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Abstract

A significant part of world trade volume is transported by container ship today. Growing world trade will enforce containerization, since standardized shipment reduces transport costs. The research aim of this paper is to identify the impact of variables used in merchandise trade flow models, like GDP, or colonial ties, and especially distance, on bilateral container transport flows. Distance is one of the most important natural barriers in trade models, and despite globalization, its impact has been quite persistent in world trade. For container transport, the impact might be smaller, since it takes place especially between distant regions. The results show that the distance effect is even positive in some of the model specifications. Furthermore, compared to traditional measures of distance, the use of shipping route distances reveals noticeable differences in the impact of distance and border on container transport. The impact of other variables is comparable to empirical findings in the related literature.

JEL Classification: C33, F10, O18, R40

Key Words: Panel Data, International Trade, Transportation, Containerization

1 Introduction

The focus of this paper is on seaborne container shipment. Container transport has become more and more important during the last decade since a growing number of goods can be shipped by container. The boxes themselves can be transported by train, truck or ship and can be seen as a standardized good.

Usually, containers are at first shipped to a major container port in their home region, then transported to a major container port in the target region and then shipped by smaller feeder ships to their destination port. This system is called hub-and-spoke. So, transport between one country's container hub and another country's minor port is not necessarily caused by trade between these countries. As a result, container throughput is higher than genuine bilateral trade, since most of the boxes are handled in more than their respective departure and arrival ports.

There exists a link between overall bilateral trade in goods and container transport, but there are also differences, since (1) only part of the goods is transported by container ship, (2) container transport is an especially convenient transport mode for longer distances, and (3) feeder transport takes place in the respective home and target region.

Today, world trade is usually explained with the help of the gravity model. In this model, trade is explained by gross domestic product or population as a measure of two countries' size, and their distance. The model is frequently used to analyze the effects of binary variables, like membership of the WTO or sharing a common currency (see, for example, Rose 2004; Baldwin and Taglioni 2006). Other papers try to forecast trade potential for countries with relatively low trade relations, as between Cuba and the United States.

While there exists a growing number of articles discussing bilateral trade flows, there are only few papers that analyze bilateral container trade. Here, one of the main questions will be, wether the natural trade barriers that influence bilateral trade, like distance or adjacency, have a comparable impact on bilateral container transport.

The next chapter will give an overview of the model's theoretical background and the existing literature. Chapter 3 describes the data and the estimation methods. Chapter 4 shows the estimation results, while Chapter 5 concludes.

2 Related Literature

The analysis builds on three strands of literature. The first deals with the theoretical background of the gravity model, the second with its empirical application, and the third with container shipping topics.

Gravity Models, first derived in the 1960s, explain bilateral trade flows F_{hs} by the exporter's and importer's GDP Y_h and Y_s, their distance D_{hs}, and a gravitational constant A:

$$F_{hs} = A\frac{Y_h^{\alpha}Y_s^{\beta}}{D_{hs}^{\Theta}}.$$

Recent papers focus on other explanatory variables, such as GDP per capita, or population, and include dummies for common border, common colonial ties, common language, or both countries' membership of a preferential trading agreement or a currency union (see Rose 2004; McPherson and Trumbull 2008).

Anderson (1979) presents a theoretical foundation for these models by showing that they can be derived from expenditure systems including different goods to be traded under the assumption of (1) identical CES preferences for traded goods across countries and (2) goods to be differentiated by country of origin. In a simple Pure Expenditure System Model, trade between countries is explained only by income, since income in both exporter's and importer's country determines the fraction of income spent on the traded good in the importer's country. In a Trade-Share-Expenditure System Model in which each country produces a traded and a nontraded good, individual traded-goods demands are determined by maximising a homothetic utility function in traded goods subject to a budget constraint involving the share of income spent on tradable goods. Bilateral trade flows depend on income (Y) and population (N) and can be expressed as follows:

$$M_{hs} = \frac{m_h \phi_h Y_h \phi_s Y_s}{\sum_h \sum_h M_{hs}},$$

where ϕ is the share of expenditure on all traded goods in total expenditure of country s with $\phi_s = F(Y_s, N_s)$, and m is a scale factor with $m_h = m(Y_h, N_h)$ (see Anderson 1979, p. 109).

