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SOCIO-ECONOMIC VALUATION OF TRAFFIC IN INLAND PORTS: THE DEVELOPMENT OF A WEIGHING RULE FOR THE PORT OF BRUSSELS

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SOCIO-ECONOMIC VALUATION OF TRAFFIC IN INLAND PORTS: THE DEVELOPMENT OF A WEIGHING RULE FOR THE PORT OF BRUSSELS

ABSTRACT

The objective of this paper is to develop a weighing rule for the socio-economic valuation of traffic categories in inland ports. Weighing rules are tools that provide insights based on the gross and relative added value per ton for different prevalent traffic categories. While port performance indicators rather focus on throughput in absolute tons, stakeholder requests on the impact of ports on society suggest that value added of each tonne handled should also be an important parameter. While most weighing rules developed and applied during the last decades have been focussing on seaports, limited research has been devoted to inland ports and their specific characteristics. Our results show the relatively higher and lower added values for the case of the Port of Brussels, and that the trade off with seaports and development of co-located logistical activities can be of considerable influence on the added value of an inland port.

Keywords: Strategic management, port management, development, value added, socio-economic, inland port.

1. INTRODUCTION

The objective of this paper is to develop and apply a methodology, called a weighing rule, for the socio-economic valuation of the different traffic categories in European inland ports. We develop a rule for inland ports building upon the approach for seaports by Haezendonck *et al.* (2000). However, we assume that the seaport approach cannot automatically be applied to inland ports. Inland ports are characterised by several functions (Rodrigue *et al.*, 2010), different traffic flows, and distinct strategic issues such as a heavy environmental and stakeholder pressure (Pettit and Beresford, 2009; Rodrigue and Notteboom, 2009; Rodrigue *et al.*, 2010), trade offs with seaports, competitive pressure from seaports, from other inland ports (Rodrigue *et al.*, 2010; Veenstra *et al.*, 2012) and other transport modes (Dooms *et al.*, 2013) and increasingly complex regulation combined with decreased government funding (Devinney, 2009; McWilliams & Siegel, 2001; Porter & Kramer, 2006; Werther & Chandler, 2011; Dooms *et al.*, 2013). A weighing rule can provide an answer to these key strategic issues as it can be used to (i) manage stakeholder pressures as it strengthens the port's 'license to operate', and (ii) highlight activities to prioritize in order to increase the added value created by the port, strengthening its strategic position. While port strategy and performance indicators rather focus on throughput in absolute tons, stakeholder requests on what ports bring to society suggest that value added of each ton handled should also be an important parameter for port strategy analyses.

Weighted traffic analysis can be a means for evaluating the socio-economic impact of a port's traffic structure, and thus supports port management with objective measures to formulate development strategies. More specifically, a rule for such weighted analysis provides insights based on: (i) absolute gross added value figures, reflecting the impact of a port's traffic on employment; and (ii) relative added value figures, which provide insights in how many tons of a specific traffic category need to be handled to produce as much gross added value as one ton of traffic of the reference category, i.e. the category with the highest gross added value per ton.

While most weighing rules developed have been focussing on seaports, very limited research on this subject has been devoted to inland ports. For inland ports, we expect that the trade off of certain activities (e.g. stuffing and stripping of containers) between an inland port and a nearby sea- or inland port will have an impact on the distribution of the created added value. Also, we assume that the capacity restriction or otherwise recapturing of capacity by seaports will have an impact on the traffic, and thus on the added value created in inland ports (Rodrigue *et al.*, 2010). River cruise passengers tend to spend relatively more in a visited city because sea cruise vessels offer more facilities for entertainment on board (such as e.g. swimming pools or cinemas), or because of the differences in passenger profile (Brida *et al.*, 2012; Van Balen *et al.* 2013). Thus, we expect higher total added value created by river cruise passengers.

The resulting value added performance indicator in terms of a inland port weighing rule that we present in this paper, will be of interest to stakeholders with a socio-economic interest in the port and provides the following strategic insights and advantages for inland port managers:

1. Formulate an up-to-date and objective view on the activities of the firms active in the port area: analysing value added in absolute figures (currency), as well as in relative terms (coefficients reflecting number of tons required for equal value added creation);
2. Strategy formulation: based on the weighing rule, policy implications can be formulated for strategy development. Linking the inland rule to the concession policy and tariff structure of a port can lead to a strategy that promotes those traffic categories with higher added values;
3. Stakeholder management: a weighing rule can aid to strengthen an inland port's 'license to operate': on the one hand towards the community, for whom activities of inland ports are often less obvious, and on the other hand towards pressure groups, whom tend to focus on the negative social and/or environmental externalities of an inland port's activities (de Langen *et al.*, 2007).

Section 2 starts with a critical review on socio-economic valuation methodologies for port traffic. Section 3 continues by discussing strategic issues relevant to the inland ports today which may affect a weighing rule. In section 4, we provide the methodology applied to develop the weighing rule, where after in section 5 we elaborate on the proposed 'Brussels-rule' and include a benchmark analysis. Section 6 concludes and lists limitations and suggestions for future research.

