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Mueller, Michiel; Wiegmans, Bart; van Duin, Ron

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ORIGINAL ARTICLE

The geography of container port choice: modelling the impact of hinterland changes on port choice

M. A. Mueller[1] · B. Wiegmans[1] · J. H. R. van Duin[2,3]

Abstract
European container ports compete in partially overlapping hinterland areas. The objective of this study is to model port choice and obtain insight into port choice decisions for European container imports from Asia. The importance of port choice factors and their impact on port market shares in the hinterland were investigated. Furthermore, sensitivity of the model in predicting the impact of increasing fuel prices on port hinterlands was tested. Containerised imports of 231 European mainland regions were compiled, based on shipping data, port statistics, modal split and gross regional products. Using literature sources, 11 port choice factors were selected; five of these were found to be statistically significant. These factors and their respective weights were used as input for a logit port choice model to analyse container port imports for 31 ports; the most detailed model yet. A varying oil price scenario was used to show the application and sensitivity of the model. Changing oil prices were found to have an impact on modal split and on the average hinterland transport distance.

Keywords Port choice · Modelling · Hinterland · Maritime container transport · Modal split · Container imports

✉ B. Wiegmans
b.wiegmans@tudelft.nl

[1] Department of Transport and Planning, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Stevinweg 1, 2628 CN Delft, The Netherlands

[2] Department of Transport and Logistics, Faculty of Technology Policy and Management, Delft University of Technology, Delft, The Netherlands

[3] Research Centre Sustainable Port Cities, Rotterdam University of Applied Sciences, Rotterdam, The Netherlands

1 Introduction

In the last decades, global container transport, particularly container transport from Asia to Europe, has grown rapidly [United Nations Conference on Trade And Development (UNCTAD) 2018]. The majority of containers shipped between Asia and Europe are still transported via the Suez Canal. Competition for these containers between European container ports is fierce due to the ease of handling containers at ports and during hinterland transport (Notteboom and Rodrigue 2008). Due to the high flexibility of re-routing containers, the once captive hinterlands of container ports have diminished and still continue to do so over time (Haralambides 2019); For example, for central Europe (e.g. Switzerland and South Germany), hinterland areas can be served both by North Sea and Mediterranean seaports (de Langen 2007) (Fig. 1).

Biermann and Wedemeier (2016) computed the contestable economic potential of the hinterland from Hamburg and from its possible emerging competitors by using simple travel time matrices for different transport modes. Also Merk and Notteboom identified main port–hinterland connectivity challenges and showed the potential policy responses to resolve them. A previously developed port choice model is the world container model (Tavasszy et al. 2011), modelling the movement of containers on a global scale. Veldman and Buckmann (2003) built a container port competition

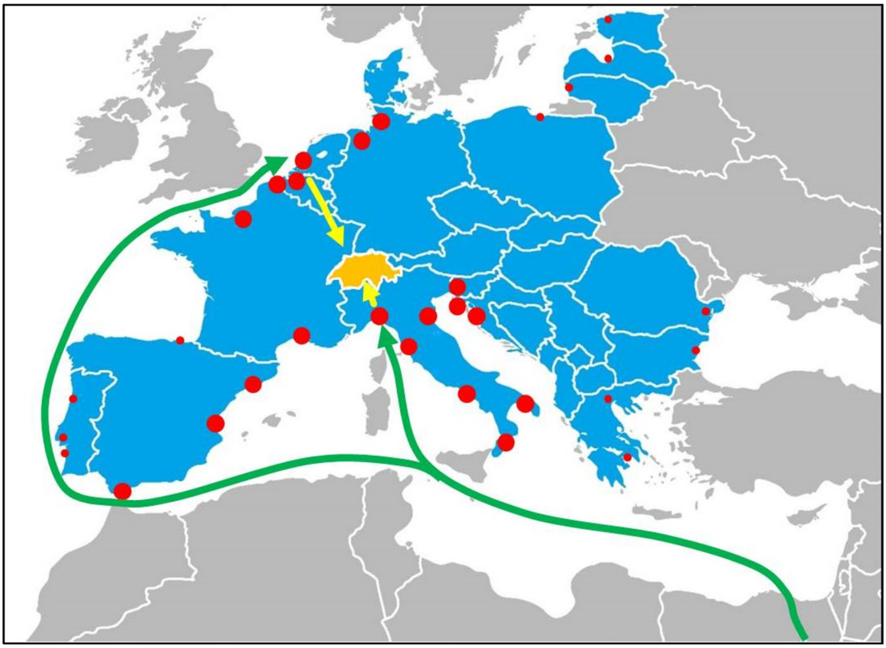

Fig. 1 Routes via the North Sea and Mediterranean Basin to the centre of Europe. The large red dots are the coastline ports for the Mediterranean and North Sea; the small red dots are ports included in the model but not considered in this study. *Source*: Authors' illustration. (Color figure online)

model for the Western European container hub ports using statistical analyses. This model was later expanded to include the water depth of ports (Veldman et al. 2005). Zondag et al. (2010) built a container port competition model for North West Europe using a generalised cost function. Dekker et al. (2011) viewed port competition from the perspective of investments in port capacities. The Institute of Shipping Economics and Logistics built a model concerning North European ports focussed on short sea transport (ISL 2014). Freight transport for the European hinterland was modelled with Transtools (Burgess 2008). However, in the latter model, port competition and maritime changes were not explicitly addressed. Although these models have worked well in terms of achieving their objective, they do not model all European mainland ports and their hinterlands at the level of detail necessary to model port choice for the complete European mainland. Therefore, the model developed in this paper includes 31 European mainland container ports and 231 Nomenclature of Territorial Units for Statistics-2 (NUTS-2, used by Eurostat) hinterland regions. Furthermore, hinterland transport modes were also included (road, rail and inland waterway transport), as well as deep-sea and feeder shipping, to analyse port choice.

The important position of ports in serving hinterlands motivates an in-depth study into the geography of port choice, which is the topic of this paper. Often, port choice focusses on the port of call only after the deep-sea trip. However, in addition, terminal selection within ports, port hinterland strategies, hinterland corridor efficiency and inland port operations form important determinants of port choice. In the work presented herein, a new model, showing how containerised imports from Asia could be affected by changes in factors influencing port choice, is discussed. These factors focus especially on hinterland strategies of ports, hinterland corridors and inland port operations.

The research question addressed by this study is: How will the geography of port choice be influenced by changes in port choice factors regarding port hinterlands? After the introduction, Sect. 2 presents the literature review on the geography of port choice, hinterlands and corridors. In Sect. 3, port choice modelling and data availability are introduced and discussed. Section 4 presents results of the model output and provides a case study to illustrate the sensitivity of the model. The main conclusions are provided in Sect. 5.