While the value of the trade flow for all goods is M_{hs} in home country h, it is M_{hsk} for good k. In the target country s, the value of good k produced in country h is $M_{hsk}\tau_{hsk}$, with τ_{hsk} being the transit costs. These include both transport costs and border adjustments. Trade costs are of iceberg type and for positive trade costs, $\tau_{hsk} > 1$. If transit costs are an increasing function of distance and the same for all sorts of commodities - as often assumed - then transit costs can be defined as $\tau_{hsk} = f(d_{hs})$, where d is a measure of distance. Since trade between two countries does not only depend on their absolute distance but also on their bilateral distance relative to other countries, aggregate bilateral trade flows can be estimated as follows:

$$\begin{aligned} M_{hs} &= \frac{m_h \phi_h Y_h \phi_s Y_s}{\sum_s \phi_s Y_s} * \frac{1}{f(d_{hs})} \\ &\quad * \left[\sum_s \frac{\phi_s Y_s}{\sum_s \phi_s Y_s} * \frac{1}{f(d_{hs})} \right]^{-1} U_{hs}, \end{aligned}$$

with m and ϕ made log-linear functions of income and population, and U_{hs} being a log-normal disturbance term with $\mathrm{E}[\ln U_{hs}] = 0$. So, after controlling for size, bilateral trade is decreasing in two countries' trade barrier relative to these countries' trade barrier with other countries (see Anderson 1979, pp. 112-113; Anderson and van Wincoop 2003).

Bergstrand (1985) shows that the model can be explained as a "(...) reduced form from a partial equilibrium subsystem of a general equilibrium trade model with nationally differentiated products" (see Bergstrand 1985, p. 475). He gives a microeconomic foundation for the gravity equation with CES utility functions and CET production functions. Assumptions are (1) a small open economy in which foreign price level, foreign interest rate and foreign income are to be exogenous, (2) identical utility and production functions across countries, (3) perfect substitutability of goods, (4) perfect commodity arbitrage, (5) zero tariffs, and (6) zero transport costs (see Bergstrand 1985, pp. 476-477). Testing the simple gravity equation based on the six assumptions against a "generalized" gravity equation based on only the first and second assumption by OLS indicates that the imputation of zero coefficient estimates for price and exchange rate variables has to be rejected. Price terms derived from utilty and production functions have a significant impact on trade flows (see Bergstrand 1985, pp. 478-480).

Gravity models have been recently used by various authors to estimate trade flows, trade potentials, and the impact of trade barriers. In contrast to earlier papers they use panel data instead of cross-sectional data, since time and trading partners' individual effects have proven to be important for the correct model specification. The authors use different variables to test the gravity equation, though only income, and transport costs (e.g. tariffs) have a theoretical foundation. Frankel and Romer (1999), for example, use only country specific geographic characteristics to avoid reverse causality stemming from the fact that income may influence trade as well as trade may influence income.

Baltagi et al. (2003) analyze bilateral trade between the United States, Japan, and the EU15 countries, respectively, and their 57 most important trading partners by applying the gravity model. They show how the omission of interaction effects can result in biased estimates. If those interaction effects (country-pair effects or time-varying country fixed effects) are included in the gravity model, it will support Linder's hypothesis and the New Trade Theory which state that similar preferences between trading partners, economies of scale, and product differentiation should play a significant role in explaining trade patterns. In contrast, Deardorff (1998) argues that the gravity model supports different types of trade theory, for example Heckscher-Ohlin or Ricardian models.

Mátyás (1997) shows that the omission of country and time specific effects will result in a misspecification of the model. Baldwin and Taglioni (2006) propose time-varying country fixed effects, and time-invariant pair-specific dummies. The disadvantage of country-pair effects is that any pair-specific effect like distance, adjacency, or colonial ties, cannot be estimated anymore.

McPherson and Trumbull (2008) and Péridy (2005) use the Hausman-Taylor method to estimate the trade potential between the United States on the one hand and Cuba and the Middle East countries, respectively, on the other hand. Both papers compare coefficients derived by the fixed effects method, the GLS estimation, and the Hausman-Taylor method in order to demonstrate differences in coefficient estimates and significance as well.

Distance as a measure of trade costs is discussed in several papers. Disdier and Head (2008) conduct a meta-analysis of 103 papers covering 1 467 estimates to find out which factors affect the distance measure. The authors find a mean distance effect of about -0.9 in their meta-analysis of distance estimates in trade flow models, with 90 % of the estimates between -0.28 and -1.55. Baldwin and Taglioni find a negative distance effect between -0.75 and -0.91, depending on the model specification. Péridy finds a negative and highly significant distance effect of -0.84 when estimating a Hausman-Taylor model. Egger (2002) finds a positive but insignificant distance effect when applying a Hausman-Taylor model, where 7 out of 8 time-varying variables have approximately the same size and significance as in the Fixed effects model. Serlenga and Shin (2004) find a postive, insignificant distance effect when estimating a Hausman-Taylor model with time dummies.

