share of GDP has a significant relationship with real per capital GDP growth. Overall, the contemporaneous impact of the TEUs is quantitatively and qualitatively similar with Table 1, thus further confirming the positive relationship between TEU volume and real GDP growth.

4. Conclusions

We have provided evidence that containership trade is an important determinant of GDP growth. The amount of TEUs transported, both contemporaneously as well as in the previous year, has a significant positive effect on economic growth. This can be explained via the fact that TEUs, as previously documented, have a positive effect on trade flows between countries and trade flows have long been shown to act bilaterally positively on GDP (Frankel & Rose, 1998; Egger & Larch, 2011; Blonigen et al., 2014 inter alias). Thus, our research further enhances existing knowledge on the importance of trade flows and international trade with regards to their relationship with economic growth by employing an easily measured variable which has not been used in the past. At the same time, given the existence of a relationship, TEU volume can potentially also be used as a leading indicator for the global economy, a question we leave open for future research.

Our results are of particular importance for international organizations and for policy makers since they provide an insight on how maritime transportation enacts trade flow and ultimately affects the real GDP growth of a country. The relevant stakeholders can thus focus on the maritime container cluster and further enhance its connectivity and additionally invest more in ports.

Table 2 – Dynamic Panel Estimates

	(1)	(2)	(3)	(4)	(5)
$\Delta TEU_{i,t}$	0.010***	0.012***	0.011***	0.010***	0.019***
	(0.003)	(0.005)	(0.002)	(0.003)	(0.002)
$\Delta TEU_{i,t-1}$		0.005			
		(0.009)			
$\Delta EX_{i,t-1}$				0.008	-0.003
				(0.017)	(0.019)
$\Delta Inv_{i,t-1}$			-0.057		-0.011
			(0.0.88)		(0.008)
$\Delta Gov_{i,t-1}$					0.305***
					(0.067)
$\Delta Pop_{i,t}$					-0.257
					(0.247)
$\Delta O_{i,t}$					-0.0210
					(0.015)
$\Delta HC_{i,t}$					-0.090
					(0.260)
Constant	0.008***	0.008***	0.025	0.008***	0.021***
	(0.001)	(0.002)	(0.020)	(0.003)	(0.006)
$\Delta GDPPC_{i,t}$	0.352***	0.336**	0.262**	0.352***	0.152**
	(0.04)	(0.136)	(0.096)	(0.017)	(0.083)
Observations	808	808	587	766	490
Chi-squared	0.00	0.00	0.00	0.00	0.00

Notes: Dependent variable is $\Delta GDPPC_{i,t}$ and parentheses are the standard errors. *,**,*** indicate significance at the 10%, 5%, and 1% level respectively. In all specifications, a robust standard error estimator was used.

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Appendix - Table 3: Variable List and Transformations

Variable	Definition	Units	Transformation	Source
$GDP_{i,t}$	Real GDP per Capita	USD	Log First Difference	Penn Table
$TEU_{i,t}$	Number of TEUs transported	TEUs	Log First Difference	UNCTAD Data Centre
$EX_{i,t}$	Exchange rate with respect to the USD	USD	Log First Difference	Penn Table
$HC_{i,t}$	Human Capital Index	Index	Log First Difference	Penn Table
$I_{i,t}$	Investment Share of GDP	Percentage	First Difference	Penn Table
$O_{i,t}$	Trade Openness (Exports plus Imports) as a share of GDP	Percentage	First Difference	Penn Tables
$Pop_{i,t}$	Population	Thousands	Log First Difference	Penn Tables
$Gov_{i,t}$	Government Share of GDP	Percentage	First Difference	Penn Tables

Appendix - Table 4: Country List

No	Country Name	No	Country Name
1	Algeria	35	Denmark
2	Angola	36	Djibouti
3	Anguilla	37	Dominica
4	Antigua and Barbuda	38	Dominican Republic
5	Argentina	39	Ecuador
6	Aruba	40	Egypt
7	Australia	41	El Salvador
8	Austria	42	Equatorial Guinea
9	Bahamas	43	Estonia
10	Bahrain	44	Fiji
11	Bangladesh	45	Finland
12	Barbados	46	France
13	Belgium	47	French Polynesia
14	Belize	48	Gabon
15	Benin	49	Gambia
16	Brazil	50	Georgia
17	Brunei Darussalam	51	Germany
18	Bulgaria	52	Ghana
19	Cambodia	53	Greece
20	Cameroon	54	Grenada
21	Canada	55	Guatemala
22	Cayman Islands	56	Guinea
23	Chile	57	Guyana
24	China	58	Haiti
25	Hong Kong SAR	59	Honduras
26	Taiwan	60	Iceland
27	Colombia	61	India
28	Congo	62	Indonesia
29	Costa Rica	63	Iran
30	Croatia	64	Ireland
31	Cuba	65	Israel
32	Cyprus	66	Italy
33	Cote D Ivoire	67	Jamaica
34	Dem. Rep. of the Congo	68	Japan

Table 4: Country List (cont.)

No	Country Name	No	Country Name
69	Jordan	103	Qatar
70	Kenya	104	Romania
71	Korea (South)	105	Russian Federation
72	Kuwait	106	Saint Kitts and Nevis
73	Latvia	107	Saint Lucia
74	Lebanon	108	Saint Vincent and the Grenadines
75	Liberia	109	Samoa
76	Lithuania	110	Saudi Arabia
77	Madagascar	111	Senegal
78	Malaysia	112	Sierra Leone
79	Maldives	113	Singapore
80	Malta	114	Slovenia
81	Mauritania	115	South Africa
82	Mauritius	116	Spain
83	Mexico	117	Sri Lanka
84	Montserrat	118	Suriname
85	Morocco	119	Sweden
86	Mozambique	120	Switzerland
87	Myanmar	121	Syria
88	Namibia	122	Tanzania
89	Netherlands	123	Thailand
90	New Caledonia	124	Togo
91	New Zealand	125	Trinidad and Tobago
92	Nicaragua	126	Tunisia
93	Nigeria	127	Turkey
94	Norway	128	Ukraine
95	Oman	129	United Arab Emirates
96	Pakistan	130	United Kingdom
97	Panama	131	United States of America
98	Papua New Guinea	132	Uruguay
99	Peru	133	Venezuela
100	Philippines	134	Vietnam
101	Poland	135	Yemen
102	Portugal		