2 The geography of port choice

In this study, the transport origin is assumed to be Asia and the destination is a region in Europe. Maritime transport between Asia and Europe is performed by deep-sea shipping, and hinterland transport is achieved by truck, train or barge. Transhipment occurs at container terminals situated at the seaports, and hinterland transhipment takes place at smaller inland terminals. Shippers, forwarders and shipping lines have been identified as the major decision-makers of port choice (Aronietis et al. 2011). Container port competitiveness is generally conceptualised as being driven by straightforward criteria, such as port costs, handling efficiency, hinterland connectivity and the quality of infrastructure and services (Parola et al. 2017). Port choice factors cited most often, following a larger literature review, include:

geographic location (de Langen 2007): port services—turn-around-times (Lirn et al. 2004): port costs—tariffs (Ha 2003): cargo base—demand (Song and Yeo 2004; Karlaftis et al. 2009): availability of hinterland connections—capacity, inter-modal transport, quality of infrastructure, cost, speed and time (Nir et al. 2003; Grosso and Monteiro 2009); physical infrastructure—water depth, number of feeder services (Chang et al. 2008); port reliability (Wiegmans et al. 2008); port efficiency (Ugboma et al. 2006) and frequency of sailings (Malchow and Kanafani 2001; Tongzon 2009; Tongzon and Sawant 2007).

2.1 Port choice factors

The port choice factors mentioned above (geographic location) and the way they are used in this study are elaborated. The factor *geographic location*, which is the core topic in the present study, describes the distance of a port to markets, and it can be interpreted as a function of demand and distance. To model the geographic location of a port, the hinterland demand- and distance-related transport costs and times are used. Transport costs and times are modelled for road, rail and inland waterway transport (IWT) using current infrastructure, thus including the factor *availability of hinterland connections*. For inter-modal transport, the number of port rail and IWT services is taken into account. The hinterland container demand is considered to be equivalent to the factor *cargo base*. Transport costs and time have been split into different sub-factors according to their location in the transport chain. These include *maritime transport costs and time*, *port costs and time* and *hinterland transport costs and time*. For *frequency of sailings*, the number of direct port calls by deep-sea ships is used. For *feeder services*, the number of short sea services is taken into account. The port physical infrastructure consists of the waterside of the port. *Water depth* is considered an important factor for port comparisons, as water depth indicates the size of ships that can enter a port and, therefore, the nautical accessibility of a port. *Port reliability*, *port efficiency* and *port services* are factors not included in this study. These factors are more terminal oriented rather than port oriented, due to an increasing number of global terminal operators using dedicated container terminals. The role of these factors seems to become less important since the three largest shipping alliances in the world have their own terminal in many large ports, securing good performance levels for these factors. In addition, publicly available comparable data were not found for the terminals used in this study.

In summary, the following 11 port choice factors were used: maritime transport costs (1), maritime transport time (2), port costs (3), port dwell time (4), number of deep sea port calls (5), number of IWT services (6), number of rail services (7), number of short sea port calls (8), water depth (9), hinterland transport costs (10) and hinterland transport time (11). In addition, hinterland demand is used as a factor, but it is assumed to be fixed.

Most of the port competition literature focusses on the seaside and sometimes on the port location, and to a lesser extent, on hinterland factors (e.g. Lam and Yap 2006). In this paper, however, the 'hinterland part' of port choice (seaside, port and hinterland) is the focus, and the number of identified factors is enlarged and applied to an in-depth comparative case study. With the focus on hinterland strategies of ports, hinterland corridors and inland port operations, the factors taking centre stage in the geography of port choice are number of IWT services, number of rail services, hinterland transport cost and hinterland transport time.

2.2 Port hinterland

The contestability of port hinterlands often relates to their strategic planning; For instance Preston (1996) defines strategic planning as investment planning and land-use planning with regard to transport infrastructure. These are also among the core issues in the port hinterland. This is underlined by SteadieSeifi et al. (2014) and Dekker et al. (2011), who relate strategic planning problems to investment decisions in infrastructure (networks). On the strategic level, the logistics network is designed (links and nodes). The design of a logistics network is a long-term decision and often the responsibility of the respective government body. Infrastructure capacity by mode, terminal handling capacity, number of competing ports in a certain distance range, geographic location and cargo base are factors of relevance for the determination of hinterland port strategies. An interesting distinction in these hinterland strategies was made by Wilmsmeier et al. (2011). They distinguished between inside-out (inland terminal seeking closer ties with the seaport) and outside-in (seaports use inland ports as tools to enlarge their hinterland).

In general, the hinterland is an area around or beyond a major port, from which it draws its customers, connected to the port by freight transport corridors. The hinterland consists of the port, the transportation infrastructure (rail, truck and inland waterways), inland ports directly connected to the port and the final customers' locations. Parts of a port's hinterland are shaped by the structure of transportation networks. Many deep-sea port hinterlands can be considered as corridors, extending from the terminal facility to inland ports (Rodrigue et al. 2009). Three types of port hinterlands can be identified: the natural or main hinterland, the competitive or contestable hinterland and the non-competitive hinterland. All three hinterland types are connected to the port via freight transport corridors. The main hinterland is the area where a port accounts for the majority of the freight it handles, mainly because of proximity, accessibility and well-developed transport corridors. The competitive hinterlands are the areas where ports compete for incoming and outgoing freight flows with other ports. The third is the non-competitive hinterland; this is the hinterland where a port cannot compete effectively, mostly because of prohibitive transport costs or lack of transport corridors.

In the hinterland, at the end of the corridors, inland ports are often found. In recent years, scientific attention to inland ports has grown. Rodrigue et al. (2010) and Monios and Wang provided in-depth analyses of the different definitions of inland ports, including important differences between the USA and Europe; For instance, in the USA-based literature, inland ports refer to freight sites with rail terminals, including surrounding business areas and an own governance structure. In Europe, these rail-oriented nodes are defined as Güterverkehrszentrum, freight village, dry port or interporto. In the European-based literature, an inland port is a place (or a town or city) along a waterway with facilities for loading and unloading inland waterway vessels. Inland port geographies can range from one company with a quay to a container terminal with a quay, to a number of companies with quays concentrated in a dock in a certain municipality, to the inland port municipality level (sometimes with multiple docks). Gateway logistics leads to regionalism of freight distribution and, as a consequence, to changing roles of inland ports (Rodrigue and Notteboom 2010). This changing role can be either divergence or convergence with deep-sea ports. Witte et al. (2014) found that inland port strategies were often either missing or 'under construction'. In addition, inland ports can take a more pro-active role and claim their own position in hinterland transport and logistics.

3 Modelling port choice

3.1 Modelling introduction

The model presented herein is based on the initial model built by Veldman and Buckmann (2003). The extension of the model includes more ports and hinterland regions to choose from, more recent data and maritime factors and services. A route choice methodology was used to determine port imports. A route consists of maritime transport, port choice and mode-specific hinterland connections. The route choice is influenced by port choice factors, such as cost and time, and is calibrated using actual container origin–destination (OD) data. A conceptualisation of the model is shown in Fig. 2.

3.2 Route choice using multinomial logit

A multinomial logit model was used to model route choice. Because a port is a node in a transport chain, route choice was first analysed in order to be able to analyse port choice. Multinomial logit models are widely used to determine routes, due to their mathematical advantages (Ortuzar and Willumsen 2011). The multinomial logit model determines the probability of a certain route being chosen, based on the utility of the route. This is done by comparing all possible alternative routes. The probability of choosing a certain route, a combination of port, hinterland mode and hinterland region is expressed by Eq. (1).

$$P_{ijm} = \frac{e^{U_{ijm}}}{\sum_{i'} \sum_{m'} e^{U_{i'jm'}}}, \tag{1}$$

where P_{ijm} is the probability of choosing a route from port i to hinterland region j using hinterland mode m. The probability is associated with the utility U_{ijm} of that route.

