

## **To perform or not to perform (that's the question)**

*A statistical analysis of inland port performance in the Netherlands*

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Most scientific attention in port studies centres on deep-sea ports, in particular container ports. In our paper, in contrast, we focus our attention on the determining characteristics of inland port performance in a European context, which is up to now an overlooked part in the scientific literature on port development. Based on a large-scale quantitative dataset of Dutch inland ports we performed various statistical analyses to arrive at a more detailed understanding of the question: what are the determining characteristics of inland ports? We try to explain the performance of inland ports in terms of transshipment level and growth in transshipment by several transport and economic factors. We control for differences in size, in volume growth, in type of port and in availability of a container terminal in the inland port. The findings contribute to the understanding of the performance of inland ports, as explained by general port characteristics. But also, a better understanding of the characteristics and growth patterns of inland ports might also be beneficial to European practitioners and policy-makers in dealing with inland ports' development strategies in their daily practice.

Keywords: inland port, port system development, transshipment, performance indicator, port governance

### **1. Introduction**

Most scientific attention in port studies centres on deep-sea ports, and more particularly container ports. The efficiency of maritime ports and of terminals especially has received much attention, but the analysis of the role of deep-sea ports in transport and supply chains, including the analysis of the management and organisation of ports and terminals, also forms part of the body of scientific literature (e.g. Van Klink & Van den Berg, 1998; Bontekoning *et al.*, 2004; Hesse & Rodrigue, 2004; Notteboom & Rodrigue, 2005; Woxenius, 2007; Notteboom, 2010; Pallis *et al.*, 2010). In the hinterland of deep-sea ports (i.e. in inland ports) most scientific attention goes to container terminals in

combination with the logistics role of inland ports versus the hinterland of the larger maritime ports (see for instance the recent Inside-Out, Outside-In discussion in Wilmsmeier *et al.*, 2011 and Monios & Wilmsmeier, 2012). However, inland ports are becoming more and more important in global supply chains and up to now scientific attention to these processes is lagging behind for inland ports, especially in the European context.<sup>1</sup> Furthermore, governmental bodies such as inland port authorities, cities and regions all use similar strategies: they try to optimise their production factors in terms of people, planet and profits in and around inland ports. Therefore, they can be expected to benefit from more detailed insights into the determining characteristics of inland ports in Europe. In terms of port governance, this poses considerable multi-level challenges, which leads us to the following research question:

*'How can the determining characteristics of inland ports explain their performance (size and growth) and what does this imply for port governance strategies?'*

In our paper, we focus our attention on the characteristics of inland ports *in general* (i.e. as compared to focusing solely on container terminals in inland ports). By doing so, we aim to analyse the undervalued position of European inland ports within its own specific context. In Section 2, we present a literature review of port studies. Due to the limited availability of scientific literature which focuses purely on inland ports, the review mainly focuses on issues identified in the context of maritime ports and the implications of these respective issues for the context of European inland ports. In Section 3, we explain the development of a large-scale dataset of 135 municipalities in the Netherlands with information about the transport characteristics of their inland navigation activities, combined with economic characteristics of the inland port, the city and the region. In Section 4, based on this large-scale quantitative dataset, we perform various statistical analyses (single-measure performance measurement and multivariate regression analyses) in order to arrive at a detailed understanding of the determining characteristics of inland ports. We try to explain the performance of inland ports by several transport and economic factors. We control for differences in size, in volume growth, in type of port and in availability of a container terminal in the inland port. Section 5 contains the conclusions of our paper and the implications of our findings for port governance strategies in the daily practice of European inland ports.

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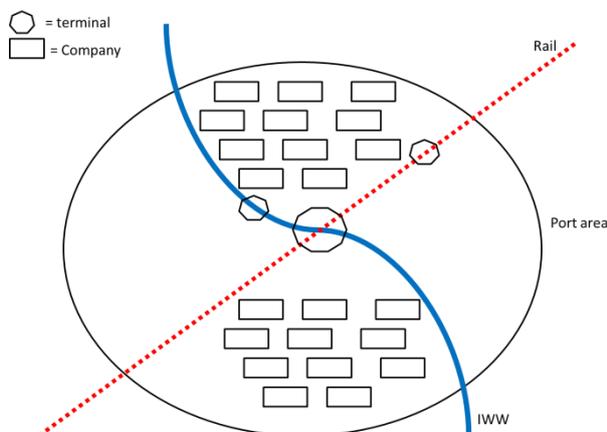
<sup>1</sup> Much of the academic literature which pays specific attention to the processes in inland ports is focused on empirical evidence stemming from the American or – more recently – the Asian context (e.g. Leitner & Harrison, 2001; Walter & Poist, 2004; Rahimi *et al.*, 2008; Monios & Wang, 2013).

