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THE EFFECTS OF ROAD TAXATION ON THE INTERMODAL SPLITS IN THE HAMBURG-LE HAVRE RANGE

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Abstract

The paper will try to determinethe effect of road tax and/or road environmental policies on the intermodal split of ports in the Hamburg-Le Havre (HLH) range. We take the case of an EU-wide policy on trucks to reduce road traffic and we explore ascenario using the modified Generic Statistical Information Model (GSIM) model. A 10% EU road tax onall EU member states has ledto a reduction in the market share for the HLH range of ports vis-à-vis non-EU ports. The number of containers is expected to drop by 1 million TEU. The results are relatively less clear-cut: the EU road policy has a positive impact on the market shares of the ports of Amsterdam, Rotterdam and Bremerhaven, and a very negative effect, especially on the ports of Le Havre and Hamburg. As for the intermodal split, the results show that there is a decrease ranging from 1 to 5% of road transport share (with a decrease of 5% for the port of Le Havre, and a decrease of 1% for the port of Bremerhaven) to the benefit of rail and waterway transport. However, substitution is imperfect, so the increases in rail and inland waterway modes of transport do not compensate fully for the decrease in the number of containers transported by road.

Keywords: Port Competitivess, Road Taxation, IntermodalSplit, GSIM

JEL classification: R40, R49, F18

Introduction

Road congestion is one of the most serious problems in Western Europe. This is especially the case for the existing ports in the Hamburg-Le Havre range, which are considered the gate-way to Europe's international trade, since theports belonging tothe range represent a total of around 40% of the European total container throughput (Notteboom, 2008). The problem with congestion is that it causes pollution, which is detrimental to human health and an important issuenowadays,what with the growing effects of global warming. Moreover, Europe, and especially the regions where the ports are located, is one of the world's most polluted areas. It is known that the north-western part of Europe, with its numerous industrial outfits,causes massive pollution with CO2 emissions. In addition, the transport sector is a large emitter of CO2 and other types of dangerous gases. In response to that problem, the European Union has introduced several policies and legislative measures, such asthe European Union Emissions Trading Scheme (EU ETS) and the EU standards for trucks, locomotives and barges used in the European Union (Directive of the European Parliament and Council, 2003). As a reaction to the congestion problem,a great number ofpolicies may be needed to reduce the number of trucks on the roads in favor of different – more environmentally friendly – modes of transport. Therefore, the introduction of a new tax on trucks might be the solution capable of increasing the costs of road transport.This paper focuses on container trade, astrucks handle the bulk of container transports thanks to the flexibility of this mode of transport compared to other modes.

1. Port Competitiveness

In this section, we define factors determining port competitiveness and decidewhich of these factors are qualitative. The main purpose of this paper is to measuretheirimpacton the competitiveness of ports. In order to do that, we need to explain the factors impacting competitiveness. In their paper,Tongzon and Heng (2005) claim that the number of factors affecting port competitiveness has risen as a result of improvements and new developments in the maritime sector. They defined eight modern factors as discussedbelow:

1.1. Cargo handling at the port

In economic theory, price is the main incentivedeciding the choice between products with the same or similar characteristics. The processes by which ports are chosen are not entirely disconnected from economic theories. Port taxes consist of four different items: taxes on infrastructure use, berthing services, cargo handling and consignees. The cargo handling costs are between 70 % and 90 % of total port taxes (Trujillo &Nombela, 1999). In order to be competitive,a port must reduce cargo handling bills, and attract carriers. Carriers nowadays are facing tough competition providing similar services at fraction differences in prices. Thus, a small difference in port taxes can be decisive for carriers choosing berthing ports.

1.2. The Efficiency level of port and terminal operation

According to Peters (2001), the time spent at the port is a major component ofa ship's service life. Thus, the shorter thistime is, the more competitive are the port authority and operators. Efficiency is measured by the productivity of the terminal and how the terminal can allocate its resources to achieve maximum throughput. The productivity of the terminal is determined by the productivity of its components, including a crane, berth, yard, gate and labor. Enhancing the productivity of the terminal can be achieved bystreamlining the productivity of one or more of its elements.

