Ports and Regional Development: a European Perspective

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ABSTRACT

This paper studies the impact of port activity on regional employment, analysing approximately 560 western European regions, including the largest OECD European ports (116 ports), from 2000-06. The empirical analysis is based on a set of employment equations using the Blundell and Bond (1998) GMM-System estimator that takes into account persistence effects in employment, regional unobserved time-invariant heterogeneity and endogeneity of port activity.

Our main findings are (1) regional employment is positively correlated to port throughput, while the number of passengers is not; (2) the impact of port throughput on employment might depend on the institutional characteristics of each port, with private ports having the largest impact on regional employment of the host region if compared with those operating under different governance models ("Hanseatic", "Latin"); (3) there is a higher impact of port throughput when liquid bulk is not considered; and (4) the main results are confirmed when service and manufacturing employment rather than total employment are considered.

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Keywords: ports, regional development, regional growth, transportation

FOREWORD

This working paper is one in a series of *OECD Working Papers on Regional Development* published by the OECD Public Governance and Territorial Development Directorate. It forms part of the *OECD Port Cities Programme*. This paper was written by Claudio Ferrari (Italian Centre of Excellence on Integrated Logistics [CIELI], University of Genoa), Olaf Merk, (Administrator, OECD Regional Development Policy Division), Anna Bottasso (Department of Economics and Business [DIE], University of Genoa), Maurizio Conti (DIE, University of Genoa) and Alessio Tei (CIELI, University of Genoa). The publication was edited by Caitlin Connelly.

The paper can be downloaded on the OECD website: www.oecd.org/regional/portcities

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Port throughput is positively correlated to employment in port regions. This study indicates that an increase of one million tonnes of port throughput is associated with an increase in employment in the port region of 0.0003%. This means that in a region with one million employees, employment would increase by 300 units; in the long run this increase would be 7500 units. This impact is slightly larger on industry than on service employment. These conclusions are based an evaluation of the impact of port activity on regional employment in a sample of 560 regions in 10 European countries, 100 of which home to one or more port, from 2000-06.

Liquid bulk has lower employment impacts than the other cargo categories (dry bulk, containers, general cargo). If liquid bulk is not included in port throughput numbers, the employment impact in the region doubles: an increase of one million tonnes port throughput is then associated with a regional employment increase of 600 units. This finding confirms the fact that only a few jobs are needed to handle liquid bulk, due to loading and unloading of a large part of this bulk by pipelines. The number of passengers in a port is not correlated to employment in port regions. It has a positive but not statistically significant effect on regional employment. This is probably due to the fact that ferry industries handle large numbers of transit passengers.

Private ports have the largest employment impacts in regions. Their impact per one million additional tonnes of port throughput is 1000 jobs; this is 550 for European ports with the "Latin" governance model and 170 for "Hanseatic" ports. This is rationalised to some extent by the fact that some of these private ports are located close to the main UK cities or are functional to some local industries, therefore the results might be influenced by local situations rather than caused by its governance structure.

1. INTRODUCTION

Historically, transport infrastructures have played an important role in long-term growth and regional development processes, and many economists and studies have sought to quantify this role.[1] Recently, transport economists have shown interest in the impact of different transport nodes, such as ports, on regional development. In particular, economists are looking at what role the efficiency and effectiveness of port activities can play on regional development (Cullinane and Brooks, 2007), the environmental concern associated with port activity and the importance of high-quality land infrastructure as crucial factors for reducing transport sector bottlenecks (*e.g.* OECD, 2002; Ferrari *et al.*, 2011b).

Existing literature lacks systematic evidence on the potential impact of port activity on regional development. This is in part due to the small sample size used in these bodies of literature, as well as the narrow analytical focus - concentrating on local problems or based on case studies - making it difficult to generalise the empirical results. This report addresses this gap by using a broader sample (560 regions from ten OECD western European countries[2]) over a six-year period (2000-06) to evaluate the impact of port activity on regional employment. It includes 116 ports from about 100 regions, considering all main traffic categories (*i.e.* container, liquid bulk, dry bulk, Roll-on/Roll-off (RoRo) self-propelled, Ro-Ro non-self-propelled, other traffic and passengers) to account for the substantial heterogeneity in port specialisation.

The findings in this report are based on the estimation of a set of employment equations using GMM techniques (Blundell and Bond (1998) GMM-System estimator), which are robust to regional unobserved heterogeneity and to endogeneity of port activity. The results showed that port throughput significantly increased employment levels in host regions, with a less pronounced effect on the service sector when compared with manufacturing industries. The analysis also found that there was no statistically significant impact on the number of passengers, and that the employment effects of port throughput tended to be smaller in the case of ports characterised by “Latin" and "Hanseatic" governance models.

This report is organised into six sections, including this introduction (Section 1). Section 2 discusses previous empirical literature and related studies, and Section 3 describes that data used for the analyses. Section 4 presents the empirical model and the econometric issues involved in the applied analysis, and Section 5 reports and discusses the empirical results. The last section, Section 6, concludes and provides possible directions of future research.

2. REVIEW OF LITERATURE ON PORTS AND REGIONAL DEVELOPMENT

The scientific literature related to the regional impacts of transport infrastructure is quite extensive, however, it emphasises the economic effects of roads and railways with less coverage of punctual infrastructures, such as airports and ports. The literature review suggests that while older studies support the theory that transport infrastructure have a positive impact on regional development, more recent works challenge this conclusion (Martin and Rogers, 1995; Fujita and Mori, 1996). These reports go further to suggest that an increase in transport infrastructure endowment leads to the opening up of markets and intensifies the degree of competition to which the local producers are exposed. Stronger competition might induce local producers to innovate and/or cut costs in order to maintain or even expand their competitive position, with positive effects on regional economic growth and, possibly, employment levels. Furthermore, the reduction in transport costs associated with the new transport infrastructure should allow local producers to (1) buy cheaper inputs, (2) specialise in those sectors where the regional economy has a comparative advantage, or (3) find new markets for their products. However, if local producers are not efficient, the construction of the new transport infrastructure, by favouring the import of cheaper goods, might cause, especially in the short run, a reduction in local growth and employment.

Although, the analysis of the economic impact of port infrastructure shares some common elements with other transport infrastructure related studies, further analysis is necessary to fully comprehend the relationship. This is mostly due to port peculiarities and the crucial role ports play within international trade flows – they account for almost 80% of total world trade (UNCTAD, 2009). Some authors have argued that port activities might have a greater impact on regional economies when compared to other transport infrastructures; this is mainly because they generate strong externalities on the hinterland area (Clark *et al.,* 2004). However, the positive effects of port activities on the regional economy have slowed down, especially over the past 40 years, due to changes in the shipping market, *e.g.* the introduction of containers and more capital intensive handling systems, both of which have significantly reduced the direct employment effect (Musso *et al.,* 2000; Cullinane and Brooks, 2007). Furthermore, the benefits of port activities extend beyond the port city or region, and sometimes such benefits are stronger for regions located at a distance from the port of origin. This process – often referred to as "de-maritimisation" – is characterised by the loss of traditional port functions to other regions and is highlighted in studies. The main costs associated with port activities, however, are still localised in the port region, giving rise to possible conflicts within the local community (Hoyle and Hilling, 1984; Ferrari *et al.,* 2006).

The impact of port activity on production costs, on port related activities and on actual organisation of logistics has been analysed by empirical literature.[3] The studies have been conducted by adopting different methodological approaches, like direct surveys, input-output models or descriptive analysis of the economic base of port regions (*e.g.* Rietveld, 1994; Censis Foundation and Federazione del Mare, 1998; Coppens *et al.*, 2007). Most of the papers apply the input-output approach in order to classify the different kinds of economic impacts that ports may have, namely direct, indirect, induced and catalytic. Existing literature also discusses the importance of port governance, in particular the role that port authorities have gained since the 1980s when organisational changes were made to the world port's governance system (*e.g.* Goss 1990a and 1990b). The reforms included the creation of a public body – *i.e.* the Port Authority – responsible for (1) managing port spaces and operations and (2) awarding concessions to private companies for operating port terminals. Under this new framework, port authorities would control concession contracts, which means that they would not only be responsible for assigning the right to use port land to terminal operators, they would also assure constant growth for the port and balanced development for the port region. The port authorities achieve this by reducing negative and encouraging positive externalities (Hall, 2002; Meersman *et al.,* 2009; Ferrari *et al.,* 2011).