Most of the literature suggests that the distance effect should be negative, i.e. growing distance impedes trade. The high container transport volumes between European countries and China indicate a somewhat negligible distance effect. According to Busse (2003) shipping costs in seaborne transport decreased by two thirds bteween 1930 and 2000 (see Busse 2003, p. 23). The transportation infrastructure, for example port containerization, seems to play a more important role. As the results by Egger (2002) and Serlenga and Shin (2004) show, the choice of the model specification should also have an impact on the distance variable. In this paper, the distance effect for container transport might be insignificant or even positive.

The factors influencing container trade should roughly be the same as for trade in general, since - except for bulk and oil trade - container trade is a convenient transport mode for most goods. In contrast to trade volumes that cover heterogenous goods, container trade refers to a standardized homogenous good for which transport costs should not differ with respect to the goods loaded. Most of the goods transported via container are manufactures, but even agricultural goods or minor bulks are carried by container today (see Prinz and Schulze 2004).

Prinz and Schulze (2004) and Eschermann and Schulze (2007) analyze world container fleet development and Germany's container throughput development, respectively. Fleet capacity as well as throughput is measured in TEU, that is twenty-foot equivalent unit. While the former model is estimated as a panel with fixed effects, the latter is estimated by OLS regresssion. The authors find that GDP per capita, world imports and exports, and freight rates have a significant impact on container fleet development. Germany's container throughput is mainly driven by world's GDP and Germany's foreign trade as well as globalization (see Eschermann and Schulze 2007). The positive impact of globalization on trade flows is caused by growing distance between country of production and country of consumption that leads to higher demand for seaborne transport (see Notteboom and Rodrigue 2009, p. 12). But, globalization itself may be influenced by container traffic (see Prinz and Schulze 2004, Frankel and Romer 1999). Hummels (2007, p. 132) states that most of the merchandise trade between non-adjacent countries is by ship or aircraft, so seaborne container shipment is a transport mode especially for longer distances.

De Monie et al. (2010) analyze the events that led to the sharp drop in seaborne trade in 2008/2009 and find that the former rise in trade volume was driven by similar factors as the financial crisis. Low interest rates supported credit demand growth that cumulated in asset inflation. These assets, usually real estate, were then used as collateral for consumer credit, thus enforcing import demand. So, since the late 1990s, growth in world trade had not been on a sustainable path. Production of durable consumer goods in the United States nearly doubled between 1990 and 2008, just to drop about 25 % during the crisis, when aggregate demand decreased (see Notteboom and Rodrigue 2009, p. 10). De Monie et al. use their findings as a warning to overestimate container trade flows by analyzing periods with especially high growth rates. Furthermore, they point out that container shipping demand is only a derived demand, since the demand for the goods transported in the boxes is unknown.

A recent, unpublished paper by Bernhofen et al. (2011) analyzes the effect of containerization on world trade. The dataset covers the period from the beginning of containerization in the 1960s to the end of the containerization in most of the developed countries in the 1980s. The authors introduce a containerization dummy that switches from 0 to 1 when a country launches container facilities. In a treatment-effect panel data model they find a highly significant impact for port as well as port and railway containerization on world trade.

3 Data and Methodology

The dependent variable is incoming and outgoing container transport within a certain period, measured in TEU (Twenty-foot Equivalent Unit). Data comes from Eurostat and covers bilateral container transport from 1st quarter 2000 to 2nd quarter 2010 between Belgium, Germany, France, United Kingdom, The Netherlands, and Spain, respectively, and the European Union's 50 most important trading partners, including the reporter countries themselves (see Appendix Table 3). Data consists of national container transport collected at each country's main ports (see Eurostat 2010).

Independent variables are lagged nominal GDP (GDP_{t-1}), trade freedom (TFM), and the exporter's fraction of manufactures exports (FMANUF). These variables are all time-varying. Furthermore, there are different dummy variables. The first is 1 if both countries share a common border (BOR),[1] the second is 1

[1] common border can be used as a proxy for feeder transport that usually takes place between adjacent countries.

if both countries share a fixed exchange rate (FER)[2], the third is 1 for colonial ties between two countries (COL), the fourth is 1 for one of the trading partners being an island (ISL), the fifth is 1 if both countries are member of the European Union (EU), the sixth is 1 if both countries are member of the World Trade Organization (WTO), and the seventh is 1 if both countries are member of the Union for the Mediterranean (UnionMED). EU, WTO, and UnionMED are dummy variables that are not constant over time, since countries joined these agreements during the analyzed period (see Appendix Table 5). Also, both countries' port infrastructure (PortInf) is included, which is the mean of both countries' port infrastructure, reported during 2007 und 2010 and published by the World Bank. The variable is time-invariant. The dataset consists of 23,436 observations and includes 2,221 bilateral trade flows with a container trade value of zero. Container trade volumes, GDP, and the measure of distance are log-transformed.