The decision-makers from each hinterland region choose a route based on the utility of that route compared with alternative routes. The utility U_{ijm} is considered to be a linear function of attributes associated with different port choice factors [Eq. (2)]. For every attribute X_n a corresponding coefficient α_n is used because

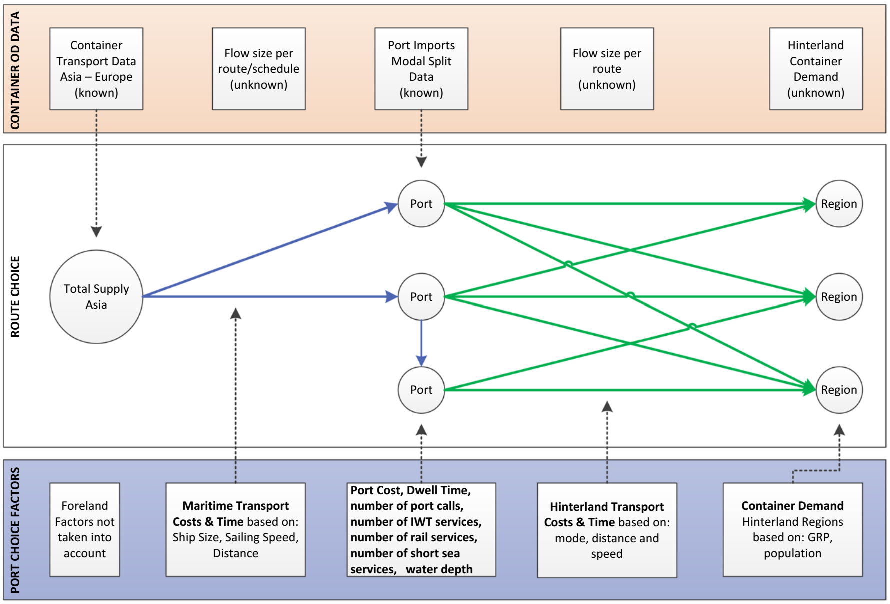

Fig. 2 Conceptualisation of the model. *Source* Mueller (2014)

different attributes contribute differently to the utility. An error term ε represents measurement errors and the unobserved modelling attributes.

$$U_{ijm} = \alpha_1 X_{1(ijm)} + \cdots + \alpha_n X_{n(ijm)} + \varepsilon_{ijm}. \tag{2}$$

The attributes included in the utility function are the 11 factors grouped in maritime, port and hinterland factors (Fig. 2). The corresponding coefficients are unknown and will be determined using statistical analyses.

3.3 Data for port choice factors

Data are necessary to quantify port choice factors. The year 2010 is the base year for which data were collected. In cases where data were not found for 2010, data from other years were used.

Maritime factors Two typical round-trip options for transport between Asia and Europe were identified from carrier schedules of 2010 (Drewry 2011): round-trips calling Asia and North Sea ports (1) and round-trips calling Asia and Mediterranean ports (2). Per round-trip, multiple ports are called in different orders, all of which (un)load a different number of containers. From the available data, it is impossible to determine maritime port transport costs and transport time individually. Maritime costs and transport time are therefore determined per typical round-trip, based on sailing distance, speed and average ship size. If a port has no direct deep-sea connection, then extra feeder and port costs and time are taken into account.

Port factors For port costs, terminal handling charges (THC), International Shipping and Port Facility Security Code (ISPS) and documentation fees per bill of lading (B/L) are considered. Port dues are not taken into account as they differ according to ship size and call size (number of TEUs loaded and unloaded). The THC, ISPS and B/L charges are obtained from different carriers and terminal operators (OOCL 2009; DAL 2012; Maersk 2009; CMACGM 2012; APL 2013; Hapag-Lloyd 2010; MSC 2013; Hapag-Lloyd 2013; Maersk 2013). Per port, an average cost/TEU was found (Table 1). Average dwell times of 6 to 7 days were found from ports in the Hamburg–le Havre range (OECD 2010). For transhipment, dwell times are found to be between 3 and 5 days (Kemme 2013). In this study, an average dwell time of 6 port days is used for all imports and 3 days for transhipment. The number of port calls was extracted from Drewry (2011). The number of inland waterway services,

Table 1 Overview of data availability, variability and sources

Port choice factor	Data availability and variation
Maritime	
1. Cost maritime + feeder	Deep-sea maritime cost is calculated for three coastlines, based on the sailing schedules. An average feeder cost is calculated. The different routes therefore do not vary a lot
2. Time maritime	Deep-sea maritime time is calculated for three coastlines, based on the sailing schedules. An average feeder time is calculated. The different routes therefore do not vary a lot
Port	
3. Cost port	Vary between €86 and €160 per TEU per port
4. Time port dwell	Port dwell time is set to 6 days for all imports and 3 days for transshipment in ports, as reliable data for all the ports could not be found
5. Number of port calls	Vary between 0 and 28 deep-sea ship calls per week. Drewry (2011)
6. Number of IWT services	Vary from 0 to 45 services per week, limited to the North Sea ports (ECORYS 2013)
7. Number of rail services	Vary between 0 and 38 services from ports per week (ECORYS 2013)
8. Number of short sea services	Vary between 2 and 24 services per week for the different ports (ECORYS 2013)
9. Water depth	Vary between 8 and 21 m, with an average of 16 m. (Containerisation International 2011)
Hinterland	
10. Cost hinterland	Large variation for different choices is found [calculated specifically for each of the 2724 alternative routes (NEA 2009)]
11. Time hinterland	Large variation for different choices is found (calculated specifically for each of the 2724 alternative routes[a]) (ETISplus Consortium 2013)

[a]The number of 'theoretical' routes is (31 ports × 231 regions × 3 modes) = 21.483. The number of 'practical' routes used is much smaller. 1—Not all ports and hinterland regions have access to inland waterway infrastructure. 2—Some flows have no containers (i.e. Port of Klaipeda for the region of Athens). 3—A minimum number of TEU per year is necessary for inland barge or rail terminal. 4—Minimum number of TEU for a train and barge service is necessary for a service to be viable. 5—For the regression analysis, the 'basic route' (Antwerp by road) was subtracted from the other routes, therefore lowering the number of total routes. After these steps were taken, 2309 road, 342 rail and 73 IWT routes were left, adding up to 2724 routes (observations) in total

rail services and short sea services was extracted from the inter-modal links database (Ecorys 2013), containing inter-modal container transport services for Europe. The major inter-modal transport service operators are included, and the database is expected to cover over 70% of all scheduled inter-modal services. Water depths were obtained from Containerisation International (2011). In Appendices 1 and 2, an overview is presented of the data used and a screenshot of the OD-matrix is given.

Hinterland factors Hinterland transport costs and times were computed port pairwise and hinterland region. Costs were split into fixed and variable costs/TEU. A distinction was made between modes of transport including road, rail and inland waterway (NEA 2009). Costs for an inland terminal and end haulage were added for inter-modal transport. Transport time is related to the mode and its route. According to the European Transport Information System (ETIS) database, transport times and distances are extracted for each route (ETISplus Consortium 2013).