## 2. Inland ports: literature review and hypotheses

### 2.1 Characteristics of inland ports

Inland ports are increasingly receiving scientific attention in recent years, although there is no consensus about the term 'inland port' itself. Both Rodrigue *et al.* (2010) and Monios and Wang (2013) provide an in-depth analysis of the different definitions of inland ports. The main conclusion from both papers concerning the definition of inland ports is that there are different levels of inland port geographies (spatial scales), actors, regulatory settings and functions. Inland port geographies can range from the container terminal, to the inland port, to the hinterland of the inland port, up to the connections with the deep-sea ports. Inland port actors can include public authorities, the port authority, transport operators of the respective transport modes, logistics service providers and the terminal operators. Regulatory settings can refer either to the type of ownership of the inland port or the type of port governance strategy used by the public authorities. Inland port functions for their part can refer to the transport and logistics functions performed inside the inland port, but also to the network function of the inland port versus other inland ports and its relations towards deep-sea ports. What is largely absent in the definitions of inland ports is the *performance* of the inland port and the most important economic sectors that are operating in these inland ports. The performance of inland ports is therefore the key concept included in our paper and is particularly reflected in the data analysis on the determining characteristics of inland ports in relation to transshipment level and growth in transshipment of inland ports. In Figure 1, we combine inland port geographies, actors and functions in order to define the 'borders' of our analysis.

Figure 1: Schematic overview of a possible inland port area



Source: Authors' own drawing

An inland port area is an area of a certain size (the large oval) encompassing road infrastructure, inland waterway(s) and rail infrastructure(s). In the centre of the large oval, a small oval is depicted that connects rail and inland waterway in a tri-modal terminal. Two smaller ovals are a dedicated inland waterway terminal and a dedicated rail terminal in the port area. In practice, different constellations of one or more terminals can be found in inland ports. Inside the inland port area, many companies are found providing production, logistics and transport services. Close to or 'interfering with' the port area, an urbanised area can often be found, leading to a number of issues where port and city compete or are complementary. For our paper, the interaction between city and port is outside the scope of the research. For further reading, we refer to Witte *et al.* (2014) and Wiegmans and Louw (2011). In the end, different combinations of infrastructures, terminals, companies, functions and regulatory settings lead to different outlines for the governance of inland ports.

A classification of inland ports is necessary in order to be able to differentiate inland ports. A first criterion for classification can be found in infrastructure availability. Inland ports (and/or inland terminals) can be accessible by rail, inland waterways or a combination of both (in addition to road). Secondly, inland ports can be classified according to type of ownership: public ownership (e.g. a municipality province, and/or regional body), private ownership (e.g. a privatised port authority), or a public private partnership where public and private entities cooperate. A third criterion for classification is the importance of transportation and logistics activities (such as customs clearance, intermodal transport, production, logistics, and supply chain management) in inland ports. In our analysis, the focus in classifying inland ports is on inland port size and growth, combined with the different economic sectors operating in inland ports and the availability of a container terminal in the inland port. We presume therewith that the performance of inland ports primarily depends on these variables (compare for instance the study of inland ports by the NVB Dutch Inland Ports Association, 2004), which represents a mixture of these criteria for classification.

## 2.2 *Issues for inland port studies*

In order to measure inland port performance, we formulated some presumptions regarding a number of issues which are relevant for inland port studies. We based our presumptions upon the topics presented in a thorough literature analysis by Pallis *et al.* (2010). Given the breadth and depth of their study and the lack of a sufficient number of scientific studies that focus solely on inland ports, we have taken their defined topics as a starting point for structuring our analysis of the scientific literature for inland ports.

Therefore, based on Pallis et al. (2010) we selected four topics and formulated seven presumptions, which together are intended to represent the performance of inland ports. The topics we selected (based on availability of scientific literature and relevance for the inland port context) are: 1. Terminal studies and port performance; 2. Ports in transport and supply chains; 3. Port governance; and 4. Spatial analysis of ports. Below, we discuss these topics and relate them to our presumptions and our data.