3. DATA BEHIND THE ANALYSIS

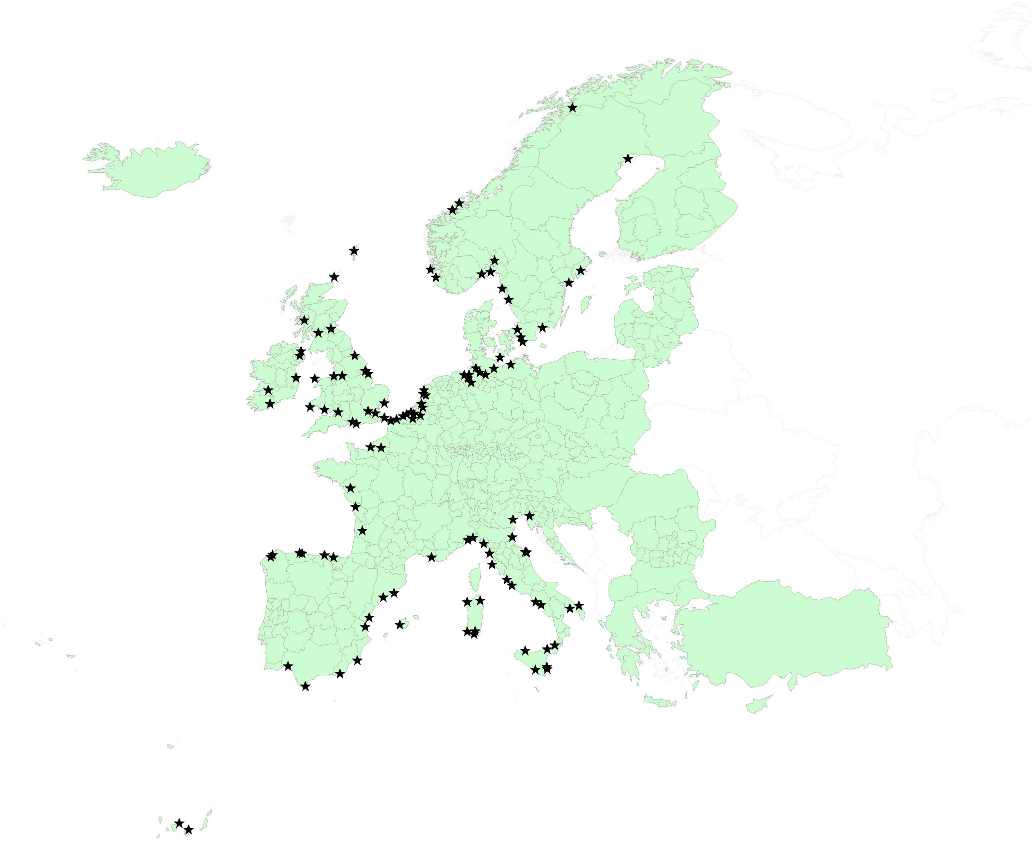
The analysis considers 562 regions using main variables aggregated at OECD Territorial Level 3 (OECD TL-3), which broadly corresponds to regions, provinces or departments, depending on the country considered. In some instances EUROSTAT NUTS-2 variables were used, which aggregate at a slightly higher than OECD TL-3. The analysis further divides the region sample into 97 port regions[4] and 465 non-port regions, so that the effect of port presence on the regional economy can be calculated. Port data are mainly based on the Eurostat-databases, while regional information is based on OECD statistics and on Lloyd's Reports. The largest ports per traffic category (100 ports each), including the passenger sector, were grouped together totalling 116 ports. Ports were also grouped by country (see Table 1) and geographic location (see Figure 1). Some countries have ports in different regions, for example France and Spain, which have ports on their Mediterranean and Atlantic sides and ports located in the Baltic and North Sea regions. Italian ports are an exception; their ports are only located in the Mediterranean. Figure 2 shows the distribution of port locations and suggests that most of the ports are located in the North Sea area (43%) while 32% are located on the Mediterranean.

Table 1. Sample ports by country

Belgium	Antwerp	**Italy**	Porto Foxi	**Norway**	Molde	**UK**	Tees & Hartlepool
Belgium	Zeebrugge	**Italy**	Livorno	**Norway**	Oslo	**UK**	Southampton
Belgium	Ghent	**Italy**	Savona - Vado	**Norway**	Kristiansund	**UK**	Forth
Belgium	Ostende	**Italy**	La Spezia	**Spain**	Algeciras	**UK**	Liverpool
France	Marseille	**Italy**	Santa Panagia	**Spain**	Valencia	**UK**	Dover
France	Le Havre	**Italy**	Milazzo	**Spain**	Barcelona	**UK**	Felixstowe
France	Dunkerque	**Italy**	Napoli	**Spain**	Tarragona	**UK**	Medway
France	Nantes Saint-Nazaire	**Italy**	Olbia	**Spain**	Bilbao	**UK**	Clydeport
France	Rouen	**Italy**	Brindisi	**Spain**	Cartagena	**UK**	Belfast
France	Calais	**Italy**	Piombino	**Spain**	Huelva	**UK**	Sullom Voe
France	Bordeaux	**Italy**	Cagliari	**Spain**	Las Palmas, Gran Canaria	**UK**	Hull
France	La Rochelle	**Italy**	Gela	**Spain**	Gijon	**UK**	Rivers Hull & Humber
Germany	Hamburg	**Italy**	Fiumicino	**Spain**	Santa Cruz De Tenerife	**UK**	Bristol
Germany	Bremerhaven	**Italy**	Palermo	**Spain**	Ferrol	**UK**	Manchester
Germany	Wilhelmshaven	**Italy**	Falconara Marittima	**Spain**	La Coruña	**UK**	Glensanda
Germany	Luebeck	**Italy**	Porto Torres	**Spain**	Castellon De La Plana	**UK**	Port Talbot
Germany	Rostock	**Italy**	Ancona	**Spain**	Palma Mallorca	**UK**	Larne
Germany	Bremen	**Italy**	Salerno	**Spain**	Santander	**UK**	Portsmouth
Germany	Brunsbuettel	**Italy**	Civitavecchia	**Spain**	Aviles	**UK**	Kirkwall
Germany	Brake	**Italy**	Portovesme	**Spain**	Almeria	**UK**	Holyhead

Germany	Buetzfleth	**Netherlands**	Rotterdam	**Sweden**	Goteborg
Germany	Puttgarden	**Netherlands**	Amsterdam	**Sweden**	Brofjorden Scanraff
Ireland	Dublin	**Netherlands**	Vlissingen	**Sweden**	Trelleborg
Ireland	Cork	**Netherlands**	Velsen/Ijmuiden	**Sweden**	Malmo
Ireland	Limerick	**Netherlands**	Terneuzen	**Sweden**	Helsingborg
Italy	Genova	**Netherlands**	Moerdijk	**Sweden**	Lulea
Italy	Trieste	**Norway**	Bergen	**Sweden**	Karlshamn
Italy	Taranto	**Norway**	Narvik	**Sweden**	Oxelosund/Oxelosund SSAB(134)
Italy	Gioia Tauro	**Norway**	Karmsund/Haugesund/Karmøy	**Sweden**	Stockholm
Italy	Venezia	**Norway**	Tonsberg	**UK**	Grimsby & Immingham
Italy	Augusta	**Norway**	Grenland/Skien/Porsgrunn/Bamble	**UK**	London
Italy	Ravenna	**Norway**	Stavanger	**UK**	Milford Haven