3.4 Container origin—destination data

To determine utility function coefficients, the model must be compared with actual container OD data. Publicly available OD data for containers and transport mode do not exist in Europe. Therefore, European studies use trade data from EU Comext and UN Comtrade to determine OD patterns (Zondag et al. 2010; Burgess 2008). These data are given in tons and monetary values per pair of countries. From this, the number of containers is typically computed and then distributed over different hinterland regions using simulation algorithms. This is in contrast to the USA, where OD data are gathered using bill of lading information, which is then used for analytical research (Anderson et al. 2009). In this study, a different approach was used. Instead of using trade data, the number of full containers imported from Asia—including containers from Oceania, East Africa and the Middle East that are transhipped in Asian ports—through the Suez Canal to the European mainland, for 2010, were computed. Different available sources (Drewry, UNCTAD, World Shipping, EUROSTAT, ESPO and Containerisation International) were combined, adjusted and harmonised for the specific scope of this study. This was done by making corrections to the different datasets for empty containers, transhipment and the geographical scope (mainland Europe). This way, it was calculated that approximately 12.5 million TEUs were imported in 2010. This container flow was chosen based on its relatively large volumes, making it normative for the required maritime transport capacity.

The port imports were found using container port import data. Transhipment and empty containers were subtracted from this number so that only full imported containers were counted. Total port imports were then scaled to the total flow of containers from Asia. This was necessary, as the total supply of containers should be equal to the total number of imported containers. Using modal split data from port statistics, the number of TEUs/mode/port was calculated ("Appendix 1"). The number of containers was then allocated to the different NUTS-2 hinterland regions based on gross regional product (GRP) and GRP/capita, as these have been found to be the dominant factors in trade (Hausman et al. 2005). Based on these data, an

OD-matrix was generated ("Appendix 2") using a double constraint distribution model, also known as *bi-proportional fitting* or as a gravity based distribution model (Ortuzar and Willumsen 2011). First, a base OD-matrix was constructed using a distribution function with a calibrated parameter $\beta = 0.007$. Secondly, the base OD-matrix was iteratively balanced by equalising the constraints of the matrix.

3.5 Linearisation of the multinomial logit model

Using statistical analysis, the port choice factors that significantly influence utility differences observed can be found. As a result, their corresponding coefficients are quantified.

Based on the OD-matrix, the statistical analysis was performed using a multivariate regression model. The logit function has the property of independence from irrelevant alternatives (IIA), which means that the ratio or probability of any two alternatives is entirely unaffected by the systematic utilities of any other alternative (Ben-Akiva and Lerman 1985). The IIA property is considered to be controversial, as it assumes that all alternatives are independent of each other. To test the shortcomings of the multinomial logit model, different analyses were done while interpreting the results. These included 'nesting' coastlines and modes to see the effects on different subsets of the data. Another controversial part of the IIA property is that the ratio between alternatives changes when an (irrelevant) alternative is added or dismissed in the model. In this study, all alternatives are constantly considered during the modelling. This means that the model structure is not changed, thus the ratio between the alternatives does not change either. As this model does not research the impact of adding or dismissing an alternative route, the IIA property is not violated. Oum (1989) estimated the coefficients of the differences in attributes using linear regression for aggregated inter-regional freight flows in Canada. For each hinterland region, the market share of each alternative route was calculated by dividing the number of containers on a certain route by the total demand for containers of that region. When the market shares of all routes for a region are found, their corresponding utilities (U_{ijm}) can be determined from the multinomial logit function.

If all routes to a hinterland region j are compared with a basic route to that region, then by using the IIA property, Eq. (3) can be created. This is called the Berkson–Theil method (Ben-Akiva and Lerman 1985).

$$Ln\left(\frac{P_{ijm}}{P_{\text{basic}}}\right) = \Delta U = U_{ijm} - U_{\text{basic}} = \alpha_n \left(X_{n(ijm)} - X_{n(\text{basic})}\right). \tag{3}$$

The dependent variable used in the regression analysis was ΔU. The route from the port of Antwerp to the different hinterland regions by truck was considered as the basic route, with its corresponding utility (U_{basic}). As all routes are compared with the basic route, it is important that the utility of the latter is reliable and accurate. First, the port of Antwerp seems to be among those with the most reliable data. Secondly, Antwerp is a port with a large hinterland, so it is assumed representative as a basic route for the hinterland regions. This is important, because a basic route must be used for all hinterland routes. The independent variables, X_n, are the different port choice attributes, which have a linear and functional relationship in the utility function U_{ijm}. The goal is to find which port choice factors significantly influence the utility differences and dependent variables ΔU, and by how much.

3.6 Regression estimates of port choice factors

A sample size of 2724 routes was used. Outliers, found when the standardised value of a variable was ± 3 times the standard deviation, were dismissed. The observations (routes) were weighted with the number of TEUs for that observation. This way, the limited numbers of IWT and rail flows, which have large volumes due to consolidation, are taken into account proportionally to their flow size.

During the regression analyses, a stepwise estimation method was used, which consecutively introduced the factor with the highest correlation to the dependent variable. Multiple methods were tested, including stepwise estimation, forward addition, backward elimination and manually chosen variable combinations, as the order of entrance of the variables may cut off certain combinations amongst them. The forward addition model is similar to the stepwise procedure in that it builds the regression equation starting with a single independent variable, whereas the backward elimination procedure starts with a regression equation including all the independent variables and then removes independent variables that do not contribute significantly (Hair et al. 2014). From the different methods, the stepwise method gave the best result, according to the adjusted R^2, the number of significant variables included and the variance inflation factor (VIF). Whenever a regression coefficient sign of an attribute was different, compared with the hypothesis found in literature, or rational decision-making behaviour was lacking, the attribute was discarded. Collinearity was considered using the VIF, the inverse of the tolerance. Whenever the VIF value was higher than five, the last variable introduced in the regression was removed. Also, the sample was split into two to validate the regression results. Regression results are presented in eight steps to show which factors contributed to the model fit. Model fit was measured by R^2. Values in Table 2 are unstandardised beta values: P values are given in brackets.

The first regression step used the *route* variables 'total cost' and 'total time'. These variables were found to be significant and had a negative sign as expected. This means that if the cost or the time for a route increases, the utility of that route decreases. The adjusted R^2 for this step was 0.796, which means that 79.6% of the model variance can be explained by just these two variables. In the second step, the variables 'total cost' and 'total time' were split into the variables 'maritime cost', 'port cost', 'hinterland cost', 'maritime time', 'port dwell time' and 'hinterland time'. This resulted in a higher adjusted R^2 of 0.838. However, for the variables 'port cost', 'maritime time' and 'port dwell time', the sign was wrong; i.e. positive instead of negative.