2. EXISTING SOCIO-ECONOMIC VALUATION METHODOLOGIES IN THE PORT INDUSTRY

2.1. Value added

A socio-economic impact study attempts to create clarity on the value added created by port traffic, and communicate this towards stakeholders (Dooms *et al.*, 2015). In the past, such studies were conducted (such as, amongst others, Gripaios & Gripaios, 1995; Bryan *et al.*, 2006; Chang *et al.*, 2012 and Ferrari *et al.*, 2012) and argued that a port has an impact on the added value of a region, and that specialization in certain traffic categories or niches can be an indicator for differences in created value added of ports (Haezendonck *et al.*, 2000). The added value is in economic literature usually derived from employment or surplus value figures produced by a region or city (Op de Beeck, 1983; Léonard, 1989; Marcadon, 1994; Haezendonck, 2001), and is rarely incorporated in a comparative positioning of ports in competition, with the exception of authors as De Lombaerde and Verbeke (1989) or Charlier (1995). Port authorities are interested in those traffic categories that yield a high added value, and that entail a promising growth scenario (Haezendonck, 2001). Therefore, Haezendonck *et al.* (2000) and Haezendonck (2001), in their approach for the development of the 'Antwerp-rule' and the 'Range-rule', introduce the value added concept which allows transforming 'nominal tons' into 'intrinsic cargo handling tons' or 'value tons' and which allows impact comparison between a set of seaports in a range. The present study follows the definition of added value and the focus on the core port activities, as proposed by Haezendonck *et al.* (2000): value added is the sum of labour costs, depreciations, (+/-) profits or losses and other costs (e.g. provisions) related to cargo handling at the terminals. Labour costs are the major component of value added, representing 66% of the total value added (Haezendonck, 2001).

2.2. Existing weighing rules

Until 2000, weighing traffic based on value added per ton has been elaborated four times in the context of seaports: the Hamburg-rule, the Bremen-rule, the Rotterdam-rule and the Dupuydauby-rule (Haezendonck, 2001; Notteboom, 2010). Table 1 presents an overview of these rules. For inland ports, Charlier (1992) analysed the specific flows in Brussels, but entrusted in the existing seaport rules (Bremen-rule and Rotterdam-rule) and used their applications as a range within which the actual value added for the inland port would be estimated.

Table 1: Weighing rules developed before 2000

Rule	Year	Findings/Coefficients	Approach/Use
Hamburg-rule	1976	Added value of one ton of conventional cargo equals 5 tons of dry bulk and 15 tons of liquid bulk.	- Used in analyses of port competition.
Bremen-rule	1982	Added value of one ton of general cargo equals 3 tons of dry bulk and 12 tons of liquid bulk.	- Often used in the framework of traffic evolution; - Use of differences in labour costs, based on survey among port operators; - Main rule used by practitioners in value added thinking in traffic analysis; - Also frequently used for calculation of intrinsic value tons in the Hamburg-Le Havre range.

Rotterdam-rule	1985	Added value created by 1 ton of conventional cargo equals 2.5 tons of oil products, 3 tons of containers, 4 tons of cereals, 7.5 tons of other bulk, 8 tons of ro-ro traffic, 10 tons of coal, 12.7 tons of iron and 15 tons of crude oil.	- Top-down approach, based on data from the national CBS (Centraal Bureau voor de Statistiek – the Netherlands); - Value added created by the port of Rotterdam was derived from the value added created in the region. The data then needed to be regionalized, to focus on the Rijnmond-area, and subsequently allocated to port activities (Hanson, 1991). - In 1991, due to limitations of a top-down approach with respect to differentiation, some refinement to the Rotterdam-rule was made: collecting the necessary data for classification in traffic categories bottom-up (via questionnaires [Koele, 1992]).
Dupuydauby-rule	1986	Added value created by one ton of conventional cargo equals 12 tons of crude oil, 9 tons of liquid bulk, 6 tons of dry bulk, 3 tons of containers and ro-ro cargo.	- No methodological basis is provided in economic literature.

Source: Authors, based on De Lombaerde and Verbeke (1989), Haezendonck (2001) and Notteboom (2010).

As the aforementioned rules insufficiently explained their methodology (due to confidentiality and strategic importance of the underlying information) and had biased methods of data collection and interpretation, Haezendonck *et al.* (2000) have developed a weighing rule for the Port of Antwerp with consideration for the reliability and replicability of their approach. The ‘Antwerp-rule’ focuses specifically on transparent procedures for data collection and the selection of traffic categories, which allows replication. A total of thirteen traffic categories were identified, with following proposed equal weights in terms of value added relative to 1 ton of fruit: 1.6 tons of other conventional cargo, 3 tons of forest products, 3.5 tons of iron ore, 1.5 tons of cars and vehicles, 3 tons of other ro-ro, 7 tons of containers, 10 tons of other dry bulk, 8 tons of fertilizers, 11 tons of iron and coal, 12 tons of cereal, 5 tons of other liquid bulk and 47 tons of crude oil (Haezendonck *et al.*, 2000). As applying different port specific rules to analyse the position of the seaports within a competitive range, Haezendonck *et al.* (2000) also developed a Range-rule that allows application to all seaports within that range. After validating similar value added structures within the Hamburg-Le Havre range, Haezendonck *et al.'s* (2000) Range-rule defined the coefficients as: 1 for ro-ro, 1 for conventional cargo, 3 for containers, 5 for dry bulk, 2 for liquid bulk and 18 for crude oil. This explicitly means that they concluded that the value added per single ton ro-ro equals the value added generated by for example 3 tons of container traffic.

3. STRATEGIC ISSUES IN INLAND PORTS

The term ‘inland port’ encompasses a range of forms (going from a simple terminal to a complex structure including logistics zones and a separate port authority [PA]), which can lead to confusion and interchangeable use with quasi-substitutive terminologies like ‘dry port’ or ‘inland terminal’. Rodrigue *et al.* (2010) define an ‘inland port’ as a rail or barge terminal, linked to, and integrated to a certain extent with, a maritime terminal that provides regular inland transport services, supporting access to an inland market. Table 2 highlights the complexity of inland ports: (i) inland ports have more interfaces whereas seaports are usually dominated by a maritime cargo flow given its main function at the sea/land interface (ii) following Rodrigue *et al.* (2010) we argue that inland ports have multiple functions, such as metropolitan distribution or consolidation/deconsolidation of cargo, which can involve palletized cargo (Rodrigue *et al.*, 2010).