The model explains seaborne container traffic. Therefore, the great circle distance which is used, for example, by Mayer and Zignano (2011) or Rose (2004), is not appropriate. When analyzing seaborne traffic, one should use shipping routes as a measure of distance, which allows for more accurate results. Shipping routes are provided by Portworld[3], where one can select a starting a and destination port, and if transport via Suez Canal, or Panama Canal, is allowed. However, the actual route route a ship has taken can not be traced, but the selected routes should provide a much better measure of distance than the great circle distance.[4]

For the six reporter countries, Zeebrugge, Bremen, Le Havre, Felixstowe, Rotterdam, and Valencia are the selected ports. For the partner countries, the country's main, or most central port is selected (see Appendix Table 4). For short distances, the great circle distance is usually larger than the shipping route and vice versa. Trade relations with the highest differences between the measures of distance are those between the reporter countries and China, Japan, and Korea, respectively. For these trade relations, shipping routes are up to 2.6 times longer than the great circle distance. The variables SDIST (shipping route

[2]The variable FER differs from the Currency Union (CU) variable used by Glick and Rose (2002) and Baldwin and Taglioni (2006). Not only countries with a common currency, but also countries that participate in the European Exchange Rate Mechanism (ERM II), and country pairs where one currency is pegged to the other one, are included.

[3]see www.portworld.com/map/.

[4]For eastern partner countries, the route via the Suez Canal is selected. For the United States and Canada, an average distance of the routes to New York, and Halifax, on the one hand, and Los Angeles and Vancouver via the Panama Canal, on the other hand, is computed.

distance), and CDIST (CEPII distance measure used by Mayer and Zignano) are included to address the differences between the two distance measures.

Since shipping routes are not available for trade relations with Norway, Croatia, Thailand, Bulgaria, and Russia, these countries are excluded from the analysis. Also, The Bahamas, Taiwan, and Iran are excluded because of missing data. The dataset then consists of 18,039 observations. Bilateral trade flows with a container trade value of zero are excluded.

Container traffic and GDP data are collected on a quarterly base, the fraction of each country's manufactures exports is collected on a monthly base and aggregated to quarterly data. Trade freedom data is made quarterly by assuming constant growth within a year.

A Pooled OLS model assumes that there is no unobserved individual heterogeneity, and ignores the panel structure of the dataset. All observations are treated as uncorrelated. The equation is then

$$Y_{hst} = a + \beta \mathbf{X}_{hst} + \gamma \mathbf{Z}_{hs} + u_{hst}, \tag{1}$$

where $\mathbf{X}$ are the time-varying and $\mathbf{Z}$ are the time-invariant variables.

Since data cover several quarters and countries, panel analysis should be used to estimate container transport flows. The panel consists of 459 entities (i). These are the trade relationships in each direction, meaning that each of the entities consists of two countries and the specific direction. The entities are observed between 1 and 42 points in time (t).

Common methods to estimate panel data are Fixed effects models (FEM), and Random effects models (REM). Fixed effect regression controls for omitted variables that differ between entities but are constant over time. This entity-specific time-invariant unobserved effect is covered by the intercept c_i in the model

$$Y_{it} = (a + c_i) + \beta \mathbf{X}_{it} + u_{it} \tag{2}$$

(see, for example, Stock and Watson 2007, pp. 356-371; Wooldridge 2002, pp. 247-262). In the Random effects model, c_i is a random effect and cannot be treated as an intercept in the regression model. Instead, c_i is part of the error term $\nu_{it} = c_i + u_{it}$, and

$$Y_{it} = a + \beta \mathbf{X}_{it} + \gamma \mathbf{Z}_i + \nu_{it}. \tag{3}$$

While the Fixed effects model is always consistent, its disadvantage is that the impact of time-invariant variables, like distance or colonial ties, cannot be estimated. The Random effects model assumes all variables to be uncorrelated with c_i, but is not always consistent. A method proposed by Hausman and Taylor (1981) allows some of the variables to be correlated with c_i (endogenous), while the others are not (exogenous). The resulting estimation is

$$Y_{it} = \beta_1 \mathbf{X}_{1it} + \beta_2 \mathbf{X}_{2it} + \gamma_1 \mathbf{Z}_{1i} + \gamma_2 \mathbf{Z}_{2i} + c_i + u_{it}, \qquad (4)$$

where the subscripts 1 and 2 refer to the exogenous and endogenous variables, respectively.