Port dwell time was set to 6 days for all ports, as more reliable data or data for all the ports could not be obtained. The variable thus acted as a constant and it was discarded. Port costs are largely determined by terminal handling charges and do not include port dues. Our data showed that larger ports charge higher THCs than

Table 2 Regression results. *Source* Mueller (2014)

Step	1	2	3	4	5	6	7	8
Total costs	−0.005 (0.000)							
Cost hinterland		−0.005 (0.000)	−0.005 (0.000)	−0.005 (0.000)	−0.005 (0.000)	−0.005 (0.000)	−0.005 (0.000)	−0.005 (0.000)
Cost maritime + feeder		−0.091 (0.000)	−0.029 (0.000)	−0.027 (0.000)	−0.027 (0.000)	−0.026 (0.000)	−0.024 (0.000)	−0.027 (0.000)
Cost port		0.011 (0.000)						
Total time	−0.043 (0.000)							
Time hinterland		−0.190 (0.000)	−0.152 (0.000)	−0.206 (0.000)	−0.211 (0.000)	−0.206 (0.000)	−0.255 (0.000)	−0.151 (0.000)
Time maritime		0.189 (0.000)						
Time port dwell		1.134 (0.000)						
Number of port calls				0.024 (0.000)	0.032 (0.000)	0.025 (0.000)	−0.026 (0.000)	0.025 (0.000)
Number of IWT services					0.006 (0.010)	−0.003 (0.353)		
Number of rail services					−0.022 (0.000)			
Number of short sea services						−0.001 (0.919)		
Water depth							0.364 (0.000)	
Dummy rail								−0.612 (0.000)
Adjusted R^2	0.796	0.838	0.820	0.823	0.825	0.823	0.843	**0.826**

P values in brackets ()

Bold indicates the selected model

smaller ones. This could explain the positive relationship found in the regression results. However, as higher costs could not lead to higher utility, given comparable service levels, the variable was dropped.

Data for the *maritime costs* and *time* variables vary only slightly for each port, as they are calculated for each coastline. Due to the different carrier schedules and different utility rates of the ships during their voyage, it was impossible to calculate different maritime costs and time components for each port. Therefore, average maritime costs and time were modelled per coastline, and for feeder ports, an average cost and time component was added; together they formed the *maritime component*. As the *sailing time* variable had a positive coefficient, instead of the presumed negative influence on utility, this variable was dropped too from the regression analysis.

For the *hinterland costs* and *time* variables, a large variation among the different choices was found, as these were calculated specifically for each of the 2724 alternative routes. Due to the fact that there are more hinterland routes than maritime routes and ports, the analysis seemed to be more reliable, as more and more detailed 'observations' for the hinterland component are available. The third step included the variables of step two, which had a negative sign. When only these variables were used, an adjusted R^2 of 0.820 was found, higher than 0.796 of step one. This suggests that the variables 'maritime cost', 'hinterland cost' and 'hinterland time' increased model fit. The coefficient for 'maritime costs' has a larger effect on utility than that of 'hinterland costs' (0.027 versus 0.005). This has partly to do with the *maritime cost* variable, which includes both the deep-sea and feeder component. Therefore, feeder ports, which can only be reached by a feeder ship, as hypothesised, are compared with hub ports, which can be reached by ocean carriers. A dummy variable for feeder ports was used to analyse this effect. A negative coefficient was found, suggesting that feeder ports are less favourable in practice as they are in our model. However, adding the feeder 'dummy' resulted in 'maritime costs' being no longer significant, and the R^2 decreased. Therefore, the 'feeder' dummy was not included in the model. This implied that the coefficient for *maritime costs* was larger than that of hinterland costs.

In steps four to seven, port service variables were introduced. In step four, the 'number of port calls' was investigated. This variable includes the number of direct port calls from ocean vessels, and it is assumed to positively influence utility and model fit. In step five, the variables 'number of IWT services' and 'number of rail services' were added. The latter variable had a negative sign, indicating that if the number of rail services in a port increases, the port's utility decreases. The variable was thus discarded (Veldman 2011).

In step six, the variable 'number of short sea services' was introduced. This variable indicates the number of short sea connections a port has. The variable was found to be insignificant (p value was much higher than that of the 0.05 significance level). Also, the variable 'number of IWT services' had a P value higher than 0.05. These two variables were therefore dismissed from further regression steps.

The variable 'water depth' was added to the regression in step seven. In general, this variable indicates the maximum available water depth of a port available for container terminals. The variable had a positive influence on utility and model fit, with an adjusted R^2 of 0.843. However, the variable 'number of port calls' switched from a positive to negative sign. Based on the quality of the available data and its explanatory power, the variable ‘number of port calls’ was considered to be a more reliable variable than ‘water depth’. Therefore, in the following regression steps, the variable ‘water depth’ was disregarded.

In the final eighth step, mode specific dummy variables were tested. All modes were included in the regression. However, as most cargo is carried by truck, the results may be biased, as the number of truck services is considered unlimited. To determine whether rail and IWT are different from road, a dummy variable was used for these two modes. For the dummy IWT, no significant contribution was found. For the variable ‘dummy rail’, a significant negative coefficient was found, indicating that rail transport is not popular. The ‘dummy rail’ states that, when rail transport is used as a hinterland transport mode (actual use), that alternative gets a negative utility attached to it. According to the data used, rail is competitive with road transport on certain routes, given transport costs and time. Negative alternative constants for rail transport for port choice are also found by Nugroho et al. (2016). The negative dummy variable could be explained by other factors (besides cost and time) that have a negative effect on the hinterland mode *rail*. These factors could include service and quality, but also the administrative, technical and regulatory obstacles present in the EU rail sector (EC 2013). Findings regarding this dummy variable should be treated with caution, as data imperfections may influence model accuracy.

Interpreting regression results should be done sensibly and carefully, as imperfections in data need to be taken into account. Although step two and seven have a high R^2 value, taking the model fit and the interpretation of the variables into account, the regression analysis of step eight appears to be the most appropriate. This analysis has a reasonable model fit of 0.826 and includes the variables that seem to best represent the decision-making process of the decision-makers: maritime transport cost, hinterland transport cost, hinterland transport time and number of port calls. This is along the lines found in scientific literature, where also cost and (reliability of) time are often found to be important decision-making variables (Danielis and Marcucci 2007; Wiegmans et al. 2008; Feo-Valero et al. 2011). Maritime costs form an important part of total costs and might therefore be expected to be a significant variable influencing port choice. Maritime transport time (not included as variable) had a positive coefficient, suggesting that longer maritime transport time leads to higher utility, which appears to be strange. However, this result might be caused by the assumptions made for this variable, and thus, the result should be treated carefully. First, total transport time between Asia and Europe is approximately 25–30 days; therefore, a number of hours less or more might not be so decisive. Secondly, slow steaming has become standard in ocean shipping (Cariou 2011), resulting in increased maritime transport time. This might lead to a decrease in the importance of the maritime transport time factor in overall port choice.