1. *Terminal studies and port performance*: Deep-sea terminal studies focus especially on the measurement of terminal performance, terminal operations and strategies of maritime terminal companies. These issues are not extensively studied for inland ports. Data on terminal operations in inland ports is mostly missing in scientific research, as in our research. Furthermore, Witte *et al.* (2014) have found that inland port strategies are often either missing or 'under construction'. Therefore, we broadened the scope for measuring performance from the terminal level to the port level. Data which we have available include the presence of a container terminal in an inland port and the transshipment levels (in tonnes/year) of inland ports in 2001 and 2006. Consequently, these data can be used to test some presumptions relating to port performance on the inland port level:

- a. *The transshipment level is negatively related to the growth in transshipment* (if the basic level of transshipment is already high, inland ports are less likely to sustain further growth, because of convergence processes on the port system level)

- b. *The transshipment level and the growth in transshipment are positively related to the presence of a container terminal in the inland port* (because container terminals are expected to be located in strategic locations, creating an additional pull-factor, which can attract higher levels of overall transshipment capacity and trigger further growth in transshipment)

2. *Ports in transport and supply chains*: This category consists of shipping networks, supply chain trends, logistics activities, information flows and hinterland chains (e.g. Notteboom & Rodrigue, 2005; Veenstra *et al.*, 2012). For inland ports, Rodrigue *et al.* (2010) have found that the functional outcome remains relatively similar irrespective of their geographical, regulatory and operational settings. Distance from a deep-sea port is important for an inland port, but more important is the possibility for the 'massification' of flows (regular rail and/or barge service) between a port and an inland port. In Europe, port authorities and terminal operators tend to be the major actors in inland port development, while in the

American context, rail operators and real estate companies tend to take the initiative. Our available data regarding networks, flows and chains include the regional employment level and the functional range of distribution activities. These data can be used to develop presumptions relating to 'ports in transport and supply chains':

*c. The transshipment level and the growth in transshipment are positively related to the number of jobs in the region to which the inland port belongs (because a larger number of jobs is expected to result in greater flows of people, goods and services, which can attract higher levels of transport capacity and trigger further growth in transshipment)*

*d. The transshipment level and the growth in transshipment are positively related to the functional range of the inland port's distribution activities (the greater the catchment area of an inland port, the larger the volumes and growth are expected to be; thus we expect the long distance range to have a greater effect on volumes and growth compared to the medium and short distance ranges)*

3. *Port governance:* This category consists of port models and port reform, the role of the port authority, industrial relations in ports and port community cooperation in seaports. In the inland port scientific literature little or no attention is paid to inland port governance. In our database, some data regarding the transshipment per NSTR-unit can be used to develop a presumption related to 'port governance', especially focusing on industrial relations in inland ports:

*e. The transshipment level and the growth in transshipment are positively related to the diversity in types of transhipped goods (because the diversity in types of goods is expected to be beneficial in creating a portfolio strategy in port governance, which can attract higher levels of transshipment capacity and trigger further growth in transshipment)*

4. *Spatial analysis and features of seaports:* This category consists of spatial change in seaports, spatial studies of port networks, studies of spatial change of port cities and the port city interface, and analysis of port hinterlands. In the inland port, the traffic structure which represents the relative shares of the different transport modes used for incoming and outgoing flows to and from the hinterland is important (Dooms *et al.*, 2013). Often in the inland ports, traffic imbalances exist between imports and exports leading to empty vessel movements and also to empty load unit movements (such as containers). Data problems often arise due to measurement issues connected to quay measurement or terminal

measurement. Furthermore, quays and terminals can be under (or outside) the jurisdiction of the inland port authority, which complicates data issues (Dooms *et al.*, 2013). Still, some accessibility data in our database can be used to develop presumptions relating to the spatial features of inland ports:

*f. The transshipment level and growth in transshipment are negatively related to the distance from an inland port to the nearest access point to a main road or motorway (because a short distance from the inland port to a main road or motorway is expected to result into greater accessibility of the inland port, which can attract higher levels of transport capacity and trigger further growth in transshipment)*

*g. The transshipment level and growth in transshipment are negatively related to the distance to the nearest seaport (because a short distance from the inland port to a nearby seaport is expected to result in greater spill-over effects from the seaport to the inland port, leading to higher levels of transport capacity and triggering further growth in transshipment)*

In the next section, we explain the characteristics of our database and the methods we used for our analyses.