Figure 1. Port localisation in Europe



Source: Authors' elaboration

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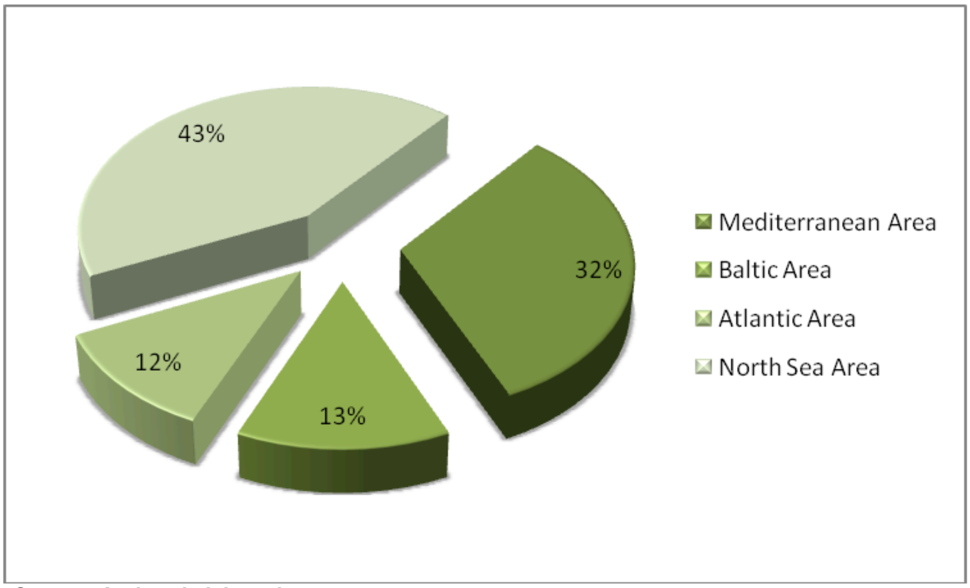
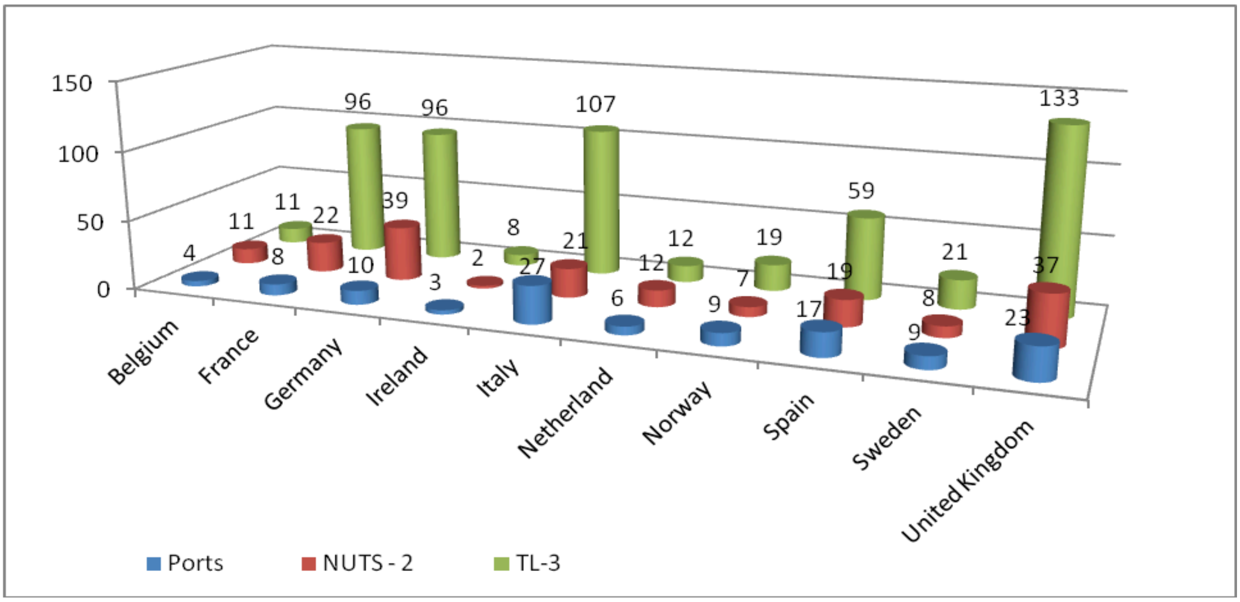
Figure 2. Port localisation according to area in Europe



Source: Authors' elaboration.

Port presence is not related to the territorial statistical aggregations in each country (see Figure 3). As shown, the UK and Italy have the largest numbers of ports and regions. Such heterogeneity is reflected by the variability of the ratio between the number of ports and the territorial units. In particular, Germany and France register a ratio of 1 port per 9.6 regions, and 12 regions against a value of 3.9 for Italy and 3.4 for Spain. These differentials need to be taken into account when discussing the economic impact of port activities, since they reflect different distributions of ports across countries, port size and function differentials.

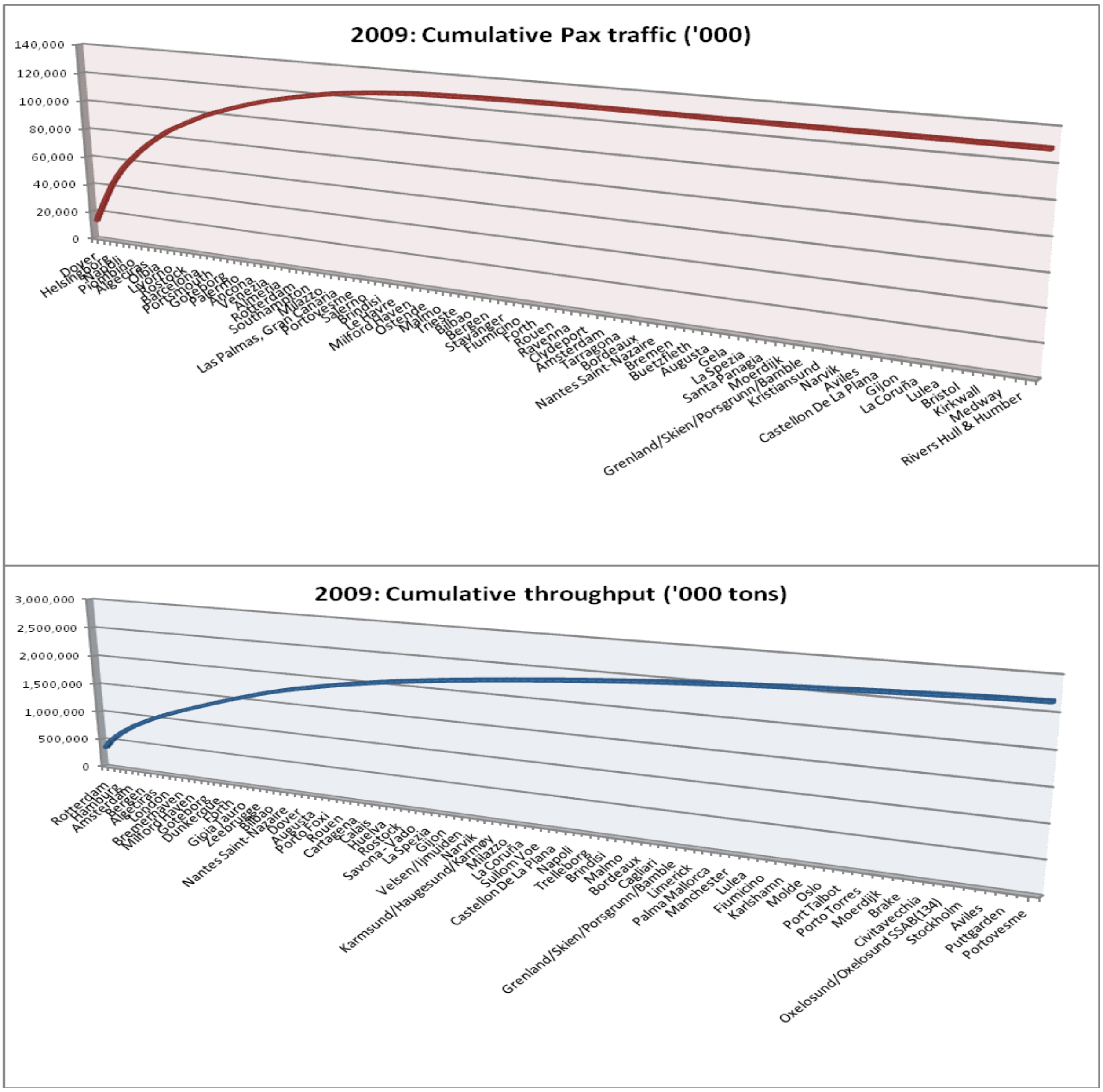
Figure 3. Number of ports, NUTS-2 and TL-3 by country



Source: Authors' elaboration.

