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A combined approach to forecast container throughput demand: Scenarios for the Hamburg-Le Havre range of ports

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ABSTRACT

The decision to provide new or additional capacities in the ports is challenging since it should be supported by a growing demand, which require modelling and forecasting the demand of container throughput. This paper develops an instrument which assists the ports' infrastructure investment-decision-making. A three-step approach is developed by combining the autoregressive distributed lag model with economic scenarios to capture the potential impact of specific risks. The empirical analysis is based on an annual time series (1995–2017) for the total container throughput measured in twenty-foot equivalent units for the main ports within the Hamburg-Le Havre (H-LH) range and a number of economic indices. The study shows that there exists a long-run relationship between the trade indices of EU19 and the total container throughput. The empirical model estimates that the elasticity of the container throughput in the H-LH range to trade indices is about 1.4 on average, and it shows that the moment at which congestion emerges depends strongly on the specific scenario considered.

1. Introduction

Port capacity, that reflects the supply side, plays a crucial role in the port's competitive position and the maritime supply chain in order to meet the growing demand, avoid congestion, and hence, decrease the cost and time lost at the port and increase productivity. In addition, port capacity is of importance to the maritime sector stakeholders: the shipping lines, port authority, shippers, terminal operators, the hinterland transport companies, importers and exporters, and the banking sector that finances maritime projects. In the context of this paper, capacity is defined in terms of 'the terminal commercial capacity' that is the maximum throughput that can be attained to avoid congestion. Maximum throughput corresponds with an average berth occupancy rate of around 65% (Drewry, 2010, p. 41). The demand side is determined by socio-economic factors and the market share that reflects the port's competitive position and strategic alliances. The decision to make new investments is a complex issue: both overcapacity or undercapacity causes problems. On the one hand, undercapacity of the port infrastructure can cause logistics bottlenecks, loss of port's market share and put a constraint on growth (Brooks et al., 2014). On the other hand, overcapacity is a consequence of unnecessary investments that lead to higher costs. Meersman and Van de Voorde (2014) emphasised the importance of studying the trade-off between the costs and benefits of excess capacity and related funding. Therefore, port authorities, terminal operators and financial institutions rely on long-

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term demand forecasts to support their decisions for port infrastructure projects and avoid unneeded costly over-investment.

Ortúzar and Willumsen (2011) emphasised the important role of modelling in the transport planning process; however, modelling and forecasting maritime freight transport demand at the port level is a complex and challenging process for the following reasons:

- The fact that transport service is a *derived demand* from the need of various goods in different locations of infinite economic activities. Moreover, the correlation between the maritime sector and the social and macroeconomic trends is changing over time as a result of, among others, shifts in global and regional maritime transport patterns along different trade routes. However, empirical evidence showed that the relationship is still coupled (Meersman and Van de Voorde, 2005; Zondag et al., 2010). This relationship is emphasized since the maritime sector slowed down as a result of the financial crisis in 2008.
- The ports' handling of different types of cargo which have different determinants and market forces.
- The numerous decision-makers, stakeholders and market players involved in the port sector, such as port authorities, shipping lines, terminal operators, shipowners, shippers and investors add another dimension to the complexity of modelling since their relationships are intertwined and correlated.
- The changes in the liner shipping market: the changes in the market structure by forming different alliances by the terminal operators and the technological changes like the introduction of mega container ships.

The objective of this paper is to develop an instrument which can assist stakeholders involved in the ports infrastructure investment-decision-making process. The quantified model forecasts the container throughput, with an application to the Hamburg-Le Havre (H-LH) range of ports. This approach is based on the assumption that the main driver of seaport activity is maritime trade, which is driven by evolutions in economic activity and international trade (Meersman, 2009). However, container throughput is not only related to the economic activity, but also to other dynamic factors such as the port's competitive position, logistics services provided and hinterland connectivity.

The main research question is: *how will the aggregate container throughput in the Hamburg-Le Havre range develop until 2050 under different scenarios?* This is followed by an application to the port level; where the container throughput at the port of Antwerp is forecast until 2050 under different market share scenarios. That implicitly provides insight about the question *how much capacity developments are needed in the future?* To tackle these questions, a three-step approach is developed to overcome the complexity of modelling the container throughput at the port of Antwerp within the Hamburg-Le Havre range of ports.

The first step is applying an autoregressive distributed lag (ARDL) model. This causal model type is useful to test for a cointegration relationship and to quantify the short-run and the long-run dynamic interactions. The ARDL model depends on understanding the past developments and building a structural model that estimates the causal relationships among the variables.

The second step is developing different scenarios for the likely future evolution of the variables used in the models, where the goal of scenario planning is not predicting the future, but rather seeing the differences in future evolutions under certain conditions (Chermack et al., 2001).

The third step is combining the outcome of the estimated relationship in step one and the scenario analysis in step two to assess the impact of different economic courses of action on the container throughput for the Hamburg-Le Havre range of ports. Then, the port of Antwerp container throughput is estimated based on different scenarios for the growth rates of the Antwerp port market share. The market share of the port accounts for the qualitative factors such as the port's competitive position, the connectivity of the port to the hinterland and the performance of the port terminals. Fig. 1 shows the structure of the three-step approach applied in this paper. The dataset of the empirical analysis is based on an aggregate annual time series (1995–2017) for the total container throughput measured in twenty-foot equivalent units (TEUs) for the main ports within the Hamburg-Le Havre range of ports.

The paper is structured as follows. The relevant literature review is presented in Section 2. Step one of the approach is illustrated

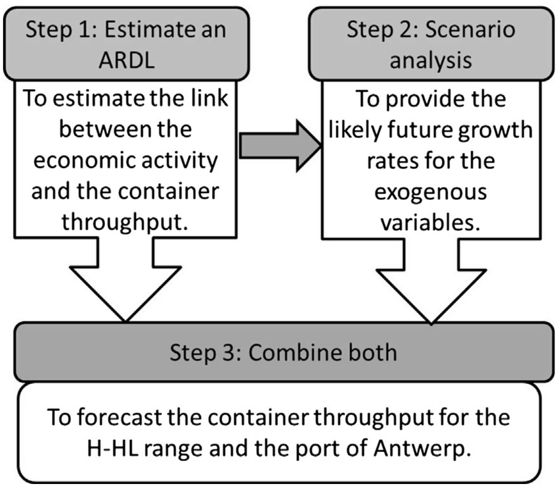

Fig. 1. The structure of the approach.