For the Hausman-Taylor model, the time-varying and time-invariant variables that might be correlated with the observation-specific error term have to be determined. The mean of the exogenous variables will serve as an instrument for the time-invariant endogenous variables. To select the endogenous variables, the correlation between the exogenous and endogenous variables has to be computed to avoid the problem of weak instruments (see Baltagi and Khanti-Akom 1990). In the trade literature, different variables are supposed to be correlated with the residuals. For example, Serlenga and Shin select common language as the time-invariant variable correlated with unobserved individual effect c_i. McPherson and Trumbull select both countries' economic freedom and the Linder variable (the absolute value of the difference in both countries' GDP per capita) as time-varying variables that correlate with the unobserved individual effect. Both countries' communist and non-communist past, respectively, is used as a time-invariant variable correlated with the c_i. Péridy (2005) chooses both country's GDP and distance as independent variables that are correlated with the residuals.

Following the authors, common colonial ties, both countries' trade freedom and port infrastructure could be selected as the time-invariant and time-varying endogenous variables. While colonial ties should be correlated with c_i, a correlation analysis reveals that most of the exogenous variables are only weak instruments. Selecting colony as endogenous variable, its impact is up to 7.6 times higher than in any other specification. Therefore, trade freedom and port infrastructure[5], whose correlation with the exogenous variables is considerably higher, are selected as endogenous variables.

[5] Port Infrastructure is selected as endogenous variable since it should increase with the port's increasing container throughput.

The time effect is included in any model specification. In the Pooled OLS model, also the exporter's and importer's country fixed effects are included. Baldwin and Taglioni (2006) suggest uni-directional nominal trade data to avoid what they call the gold, silver, and bronze medal mistake. The panel variable is a uni-directional pair dummy.

We expect the coefficients on GDP, trade freedom, and common colonial ties to be positive. For container trade, the distance effect might be smaller than in some merchandise trade models, or even positive, since container trade is an especially convenient transport mode for longer distances. On the other hand, feeder traffic could lead to higher transport volumes between nearby countries.

As suggested by several former papers, the effect of a common currency should be positive (see, for example, Baldwin 2006), but Baldwin and Taglioni (2006) find a negative and highly significant impact when using time-varying nation dummies and time-invariant pair dummies. Since Slovenia joined a fixed exchange-rate mechanism during the analyzed period, the variable is time-varying. As a robustness check, the model is estimated with and without Slovenia.

A Random effects model (REM), a Fixed effects model (FEM), a Hausman-Taylor model (HTM), all three with time effects, and a pooled OLS model (POLS) with time and country fixed effects, are estimated.

4 Results

Table 1a and 2a (see Appendix) show the results for the model with CEPII distance (CDIST) and shipping routes (SDIST), respectively, including Slovenia.[6] The results for the Pooled OLS model (Equation 1), given in the first column of each table, show that all variables have the expected sign. The distance effect is negative in both estimations and its size is in line with the results found by Disdier and Head (2008).

The results for the Fixed effects model (Equation 2), given in the second column, where only the time-varying variables are estimated, do not differ with respect to the measure of distance, since this variable is time-invariant. The variables' impact is similar to the results of the Pooled OLS model.

The estimation results for the Random effects model (Equation 3, third column) and the Hausman-Taylor model (Equation 4, fourth column)[7] show

[6] This makes the variable FER time-varying.

[7] The endogenous variables are trade freedom and port infrastructure.

significant differences in the distance's impact, compared to the Pooled OLS model. The impact is positive and significant. Compared to the Pooled OLS model, the time-invarant variables' impact in these models is quite different. Most of the variables have a higher impact in the Random effects model and the Hausman-Taylor model.

While the distance effect is significant in the Random effects as well as in the Hausman-Taylor model, its size is up to three times higher when using the CEPII measure of distance. In contrast, the impact of GDP, colonial ties, membership of the WTO and both' countries port infrastructure is higher when using shipping routes.

Table 1b and 2b show the results for the same model, excluding Slovenia.[8] In all estimations, the negative impact of a fixed exchange rate is stronger, compared to the results given in Table 1a and 2a. In the Random effects model, the distance's impact is smaller, but still positive. In the Hausman-Taylor model, the distance's impact is also smaller and positive, but insignificant when using shipping routes.

The finding of a positive but insignificant distance effect in a Hausman-Taylor estimation is in line with the results published by Serlenga and Shin (2004) and Egger (2002). The fact that its effect is up to 3 times higher when using CEPII distance measure, compared to shipping routes, is due to the fact that in the dataset trade relations with the highest differences in the measure of distance often exhibit the highest trade volumes, as it is the case between the reporter countries and China.

In any of the model specifications, GDP, trade freedom (TFM), and membership of the World Trade Organization (WTO) all have a positive and significant impact. The fraction of manufactures exports (FMANUF) is small, but positive in all specifications, but significant only in the Pooled OLS. Except for the Pooled OLS model, membership of the European Union (EU) is negative, but insignificant in any specification. GDP, trade freedom, common border, colonial ties, membership of the WTO and Union for the Mediterranean, and being an island have the expected sign and are significant in most of the estimations. Membership of the EU is mostly negative, but always insignificant. While a fixed exchange rate (FER) has a negative and highly significant impact in the Pooled OLS model with shipping routes and CEPII distance measure, it is negative and significant in the Random effects model and Hausman-Taylor model

[8]This makes the variable FER time-invariant.

when using shipping routes, and insignificant when using CEPII data.