### **3. Data analysis approaches towards inland port performance**

#### *3.1 Data availability, sampling and characteristics*

##### Data availability

The basis of our analyses is a large-scale quantitative dataset of Dutch inland ports largely based on data provided by CBS Statistics Netherlands, consisting of transshipment figures and related transport and economic factors. Given the importance of the Dutch inland ports on the European level also, in our analysis we assume the Dutch inland ports to show similarities with other inland ports in Europe. The transshipment figures are based on data from CBS Statistics Netherlands on the *overall transshipment level* in inland navigation in tonnes/year for all Dutch municipalities in 2006.<sup>2</sup> The municipal level is the best proxy for the inland port level itself, as nearly all municipalities with an inland port in the Netherlands only have one port within their territory. Since 2006, figures on the transshipment levels in inland navigation have not been collected in a systematic way on the local scale, but only at an aggregated level, which cannot be differentiated for inland ports. The variable *growth in transshipment* has been created by calculating the factor increase or decrease over the 2001-2006 period.

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<sup>2</sup> Unfortunately, disaggregated data on container transshipment in TEU/year are not available.

The data on the overall transshipment level in inland navigation can be disaggregated to transshipment levels per NSTR-unit (*Nomenclature uniforme des marchandises pour les Statistiques de Transport, Révisée*). This means that a subdivision can be made into transshipment in agriculture products; nutrition products; mineral oils; petroleum products; minerals; iron, steel and semi-manufactured goods; pure minerals and manufactured goods; fertilisation products; chemical products; and vehicles, machines and other general cargo. These disaggregated figures are used to construct the variable *diversity in types of goods* (only including the number of NSTR-units exceeding transshipment of 100,000 tonnes/year).

Other data on transport factors that have been collected include the *presence of a container terminal* in the inland port and the *functional range of distribution activities* of the inland port. The presence of a container terminal is derived from information provided by the Dutch Centre for Expertise and Innovation in Inland Navigation and is constructed as a dummy variable (0=not present, 1=present) in our dataset. The *functional range of distribution activities* relates to the distance class to which (or from) the majority of the cargo of an inland port is being transhipped. Based on an earlier definition of the functional range of distribution activities by the NVB Dutch Inland Ports Association (2004) we have constructed three categories: the *short distance range* (with a distribution radius ranging from 0 to 100 km from the inland port), *medium distance range* (101-350 km radius) and *long distance range* (351-N km radius). Actual destination data of transshipment from the inland port to (and from) a certain distance class are linked to these three categories.

Data on economic factors which have been collected include the *number of companies* and the *number of jobs* in the region to which the inland port belongs. Both variables have been derived from CBS Statistics Netherlands data. Because of the – obvious – high correlation between the two, only the number of jobs in the region is used in the analysis. The variable *distance to the nearest access point to a main road or motorway* is also derived from CBS Statistics Netherlands data and can be used as a proxy to measure the relative accessibility of the inland port. Finally, the variable *distance to the nearest seaport* is included to control for spatial autocorrelation. This variable is calculated using four-digit postal codes of the inland ports and seaports in the dataset and measuring the shortest travel time in minutes by road from an inland port to any seaport. The travel time is derived from the software program FlowMap.

### Data sampling and characteristics

In the first step of creating a representative sample from the raw data, the total number of municipalities in the Netherlands in 2006 (458 municipalities) was brought down to the total number of municipalities which actually showed transshipment levels exceeding 0 in 2006 (217 municipalities). The second step consisted of excluding municipalities which are hosting a deep-sea port instead of or next to an inland port and municipalities which are an island, thus are not part of the inland navigation work of the mainland. These exclusions are derived from the classification made by the NVB Dutch Inland Ports Association (2004). This leaves 203 municipalities hosting an inland port and not being a deep-sea port or an island. Next, municipalities which did not show transshipment figures for 2001 but did show figures for 2006 were excluded to avoid infinite growth figures. The remaining dataset consisted of 185 municipalities hosting an active inland port in both 2001 and 2006. Finally, a filter was applied to select those municipalities which hosted an inland port having a critical mass of transshipment of at least 100,000 tonne/year. This final limitation resulted in a dataset consisting of 135 inland ports.<sup>3</sup> Some descriptive characteristics of the final sample are outlined in Table 1.