Table 2: Traffic flows in inland ports

Maritime traffic flow	Cargo traffic coming from/going to a connected seaport for overseas transport.
Continental traffic flow	Cargo traffic of industrial companies or for metropolitan distribution coming from/going to the mainland for inland transport.
Local traffic flow	Cargo traffic coming from/going to locally vested industry.
Passengers flow	Passengers visiting the port for events, short sight seeing trips or as a river cruise destination.

Source: Authors.

Consequently, a set of related logistical activities (distribution centres, depots, warehouses and logistical service providers) are associated and often co-located with the terminal, supporting the freight transport (Rodrigue *et al.*, 2010; 2013). Thus it is important to incorporate the co-located logistics platforms in the inland rule. Inland ports are furthermore multimodal nodes in the supply chain that either can be classified as ‘metropolitan supporting’ (MS) inland ports or ‘industry supporting’ (IS) inland ports (Dooms and Haezendonck 2004; Dooms *et al*., 2013). MS inland ports are characterized by dominant traffic flows as construction materials, oil products, and finished consumer goods, a small amount of port land in comparison with the size and population of the relevant urban region, and with more inbound waterway traffic than outbound. IS inland ports on the other hand typically handle oil products, steel, chemicals, iron ore, scrap or construction materials, while having a large area compared to the total urban region and a balance between inbound and outbound traffic (Dooms *et al.*, 2013). The benchmarking exercise must thus be conducted within a range of similar types of inland ports.

Transport development is moving more inland after a phase of maritime terminal development, driven by a higher complexity of modern freight distribution, and increased attention for intermodal and co-modal transport, as well as capacity issues. Although these issues can be resolved initially by truck transport directly to final destinations, a certain level of activity will necessitate the development of inland terminals as consolidation points and/or permitting the use of more environmentally friendly modes such as rail and barge transport. Other issues that drive this evolution are congestion, energy consumption and empty movements (Rodrigue *et al.*, 2010; Rodrigue *et al.*, 2013). In their research, de Langen and Haezendonck (2012) argue to consider a (sea)port as a cluster, rather than as a transport node: they encourage the inclusion of additional performance measures as value added besides throughput volume (Haezendonck *et al.* 2000; Haezendonck, 2001; Robinson 2002). In ports, the overall performance can be greatly influenced by certain dominant firms or operators (McKendrick *et al.*, 2000). Therefore, analysis at cluster-level is more relevant as it focuses on what a PA can do to attract and facilitate industrial activity (Talley, 2012). Combining the insights of de Langen and Haezendonck (2012) with Rodrigue *et al.*'s definition and insights on inland ports (2013), and in line with Dooms *et al.* (2013), we propose to consider inland ports as multimodal clusters that include co-located logistical and service activities.

Given the characteristics of inland ports, it can be argued that such ports are more in competition with other modes for transport, rather than with other inland ports or seaports. We must also note that commercial changes and competition in and from other inland ports can drastically influence an inland port's business model. Factors like the market an inland port serves and the functions it performs, as well as the actors involved will affect its commercial viability (Rodrigue *et al.*, 2010). In addition, not only will an inland port be affected by other inland ports, seaports can influence the performance of an inland port as well, as certain inland ports were established to accommodate the capacity restrictions and congestion of a seaport (Rodrigue *et al.*, 2010; Veenstra *et al.*, 2012). Should a seaport expand its capacity, it could recollect the functions initially lost to inland ports (Rodrigue *et al.*, 2010). The latter strategic issue reflects a trade-off between sea- and inland ports: either the volume is shifted and handled land inwards due to restrictions at the seaport, or, alternatively, the seaport is able to perform this function on its own (causing a shift in the value added creation). For inland ports, expansion may be problematic as fierce competition exists for the same land between functions (inland port and logistics functions versus urban functions) (Pettit and Beresford, 2009; Rodrigue and Notteboom, 2009; Rodrigue *et al.*, 2010; Dooms *et al.*, 2013). Also, the environmental pressures are heavy for inland ports (Pellegram, 2001; Pettit and Beresford, 2009; Rodrigue and Notteboom, 2009). Consequently, stakeholder tensions increase as intermodalism and a well-functioning inland port are key elements to a sustainable inland gateway, and congestion on transport networks will be shifted towards inland locations (Dooms *et al.*, 2013). Furthermore, increasingly complex regulation and decreasing government funding threaten the financial performance of inland ports (Devinney, 2009; McWilliams and Siegel, 2001; Porter and Kramer, 2006; Werther and Chandler, 2011; Dooms *et al.*, 2013).

4. METHODOLOGY

In order to develop a weighing rule for inland ports we take a similar approach as Haezendonck *et al.* (2000) and Haezendonck (2001) in their development of the Antwerp-rule. The development will be done with specific attention to the data collection procedure (Haezendonck, 2001) and the specificity of inland ports as discussed in section 3. The bottom-up approach of Haezendonck *et al.* (2000) entailed that the collection of data was done at the level of the terminal or firm, active within the port, and only focuses on the activity of loading and discharging cargo. Furthermore, only data were collected for those firms that were specialized in a single category of traffic (unless the data for specific categories were separately available), and representative to the port (i.e. embodying at least 50% of the port traffic).