1.3. Reliability

Nowadays, with door-to-door services gaining more ground, as opposed to port-to-port services, reliability is an increasing determinant in port choice. Liners are seekingreliable ports that can provide insurance for their timetables. The port whichhas the highest accuracy in terms of timing, is the most attractive and competitive. In the same way, shippers and liners are avoiding ports that always face delays in cargo delivery. This is exemplified by French ports. In addition to their hinterland connection problems, French ports are known for repetitive delay-inducing strikes. These strikes are constant and recurring; for example, there was a 5-day strike in 2011.("Serious disruption for French ports as five-day strike begins", 2011). Another strike was in 2016, and a good look through the news would show clearly what a nuisance this is for French ports.("Strike handicaps Le Havre port's rail, barge operations", 2016). In addition to other factors, we notice that the share of French ports in container market is low.

1.4. Port selection preferences of carriers and shippers

Shippers and liners usually showed interest in specific ports and preferredsome ports to others, such as the Chinese shipper described in Tiwari, Itoh &Doi, 2003. Nowadays, however, loyalty is no more a common occurrenceexcept in some cases, such as MSC and the port of Antwerp. Still, MSC is starting to send its vessels to other competitive ports in the same range,for instance,Rotterdam. It is hard these days to keep vessels attached to ports, where no specific benefits accrue from such attachment.

1.5. Navigation channel depth

This represents the accessibility of the port and the ease with which itcan be reached. In the Hamburg-Le Havre range, this issue is the most important factor due to the type of the ports. For example, Hamburg and Antwerp ports are accessed through rivers with tidal restrictions and locks. On the other hand, Rotterdam and Wilhelmshaven haveno tidal restrictions, which allow 24 hours access to ships. Another issue is the concept of economies of scale. Largerships are entering the market with increasing draught, such as 15,000 and new ones even up to18,000 TEU. This kind of vessels need 24-hour accessibility and free tidal navigation (Peters, 2001).

1.6. Adaptability to the changing market environment

Since 1955, the container business has evolved substantially from 50 TEU vessels to 18,000 TEU vessels these days and the trend is on the rise. That is why ports must be able to adapt to the growing size of vessels in order to keep theircompetitive position. Another growing trend is the door-to-door model; this new service puts extensive pressure on the ports to provide reliability and hinterland connectivity. Ports that have provedunable to adapt will be out of the marketand will not be chosen by carriers. (Notteboom and Winkelmans, 2001a, b).

1.7. Landside accessibility

This represents hinterland connectivity, which is the main themeof this paper. The ports are no longerin the market or near it. The concept of hub ports has moved ports away from their final destination and hinterland connections have becomemore important to both carriers and ports. Road transport has the lion's share in the intermodal split,even though most ports and roads are becoming increasinglycongested, leading to delays, time waste and money losses. That is why the port's landside accessibility must be efficient for the different modes of transport to provide high-quality services. Container terminals can be strongly competitive and efficient through hinterland connectivity and support from private truck providers and authorities. The operational management among these players can be decisive for reducing congestions in ports (Acciaro, 2013). Port selection is based on several factors, but hinterland connectivity plays the main role in this decision. Moreover, road pricing as in the case of Antwerpplays a major role in the choice of port and terminals (Aronietis, 2010). Following the list of hypotheses developed in their paper, it turned out from the analysis that port accessibility is important for its characteristics (Caldeirinha& al, 2013).

1.8. Product (Service) differentiation

Differentiation is an important factor in port competitiveness. Providing a product or a service that did not exist, or has so far been providedinefficiently in competitors' ports, improves the competitive position of the port in its range. This is known as economies of scope. For example, the port of Antwerp has a competitive advantage in break bulk, which is its main focus, thanks to the added value supplied by this type of transports. Another example is the port of Rotterdam and the chemical industrial area in the port (Herrera, 1999). Both ports, for example,service roughly the same number of containers, which makes their rivalry particularly close.

After ashort description of the determinants of port competitiveness, we will try to relate it to the main topic of the paper. In the paper, the reflection of the competitive position of the port will be represented by the container throughput of the ports. In the case of the introduction of the road tax, cargo handling charges at port, the reliability and the port selection preferences are the factors that are negatively affected. The road will increase the port cargo handling charges and decrease the possibility of the port's being chosen by carriers. In addition, the increased costs in road transport will reduce the usage of trucks, which are mainly used to accomplish the door-to-door concept, thus the timelinessof container deliveries to the final destination will deteriorate because the other modes of transport are less flexible than trucks. Following the description of the factors, we can conclude that the port charges that include transport costs are the major decisive factors for carriers in their choice of ports since most carriers are profit-driven companies, hence they will be considered in the GSIM model. In addition, we can conclude that the reliability, adaptability to change in a market environment andproduct differentiation are the qualitative factors that are hard to quantify but can be explained from the GSIM model results. As a result, Table 1 below identifiesthe position of each port with respect to the Port Competition Determinants.