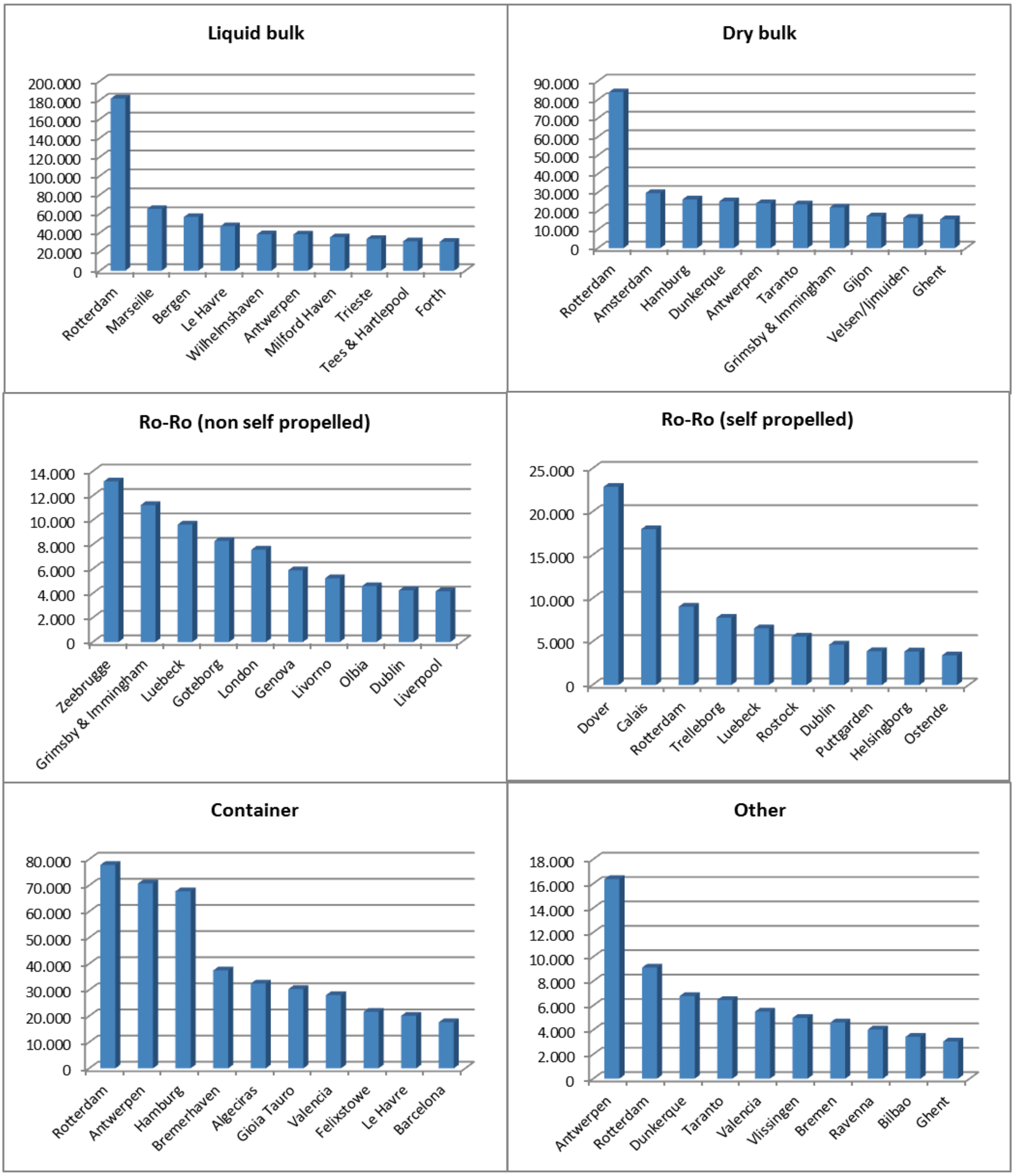
The ports selected registered an average value (during the last five years) of at least 3 million tonnes of total throughput or 1 million of passenger traffic. These criteria exclude the smallest ports, which have little influence on the regional economy but are used for specific purposes, such as the small island ports. Figure 4 suggests that ports belonging to the sample represent the large majority of total port activity, and that the cumulative impact of a single port on the total throughput, as well as on the passenger traffic, is small (zero in the case of the passenger traffic). Data for goods traffic revealed that the Dutch and Belgian ports accounted for almost 25% of total goods traffic in 2009. The English Channel terminals (Dover and Calais) dominated the passenger sector; together they accounted for almost the 20% of the total passenger traffic in 2009. The Swedish ports of Helsingborg and Stockholm registered a 14% share, and the port of Naples accounted for 5% of passenger traffic during the sample period. For Naples, this was mainly due to cruise and the ferry activities.

Figure 4. Cumulative throughput and passenger traffic in 2009



Source: Authors' elaboration.

Figure 5. Top 10 ports' average traffic values in the past 5 years ('000 of tonnes)



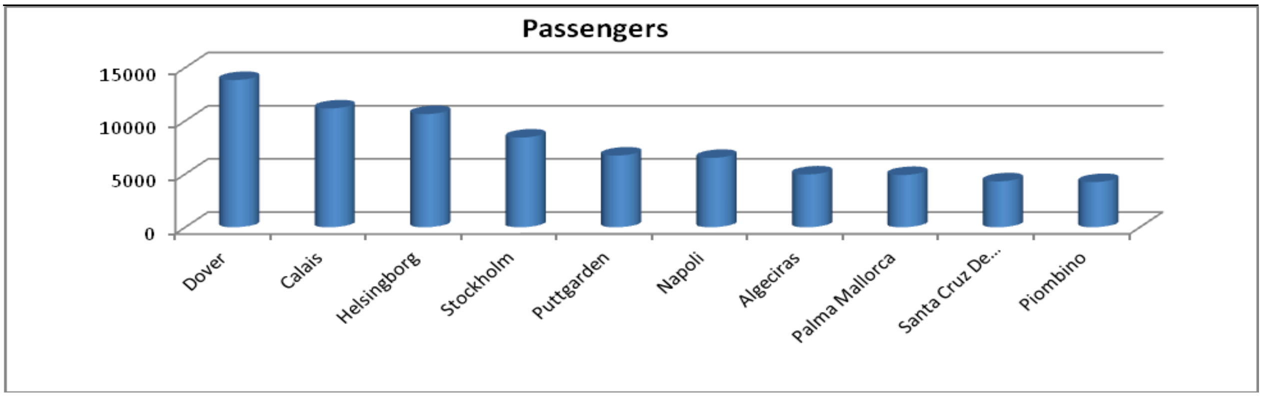
Source: Authors' elaboration on Eurostat statistics.

Review of the different traffic categories, with a focus on the average results reached during the past 5 years by the first 10 ports of the sample (Figure 5), shows Rotterdam in the top 10 of most traffic categories (with the exclusion of Ro-Ro non-self-propelled). Another Belgian port, Antwerp, does not figure in the Ro-Ro markets graph; this is mainly due to competition with Zeebrugge and Oostende, two other Belgian ports that specialise in these shipping sectors.

Figure 5 reflects a ranking of the sampled ports by cargo category. Overall, Mediterranean Sea ports lack representation among the top 10 ports with the exception of the liquid bulk traffic category where two ports (Marseille and Trieste) figure. This is also true for UK ports, where three ports are represented. A similar scenario characterises the dry bulk sector, where the Italian port of Taranto is ranked in the sixth position. The Ro-Ro sector is split into two different sub-sectors (non-self-propelled and self-propelled) according to technology and infrastructure at the port as well as effect on regional employment. The port of Luebeck (Germany) is the only port that ranks in the top ten for both Ro-Ro sub-sectors. Italy and the UK rank highest in the Ro-Ro non-self-propelled sub-sector, while the North or Baltic Sea ports (except for Dublin) dominate the self-propelled sub-sector. When looked at together, Dover and Calais have the most presence sector wide (non-self- and self-propelled). These leading ports registered a boom in goods activities connected with Ro-Ro services during a decade when ferry traffic saw an almost 50% reduction. Turning to container traffic, northern European ports dominate the top ten in this category (*i.e.* Rotterdam, Antwerp, Hamburg) along with three Spanish ports (*i.e.* Algeciras, Valencia, Barcelona) In 2009, the three northern European ports accounted for almost the 40% of total container traffic registered in the sample.