We focus for our case study on the Port of Brussels. Located in the centre of Europe and Belgium, it takes five hours for a vessel to navigate from this port to the Port of Antwerp up North. The Port of Brussels handled in 2013 a total of 6.6 million tonnes of cargo (Port of Brussels, 2013), which allows us to define it as a small PA according to Verhoeven's (2010) simplified size differentiation. Despite a decrease in local traffic flows, the increase in performance of the other traffic flows (maritime and continental) over the period 2012-'13 (+24%) has resulted in a global annual increase in traffic of 3%. In 2013, the PA noted a total of 11,450 vessels and 50,000 passengers passing through the port (Port of Brussels, 2013). The PA has outlined its strategic vision and goals in its Master Plan Horizon 2030 (Port of Brussels, 2012b). The strategic goals of the Port of Brussels are to (1) apply technological innovations for sustainable metropolitan logistics, (2) establish logistical activities with high added values, to add to the supranational goal of sustainable growth, (3) actively engage in the regional industries and network, (4) participate in the development of touristic and recreational activities (cruises and events), and (5) optimally integrate within the city. To attain these goals, strategic planning is necessary, such as acquiring new and optimizing current port terrains, paying attention to the externalities created, managing and collaborating with other modes in innovative projects, and engaging permanently with stakeholders for metropolitan development.

The study was conducted during a 6-month research period (January–June 2014). To identify the traffic categories and subcategories of the port, we based ourselves on data of traffic flows of the port, combined with potential developments as specified in the Masterplan of the Port of Brussels (Port of Brussels, 2012b). We conducted in-depth interviews and colloquia with managers of firms active in the port area, to validate our findings once more. We defined traffic categories and subcategories that comprehend both the current traffic structure (e.g. construction materials, oil and petroleum products, containers, and passengers) of the port, as well as potential future evolutions (i.e. in ro-ro traffic for the case), and that are furthermore specific enough to allow a benchmarking exercise with other European inland ports. With regard to the potential future traffic categories, no time series on traffic were available, so for these categories a bottom-up approach is necessarily applied. Per traffic subcategory, an adequate approach was defined for the analysis in the port of Brussels. Table 3 provides an overview of the 8 identified main traffic categories and 12 subcategories for the port of Brussels. In case the subcategory states not applicable (N/A), this means that no further specification of the traffic category is applicable.

Table 3: Identification traffic categories and subcategories

Traffic category	Subcategory
Dry Bulk	Construction
Other Dry Bulk	Concrete
	Food products
Liquid Bulk	Oil and Petroleum Products
Containers	N/A
Conventional Cargo	Metal
	Pallets
Ro-ro	Cars
Recycling	Construction Waste
	Scrap
Passengers	Cruise Passengers
	Passengers for Events

Source: Authors (2015), based on traffic data of 2011 of the Port of Brussels.

In general, the approach to collect the tonnage and added value consisted of in-depth interviews (bottom-up approach) and extensive desk research consisting of the analysis of annual reports, as well as calculating the added value based on reports (top-down approach) of, amongst others, the National Bank of Belgium (NBB). Specifically the most recent available working papers of the NBB on the economic importance of Belgian ports were used to observe the evolution of traffic over a period of 11 years (2001-2011) (NBB, 2006; 2011). These working papers contain detailed information on employment and gross added value of industry sectors in ports. For certain categories a divergent approach was employed, which will be specified later. As the calendar year 2011 was the most recent year with available data at the time of the study, all additional data was collected from the year 2011 (except for the future potential traffic categories). To construct correct indications on the value added of the firms active within the port area, face-to-face meetings as well as follow-up telephone conversations and e-mails were set up with the NBB. Out of these contacts we were able to obtain detailed information on the specific composition of the reported value added per sector in the Working Papers (anonymous data on the company level). This became the basis for the elaboration and calculation of value added per ton, for each traffic category. To crosscheck the information, we also computed the value added per firm based on their financial statements. We followed the calculation method of the NBB (see Formula 1) for firms with activities exclusively performed in the port of Brussels (or firms whose share of total activities that relates to the port were known).

Value added = Personnel costs + Depreciations & Amortizations + Provisions + Operating Income –Operating Grants (1)

In a second stage of the bottom-up approach, we set up a series of in-depth interviews with the firms of the different traffic categories to discuss our 'top-down' results and fill gaps. From the contacts of the commercial department of the Port of Brussels, a list of interviewees was drafted. In a first stage contact was initiated via telephone, with follow up via e-mail. Subsequently we set up the in-depth interviews. The interviews generally took 25-50 minutes, and we interviewed managers or employees who could inform us on the traffic and value added figures. In the 20 in-depth interviews, we were able to validate the collected and calculated figures, receive additional information (origin, destination and modal split data) and fill remaining gaps.

Containers, ro-ro, passenger and pallet traffic have divergent approaches. For container traffic, a specific bottom-up approach was employed, as the firm responsible for the terminal exploitation was not operational for a full year yet (a new concession holder was appointed during this period). The figures used for containers refer to the calendar year 2014 (whereas the other categories refer to 2011). In order to determine the value added the personnel costs proxy was applied (ca. 66% of the value added; Haezendonck, 2001). Passenger traffic data was collected from a recent study on the socio-economic feasibility of a passenger terminal in the port of Brussels (Van Balen *et al.*, 2013). As the other traffic categories units are tons, we define as an equivalent of one passenger to be 100 kilograms, i.o.w. one ton equals 10 passengers. Palletized unit traffic is a very novel traffic category to the Port of Brussels, which results in limited data availability. Thus, we performed an in-depth interview with one of the relevant firms, and secondary data sources such as the business plan of an inland barge operator, as well as a large study of the Flanders Institute for Mobility (VIM, 2012) for the transportation of construction materials via pallet barges, to develop an indication for the tonnage and value added parameters. Ro-ro traffic, in this case under the form of export oriented second hand cars, also is a new traffic category for the port of Brussels. For this category, we reinterpreted the analysis of a recent market and feasibility assessment of a ro-ro terminal in the port of Brussels (ECSA, 2010), and additional information received from the stakeholders through interviews. Based on the parameters, we can construct and develop the ‘Brussels-rule’, both for current traffic categories, future potential categories, and metropolitan distribution cargo. Once the rule is established, policy recommendations are formulated towards the tariff structure, concession policy and the commercial strategy of the Port of Brussels.