Table 1. Ports advantage (+) or disadvantage (-) with respect to the port competition determinants.

Determinant/Port	Havre	Antwerp	Zeebrugge	Rotterdam	Amsterdam	Bremerhaven	Hamburg

Port and terminal operation efficiency level	-	+	-	+	+	+	+
Port cargo handling charges	-	+	-	+	-	+	+
Reliability	-	+	-	+	-	+	+
Port selection preferences of carriers and shippers	-	+	-	+	-	+	+
The depth of the navigation channel	+	-	+	+	-	-	-
Adaptability to the changing market environment	-	+	+	+	+	+	+
Landside accessibility	-	+	-	+	-	+	+

Source: (The author's own estimates& Herrera, 1999)

In order to estimate the effect on the intermodal split after the implementation of the tax, the table below shows clearly how goods are transported from the port to the hinterlands. Road transport is the dominant mode of transport in all the ports except the port of Bremerhaven where the dominant mode of transport is by rail. At the ports of Le Havre, Antwerp, Rotterdam and Amsterdam, the railways account forless than 10% of the intermodal split. On the other hand, at the ports of Zeebrugge, Bremerhaven and Hamburg the railways make up from 30% to 60 % of the intermodal split.As for the waterways, the ports of Antwerp, Rotterdam and Amsterdam have around 1/3 if their goods transported by barges due to the nature of the land in the Netherlands and Belgium, or the rivers are dominant. In addition to the nature of lands, other reasons can be considered in order to decide on the mode by which the goods are transported at a certain port. One of the main reasons is the type of goods being transported whether it is bulk, liquid, containerized or RORO cargo. For simplicity's sake, the previous intermodal percentage will be used as a determinant for the containerized cargo, which is the central point of this paper.

Table 2. Intermodal Split of HLH range ports

	ROAD	RAIL	WATERWAYS
LE HAVRE	84%	7%	9%
ANTWERP	60%	8%	32%
ZEEBRUGGE	55%	44%	1%
ROTTERDAM	60%	9%	31%

AMSTERDAM	50%	7%	43%
BREMERHAVEN	37%	59%	4%
HAMBURG	66%	32%	2%

Source: Intermodal Holland, 2008

2. GSIM Model

In order to assess the effect of implementing a road tax on trucks, we use the Global Simulation Model (GSIM) developed by Francois and Hall (2003). The GSIM model is based on partial equilibrium focusing on one industry with a global or regional perspective, which in this paper is the ports in the Hamburg-Le Havre range. In this model, we wish to limit the study to specific factors that help to perform a quick and translucent analysis of the ports using minimum set of data and computational requirements. (Francois and Hall, 2003).

This thesis will use the 25x25 GSIM model with some modifications to come to the dimensions of 21 by4. There are seven ports in the HLH range that we look at, each for three modes of transport (3 x 7 = 21) and we have divided the EU into four regions: North, East, South, and West. The model uses tax and trade data at world prices, which is represented in this paper by the container throughput of each port and the cost of transporting the container from the port to its final destination. The GSIM model is then used to show the effect of introducing a tax or the effect of singing a Free Trade Agreement that decreases the cost of trading.

Mathematically speaking, the model is constructed as follows:by assuming that within each importing port *v*, import demand within product category *i* of goods from country *r* is a function of industry prices and total expenditure on the category:

$$M_{(i,v),r} = f(P_{(i,v),r}, P_{(i,v),sr}, y_{(i,v)}) \quad \textbf{(2.1)}$$

By differentiating equation 3.1, we can arrive at the cross-price demand elasticity, while price demand elasticity can be defined as follows, where $\Theta(i,v),s$ represents an expenditure share, Es is demand elasticity and $EM,v$is composite demand elasticity in importing region *v*.