The analysis of the distribution of ports across different traffic categories is an important issue because of the possible direct and induced impacts each traffic category could have on hinterland economy. Liquid bulk traffic is generally found to have a small effect on employment and on regional port economies, while containers and Ro-Ro traffic tend to have a stronger impact on the performance of the port region. Container traffic, while not labour intensive, provides more added-value services when compared to other traffic categories. As a result, it has a highly induced effect on employment. Within the Ro-Ro sector, non-self-propelled services tend to require more investments and organisational structure, potentially generating a stronger productive effect on employment than self-propelled services. Regarding passenger traffic, it is arguable that this sector should have a great impact on regional economy due to infrastructure provision requirements and possible expansive effects induced by tourist expenditure. However, research shows that several of the port cities in the sample with high passenger volumes do not have high tourist traffic, in which case the effect on employment might not be observed. Figure 6 shows the main passenger ports and their traffic intensity.

Figure 6. Top ten sample ports in the passenger traffic sector, based on average passenger traffic over the last five years ('000 of passengers)



Source: Authors' elaboration on Eurostat statistics.

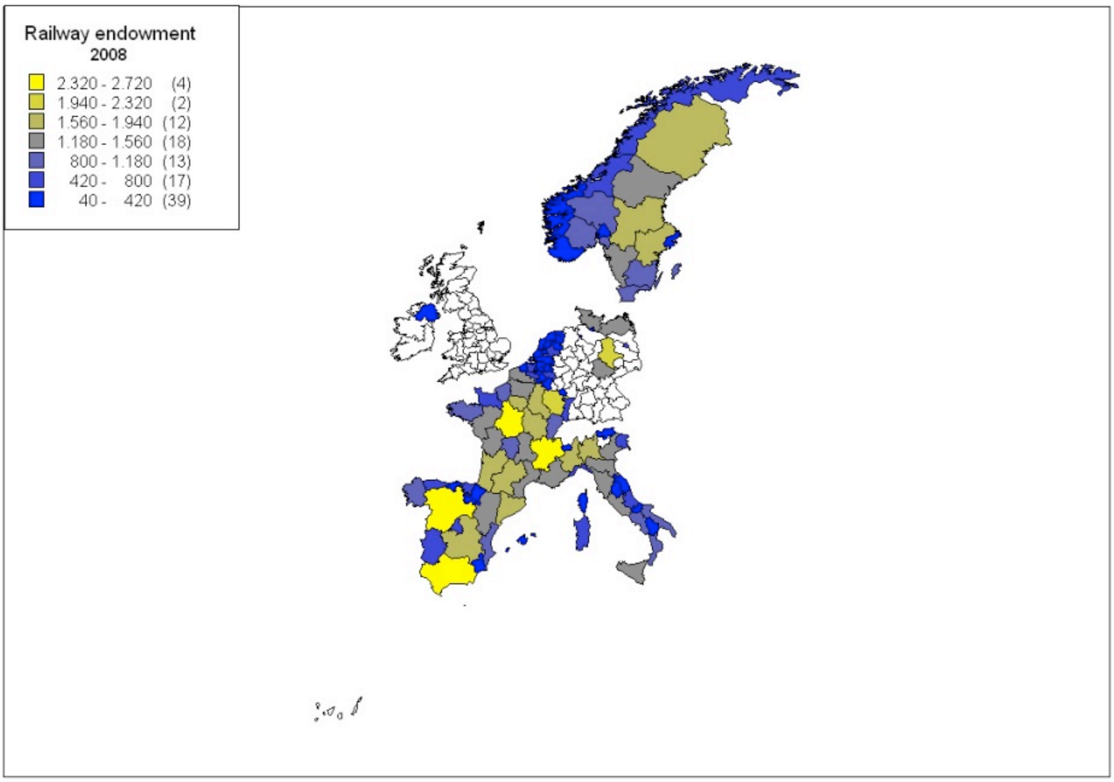
The positioning of ports within the rankings differs across countries. For example, Italy and Spain have many ports, but they do not handle a significant quantity of goods. In contrast, although they have few ports, Belgian and Dutch ports account for a significant share of traffic. The UK is represented by one port in the top ten across traffic categories. Germany and France have at least one big port within the first five positions in the majority of the traffic rankings. Ireland and Norway never figure in the top ten, and Sweden only appears once in the passenger traffic group.

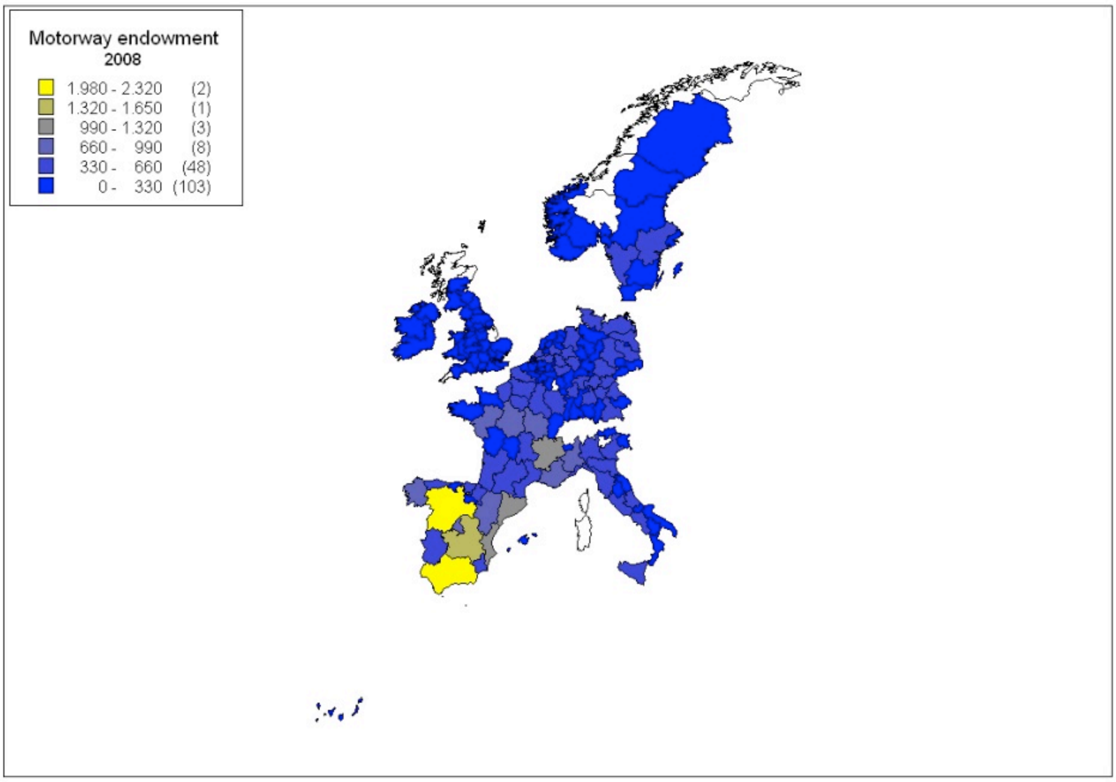
Date on infrastructure endowment, demographics, innovation and employment were collected for the regions and included in the sample to deduce the main characteristics of the regions. Infrastructure provision is aggregated according to NUTS-2, the employment data is aggregated using TL-3 and the demographic data are represented in both aggregation levels, depending on the specific information collected.Concerning infrastructure endowment, Figure 7 underlines how the provision of motorway networks is quite homogeneous in all observed regions: more than 90% of the analysed NUTS-2 register a value lower than 660 km, while only two register a value higher than 2000 km (*i.e.* the biggest Spanish regions). In contrast, the railway network is less uniformly distributed across regions. However, data on railway infrastructure are lacking for countries such as the UK, Ireland and Germany, which have a good reputation with regard to railway quality and density. Moreover, the heterogeneity in observed railway endowment is linked to differences in physical characteristics and territorial organisation (*e.g.* NUTS-2 regions in Spain are much larger than in other Mediterranean countries).

Regarding demographics, the regions in the sample registered a significant difference in population distribution. Figure 8 shows the "Blue Banana" consisting of greater London, Flanders, Randstad, the Rheine-Ruhr area, up until Milan, combined with more "isolated" city-regions, including Paris, Madrid and Rome with high population density, and others with low population density, such as Norway, Sweden and Scotland. Figure 8 also shows an indicator of innovation, namely the number of patent applications, and highlights the difference in patents per habitants among Latin countries and German regions.