In our benchmarking analysis, wherein we sought validation for our case findings, we consulted experts of the to-be-benchmarked ports. The question was asked if they (dis)agree on the relative coefficients should they be applied to their ports. This pragmatic approach allows unravelling why the added value ratios would correspond/diverge. For the Range-rule developed by Haezendonck *et al.* (2000), the authors started from the Antwerp-rule, after which 8 of the 9 competing seaports in the Hamburg-Le Havre range were consulted on the ratios for their categories. This approach was also followed in the present research. The approach of Haezendonck *et al.* (2000) accounted for the relative importance of each subcategory to the category based on the average share of this subcategory over the ports of the range. For inland ports, this aspect is less relevant to incorporate given that inland ports are less competitive towards each other than seaports. Inland ports usually serve different hinterlands, as they do not belong to the same port network or are linked to different seaports, or are either a metropolitan supporting or industry supporting port. Therefore, the benchmark analysis is kept at the level of main traffic categories. Data to perform the benchmarking exercise was consequently collected through a request for inputs in a workshop for the Connecting Citizen Ports 21 (CCP21) project, a European Union co-funded research project for which the Port of Brussels is a key member. In the workshop, the other present port representatives validated the ‘Brussels-rule’. Through follow-up communication (e-mail and telephone) we were able to compare how the Brussels-rule would change for other metropolitan supporting inland ports active in the project.

5. A WEIGHING RULE FOR INLAND PORTS

5.1.1. Case study

The Port of Brussels previously used the method of Charlier (1991, 1996) to evaluate its different traffic categories in terms of socio-economic value. This approach was however merely an application of existing seaport rules applied to the traffic figures of the port of Brussels (used as a range of probable value added creation), not adapted to the current structure of the port, and did not reflect future trends and development scenarios. The Port of Brussels handles the different types of traffic flows (see Table 2) in its range (in Table 4 we illustrate this), handles almost all categories and has co-located logistics platforms. Based on expert information we identified two relevant logistics platforms: the European Centre for Fruit and Vegetables (ECFV) and the TIR-centre. The former handles annually 600,000 tons of fruit and vegetables (food products), while the latter is mainly a storage and distribution centre, handling 1,381,900 tons of palletized cargo annually. Both logistical distribution centres are identified as subcategories of conventional cargo.

Table 4: Cargo traffic flows in the port of Brussels

Maritime traffic flow	Ro-ro traffic coming to the Port of Brussels via the Port of Antwerp.
Continental traffic flow	Construction materials, food products, the ECFV and TIR-centre.
Local traffic flow	Concrete, recycling of scrap and construction waste, meant for the region.
Passengers flow	River cruise passengers with Brussels as their destination and passengers for events organized by Belgian companies.

Source: Authors

5.1.2. The ‘Brussels-rule’

The highest absolute value added per ton is created in the port of Brussels by the subcategory ‘food products’, with a value of €37.60/ton. This value will be the reference value to which we link all the other subcategories’ (SC) added values to this reference value, by dividing the reference value by the absolute added values per ton of the separate subcategories. So we have calculated the amount of tons that must be handled by the port of Brussels to create the same amount of added value created by one ton of food products. Following coefficients are found: for construction 19.79, for concrete 3.08, for oil and petroleum products 10.74, for containers 20.89, for pallets 17.09 (3.33 in rule C***), for metal 2.16, for recycling of construction waste 2.69, for recycling scrap 1.61, for cruise passengers 1.06 and for passengers for events, 1.43. These coefficients are visualized in the rows labelled “Coefficients SC” of the ‘Brussels-rule’ in Figure 1. In a similar manner, this includes the coefficient for future traffics of ro-ro of 1.72 on the fourth row (reflected in Rule B**), i.o.w. 2 tons of ro-ro have to be handled to create the same value added as 1 ton of food products. We emphasize the inclusion of potential future traffic with a dark-grey indication. When we include the co-located metropolitan logistical function of the case, the ECFV appears as a subcategory in the conventional cargo category and the TIR-centre is included in the pallets subcategory (reflected in Rule C***, emphasized by the light-grey indication). For the ECFV a coefficient of 1.04 is obtained, while for pallets the coefficient changes from 17.09 to 3.33.

Figure 1: The 'Brussels-rule'

	Main Category (MC)	Dry Bulk	Other Dry Bulk		Liquid Bulk	Containers	Ro/Ro	Conventional Cargo			Recycling		Passengers	
	Subcategory (SC)	Construction	Concrete	Food Products	Oil and Petroleum Products			Palets	Metal	ECFV	Construction Waste	Scrap	Cruise	Events
Rule A*	Weighted Added Value/Ton (EUR)	1,9	12,2	37,6	3,5	1,8		2,2	17,4		14,0	23,4	35,43	26,31
	Coefficient SC (reference value: 37,6)	19,79	3,08	1,00	10,74	20,89		17,09	2,16		2,69	1,61	1,06	1,43
			57,02%	42,98%				72,29%	27,71%		89,06%	10,94%	69,05%	30,95%
	Coefficient MC	19,79	2,19		10,74	20,89		12,95			2,57		1,18	
	Aggregatuion (reference value: 1,18)	**17**	**2**		**9**	**18**		**11**			**2**		**1**	
Rule B**	Weighted Added Value/Ton (EUR)	1,9	12,2	37,6	3,5	1,8	21,9	2,2	17,4		14,0	23,4	35,43	26,31
	Coefficient SC (reference value: 37,6)	19,79	3,08	1,00	10,74	20,89	1,72	17,09	2,16		2,69	1,61	1,06	1,43
			57,02%	42,98%				72,29%	27,71%		89,06%	10,94%	69,05%	30,95%
	Coefficient MC	19,79	2,19		10,74	20,89	1,72	12,95			2,57		1,18	
	Aggregatuion (reference value: 1,18)	**17**	**2**		**9**	**18**	**1**	**11**			**2**		**1**	
Rule C***	Weighted Added Value/Ton (EUR)	1,9	12,2	37,6	3,5	1,8	21,9	11,28	17,4	36,1	14,0	23,4	35,43	26,31
	Coefficient SC (reference value: 37,6)	19,79	3,08	1,00	10,74	20,89	1,72	3,33	2,16	1,04	2,69	1,61	1,06	1,43
			57,02%	42,98%				69,91%	1,96%	28,13%	89,06%	10,94%	69,05%	30,95%
	Coefficient MC	19,79	2,19		10,74	20,89	1,72	2,67			2,57		1,18	
	Aggregatuion (reference value: 1,18)	**17**	**2**		**9**	**18**	**1**	**2**			**2**		**1**	