$$N_{(i,v),(r,s)} = \theta_{(i,v),s}(E_m + E_s) \quad \textbf{(2.2)}$$

$$N_{(i,v),(r,r)} = \theta_{(i,v),r} E_m - \sum_{sr} \theta_{(i,v),s} E_s = \theta_{(i,v),r} E_m - (1 - \theta_{(i,v),r}) E_s$$

(2.3)

The global market clearing condition for each export variety is the sum of the products of own price demand elasticity and the sum of world price for exports from region *r* and the power of the tax, T= (1+t), plus the sum of cross price elasticity and the sum of world price for exports from region *r* and the power of tax, T= (1+t)

$$E_{X(i,r)}\hat{P}_{i,r}* = \sum_v N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_v \sum_{s \neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s}$$
$$= \sum_v N_{(i,v),(r,r)}[P_r * + \hat{T}_{(i,v),r}] + \sum_v \sum_{s \neq r} N_{(i,v),(r,s)}[\hat{P}_s * + \hat{T}_{(i,v),s}]$$
(2.4)

Producer surplus which is the gain of producers, generated by selling at a price higher than they are willing to sell, depends on the benchmark revenue export times the world price for exports from region r plus half of the product of the benchmark revenue, the world price for exports from region r and the export quantity.

$$\Delta PS_{(i,r)} = R^0_{(i,r)} \hat{P}_{i,r}* + \tfrac{1}{2} R^0_{(i,r)} \hat{P}_{i,r}* \hat{X}_{i,r}$$
$$= \left(R^0_{(i,r)} \hat{P}_{i,r}*\right)\left(1 + \frac{E_{X,(i,r)} \hat{P}_{i,r}*}{2}\right)$$
(2.5)

Consumer surplus is the amount gained by the consumer for paying a price lower than they are willing to buy, is calculated by multiplying the initial expenditures by the price for composite imports.

(2.6)
$$\Delta CS_{(i,v)} = \left(\sum_r R^0_{(i,v),r} T^0_{(i,v),r}\right)\left(\tfrac{1}{2} E_{M,(i,v)} \hat{P}_{(i,v)}^2 \, sign(\hat{P}_{(i,v)}) - \hat{P}_{(i,v)}\right)$$
$$where\ \hat{P}_{(i,v)} = \sum_r \theta_{(i,v),r} \hat{P}_r * + \hat{T}_{(i,v),r}$$

The own-trade effect is the product of import quantity, the own price demand elasticity and the power of the tax:

$$TC_{(i,v),r} = M_{(i,v),r} \times [N_{(i,v),(r,r)} \ddot{T}_{(i,v),r}] \quad \textbf{(2.7)}$$

The cross-trade effect is the product of the import quantity and the sum product of cross price elasticity and the power of the tax:

$$TD_{(i,v),r} = M_{(i,v),r} \times \sum_{s \neq r} N_{(i,v),(r,s)} \hat{T}_{(i,v),s} \quad \textbf{(2.8)}$$

Global equilibrium conditions are represented as the sum product of the own price elasticity demand and the world price for exports from region r and the tax power in addition to the sum product of cross price elasticity and the world price for exports from region and the tax power.

$$\hat{M}_{i,r} = \sum_v \hat{M}_{(i,v),r} = \sum_v N_{(i,v),(r,r)}\hat{P}_{(i,v),r} + \sum_v \sum_{s \neq r} N_{(i,v),(r,s)}\hat{P}_{(i,v),s} \quad \textbf{(2.9)}$$
$$= \sum_v N_{(i,v),(r,r)}[P_r * + \hat{T}_{(i,v),r}] + \sum_v \sum_{s \neq r} N_{(i,v),(r,s)}[\hat{P}_s * + \hat{T}_{(i,v),s}]$$

3. Data

The required data for this model consists of the container throughput for the year 2008 of ports in the Hamburg-Le Havre range taken from the port authority of Rotterdam, but recalculated in value terms. The thesis will use the data from 2008 just before the financial crisis as this year better reflects a longer-run equilibrium than more recent ‘financial crisis’ years. Indeed, the effect of the financial crisis on the container throughput of the ports especially the port of Amsterdam has been severe.