Port costs and dwell times were found to positively influence utility. The observed positive correlation of the variable ‘port cost’ could indicate that a more popular port (higher utility) is faced with higher demand, as more ships are likely to call that port. An explanation could be that higher THCs are found in the North Sea area, where labour costs are higher, yet ports in this region are popular as well. A second explanation could be that ports that are more expensive are also more reliable and efficient, leading to higher utility. Because it is not known why higher port costs are associated with higher port utility, port costs are not useful as an independent variable. Port dwell times used in this study were assumed similar for every port, because detailed data for each port or terminal were not available. Therefore, the variable ‘dwell time’ acted as a constant in the regression, and its meaning should be ignored. The number of direct port calls from deep-sea services had a positive effect on utility. This means that, if a port attracts more deep-sea services, its utility increases. This increased utility could be the result of more service connections with more ports; a higher frequency of services (leading to increased reliability) and more port calls might lead to the attraction of flows to the port outside its captive hinterland. The Mohring effect might also be expected for the hinterland transport services of IWT, rail and short sea. However, our regression results did not support this effect. The factors ‘number of IWT services’ and ‘number of short sea services’ were not found to be significant, and for the *number of rail services*, even a negative coefficient was found. In many Northern European ports, inland waterway services are quite important, leading to a relatively lower importance of rail. In Southern European ports, rail transport is much more important, as most ports lack an inland waterway infrastructure. Overall, these port differences might result in a diffuse picture for these services.

Hinterland transport costs were highly significant in all regressions, with a stable coefficient of −0.005; i.e. for every €1 increase in hinterland costs, *utility* decreases by 0.005. For every extra day of hinterland transport, *utility* decreases by 0.151. Dividing the coefficient for hinterland time by that for hinterland cost allowed to compute the *value of time* for hinterland transport. To this end, a value of €30/TEU/day was found. When the value of time for the total transport was computed, a value of €9/TEU/day was found. These values are quite low but plausible, as values of time are found to be between €12 and €96/TEU/day (RETRACK 2012), and €39/TEU/day when considering high-value products [nomenclature uniforme des marchandises pour les statistiques de transport (NSTR) goods category 9] (TML 2010). The fact that the hinterland value of time is larger than the total value of time (including maritime transport time) is in line with literature (CPB 2004), in which time of maritime transport is valued lower than hinterland transport time. This is also in line with the earlier results of the model regarding the decrease of the importance of maritime transport time in overall port choice.

3.7 Our port choice model

The utility function is produced from regression analysis results. The port choice factors found in step eight (Table 2) are included in the utility function with their corresponding coefficients [Eq. (4)]. These include hinterland costs HC_{ijm}, maritime costs MC_i, hinterland transport time HT_{ijm}, number of weekly port calls of deep sea vessels PC_i and a dummy for rail transport DR_m.

$$U_{ijm} = -0.005 \times HC_{\mathrm{ijm}} - 0.027 \times \mathrm{M}C_i - 0.151 \times HT_{ijm} + 0.025 \times PC_i - 0.612 \times DR_m \tag{4}$$

The new utility function can be used within the multinomial logit function [Eq. (1)], which can then be used in the prediction model. The goal of the latter model is to determine the number of TEUs imported from Asia for a particular port. This is referred to as *total import* TI_i and was obtained by multiplying the market share of a port P_{ijm} on a specific route i with the demand of that specific hinterland region D_j [Eq. (5)].

$$TI_i = \sum_{m=1}^{3} \sum_{j=1}^{231} \left(P_{ijm} \times D_j\right). \tag{5}$$

4 Model results and case study outcome

4.1 Basic outcomes of the port choice model

The port choice model calculates the number of imported containers from Asia for the different European ports using the prediction model [Eq. (5)] and the utility functions with the estimated coefficients [Eq. (4)]. The performance of the port choice model was tested by comparing the modelled total port imports and modal split with actual port import and modal split data from port statistics. An R^2 value of 0.77 was obtained, meaning that 77% of the variance in container imports is explained by the model. The value is different from the R^2 value found in the regression analysis (0.826), because now $n=31$ (for the 31 ports used in the study), whereas the regression analysis was based on $n=2724$ (the number of routes). The sensitivity of the model was tested using a case study in which oil prices varied, and their impact on geographical hinterlands was analysed.

4.2 Case study: changing oil price and its impacts on the geographical hinterlands

Fuel costs are a major component of total transportation costs, both for maritime and hinterland transportation (Zhang et al. 2013). Fuel costs depend on oil prices, which are rather difficult to predict. The US Energy Information Administration has made projections for the development of future Brent crude oil prices (EIA 2011). Based on these projections, five different oil prices per barrel are considered: US \$50, US \$100, US \$150, US \$200 and US \$250, which are used as input to the model. For the different transport modes, variable costs associated with fuel costs vary, and so do total costs. The change in cost due to an increase in the oil price from US \$100 to US \$200, for the different transport modes, is given in Table 3. By using the outcomes of the port choice model, a quantitative indication of how port hinterlands are impacted can be obtained.

Table 3 Transport mode cost overview for different oil prices. *Source* NEA (2009), TML (2010), ETIS-plus Consortium (2013), Wiegmans and Konings (2015), Rodrigue et al. (2009), Notteboom and Vernimmen (2009) and Veldman (2011)

Mode	Total fixed cost (€/TEU)	Total variable cost (€/TEU)	Average end-haulage/transshipment cost (€/TEU)	Average speed (km/h)	Total costs (€/TEU)
Deep sea (8500 TEU)					
Asia–North Sea					
US $100	221 (67%)[a]	112 (33%)[b]	–	31	333
US $200	221 (50%)[a]	224 (50%)[b]			445 (+112)
Deep sea (6600 TEU)					
Asia–Med.					
US $100	212 (67%)[a]	106 (33%)[b]	–	31	318
US $200	212 (50%)[a]	212 (50%)[b]			423 (+105)
Feeder (400 TEU)					
US $100 (500 nm)	33 (17%)	40 (20%)	124 (63%)	31	197
US $200	33 (14%)	44 (34%)	124 (52%)		237 (+40)
Truck (road) (1.6 TEU)					
US $100 (500 km)	256 (58%)	189 (42%)	–	55	445
US $200	256 (40%)	378 (60%)			634 (+189)
Train (rail) (82 TEU)					
US $100 (500 km)	276 (67%)	61 (15%)	74 (18%)	35	411
US $200	276 (57%)	123 (25%)	89 (18%)		487 (+76)
Barge (IWT) (200 TEU)					
US $100 (500 km)	165 (52%)	42 (13%)	109 (34%)	8	317
US $200	165 (42%)	85 (22%)	139 (36%)		389 (+72)

[a]The fixed costs (time dependent) consist of maintenance, manning, overhead and capital costs. Capital costs depend on vessel size

[b]The variable costs (distance dependent) consist of the fuel cost, which depend on fuel price and fuel consumption. Fuel consumption depends on sailing speed and vessel size

4.3 The impact of oil price changes on modal split of hinterland transport

The three hinterland modes have different cost structures, and changes in oil prices will thus have different impacts on total transport costs and on the resulting cost/TEU. This results in a change in modal split (Fig. 3), because costs/TEU increase relatively less for IWT and rail. When oil prices increase, the use of road transport is estimated to decrease (from 68% to 43%), while rail and IWT will both increase their market shares. This is because fuel costs form a larger share of total transport costs/TEU for road transport than they do for rail and IWT (Table 3). The model uses the absolute total transport costs, therefore the

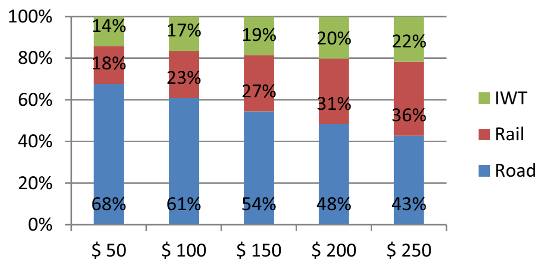

Fig. 3 Modal split for different oil prices in the European mainland. *Source* Mueller (2014)

absolute change in costs is shown. It is assumed that all ports have access to road and rail infrastructure.