Note: Rule A* reflect the Brussels-rule, developed based on current waterborne traffic categories, Rule B** reflects Rule A*, and includes potential future waterborne traffic; Rule C*** reflects the Rule B**, and includes metropolitan logistical distribution functions.

Source: Authors.

The relative weights of each subcategory in its main traffic category (MC) are shown by the percentages below the row “Coefficient SC”. In the row “Coefficient MC”, the weighted average of value added per ton per traffic category is visualized. Note that for dry bulk, there are in fact two main categories spanning the 3 subcategories: this is because the significant difference in value added between the dry bulk and other dry bulk subcategories needed to be reflected in the Brussels-rule. To be able to interpret this difference in the final set of coefficients, and after validation with the Port of Brussels, it was chosen to keep the construction subcategory separate of the other dry bulk subcategories. In the row “Coefficient MC”, we then take the lowest value (i.e. 1.18 for passenger traffic) as our reference value. By dividing the value per traffic category by this reference and rounding the coefficients, we have obtained the ratios of the realized value added by each traffic category compared to the other categories. Hence, for the handling of 1 ton of passengers, the same amount of value added is created by the handling of 17 tons of dry bulk, 2 tons of other dry bulk, 9 tons of liquid bulk, 18 tons of containers, 11 tons of conventional cargo, 1 ton of ro-ro and 2 tons of recycling cargo. Note that in the transformation from Rule A* to Rule B**, only ro-ro’s coefficient changes. This is because ro-ro is a ‘new’ category, and the values in its column are never used as a reference value. After including the main logistics operations relevant for the Port of Brussels (reflected in Rule C***), i.e. the ECFV and TIR-centre, the coefficients for the rule change as follows: 17 for dry bulk, 2 for other dry bulk, 9 for liquid bulk, 18 for containers, 1 for ro-ro, 2 for conventional cargo, 2 for recycling and 1 for passengers. Here, the coefficient of conventional cargo does change from 11 to 2, as a consequence of including the metropolitan logistics functions. The high added value per ton of the ECFV (as a new subcategory) and TIR-centre (included in the palletized cargo subcategory) cause the coefficients of the subcategories to change, which results in a change in the rule.

5.1.3. Discussion

We can observe that the activities for concrete, in comparison to construction, have a significant impact on the realized added value per ton of handled cargo. Food has the highest added value per ton, i.e. €37,6/ton. Liquid bulk only has a single subcategory in the case, i.e. oil and petroleum products, with an added value of €3,5/ton. The main value adding activities are the adding of additives to the petrol products. None of these activities are labour intensive, which explains the relatively low figure per ton. Containers’ added value is €1.8/ton. The representative firm was only active for six months at the time of the research, which obliged the research team to extrapolate the personnel costs of that period, and use the 66% proxy. For validation, we calculated the added value per ton of a large, similar inland container terminal in a Belgian port and applied the calculation formula mentioned earlier on three consecutive years (see section 4). Taking the weighted average of the added value per ton over the three years gave a result of €2.17/ton of the other inland port. Analysing the added value created by container throughput in the port of Brussels, allows us to observe a first increasing trend, until 2008, where after it starts to decrease. A possible explanation is that relatively more empty containers are handled in inland ports compared to seaports. For the loaded containers handled, heavier weights (higher ton per TEU) are noted in inland ports. Also, stuffing and stripping of containers is rather done in a ‘hub’ port than in an inland port. Because of the continuing aftermath of the economic crisis of ’07-’08, a lot of firms are still scrimping on personnel costs. The combination of such economizing with the technological evolution can elucidate the decreasing trend in added value. Competition between modes of hinterland transport is fierce, as it is a price-taker market, making subsidies and pressure on personnel costs necessary to keep barge transport competitive to road and rail. In comparison to seaports, the added value per TEU is likely to be higher in inland ports, as the average amount of ton per TEU is higher for inland ports.

Palletized cargo's added value per ton was deducted through benchmarking, as there is no available data on this cargo type at the NBB. Based on business plans and expert information, we were able to estimate the added value at €2.22/ton. Based on expert information, we note that the equivalent of one pallet equals 0.75 ton, resulting in an added value of €1.67/pallet. The data presented in the Build over Water study (VIM, 2012) validated these calculated values. The second subcategory of conventional cargo, metal, has an added value of €17.36/ton. In-depth interviews with port companies and bottom-up calculations resulted in a total added value per ton of €75.6, which needed to be corrected as we only want to include the logistics activities in the port (and not the mere trading part of the added value). A second in-depth interview and the 66% proxy-rule as validation resulted in €17.36/ton. Ro-ro traffic's added value was calculated based on a benchmarking exercise as well, using inputs from business models of the representative firm and a benchmark of a ro-ro terminal of a different port. Based on the models, the projected depreciations and the projected throughput result an added value per ton of €21.9.