The following Table 3 shows the container throughput inthe year 2008 of ports in the HLH-range

Table 3. Containers Throughput 2008

Port	Havre	Zeebrugge	Antwerp	Rotterdam	Amsterdam	Bremerhaven	Hamburg
Container Throughput in TEU in ‘000	2,450	2,210	8,863	10,784	436	5,529	9,737
Market Share	6%	6%	22%	27%	1%	14%	24%

Source: Port Authority of Rotterdam, 2010

3.1. Throughput excluding Transshipment

The second step in preparing the data is to take out the number of transshipped containers that do not exit the ports, using the transshipment ratios relative for each port as stated by the port authority of Rotterdam[1] as shown in the following Table 4. The reason behind excluding the transshipped containers is that they do not go through the hinterland connections. Therefore, in order to have a realistic analysis we need to include only the containers that go through roads, railways and inland waterways.

Table 4. Containers Throughput without Transshipment in 2008

Port	Havre	Antwerp	Zeebrugge	Rotterdam	Amsterdam	Bremerhaven	Hamburg
Container Throughput in TEU ‘000	2,450	8,863	2,210	10,784	436	5,529	9,737
Transshipment ration	26 %	37%	26%	30%	30%	61%	34%
Container Throughput ‘000	1,813	5,583	1,635	7,548	305	2,156	6,426

Source: Port of Rotterdam and the author’s own calculations

[1]http://www.portofrotterdam.com/en/News/pressreleases-news/Pages/20100624_01.aspx

3.2. Container throughput via Intermodal split

The third step in organizing the data required for the GSIM model is to distribute the container throughput among the different modes of transport based on the intermodal split mentioned in Table 2.

Table 5. Container throughputper mode of transport

Mode of transport	ROAD	RAIL	Inland Water Ways
Le Havre	1,504,790	126,910	163,170
Antwerp	3,350,214	446,695	1,786,781
Zeebrugge	899,470	719,576	16,354
Rotterdam	4,529,280	679,392	2,340,128
Amsterdam	152,600	21,364	131,236
Bremerhaven	797,835	1,272,223	86,252
Hamburg	4,241,437	2,056,454	128,528

Source: The author's owncalculations

3.3. Final destination of the Containers

The fourth step is to break downthe container throughput of each mode of transport byplaceof final destination. The final destinations will be divided into 3 different zones within Europe in addition to the rest of the world. According to the United Nations, the three regions of Europe are Eastern Europe, Southern Europe and Western Europe. The northern region is excluded from this study since the goods are transported to Northern Europe via the short-sea shipping which is part of the transshipment.

Table 6 summarizes the percentage of containers transported from port to different regions using the different modes of transport. Meanwhile,Table 7 shows the average cost of transporting one TEU from HLH to Europe.

Table 6. Percentage Distribution of Containers

	Eastern Europe	Northern Europe	Southern Europe	Western Europe
Le Havre RO	10%	5%	45%	40%
Le Havre RA	25%	0%	30%	45%
Le Havre IWW	5%	5%	5%	85%
Antwerp RO	20%	10%	25%	45%
Antwerp RA	20%	0%	30%	50%
Antwerp IWW	10%	5%	10%	75%

Zeebrugge RO	20%	10%	25%	45%
Zeebrugge RA	5%	20%	25%	50%
Zeebrugge	5%	5%	5%	85%
Rotterdam RO	20%	10%	20%	50%
Rotterdam RA	15%	0%	20%	65%
Rotterdam IWW	5%	10%	25%	60%
Amsdam RO	15%	15%	20%	50%
Amsdam RA	25%	0%	25%	50%
Amsdam IWW	5%	10%	20%	65%
Bremer RO	25%	15%	15%	45%
Bremerh RA	20%	0%	35%	45%
Bremeh IWW	5%	10%	10%	75%
Hamburg RO	25%	20%	10%	45%
Hamburg RA	30%	0%	15%	55%
Hamburg IWW	5%	15%	10%	70%

Source: The author's own calculations

Table 7. Cost of Transporting one TEU

Cost of Transporting 1 TEU from HLH ports to Europe				
Smallest Cost per TEU		€ 25.00		
Largest Cost per TEU		€ 600.00		
Trial			Cost of 1 TEU	
1	€ 174.00	Average	€	340.50
2	€ 433.00	STD	€	165.37
499	€ 320.00	MAX	€	599.96
500	€ 555.00	MIN	€	25.10

Source: The author's own calculations

3.4. Elasticity of road transport

The sixth step in building the model we need to define the elasticity of each mode of transport. The elasticity for Netherlands and Belgium can be found in the report for transport and environment made by two companies: Significance for Quantitative Research and CE Delft. In addition, we will determinethe elasticity of different ports and different countries. We can conclude from the paper the following calibrated elasticity values that are going to be used in the model to reflect the sensitivity of road transport of each port or country.