The border variable is positive and significant in most specifications. Its size and significance is affected by the choice of the distance measure. With shipping routes, the size of the common border effect is higher.The variable colony is positive and significant in all model specifications, but noticeably smaller in the Pooled OLS model. Being an Island has a negative impact, but the effect is insignificant in the Hausman-Taylor estimation.

Both countries' Port Infrastructure, which is the endogenous, time-invariant variable in the Hausman-Taylor model, has a positive and highly significant impact in all specifications. Its effect is higher in the Hausman-Taylor model than in the Random effects model, but smaller in the Hausman-Taylor model than in the Pooled OLS model.

When excluding Slovenia from the estimation, which transforms the time-varying binary variable for a fixed exchange rate (FER) into time-invariant, the results differ, but - except for the EU dummy in the Pooled OLS model that is insignificant - the signs do not change. The distance effect is noticeably smaller in the Random effects estimation and Hausman-Taylor estimation.

A Breusch-Pagan-Test reveals significant differences across entities, so the Pooled OLS model is not appropriate. The Hausman test between the Fixed effects estimation and the Random effect estimation shows that the Fixed effects method should be used. A Hausman test between the Hausman-Taylor estimation and the Fixed effects estimation (see Baltagi et al. 2003) suggests a Hausman-Taylor estimation when Slovenia is excluded from the data. When Slovenia is included and the CEPII distance measure is used, the Hausman-Taylor model is also appropriate.

5 Conclusions

This paper focuses on the analysis of bilateral container trade. It is shown that the applied measures of distance as well as the model specification lead to considerable differences in the distance's impact.

Traditional gravity models that are estimated using the great circle distance cannot correctly estimate container trade, espcecially between distant countries with high trade volumes, since the measure of distance does not correspond with the actual distance covered, especially between Europe and Asia.

Therefore, when using the CEPII data as the measure of distance, the distance's impact on container trade is overestimated. Using shipping routes as the measure of distance, the impact of the distance variable is noticeably smaller, but still positive. In the Hausman-Taylor model (without Slovenia), it is insignificant; This is in line with other findings in the literature.

Since shipping routes are shorter for nearby countries and longer for distant countries,[9] compared to the CEPII distance, the high impact of the distance variable in the estimation with CEPII data seems to be caused by an incorrect measure of distance.

The impact of a common border correlates with distance, since adjacent countries have a shorter distance. If the positive distance's impact is decreasing, the impact of a common border is also decreasing. Controlling for distance, adjacent countries trade more with each other. This is due to feeder transport between European ports.

In the Random effects model and the Hausman-Taylor model, the use of shipping routes (i.e. a decreasing impact of distance) goes along with an increasing impact of GDP, colonial ties, port infrastructure, and membership of the WTO. The impact of these variables on bilateral container trade is systematically higher when shipping routes are used, compared to CEPII data. So, using an alternative, more accurate measure of distance, those variables explain a greater portion of container trade volume.

As in bilateral trade models, GDP, and common colonial ties, and both countries' membership of the WTO, have a positive impact on container transport. Additionally, most of the variables, like GDP, tradefreedom, and membership of the WTO and the Union for the Mediterranean, respectively, do not only have the expected sign but are also highly significant. In contrast, both countries being member of the European Union *reduces* trade, but the effect is insignificant in any specification.

These results reveal that (1) container transport takes place especially between distant regions, and (2) feeder transport takes place between adjacent countries. If the border effect that controls for feeder transport is excluded from the estimation, the distance effect is smaller, but still positive.

[9]This effect is captured by the globalization variable in the estimation by Eschermann and Schulze (2007), but the globalization variable is disputed in the literature (see chapter 2).