Calculations based on the data of the NBB allowed us to determine the weighted average for the representative firms in the subcategory of recycling, for the subcategory of construction waste at €14.0/ton, and for the subcategory of scrap at €23.4/ton. We do note that the value added per ton between the different representative firms differs strongly in the former subcategory.

Based on the study of Van Balen *et al.* (2013), we were able to isolate the expenses of both types of passenger that are received by the Port of Brussels. In the study, the added value per ship was defined based on interviews and extensive desk research. Isolating the expenses per NACE-sector that go to the port, NBB ratio's (added value/revenue) were applied to calculate the added value per NACE-sector for river cruise passengers as well as passengers for events. This respectively resulted in €3.54 and €2.64 per passenger, i.o.w. €35.4/ton and €26.4/ton.

A special remark needs to be made that when we incorporate the logistical distribution centres in the analysis (reflected in Rule C*** of Figure 1), for 1 ton of passengers only 2 tons of conventional cargo needs to be handled to create the same amount of added value, as opposed to the 11 tons should we exclude these activities (i.e. in Rule B**). The cause of this transformation is found in the high added value delivered by the ECFV (€36.1/ton, based on data received from the NBB and interviews) which results in a coefficient over 5 times lower for conventional cargo, as only this category is influenced by the incorporation of the metropolitan distributions centres, and the reference values of food products and passengers are held in the development of the rule. The TIR-centre produces an added value of €11.96/ton (calculated based on an accessibility study [STRATEC, 2004] and data from the NBB), which we add proportionately to the subcategory of pallets, resulting in a new value of €11.28/ton.

5.1.4. Benchmark

As mentioned in section 5.1.1, it is important to conduct a benchmarking analysis with similar ports as the case, in terms of the inland port's function as this defines strongly the traffic structure and the associated added value (Dooms *et al.*, 2013). For our case study, we thus have performed this part of the analysis with other MS ports, alike the Port of Brussels, using expert contacts through the European project CCP21. The analysis was performed for the ports of Paris, Lille, Strasbourg, Basel and Utrecht. Also included is the Port of Liège, which is an industry supporting port, for the specific benchmark of the added value for container traffic. This benchmark is the only one for which we received specific figures, and thus have followed the more robust approach on benchmarking. This also helped to nuance the divergent results for container traffic in the benchmark.

Benchmarking inland ports in terms of added value is a more complex task than for seaports, as inland ports often have a very disparate structure and a limited set of terminals (allowing a greater deviation). Furthermore, limited data availability and unbalanced throughput evolution are characteristic to inland ports. Inland terminals frequently handle several traffic categories, making it difficult to allocate financial data of a single company or terminal to a single traffic category. The connectedness of waterborne activities to industrial, logistical or commercial activities in the port impair distillation of added value figures of waterborne traffic. The results thus have to be considered with great consideration and prudence. Table 5 shows the result of the benchmark. We had indicated the higher (lower) relative added values for the Port of Brussels with plusses (minuses), as the committees indicated they preferred not to share the direct added values with the other ports. Thus, the experts from Utrecht, Lille, Paris and Bâle/Strasbourg could also indicate if their traffic category has a similar added value (indicated by the grey highlighted cells), or a diverging added value (indicated by the black highlighted cells). If the port in question does not handle a specific category, the cell indicates non applicable (N/A). For Liège, we made the added values relative to suit the analysis.

Table 5: Benchmarking Analysis

	Dry Bulk	Other Dry Bulk		Liquid Bulk	Containers	Ro/Ro	Conventional Cargo			Recycling		Passengers	
	Construction	**Concrete**	**Food Products**	**Oil & Petroleum Products**		**Cars**	**Pallets'**	**Metal**	**Food Products**	**Construction Waste**	**Scrap**	**Cruise**	**Events**
	19,79	3,08	1,00	10,74	20,89	1,72	3,33	2,16	1,04	2,69	1,61	1,06	1,43
Bruxelles (coefficients)	**17**	**2**		**9**	**18**	**1**	**2**			**2**		**1**	
Bruxelles (relations)	- - -	+ +	+ + +	-	- - -	+ + +	+ +	+ +	+ + +	+ +	+ + +	+ + +	+ + +
Liège (idem valeur absolue)	NA	NA	NA	NA	- - -	NA	NA	NA	NA	NA	NA	NA	NA
Utrecht	- - -	NA	NA	NA	- - -	NA	NA	NA	NA	+ +	+ +	NA	NA
Lille	NA	NA	NA	- - -	+ + +	NA	+ + +	+ + +	+ + +	+ +	NA	NA	NA
Paris	+ + +	NA	+ +	- -	+ + +	+ +	+ +	+ +	+ +	+ +	+ +	+ +	+ +
Bâle/Strasbourg	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Source: Authors

For all traffic categories, except concrete, we were able to find at least one comparable weight of added value per category for at least one inland port. Moreover, for the majority of the categories no divergent result was found, excepting containers and dry bulk. For containers opposing results were found, as some inland ports agreed with the low added values and others indicated high value added for this category. The amount of added value created by containers in an inland port is dependent of the value adding logistical activities that can remain to be created in that port, reflecting a trade off between ports that can create added value for this category. In the Port of Brussels' network, the Port of Antwerp carries out these activities, making it hard for the Port of Brussels to perform additional value added activities. Containers entering the port will thus not be opened (incl. stuffing and stripping) any more but are merely transported to the end customer. *Idem*, for containers leaving the port the value added logistics could be performed by the manufacturing industry. The ports of Brussels, Liège and Utrecht supposedly fall under this line of thought. The trade off thus has less impact on the Ports of Lille and Paris. The Port of Paris pointed out that the majority of the handling and storage of containers is performed in the inland port, instead of the seaport (Port of Le Havre). For dry bulk a contradicting result was found for the Port of Paris, we argue that their position towards the definition of added value plays a role: indirect added value (e.g. processing or construction near the port site) in this port will have a strong influence.