*Table 1: Descriptive statistics of inland ports' characteristics (n=135)*

	<b>Minimum</b>	<b>Mean</b>	<b>Maximum</b>	<b>Std. Dev.</b>	<b>Skewness</b>
Transshipment level 2001 tonne/year (x 1.000)	20	1,027.13	10,645	1,316.89	3.960
Transshipment level 2006 tonne/year (x 1.000)	103	970.06	7,686	1,155.03	2.835
Growth in transshipment 2001-2006	0.12	1.38	12.35	1.50	4.344
Diversity in types of goods 2001 (0-9)	0	1.72	8	1.49	1.844
Diversity in types of goods 2006 (0-9)	0	1.84	9	1.52	1.960
Number of jobs in the region 2001 (x 1.000)	1.12	25.03	244.43	36.20	3.388
Number of jobs in the region 2006 (x 1.000)	1.19	27.64	266.58	39.51	3.359
Short distance distribution tonne/year (x 1.000)	0	445.99	3,650.77	607.90	2.704
Medium distance distribution tonne/year (x 1.000)	0.50	410.56	3,301.21	541.74	2.542
Long distance distribution tonne/year (x 1.000)	0.48	88.96	609.74	127.25	2.078
Distance to access point main road (km)	0.60	1.55	4.10	0.58	1.143
Distance to nearest seaport (travel time in min)	7	41.15	91	22.86	0.614

*Source: Authors' own data computations*

An interesting observation which can be made on the basis of Table 1 is that while the mean transshipment level has decreased over the 2001-2006 period, the mean growth figure over the same period is still positive. At the same time, the minimum level of

<sup>3</sup> One case (an inland port located relatively close to the deep-sea port of Rotterdam) originally was part of the final sample, but proved to exert a too powerful influence on the modelling outcomes (deviating over 2 standard deviations from the mean; an outlier). This case was therefore excluded from the sample, leaving 135 inland ports suitable for using in the regression analyses.

transshipment has increased, while the maximum level of transshipment has decreased. Apparently, some convergence processes have taken place on the port system level, implying that the differences between small and large inland ports have narrowed down relatively. In other words, smaller ports are possibly 'catching up' in terms of transshipment volume. However, the discussion of the regression analyses in the next section is decisive in confirming or rejecting this presumption. Another observation relates to the functional ranges of distribution activities, where a – not unexpected – gradual decrease of volumes can be observed from the short (regional) to the long distance (European) scale. Finally, it should be stressed that most of the variables show a positive skewness which exceeds the critical threshold value of 2. This implies that the data should be transformed before they are used in the regression analyses.

### 3.2 *Single-measure performance measurement and regression analyses*

#### Single-measure performance measurement

In order to analyse and compare the level of efficiency of inland ports, a benchmark could be helpful. For management purposes, the benchmark concepts must be translated into meaningful indicators (Martland, 1992). Sinclair (1992) defines a benchmark as '*something whose quality, quantity or capability is known and which can therefore be used as a standard with which other things can be compared*'. Essential elements of benchmarking are that it is continuous, systematic and implementable. Disadvantages of benchmarking are that it carries risks such as loss of sensitive data to competitors, the costly failure to implement someone else's best practice effectively, and that the benchmarking process itself might carry considerable costs through data collection and data analysis. For our analysis, some benchmarks have been checked to get a grip on the data (Table 2). One interesting observation for instance is that larger inland ports usually are located in relatively scarcely populated areas.

*Table 2: Outcomes single-measure performance measurement*

	<b>Low</b>	<b>Median</b>	<b>Mean</b>	<b>High</b>
1. Transshipment in tonnes / resident	0.30	10.10	23.10	255.60
2. Transshipment in tonnes / surface (ha)	0.80	60.00	143.21	1,384.10
3. Transshipment in tonnes / company	6.30	194.50	459.36	5,841.50
4. Transshipment in tonnes / job	0.40	24.20	66.75	676.30
5. Residents / company	12.50	20.30	20.22	36.70
6. Jobs / resident	0.13	0.39	0.42	1.39
7. Jobs / company	2.40	8.1	8.53	28.60