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Appendix

Table 1a: Results for bilateral container transport volumes (CEPII measure of distance, including Slovenia)

Dep. Var: ln Cont. trade (*hst*)	POLS		FEM		REM		HTM	
	coeff	se	coeff	se	coeff	se	coeff	se
CDIST	-0,740***	0,047	(dropped)		0,667***	0,074	0,680***	0,105
TFM	0,034***	0,004	0,030***	0,002	0,027***	0,002	0,029***	0,002
GDP_{t-1}	0,398***	0,064	0,379***	0,038	0,449***	0,030	0,410***	0,033
BOR	0,309***	0,062	(dropped)		1,701***	0,319	1,427***	0,473
COL	0,749***	0,038	(dropped)		1,103***	0,224	1,194***	0,331
WTO	0,333***	0,088	0,304***	0,052	0,365***	0,051	0,312***	0,052
PORTINF	3,957***	0,105	(dropped)		0,834***	0,097	2,070***	0,295
FMANUF	0,005***	0,001	0,000	0,001	0,001	0,001	0,000	0,001
FER	-0,941***	0,060	0,045	0,171	-0,099	0,137	-0,191	0,154
ISL	-0,425***	0,079	(dropped)		-0,564***	0,150	-0,307	0,223
EU	0,081	0,096	-0,062	0,061	-0,032	0,060	-0,054	0,061
UnionMED	0,144**	0,067	0,111***	0,040	0,122***	0,040	0,116***	0,040
constant	-13,693***	0,920	1,014**	0,451	-9,992***	0,807	-16,099***	1,743
panel variable			*hst*		*hst*		*hst*	
time effects	YES		YES		YES		YES	
Country fixed effects	YES		NO		NO		NO	
R^2	0.6173‡		0.1880†		0.2981†			

*** p<0.01, ** p<0.05, * p<0.1

† R^2 overall, ‡ adjusted R^2

Table 1b: Results for bilateral container transport volumes (CEPII measure of distance, excluding Slovenia)

Dep. Var: ln Cont. trade (*hst*)	POLS		FEM		REM		HTM	
	coeff	se	coeff	se	coeff	se	coeff	se
CDIST	-0,755***	0,047	(dropped)		0,557***	0,079	0,419***	0,125
TFM	0,033***	0,004	0,030***	0,002	0,028***	0,002	0,029***	0,002
GDP_{t-1}	0,424***	0,064	0,379***	0,038	0,423***	0,030	0,393***	0,034
BOR	0,315***	0,062	(dropped)		1,479***	0,318	1,191**	0,499
COL	0,752***	0,038	(dropped)		1,047***	0,221	1,174***	0,347
WTO	0,338***	0,087	0,304***	0,052	0,378***	0,051	0,316***	0,051
PORTINF	3,968***	0,104	(dropped)		0,871***	0,098	2,631***	0,339
FMANUF	0,004***	0,001	0,000	0,001	0,001	0,001	0,000	0,001
FER	-1,032***	0,061	(dropped)		-0,211	0,210	-1,123***	0,364
ISL	-0,418***	0,079	(dropped)		-0,517***	0,150	-0,262	0,236
EU	-0,145	0,105	-0,042	0,063	-0,021	0,062	-0,050	0,062
UnionMED	0,152**	0,067	0,115***	0,040	0,127***	0,040	0,120***	0,040
constant	-13,838***	0,890	1,045**	0,450	-8,951***	0,817	-16,544***	1,828
panel variable			*hst*		*hst*		*hst*	
time effects	YES		YES		YES		YES	
Country fixed effects	YES		NO		NO		NO	
R^2	0,6106‡		0,1821†		0,2958†			

*** p<0.01, ** p<0.05, * p<0.1

† R^2 overall, ‡ adjusted R^2

Table 2a: Results for bilateral container transport volumes (shipping routes, including Slovenia)

Dep. Var: ln Cont. trade (*hst*)	POLS		FEM		REM		HTM	
	coeff	se	coeff	se	coeff	se	coeff	se
SDIST	-0,778***	0,024	(dropped)		0,216***	0,067	0,242**	0,097
TFM	0,034***	0,004	0,030***	0,002	0,027***	0,002	0,029***	0,002
GDP_{t-1}	0,393***	0,063	0,379***	0,038	0,483***	0,029	0,429***	0,033
BOR	0,447***	0,051	(dropped)		0,862***	0,310	0,547	0,462
COL	0,796***	0,037	(dropped)		1,203***	0,223	1,303***	0,330
WTO	0,327***	0,086	0,304***	0,052	0,374***	0,051	0,315***	0,052
PORTINF	3,791***	0,104	(dropped)		0,856***	0,097	2,152***	0,298
FMANUF	0,006***	0,001	0,000	0,001	0,001	0,001	0,000	0,001
FER	-0,777***	0,059	0,045	0,171	-0,298**	0,135	-0,318**	0,154
ISL	-0,475***	0,077	(dropped)		-0,512***	0,149	-0,221	0,223
EU	0,011	0,094	-0,062	0,061	-0,088	0,061	-0,080	0,061
UnionMED	0,144**	0,066	0,111***	0,040	0,115***	0,040	0,113***	0,040
constant	-12,388***	0,831	1,014**	0,451	-6,778***	0,771	-13,136***	1,731
panel variable			*hst*		*hst*		*hst*	
time effects	YES		YES		YES		YES	
Country fixed effects	YES		NO		NO		NO	
R^2	0.6332‡		0.1880†		0.2856†			
*** p<0.01, ** p<0.05, * p<0.1								
† R^2 overall, ‡ adjusted R^2								