It is important to consider how economic activity is distributed across the industry and service sectors within each region when analysing the effect of port throughput on regional employment. Combined with port functional characteristics this information might influence the expansive impact of port activities spread over different regions. Figure 9 shows the distribution of employment in the industry and services sectors. Northern European countries, southern France and Rome show the highest values of employed people in the service sector, while Italy and Spain register the highest values of industrial employment. France has relatively low values in both industry and service sectors due to the higher share of agricultural employment.

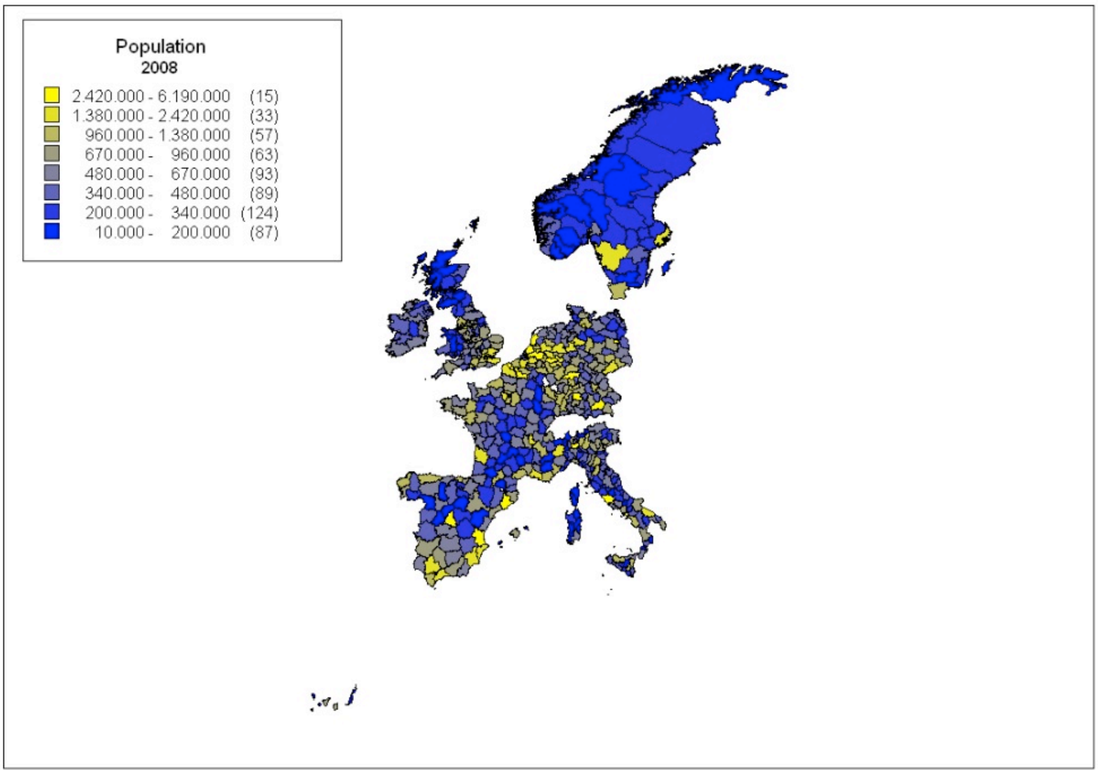
Figure 1. Figure 7. Kilometres of infrastructure (NUTS-2)

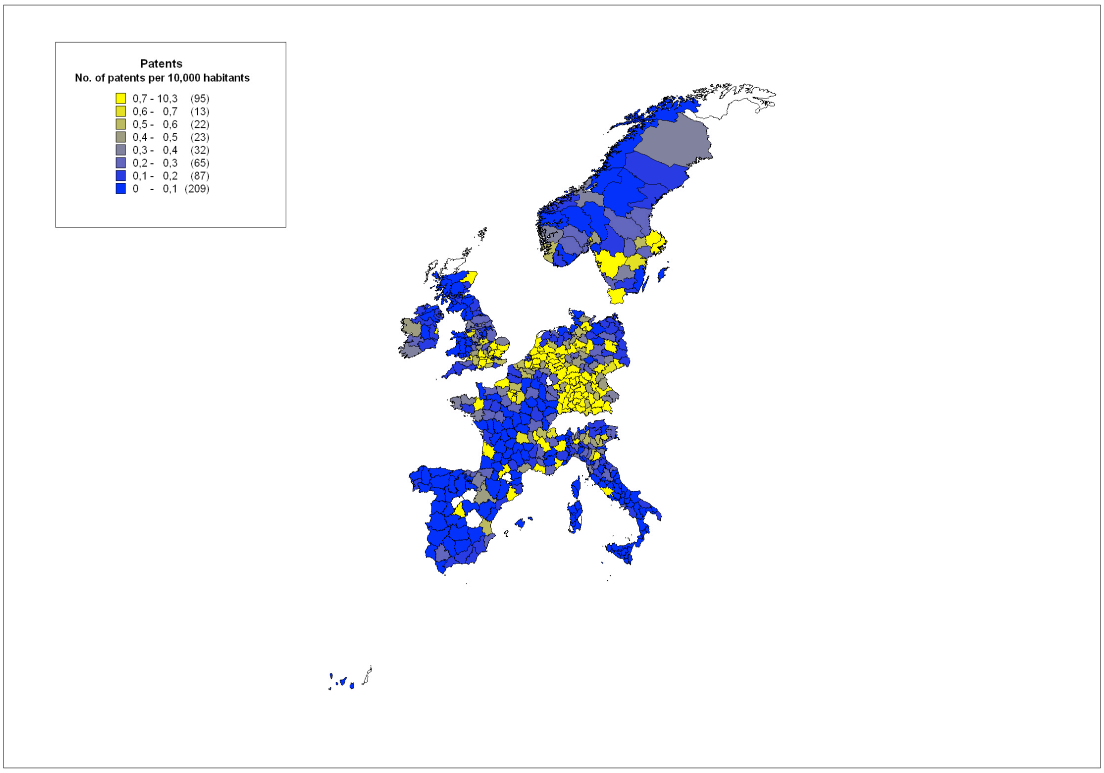




Source: Authors' elaboration on Eurostat statistics, 2012. Data for Norway and UK are only partially available

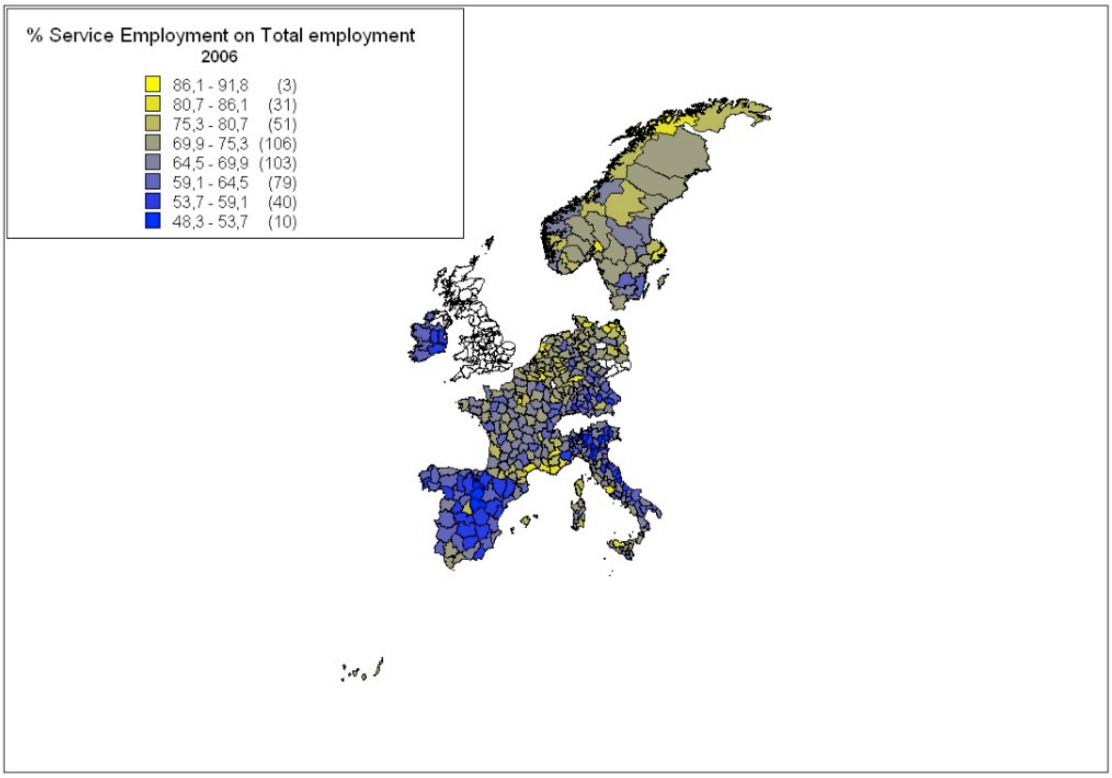
Figure 8. Total population and patents per 10,000 habitants