Table 8. Road Elasticity per Port

Port	Le Havre	Antwerp	Zee-brugge	Rotter-dam	Amster-dam	Bremer-haven	Hamburg
Road Elasticity	-2	-1.2	-1.2	-0.53	-0.53	-0.3	-0.95

Av. elasticity based on market share WA	-0.88

Source: (De Jong, 2010) and own calculations

4. Results and Analysis

4.1. Scenario: EU Policy Tax of 10 % with an average elasticity.

4.1.1. Results for Intermodal split

A few main observations can be made from Table 9. First, we notice a change in the intermodal split. The table shows that, as expected, traffic has moved from roads to the other two modes of transport (railways and inland waterways). A decrease of 13% of goods transported by roads can be noticed in all ports in the Hamburg-Le Havre range. This decrease is accompanied by an increase between 7% and 8% of goods transported via railways and inland waterways, and this result holds for all the ports. However the results in total is:

Table 8. Percentage changes of traffic per mode of transport

Percentage changes per mode					
	Total	East	North	South	West
Le Havre RO	-9.1%	-4.1%	-2.5%	-5.9%	-5.9%
Le Havre RA	0.8%	1.8%	0.0%	0.0%	0.1%
LE Havre IWW	0.8%	2.0%	3.6%	0.2%	0.2%
Antwerp RO	-12.6%	-6.7%	-5.1%	-8.5%	-8.5%
Antwerp RA	0.8%	1.9%	0.0%	0.1%	0.1%
Antwerp IWW	0.8%	1.9%	3.5%	0.1%	0.1%
Zeebrugge RO	-5.2%	-2.1%	-0.5%	-3.9%	-3.9%
Zeebrugge RA	7.5%	5.5%	7.0%	3.7%	3.7%
Zeebrugge IWW	7.4%	5.9%	7.5%	4.1%	4.1%
Rotterdam RO	-19.3%	-11.1%	-9.5%	-12.9%	-12.9%
Rotterdam RA	5.1%	4.6%	0.0%	2.8%	2.8%
Rotterdam IWW	9.8%	7.1%	8.7%	5.3%	5.3%
Amsterdam RO	-19.3%	-11.2%	-9.6%	-13.0%	-13.0%
Amsterdam RA	3.0%	3.1%	0.0%	1.3%	1.3%
Amsterdam IWW	9.8%	7.1%	8.7%	5.3%	5.3%
Bremerhaven RO	-16.0%	-9.2%	-7.6%	-11.0%	-11.0%
Bremerhaven RA	9.8%	7.2%	0.0%	5.4%	5.4%
Bremerhaven IWW	9.8%	7.1%	8.7%	5.3%	5.3%
Hamburg RO	-17.7%	-10.4%	-8.8%	-12.2%	-12.2%
Hamburg RA	9.8%	7.0%	0.0%	5.2%	5.2%
Hamburg IWW	9.8%	7.0%	8.5%	5.1%	5.2%

Average HLH RO	-9.1%	-4.1%	-2.5%	-5.9%	-5.9%
Average HLH RA	0.8%	1.8%	0.0%	0.0%	0.1%
Average HLH IWW	0.8%	2.0%	3.6%	0.2%	0.2%

Source: GSIM results and the author's owncalculations

Moreover, it becomes clear from Table 9 below that if we look at value changes for each mode of transport in absolute terms, all ports lose turnover in total because of the EU tax, which means that the loss in turnover from the road tax for the road mode of transport is only partially compensated by increases in rail and inland waterway transport. This implies that, indeed as was expected, road, rail and IWW are imperfect substitute modes of transport to each other. We also see from Table 9 that in absolute terms the value changes for the Port of Rotterdam are largest with a decrease in value of road transport of €205 million (because it is the largest port in terms of container transport), while in absolute terms the effects are smallest for Amsterdam.