Table 2b: Results for bilateral container transport volumes (shipping routes, excluding Slovenia)

Dep. Var: ln Cont. trade (*hst*)	POLS		FEM		REM		HTM	
	coeff	se	coeff	se	coeff	se	coeff	se
SDIST	-0,750***	0,024	(dropped)		0,174**	0,070	0,068	0,111
TFM	0,033***	0,004	0,030***	0,002	0,028***	0,002	0,029***	0,002
GDP_{t-1}	0,412***	0,063	0,379***	0,038	0,448***	0,030	0,403***	0,034
BOR	0,475***	0,051	(dropped)		0,902***	0,309	0,661	0,490
COL	0,797***	0,037	(dropped)		1,110***	0,220	1,246***	0,349
WTO	0,331***	0,086	0,304***	0,052	0,390***	0,051	0,317***	0,052
PORTINF	1,077***	0,132	(dropped)		0,924***	0,098	2,922***	0,343
FMANUF	0,006***	0,001	0,000	0,001	0,001	0,001	0,000	0,001
FER	-0,864***	0,060	(dropped)		-0,629***	0,205	-1,630***	0,356
ISL	-0,469***	0,077	(dropped)		-0,494***	0,149	-0,205	0,236
EU	-0,162	0,103	-0,042	0,063	-0,072	0,062	-0,072	0,062
UnionMED	0,152**	0,066	0,115***	0,040	0,122***	0,040	0,118***	0,040
constant	3,137**	1,429	1,045**	0,450	-6,297***	0,768	-15,230***	1,839
panel variable			*hst*		*hst*		*hst*	
time effects	YES		YES		YES		YES	
Country fixed effects	YES		NO		NO		NO	
R^2	0.6252‡		0.1821†		0.2846†			

*** p<0.01, ** p<0.05, * p<0.1

† R^2 overall, ‡ adjusted R^2

Table 3: List of Countries

Algeria	Libya
Argentina	Malaysia
Australia	Mexico
The Bahamas *	Morocco
Belgium	The Netherlands
Brazil	Nigeria
Bulgaria *	Norway *
Canada	Poland
China, People's Republic of	Portugal
Croatia *	Romania
Denmark	Russian Federation *
Egypt	Saudi Arabia
Finland	Singapore, Republic of
France	Slovenia
Germany	South Africa
Greece	Spain
Hongkong Special Administrative Region	Sweden
India	Taiwan *
Indonesia	Thailand *
Japan	Tunisia
Iran, Islamic Republic of *	Turkey
Ireland	Ukraine
Israel	United Arab Emirates
Italy	United Kingdom of Great Britain and Northern Ireland
Korea, Republic of	United States of America

* countries are excluded due to missing data.

Table 4: List of Countries' Ports

Bejaia, Algeria	Tanjung Pelepas, Malaysia
Buenos Aires, Argentina	Manzanillo, Mexico
Melbourne, Australia	Casablanca, Morocco
Zeebrugge, Belgium	Rotterdam, The Netherlands
Santos, Brazil	Lagos, Nigeria
Halifax, Canada and Vancouver, Canada*	Gdansk, Poland
Shanghai, China	Sines, Portugal
Aalborg, Denmark	Constanta, Romania
Helsinki, Finland	Jeddah, Saudi-Arabia
Le Havre, France	Singapore, Singapore
Bremen, Germany	Koper, Slovenia
Piraeus, Greece	Durban, South Africa
Hongkong, Hongkong	Valencia, Spain
Mumbai, India	Gothenburg, Sweden
Jakarta, Indonesia	La Goulette, Tunisia
Dublin, Ireland	Izmir, Turkey
Haifa, Israel	Odessa, Ukraine
Gioia Tauro, Italy	Dubai, United Arab Emirates
Tokyo, Japan	Felixstowe, United Kingdom
Busan, Korea	Los Angeles, USA and New York, USA*
Tripolis, Libya	

* average distance, route via Panama Canal allowed

Table 5: Countries that joined Free Trade Agreements and Currency Unions between 2000 and 2010

World Trade Organization (WTO)	China (December 2001); Croatia (November 2000); Saudi-Arabia (December 2005);
	Taiwan (January 2002); Ukraine (May 2008)
European Union (EU)	Poland, Slovenia (May 2004); Bulgaria, Romania (January 2007)
Euro / ERM II	Slovenia (June 2004)
Union for the Mediterranean	EU27, Algeria, Croatia, Egypt, Israel, Morocco, Tunisia, Turkey (July 2008)

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