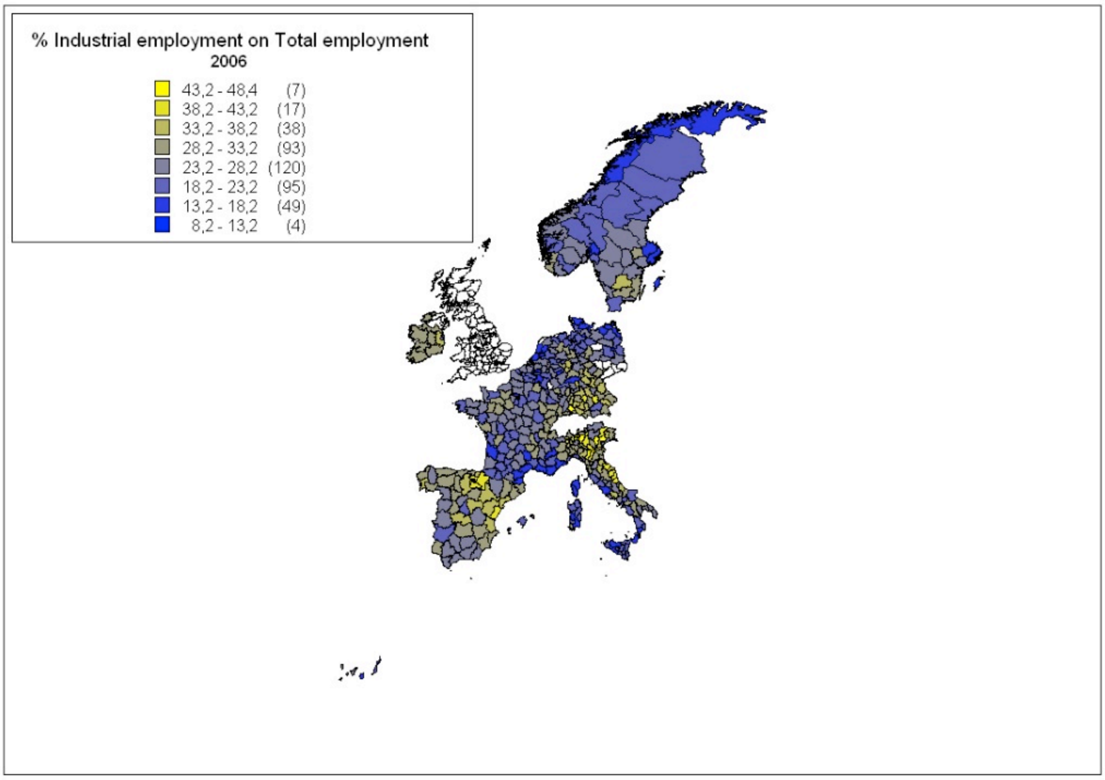




Source: Authors' elaboration on OECD and Eurostat statistics.

Figure 9. Percentage of employees of the main sectors on total employment (TL3)





Source: Authors' elaboration on OECD statistics.

There are considerable differences between the 97 regions with at least one port (port regions) and the 465 regions without a port (non-port regions) considered in this study (see Table 2). Table 2 shows that non-port regions tend to have a slightly higher stock of motorway infrastructure per person, while the service sector in port regions has, on average, a higher share in total employment. Moreover, port regions experience large size differentials in passengers and throughput levels.

There is some heterogeneity in the way ports are managed among the ports in the sample despite the number of countries and different institutional settings of the ports in the study. The Latin and Hanseatic "landlord model" of management, which is analysed in this study, is predominant in the European regions, while the private management model adopted in the UK is rare in Europe. Furthermore, some ports have a governance structure that fits neither category, which is denoted as "other ports".

The most important differences across governance models relate to the level of local and national government intervention in port activities. The landlord models vary in the degree of government intervention, but a public body manages and plans port development in both models. The Hanseatic model offers more flexibility in the management of port operations, with less government control. The port authority in this model is usually partially privatised. In contrast, the Latin model is more traditional with more power given to the port authority. In the private model, firms are not constrained by a public body – *i.e.* a Port Authority. Of the port regions included in the study sample, 16 can be considered Hanseatic, 44 Latin, 21 Private and 16 other ports.

Table 2. Summary of study statistics

	Minimum	Maximum	Mean	St Dev.	Median
Port regions (97)					
Throughput ('000 of tonnes)	0	353.576	24.254	37.321	13.402
Passenger traffic ('000 of pax)	0	16.449	1.146	2.602	116
Employment	3.200	2.663.100	369.652	392.246	226.050
Industry employment	800	865.100	97.857	113.255	61.800
Service employment	2.200	1.765.700	299.302	313.813	173.550
Motorways (km/pop)	0	0.025	0.00072	0.0016	0.0004
Patents	0	2.482	83	229	22
Non-port regions (465)					
Throughput ('000 of tonnes)	0	0	0	0	0
Passenger traffic ('000 of pax)	0	0	0	0	0
Employment	7.400	3.187.100	259.784	286.519	179.100
Industry employment	1.800	703.000	72.114	74.854	54.550
Service employment	5.500	2.469.400	186.217	232.840	119.900
Motorways (km/pop)	0	0.018	0.0011	0.0015	0.00057
Patents	0	1.518	66	131	23

4. ECONOMETRIC MODEL AND EMPIRICAL RESULTS

The estimation of the employment effect of port activities within the host region raises a series of significant econometric challenges. The first issue is the possibility that the correlation between the two might be spurious. For instance, endogeneity could arise from the correlation of port activity and regional employment with a common unobserved variable that drives both, or from reverse causality from employment levels to port activity. The use of panel data is helpful in addressing endogeneity concerns. It uses well-established panel data GMM techniques that take into account (1) the effect of unobserved, time-invariant regional variables driving both regional employment and port activity and (2) other sources of simultaneity concerns.

These techniques, however, do not consider that the level of port activity in most of the sample regions is zero because there is no port. This implies that these techniques, for example, would be treating an increase in port passengers from 0 to 100,000 exactly the same as an increase from 100,000 to 200,000, although qualitatively they are a different form of increase. One way of dealing with this problem is to make use of recently developed empirical techniques in the econometrics of program evaluation (Wooldridge, 2010). Within this theoretical framework, the effect of port activity (*e.g.* the number of passengers in the region's ports) on regional employment could be interpreted similarly to the effect of a treatment on a particular outcome. In particular, port activity could be seen as a sort of "continuous treatment", whereby a value of zero would amount to a region that is not "treated".

According to this approach, the magnitude of port activity within a region should be first explained by taking into account its left censoring, possible sample selection bias and treatment endogeneity. If this is done, the results might help to explain the impact of port activity on regional employment. However, the very few empirical applications that were found in the literature (see for instance Wooldridge, 2009) have been applied in a cross sectional context[5] and not in a panel data. This adds additional layers of complexity to the estimation. Furthermore, convincing exclusion restrictions - *i.e.* information on time varying variables that could explain the existence of a port and/or the amount of port activity - but not directly correlated to regional employment, are needed but not available.