*Source: Authors' own data computations*

### Regression analyses

In our paper we discuss the relation between the performance of inland ports (in terms of transshipment level and growth in transshipment) and some determining transport and economic factors. To this end, we make use of multivariate regression analyses. In order to meet the condition of normality for using regression analyses, we transformed our database using log-transformations to correct for positive skewness of the data. Another condition for using regression analyses is that there is no multicollinearity between independent variables. We checked this by looking at Pearson's correlation coefficients and the Variance Inflation Factors. Only one<sup>4</sup> of the correlation coefficients is too high (all others are below 0.7) and none of the Variance Inflation Factors exceeds the critical threshold value of 5 (the highest being 2.875). Also, there are no problems with homoscedasticity of variances. Based on these conditions, all remaining independent variables could be included in the models. Because we had no prior expectations about the relative importance of the independent variables and because the relations between our  $x$  and  $y$  variables are likely to be linear, we built our models using ordinary least squares (OLS) and the Enter method. The results are discussed in the next section.

## **4. Analysing the performance of inland ports**

### Modelling outcomes

We built two models to discuss our hypotheses. The first model is the OLS model for the transshipment level in 2006 (Table 3). The model is significant ( $F: 39.900$ ;  $p: 0.000$ ) with an adjusted  $R^2$  value of 0.740. Most independent variables show significant relations with the dependent variable. The second model is the OLS model for the growth in transshipment from 2001 to 2006 (Table 4). This model is also significant ( $F: 11.289$ ;  $p: 0.000$ ), but the explained variance is somewhat lower compared to the first model (adjusted  $R^2: 0.446$ ). Possibly the 'static' transshipment level in 2006 is relatively easier to explain using our independent variables compared to the 'dynamic' growth over a six-year time period, where other exogenous factors which are not captured by our independent variables may influence the growth patterns to some extent as well. Note that in the second model the transshipment level in 2001 is included to control for the 'basic level' in explaining growth patterns. Also note that the variable 'medium range distribution' is omitted because it was too highly correlated with the before-mentioned transshipment level in 2001. The outcomes of the regression analyses are discussed in the same order that we used in the introduction of the hypotheses (Section 2).

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<sup>4</sup> The medium distance range of distribution correlated too highly with the level of transshipment in 2001. We have therefore excluded the medium distance range from the growth model.

Table 3: Modelling outcomes for transshipment level 2006 (\*\*  $p < 0.05$ )

	<b>B</b>	<b>t</b>	<b>VIF</b>
Constant	1.923**	2.724	
Presence container terminal	0.367**	3.035	1.304
Number of jobs in region	0.063	1.292	1.524
Short distance range distribution	0.082**	2.294	1.263
Medium distance range distribution	0.176**	3.209	2.100
Long distance range distribution	0.027	0.791	1.756
Diversity in types of goods	0.312**	7.604	1.853
Distance to access point main road	-0.496**	-3.294	1.214
Distance to nearest seaport	0.105	1.202	1.269
Adjusted R <sup>2</sup>	0.740		

Source: Authors' own data computations

Table 4: Modelling outcomes for growth in transshipment 2001-2006 (\*\*  $p < 0.05$ ; \*  $p < 0.10$ )

	<b>B</b>	<b>t</b>	<b>VIF</b>
Constant	2.211**	3.370	
Transshipment level 2001	-0.595**	-7.610	2.875
Presence container terminal	0.288**	2.263	1.351
Number of jobs in region	0.061	1.206	1.540
Short distance range distribution	0.005	0.110	1.740
Long distance range distribution	0.062*	1.817	1.657
Diversity in types of goods	0.187**	3.836	2.253
Distance to access main road	-0.289**	-1.805	1.281
Distance to nearest seaport	0.123	1.400	1.195
Adjusted R <sup>2</sup>	0.446		

Source: Authors' own data computations

### Inland port performance

In Section 2 we stated that container terminals are expected to be located at strategic locations in the general port system. We argued that the presence of a container terminal in a port can be considered an additional pull-factor for the port, which can consequently attract higher levels of overall transshipment capacity and trigger further growth in transshipment. We presumed that for the port performance on the inland port level the presence of a container terminal in an inland port should be positively related to the transshipment level and growth in transshipment of the inland port. This presumption hypothesis is confirmed by the results (Tables 3 and 4). As expected, the presence of a container terminal is positively and significantly related to the transshipment level in 2006 and to the growth in transshipment from 2001 to 2006. These outcomes add to the argument that containerisation is becoming more important in the general port system (Rodrigue & Notteboom, 2009).