5.1.5. Strategic policy recommendations

Passengers, ro-ro and bulk traffics create relatively higher added values in waterborne concessions. The added value of container and palletized traffic is relatively low (in contrast to seaports). Seaports make an effort to keep the value adding activities 'in-house' to strengthen their 'license to operate' as they create more employment. Relatively lower capital and labour intensity on inland container terminals (compared to seaport terminals), bound to fierce competition between the service suppliers of transport modes in the hinterland (especially road), result in a great pressure on exploitation margins. This contrasts to the standing exploitation margins of seaport container terminals, which often have larger scales to allow flexible capacity management. This also holds for palletized cargo through the cost efficiency of seaports. Although passenger traffic delivers a relatively high added value figure per ton, simple substitution of cargo terminals to passenger terminals would not allow the port of Brussels to capture more added value as the potential volume of passenger traffic will remain.

The strategic issue of limited land expansion possibility of inland ports, especially for MS ports (Dooms & Haezendonck 2004; Dooms *et al.*, 2013), restrain the potential attraction of logistical activities that generate high added values. The analysis of the metropolitan logistical distribution co-located to the case shows that these activities can create significant additional added value. Therefore the current policy of the port (as laid down in the port's Masterplan of 2015 and 2030 [Port of Brussels, 2012a; 2012b]) should focus on perpetuating the acquirement and development of multimodal platforms. The Port of Brussels is indeed advised to carry through its diversified strategy whereby:

1) Historical traffic categories (construction, concrete, recycling) with high added values and a beneficial modal split should be further developed in optimal locations, with respect to the negative externalities produced on a local level (emissions, dust, noise, visual impediment). For the port's concession policy this means that new contracts with built-in incentives for reducing negative externalities should be considered in the future.
2) New traffic categories with high added values should be developed further, i.e. passenger and ro-ro traffic, with attention for the tariff setting to ensure economic profitability.
3) Conditions to improve the environmental and economic profile of unitized cargo (containers, pallets) should be created through the creation of a network of transshipment platforms for metropolitan distribution and expansion of the co-located metropolitan distribution centres. Concession- and tariff policy can influence the need for innovation, e.g. through the use of electric vehicles, aside from the traditional criteria (such as minimum guaranteed waterborne volumes). Coordination with other parties involved in the port area and the region, suppliers of innovative transport concepts via inland waterways and rail, and shippers with considerable volumes from and to the port's region should be intensified through information exchange. Trade offs and limited land expansion opportunities should motivate policy makers to consider these activities in

broader and interregional planning (location choices, seaport versus inland port, socio-economic and environmental impacts).

6. CONCLUSION

Weighing rules are tools to develop a comprehensive socio-economic impact analysis of a port. While in the past several rules were developed for seaports (Haezendonck, 2001; Notteboom, 2010), this paper is the first to construct a rule for an inland port. Haezendonck *et al.*'s (2000) approach was followed, but adapted to the specific characteristics and strategic issues of inland ports. Inland ports are complex entities, characterized by multiple interfaces and traffic flows, which have to be accounted for in a socio-economic impact analysis of inland ports. Weighing rules allow port management to observe which traffic categories yield relatively high added values and are thus attractive to invest in or develop. The rule was developed for a case study, i.e. the Port of Brussels. The resulting coefficients showed that for 1 ton of passenger cargo, the same added value is created through handling 17 for dry bulk, 2 for other dry bulk, 9 for liquid bulk, 18 for containers, 1 for ro-ro, 2 for conventional cargo and 2 for recycling. Thus we observe that passengers, ro-ro and bulk traffics create a relatively higher added value in waterborne concessions. The added value of container and palletized traffic is relatively low (which contrasts to seaports). Co-located logistical activities, which are a very typical feature of inland ports, prove to be influential on the added value created by an inland port. The trade off between activities performed in the seaport versus in the inland port has considerable influence on the added value created by the inland port. In our case, this was especially apparent for container traffic, validated by the benchmark analysis with Paris. Based on our results, we propose that the Port of Brussels focuses on the development of the high added value traffics, paying attention to the development of co-located logistics platforms, the inclusion of negative externality reducing mechanisms in concessions, and coordination with other stakeholders through increased information exchange. A limitation to the approach is that we only focus on the added value created through the loading and discharging activity at the terminal, therefore underestimating the total added value created by the port. Other industrial activities of a port could be of exceptionally great importance, and could add to the (indirect) value added created by the ports' activities, both inside the port area as in other ports. Suggestions for future research are to focus on the actualization of those traffic flows that we identified in this research as potential future traffic categories. When time series on these (sub)categories are available, an update can be made. Also, developing weighing rules for other MS inland ports could strengthen the benchmarking analysis. Furthermore, a similar approach could be followed to develop a weighing rule and benchmark for IS inland ports. Comparing results of such research to the results of this paper could add to the literature and practice of strategic management in inland ports. Also, linking the current research to other dimensions of performance management (e.g. environmental performance) could provide a more comprehensive view on the performance of an inland port. In this paper we have developed a weighing rule as a tool for socio-economic impact analysis for inland ports, which provides methodological and theoretical contributions to the academic literature and practice on strategic management and performance management of inland ports as we have proposed ways to incorporate the tool in the management of inland ports and respected the strategic issues apparent in the inland port industry.

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