4.4 Impact of oil price changes on hinterland transport distance

With an increase in oil price, the modal shift changes in favour of IWT and rail. It is expected that ports that can offer IWT have an advantage over others that cannot, and they therefore benefit from higher oil prices. However, from the results of the model, no resulting shift of containers to the former ports is observed. Modal shift does not affect the total throughput of ports. The main reason for this is that, due to higher oil prices, especially road transport becomes (relatively) more expensive. Shorter routes become more attractive, as the cost for these routes is lower than for lengthier ones. In other words, when oil prices increase, variable transport costs increase too, making it more attractive to choose a port that is relatively close by. The average transport distance for road transport drops by 15% when oil prices increase from US $100 to US $200 (Table 4). For rail and IWT, this change in average distance is not seen. The increase in share of these modes, for higher oil prices, does not affect their average distance. This means that their share increases proportionally in all hinterland areas (routes) where they already have a market share, both in the vicinity of a port and further away, and no new hinterland areas are tapped. This could be explained as the availability of infrastructure for rail and IWT is a constraint, and not all hinterland regions have access to inland waterways. When hinterland distances for road transport drop, the competitive hinterland for road transport becomes smaller, as more containers will travel to a destination using the shortest routes available, which is usually within a port's natural hinterland (Fig. 4).

Table 4 Weighted average transport distance/TEU in km for different oil prices. *Source* Mueller (2014)

Oil price ($)	Road	Rail	IWT	Total
US 50	467	593	537	499
US 100	417	594	553	479
US 150	381	594	563	472
US 200	354	593	566	471
US 250	331	589	566	472

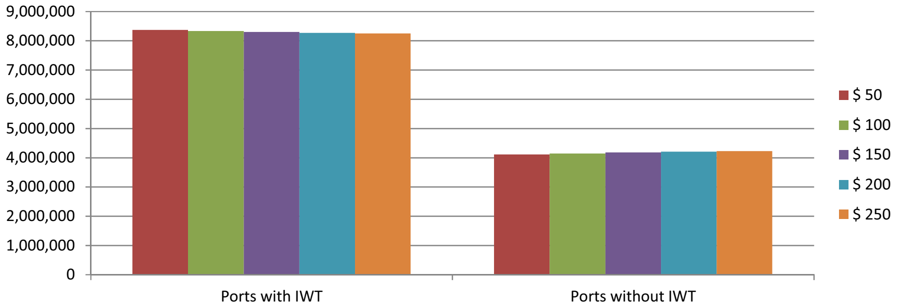

Fig. 4 Total TEU imports to ports with and without IWT connection for different oil prices. *Source* Mueller (2014)

5 Conclusions

This study focusses on the development of a new port choice model to model container imports from Asia to Europe. The model analyses the effects of global trends and thereby provides input to possible policy changes (e.g. for modal split changes, hinterland transport and the use of short sea shipping). The model can be applied to determine the impact of investments in infrastructure and shipping trends, and it provides input to policy changes by governments, such as taxation of CO_2 emissions or new International Maritime Organization (IMO) regulations, by indicating the expected results of intended policy interventions.

The important position of port hinterlands in port choice research motivated this study into the geography of port choice. Often, port choice focusses on the deep-sea part and the port of call only after the deep-sea voyage. However, in addition, terminal selection inside ports, port hinterland strategies, hinterland corridor efficiency and inland port operations form important determinants of port choice and deserve a more prominent position in port choice literature. This paper, therefore, presents a new model, showing the sensitivity of containerised imports to changes in the hinterland strategies of ports. Initially, 11 port choice factors were used and their statistical significance and associated weights were analysed. This resulted in five significant port choice factors that gave the best model fit: (1) hinterland transport costs, (2) maritime transport costs, (3) hinterland transport time, (4) number of port calls and (5) a negative dummy variable for rail transport. Hinterland transport cost was found to be the most important factor; an increasing number of port calls had a positive effect on port attractiveness, whereas the use of rail transport had a negative effect on attractiveness. Although the statistical significance of these factors was based on a constructed OD-matrix, the model explains 77% of the variance in container imports. With these five factors used as input to the logit model, the impact of changing oil prices on port hinterlands was modelled. It is interesting to see that a rise in fuel costs for road transport reduces road transport without influencing the competitive positions of ports (if implemented on a European scale).

It was shown that oil prices have a direct influence on transport costs, but the relative influence is different depending on mode. An increase in oil price changes the modal split of the hinterland transport modes: transport by road becomes less attractive, while transport by rail and inland waterways becomes more attractive due to scale economies. This means that rail and IWT do not appear to offer significant competitive advantages over road transport other than offering a lower transport cost. Secondly, after price increases, it seems that the average hinterland transport distance for road transport will start to decrease, whilst the demand per hinterland region is still met.

Recommendations for future research and model improvements include the use of additional port choice factors such as port reliability, port efficiency and port services, which could further increase the model's accuracy. Initially, from the literature review, these factors appear to be important, however, proved difficult to quantify up to now. However, given their importance, future research needs to find a way to include these factors based on data. The model can also be expanded to include both port imports and exports, as well as container transport from other parts of the world besides Asia. This could increase the applicability of the model. In addition, the quality and the availability of data to be used in the model could be further improved, leading to more detailed and reliable results on the weights and impacts of the respective variables.

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Appendix 1: Table with port data

Port	Water depth (m)	Number of port calls (per week)	Number of hinterland rail services	Number of hinterland IWT services	Number of short sea services	Port cost (€/TEU)	Modal split road (%)	Modal split rail (%)	Modal split IWT (%)	Port import scope (TEU)
Antwerp	16	13	38	33	19	131	56	11	33	1,805,057
Zeebrugge	16	5	24	0	11	131	55	44	1	497,468
Varna	8	0	0	0	0	125	100	0	0	33,715
Bremen	16	8	19	0	10	160	51	45	4	1,076,466
Hamburg	16.5	26	38	6	21	160	62	36	2	1,833,445
Talinn	14.5	0	0	0	3	101	99	1	0	43,164
Bilbao	21	0	0	0	10	129	99	1	0	127,675
Barcelona	16	8	3	0	7	133	92	8	0	406,852
Valencia	16	9	8	0	5	133	80	20	0	910,115
Algeciras	18.5	5	0	0	5	133	99	1	0	182,046