We also presumed that convergence processes would take place on the port system level, leading to smaller differences between small and large inland ports. In other words, the transshipment level should be negatively related to growth in transshipment. This presumption is also confirmed by the results (Table 4); if the basic level of transshipment is already high, inland ports are less likely to sustain further growth. This means that the relative 'catching up' of smaller inland ports – as was indicated in the previous section – is indeed likely to be happening. Perhaps this is not so surprising, given the literature on the outsourcing of capacity to smaller ports in the hinterland (e.g. Notteboom, 1997; Notteboom & Rodrigue, 2005).

#### Inland ports in transport and supply chains

With regard to the positioning of inland ports in transport and supply chains we stated in Section 2 that the long distance range of distribution especially would be important in attracting and sustaining transshipment volumes. We argued that the greater the catchment area of an inland port, the greater the level of and growth in transshipment would be. In other words, the long distance range of distribution was presumed to show a greater influence on the dependent variables 'level' and 'growth', compared to, respectively, the medium and short distance range of distribution. On the basis of the results, this presumption can only partly be confirmed. For the growth in transshipment (Table 4), the long distance range indeed shows a positive sign, but this is only significant on the  $p < 0.10$  level. The short distance level is – based on our results – not of great importance for growth in transshipment. For the transshipment level (Table 3), the results are contrary to what we expected; the short and medium distance levels of distribution both show positive and significant outcomes, whereas the long distance level is not significantly related to the transshipment level. With some caution we can therefore argue that our results indicate that the short and medium distance levels of distribution are important in achieving an initial basic level of transshipment. Also, the distribution seems to shift over time to the long distance range in order to sustain further growth in transshipment.

We also presumed that the number of jobs in the region would result in greater flows of people, goods and services, which would in turn attract higher levels of transport capacity and trigger further growth in transshipment. This presumption cannot be confirmed on the basis of our analysis. Both models indicate that the number of jobs is related neither to the transshipment level, nor to growth in transshipment. Apparently the relation between regional employment levels and transshipment figures on the inland port level is too indirect to cause any significant relations between the two. This implies that

the often-made argument in the literature of 'investments in inland port activities leading to employment growth' cannot be confirmed based on our analyses.

### Inland port governance

Although the data we used are not explicitly highlighting inland port governance, we argued in Section 2 that the diversity in types of goods which are being transhipped in an inland port can be viewed as a good proxy to indicate a distinction in two types of port governance strategies: focusing on either monofunctional or multifunctional inland ports. We presumed that the diversity in types of transhipped goods would be positively related to the level of and growth in transshipment. In other words, transshipping many different types of goods can be regarded as a portfolio strategy in port governance to attract and sustain growth, compared to a port governance strategy which is more oriented on specialisation in a specific type of good (e.g. a monofunctional sand/grit port). Based on the modelling outcomes in Tables 3 and 4, this presumption seems to be confirmed. Perhaps the positive and significant outcome for diversity in the transshipment level model is not that surprising, for ports transshipping a great variety of goods also show high overall levels of transshipment capacity. Yet, it is interesting to find that diversity in goods is related not only to high levels of transshipment capacity, but also to growth in transshipment over a prolonged period of time. Our results therefore indicate that having a portfolio strategy in port governance can be beneficial both in attracting a basic level of transshipment volume and in sustaining further growth in transshipment. Apparently an inland port is better protected against external influences such as market dynamics when the variety in types of goods is greater.

### Spatial features of inland ports

Our sixth presumption which was formulated in Section 2 dealt with the influence of the accessibility of an inland port on the level of and growth in transshipment. We argued that the distance from the inland port to an access point of a main road or motorway would be negatively related to the level of and growth in transshipment. We reasoned that the shorter the distance, the greater the accessibility would be. Our results confirm this presumption, for both the level of and the growth in transshipment (Tables 3 and 4). In both cases the distance variable is negatively and significantly related to the dependent variable. It is likely that good accessibility by road can be beneficial for an inland port, because efficient pre- and end-haulage can be regarded a pull-factor in port selection (Wiegmans *et al.*, 2008).