Table 9. Value changes of traffic per mode of transport in euros

Value changes'000 per mode					
	Total	East	North	South	West
Le Havre RO	-47,882	-4,053	-1,625	-22,358	-19,846
Le Havre RA	372	243	0	50	78
LE Havre IWW	456	67	112	15	262
Antwerp RO	-148,227	-27,203	-11,840	-39,019	-70,165
Antwerp RA	1,280	707	0	211	362
Antwerp IWW	5,111	1,418	1,206	285	2,203
Zeebrugge RO	-16,415	-2,606	-814	-4,648	-8,347
Zeebrugge RA	18,946	1,081	5,145	4,234	8,486
Zeebrugge IWW	424	26	30	20	348
Rotterdam RO	-306,706	-58,143	-26,763	-63,400	-158,400
Rotterdam RA	12,241	2,391	0	2,312	7,538
Rotterdam IWW	80,068	4,585	10,517	19,087	45,879
Amsterdam RO	-10,326	-1,474	-1,357	-2,142	-5,353
Amsterdam RA	223	81	0	47	95
Amsterdam IWW	4,490	257	590	856	2,787
Bremerhaven RO	-44,768	-10,645	-5,768	-7,093	-21,262
Bremerhaven RA	43,458	10,021	0	14,616	18,821
Bremerhaven IWW	2,951	169	388	281	2,113
Hamburg RO	-262,130	-63,231	-46,227	-27,774	-124,898
Hamburg RA	70,544	23,979	0	9,966	36,599
Hamburg IWW	4,415	249	857	413	2,896

Source: GSIM results and the author's own calculations

The shown shifts in relative (percentage) and absolute terms mean simply that following a tax, transport companies leaving the HLH port range will gravitate towards a new intermodal split).The port of Le Havre depends largely on roads (83%), making it more dependent on policies such asa road tax. This is the reason why we can observe how much the increase in transport costs affects the intermodal split of Le Havre (from 83% to 81%). On the other hand, the Port of Bremerhaven depends mostly on rails with 59% and roads with 37 % and the new intermodal split is 63% for rail and 32 % for roads. The tax shifts the intermodal split much less for Le Havre than for Bremerhaven since in Le Havre, the other two modes are much more imperfect substitutes for road transport than in Bremerhaven, where railroads provide a viable alternative.

Table 10. Old and New Intermodal split

Mode of transport	Road Old	Road New	Rail Old	Rail New	IWW Old	IWW New
Le Havre	84 %	81%	7 %	8%	9%	11%
Antwerp	60 %	55%	8%	9%	32%	36%
Zeebrugge	55 %	50%	44 %	49%	1 %	1%
Rotterdam	60 %	55%	9 %	10%	31 %	35%
Amsterdam	50 %	45%	7 %	8%	43 %	47%
Bremerhaven	37 %	32%	59 %	63%	4 %	4%
Hamburg	66 %	61%	32 %	37%	2%	2%

Source: GSIM results and own Calculations

Conclusions

Looking at studies pre-dating this paper, we can conclude that a road pricing policy moves traffic away from roads to other modes of transport. For example, an increase in CO_2 emissions charges in the Netherlands is shiftingtraffic away from roads to inland waterways to a large extent and to railways (Zhang, 2010). In the case of increasing the cost of road transport in the port of Antwerp, the port loses market share and the intermodal split change in favor to inland waterways and railways (Aconites, 2010).

The paper uses the GSIM model and the case where the EU policy 10% tax which is common for all ports as part of EU ETS policy. The first impact of the introduction of the new road tax is to reduce the total market share of the Hamburg-Le Havre range with respect to the inter-regulation and road container trade. This reductionis followed by the change in the market shares of the ports in the HLH range. From the competitiveness analysis, the paper concludes that the ports of Le Havre and Hamburg experience a loss in their market shares in the case of an EU policy tax and the others increase their market shares. On the other hand, the ports of Rotterdam, Amsterdam and Bremerhaven experience an increase in their market shares in the case of regulation and road taxes and the other ports lose market shares.

As for the intermodal split, the paper shows that there is a shift from roads to railways and inland waterways. The shift differs from port to port, based on the efficiency of the hinterland connectivity. The availability of substitutes plays amajor role in explaining the shifts in the intermodal split. The larger the availability of other modes of transport the more shift there is out of roads.

The paper has limitations because it only shows partial economic effects deriving from the transport sector. In order to have a clearer view of the total economic effect, the value of goods in the containers must be included in addition to the transportation costs.

Therefore, the paper is the first step in researching the total economic effect and different scenarios can be included in the calculations in addition to container values.

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