Port	Water depth (m)	Number of port calls (per week)	Number of hinterland rail services	Number of hinterland IWT services	Number of short sea services	Port cost (€/TEU)	Modal split road (%)	Modal split rail (%)	Modal split IWT (%)	Port import scope (TEU)
Le Havre	15.5	13	16	2	4	142	87	6	7	536,715
Marseille	14.5	7	32	0	7	145	82	12	6	212,149
Thessaloniki	15	0	0	0	6	100	99	1	0	76,548
Pireaus	18	2	0	0	9	104	99	1	0	123,698
Rijeka	10.5	1	0	0	4	124	90	10	0	29,843
Genova/Le Spezia	15	11	3	0	10	127	75	25	0	629,479
Venezia	10.5	1	1	0	6	129	97	3	0	73,796
Triest	17.5	2	11	0	4	129	60	40	0	61,340
Livorno	13	1	0	0	4	129	100	0	0	120,570
Napoli	9	1	0	0	4	129	100	0	0	118,994
Taranto	15	1	0	0	6	129	100	0	0	36,731
Gioia Tauro	16	3	0	0	2	129	100	0	0	179,966
Klaipeda	12.5	0	0	0	9	86	75	25	0	83,776
Riga	12	0	0	0	4	97	99	1	0	82,649
Rotterdam	19.5	28	37	45	24	148	57	10	33	2,511,095
Gdansk/Gdynia	16.5	1	5	0	16	79	60	40	0	163,011
Leixoes	12	0	2	0	13	120	95	5	0	127,614
Lisboa	14	0	2	0	8	120	95	5	0	119,190
Sines	17.5	1	0	0	0	120	95	5	0	83,203
Constanta	15.5	4	0	0	2	94	48	47	5	121,224

Port	Water depth (m)	Number of port calls (per week)	Number of hinterland rail services	Number of hinterland IWT services	Number of short sea services	Port cost (€/TEU)	Modal split road (%)	Modal split rail (%)	Modal split IWT (%)	Port import scope (TEU)
Koper	11.5	2	4	0	3	114	40	60	0	135,407

Appendix 2: Screenshot of OD-matrix

Hinterland region				Antwerp			Zeebrugge		
Country	NUTS code	ETIS code	NUTS-2 region	Road	Rail	IWT	Road	Rail	IWT
Austria	AT	1010000							
	AT11	1010101	Burgenland (AT)	22.6	763.8	1353.3	7.4	367.1	60.4
	AT12	1010102	Niederösterreich	211.5	2972.2	4571.2	69.3	1428.7	236.7
	AT13	1010103	Wien	103.0	3277.3	6663.2	33.9	1575.7	327.9
	AT21	1010201	Kärnten	58.5	757.3	0.0	21.2	364.1	0.0
	AT22	1010202	Steiermark	216.5	2176.7	0.0	69.1	1046.4	0.0
	AT31	1010301	Oberösterreich	586.3	3524.9	5356.6	197.1	1693.9	367.5
	AT32	1010302	Salzburg	248.8	1949.2	0.0	90.1	937.5	0.0
	AT33	1010303	Tirol	512.8	1786.3	0.0	195.4	858.8	0.0
	AT34	1010304	Vorarlberg	682.9	1933.8	0.0	329.5	929.3	0.0

Hinterland region				Antwerp			Zeebrugge		
Country	NUTS code	ETIS code	NUTS-2 region	Road	Rail	IWT	Road	Rail	IWT
Belgium	BE	1020000							
	BE10	1020100	Région de Bruxelles-Capitale	10969.8	3445.1	11452.6	6235.0	2155.4	3937.1
	BE21	1020201	Prov. Antwerpen	15422.9	3808.7	10457.1	6576.7	2005.6	3873.8
	BE22	1020202	Prov. Limburg (BE)	8254.9	2329.8	5864.4	2772.2	1101.5	1363.4
	BE23	1020203	Prov. Oost-Vlaanderen	10200.6	2728.5	7745.0	8662.7	2192.6	4204.0
	BE24	1020204	Prov. Vlaams-Brabant	10588.7	2744.5	7307.7	5454.3	1702.6	2536.8
	BE25	1020205	Prov. West-Vlaanderen	6135.8	1983.9	5906.6	10973.6	2396.9	5931.5
	BE31	1020301	Prov. Brabant Wallon	5249.7	1668.6	4629.1	2669.8	1038.8	1800.1
	BE32	1020302	Prov. Hainaut	9440.1	2832.2	5474.4	9084.0	2334.8	3233.8
	BE33	1020303	Prov. Liège	9573.5	2966.3	6270.5	3885.1	1632.9	2033.6
	BE34	1020304	Prov. Luxembourg (BE)	6502.9	2242.4	0.0	3140.4	1352.8	0.0
	BE35	1020305	Prov. Namur	6968.7	1909.7	2547.2	3760.8	1188.6	1020.6
Bulgaria	BG	1030000							
	BG31	1030301	Severozapaden	0.0	0.0	0.7	0.0	0.0	0.0
	BG32	1030302	Severen tsentralen	0.0	0.0	0.2	0.0	0.0	0.0
	BG33	1030303	Severoiztochen	0.0	0.0	0.0	0.0	0.0	0.0
	BG34	1030304	Yugoiztochen	0.0	0.1	0.0	0.0	0.1	0.0
	BG41	1030401	Yugozapaden	0.0	2.0	0.0	0.0	1.0	0.0
	BG42	1030402	Yuzhen tsentralen	0.0	0.4	0.0	0.0	0.2	0.0

Hinterland region			Varna			Bremen		
Country	NUTS code	ETIS code	Road	Rail	IWT	Road	Rail	IWT
Austria	AT	1010000						
	AT11	1010101	1.4	1.2	0.0	101.7	1161.0	46.3
	AT12	1010102	2.3	2.2	0.0	762.3	4516.5	181.7
	AT13	1010103	2.6	3.3	0.0	508.1	4985.4	251.6
	AT21	1010201	0.1	0.3	0.0	55.9	1073.1	0.0
	AT22	1010202	1.3	1.4	0.0	213.4	3307.2	0.0
	AT31	1010301	0.2	0.5	0.0	551.4	5355.9	281.9
	AT32	1010302	0.1	0.2	0.0	262.8	2671.1	0.0
	AT33	1010303	0.0	0.1	0.0	343.4	1977.7	0.0
	AT34	1010304	0.0	0.0	0.0	216.2	1463.3	0.0
Belgium	BE	1020000						
	BE10	1020100	0.0	0.0	0.0	223.1	302.3	509.9
	BE21	1020201	0.0	0.0	0.0	400.0	422.5	540.3
	BE22	1020202	0.0	0.0	0.0	389.4	359.0	328.9
	BE23	1020203	0.0	0.0	0.0	221.1	245.7	383.2
	BE24	1020204	0.0	0.0	0.0	211.0	238.5	281.9
	BE25	1020205	0.0	0.0	0.0	133.9	179.1	263.0
	BE31	1020301	0.0	0.0	0.0	95.6	145.7	233.1
	BE32	1020302	0.0	0.0	0.0	197.1	257.5	298.2
	BE33	1020303	0.0	0.0	0.0	498.5	593.3	452.8
	BE34	1020304	0.0	0.0	0.0	296.7	381.8	0.0
	BE35	1020305	0.0	0.0	0.0	186.2	251.4	157.5
Bulgaria	BG	1030000						
	BG31	1030301	75.4	29.2	0.0	0.0	0.1	0.0
	BG32	1030302	170.8	35.9	0.0	0.0	0.0	0.0
	BG33	1030303	787.5	199.2	0.0	0.0	0.0	0.0
	BG34	1030304	1122.0	271.5	0.0	0.0	0.2	0.0
	BG41	1030401	715.4	255.7	0.0	0.1	3.0	0.0
	BG42	1030402	811.1	243.9	0.0	0.0	0.7	0.0

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