We also presumed that the distance from an inland port to the nearest seaport would be negatively related to the level of and growth in transshipment, for the closer an inland

port is located to a seaport, the greater the benefits from spill-over could possibly be. This presumption cannot be confirmed based on our analyses. Both the level of and growth in transshipment (Tables 3 and 4) seem unrelated to the distance to the nearest seaport; the relation is even positive instead of negative. This leads to a possible alternative explanation: inland ports which are located further away from a seaport have more 'space' to have their own consumer market and area of distribution, which can have a positive effect on the level of and growth in transshipment. A final interesting observation is that distance to an access point of a main road is of greater importance than distance to the nearest seaport.

#### Implications for port governance strategies

The results of our analysis have several implications for port governance strategies. First, a container terminal is important for inland port transshipment volume and volume growth; however, the precise importance depends on the actual size of the inland port. For a large inland port, a container terminal is of relatively less importance. Secondly, diversity in types of goods and a relatively large share of medium distance distribution are important focal points in inland port governance. Next, accessibility of the inland port by road is important and could be regarded as a precondition for inland port performance. Fourthly, for larger inland ports, governance strategies could have less focus on growth as compared to smaller ports (because of 'saturation' of growth in the case of larger ports and convergence between large and small ports on the port system level). For inland port expansion, effects on regional employment growth should be expected to be modest. In other words, in terms of job creation there might be better alternatives for achieving growth. Finally, a timed portfolio strategy could be followed by inland ports for a sustainable growth strategy. This means that larger ports are more likely to focus on diversity in freight flows and on extension of their hinterland towards medium distance flows, whereas smaller ports focus more strongly on achieving a basic level of transshipment capacity.

## **5. Conclusion and discussion**

This paper has focused its attention on the determining characteristics of inland port performance, which is up to now an overlooked part in the scientific literature on port system development. The overview of port issues provided by Pallis *et al.* (2010) combined with our dataset has led us to formulate specific presumptions regarding the performance of inland ports in the European network. Our central question to be answered was: *'How can the determining characteristics of inland ports explain their performance (size and growth) and what does this imply for port governance strategies?'*

Our empirical analyses discussed the relation between the level of and growth in transshipment and a number of transport and economic factors. First, we concluded that the presence of a container terminal is an important performance condition for inland ports, both in attracting transshipment capacity and in sustaining further growth. This finding is in line with the growing attention to containerisation in the academic literature (Rodrigue & Notteboom, 2009). This might imply that the spatial features of an inland port to an increasing extent have to be aligned with the preconditions for accommodating container transshipment, as was already happening in the context of seaports. Secondly, other important characteristics that influence inland port performance in terms of transshipment level are 'diversity in types of goods' and a relatively large share of distribution on the medium distance range. These findings can be mirrored with insights from new economic geography regarding the specialisation vs. diversity tandem and the importance of portfolio as a growth strategy (e.g. Frenken *et al.*, 2007). Using economic geography concepts and theorising might be valuable in discovering more patterns in future inland port studies as well. Thirdly, the accessibility of an inland port by road can be considered an important indicator for inland port performance in terms of both transshipment volume and growth. This was already confirmed on the seaport level (Wiegmans *et al.*, 2008), but it is important to note that this can be an important pull-factor for inland ports as well. This conclusion is in contrast to the observations regarding the distance to the nearest seaport, which does not seem to play an important role. An alternative explanation is the possibility to establish its own area of distribution and serve its own range of customers when an inland port is located relatively far away from a seaport. This adds to the arguments of the Inside-Out approach (Wilmsmeier *et al.*, 2011; Monios & Wilmsmeier, 2012). Fourthly, the often-made argument in the literature of 'investments in inland port activities leading to employment growth' cannot be confirmed based on our analyses. We suggest that further research needs to be done here, for instance regarding the influence of regional clusters of economic activity on the performance of inland ports. Finally, we have found that the transshipment level is inversely related to growth in transshipment. Apparently, convergence or 'catching up' of smaller ports is happening at the port system level, which is not so surprising given the scientific literature on the tendency to outsource production factors when traditional port areas become congested (e.g. Notteboom, 1997; Notteboom & Rodrigue, 2005).

While we have been able to draw some conclusions regarding the determining characteristics of inland ports performance based on our dataset of Dutch inland ports, more work remains to be done in this relatively new field of scientific research. Of specific interest would be further inquiry into the spatial and institutional dimensions of

inland ports. Some work has been done here already, but based on our findings it is clear that plenty of conceptual and empirical questions still lie ahead.

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