For this reason, this study does not deal with the right censoring problem of port activity and uses conventional GMM panel data techniques to address endogeneity concerns. In order to assess whether the port's activity in a region affects regional employment levels, estimations of different versions of the following baseline employment equation were used:

$$ln\ Emp_{it} = \alpha\ ln\ Emp_{it-1} + Y'\beta + X'\gamma + u_{it} \qquad (1)$$

Where $lnEmp_{it}$ represents the log of the number of employed persons in the region i as of time t; $lnEmp_{it-1}$ is the first lag of employment, which is included given that the adjustment costs of employment preclude instantaneous adjustments to the long run equilibrium; Y is a vector of port activities, comprised of the number of passengers that used the ports of region i as of time t, and of a port's throughput or, depending on model specification, net throughput in region i as of time t; in turn, X is a vector of regional control variables and $u_{it} = e_i + t_t + v_{it}$ is an error term. The error term is composed of e_i, a set of region specific fixed effects, potentially correlated with regressors, which captures the effects of regional unobserved time invariant heterogeneity, such as institutions, levels of economic development, the structure and composition of the regional economy, etc.; t_t, a set of year fixed effects proxying for common macroeconomic effects and represented by a full set of year dummy variables and v_{it}, an idiosyncratic error term.

As noted above, the estimation of equation (1) raises a set of important econometric challenges. First, the region-specific fixed effects are correlated by construction with the lag of employment, giving rise to a problem of endogeneity and therefore to parameter estimates that would be biased and inconsistent in the case of ordinary least squares (OLS). Moreover, it seems unlikely that the level of port activity could be considered strictly exogenous. In fact, it is possible that a current or past shock to regional employment might affect the future level of port activity within the region: for instance, under some conditions, a positive shock to productivity in the region of interest, by raising output, might induce an increase in the demand for labour and, *ceteris paribus*, in regional employment. In turn, the increase in regional production might also lead to an increase, both in current and future periods, in demand for port services, introducing a correlation between Y and v_{it}.

A possible solution to deal with endogeneity concerns is to first differentiate equation (1) to get rid of the region-specific fixed effects and to use appropriate lags of the endogenous variables as instruments, using the Arellano-Bond (1991) GMM Difference estimator[6]. This approach allows for the removal of possible estimation biases arising from correlation of e_i with the regressors due to the existence of regional persistent features that drive both port activity and regional employment. However, this type of estimator is known to yield imprecise parameter estimates when included variables are very persistent, as in our sample[7]. The Blundell and Bond (1998) GMM-SYS estimator that jointly estimates the difference and the level versions of equation (1)[8] can provide more precise parameter estimates and, for this reason, it is the estimator employed in this study.[9] The main results of the paper also arise when the analysis is restricted of regions with at least one port, even if the employment effect of port activity tends to be slightly smaller in this case.

Table 3 shows the empirical results of the analysis. Column 1 reports a simple specification of equation (1), which includes the autoregressive component of employment and port throughput as the only proxy for port activity. Regression results show that including the lag of (log) employment was justified, because the magnitude of the coefficient is close to one. More importantly, port throughput enters significantly into the regression equation, with a coefficient of 0.0003; in this case, an increase of one million tonnes in port throughput is associated to an increase in employment of 0.0003%: which means that in a region with one million employees, employment would be increased by 300 units. This is not a very large effect, but not a negligible one either, if we consider that it represents only the instantaneous response of regional employment to port throughput. The long-run effect, which can be estimated as β / (1 - α), amounts to 0.0075. In a region with an employment level of one million units, an increase of 1 million tonnes in port throughput would lead, in the long run, to an increase in employment of about 7500 units.

Column 2 includes net throughput instead of total throughput. Since the total throughput also includes liquid bulk, which is expected to add very little to port region employment, net throughput might be a more precise measure of port activities, which might impact the regional economy. The coefficient had twice the effect on total throughput, and net throughput was maintained in the remaining specifications. The main findings were also confirmed with total throughput. The potential employment effect of liquid bulk is usually considered negligible because it does not require a large labour force for handling. Liquid bulk is unlikely to generate a sizeable employment impact in the host region due to (1) low added value produced for the port regions and (2) the presence of long distance pipelines starting from ports.

To check whether a non-linear effect of port output on regional employment existed, the squared product of port throughput was added to the equation. It is conceivable that the largest ports generate some of their employment effects outside their host region. In other words, it could be expected that the marginal employment effect of port output would fall within the level of port activity in the region. Empirical results (available from the authors upon request) confirm the existence of a statistically significant non-linear employment effect of port throughput; however, the non-linearity is so weak that for all ports in our sample the employment effect is positive, statistically significant and very similar to the estimates reported in Column 2.

Column 3 adds the second dimension of port activity, namely the number of passengers that used the regions' ports. The empirical results show, even including the number of passengers, that port net throughput enters positively and significantly into the equation with a barely unaltered coefficient. In turn, the number of passengers has a positive but not statistically significant effect on regional employment: this fact is probably due to the characteristics of the ferry industry and terminals that handle huge amounts of transit passengers that normally do not directly affect the regional economies, or to multicollinearity problems with net throughput.

The length of the motorway network in the region was added in Column 4. This inclusion is important for two main reasons: (1) the existence of a motorway network could significantly affect a region's output and employment; and (2) the existence of a well-developed network in the region where a port is located can be necessary for a port to display its positive effect on the host region’s economic development. Econometric results reported in Column 4 suggest that the length of a motorway network exerts a positive and significant impact on regional employment. Given that both employment and motorways are in logs, the coefficient can be interpreted as an elasticity, where a 10% increase in the length of the motorway network is associated to a 0.2 per cent increase in regional employment[10] This result can be compared to Jiwattanakulpaisaran *et al.* (2009), which did not find any discernible effects of highways on regional employment in a sample of North Carolina counties; and Clark and Murphy (1996), which in turn found a positive effect of highway stock on regional employment. Moreover, the coefficient of net throughput falls – probably indicating that previous estimates were capturing in part the effect of the motorway network – but remains statistically significant at 5%.

Column 5 tackles another econometric issue: The regional data in this study belong to ten EU countries, and it is possible that the existence of country specific business cycles, country specific changes in the structure of the economy or, more generally, country macroeconomic developments might be, at least in part, responsible for the positive association between port activity and regional employment. In other words, there can be country specific omitted factors that might drive both employment and port activity within regions located in each country. In order to control for this possibility, a full set of country-year dummy variables was added that capture these high frequency changes in employment levels. This ensures that the impact of port activity on regional employment is not driven by national specific factors. As estimates show, the coefficient of net throughput is still positive, although only statistically significant at 10%. Furthermore, the impact of the motorway network is no longer statistically significant while the number of patents, included for the first time into the regression equation, is positive and significant at the 5% level of significance.[11]

Table 3. Empirical results

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep var	**Emp**	**Emp**	**Emp**	**Emp**	**Emp**	**Emp**	**lndemp**	**Seremp**
Emp_{t-1}	0.96*** (81.0)	0.96*** (64.2)	0.95*** (68.2)	1.00*** (81.3)	0.95*** (44.4)	0.99*** (155.9)	0.93*** (53.3)	0.96*** (81.0)
Output	0.0003** (2.21)	-	-	-	-	-	-	-
Net output	-	0.0006** (2.04)	0.0006*** (2.67)	0.0004** (1.98)	0.0004* (1.66)	-	0.0007** (2.34)	0.0004** (2.45)
Passengers	-	-	0.0009 (0.74)	-0.0006 (0.73)	0.0004 (0.12)	-	0.0025 (0.67)	0.0032 (1.57)
Motorways	-	-	-	0.02*** (2.73)	-0.004 (-0.40)	0.018*** (2.99)	-	-
LnPat	-	-	-	-	0.016** (2.21)	-	-	-
Net output*Hanseat	-	-	-	-	-	0.00017* (1.78)	-	-
Net output*latin	-	-	-	-	-	0.00055** (1.99)	-	-
Net output*other	-	-	-	-	-	0.0029** (2.10)	-	-
Net output*private	-	-	-	-	-	0.001* (1.89)	-	-
AR(1)	0.00	0.00	0.00	0.00	0.00	0.40	0.00	0.00
AR(2)	0.34	0.33	0.34	0.37	0.79	0.40	0.95	0.04
Hansen	0.50	0.85	0.75	0.64	0.43	0.71	0.18	0.001
Diff Hansen	0.63	0.95	0.60	0.52	0.39	0.91	0.12	0.000

Notes: All regressions contain a set of region- and time-fixed effects. Column 5 contains a full set of country*year fixed effects. AR(1) and AR(2) are the Arellano and Bond tests for first and second order serial correlation; Hansen is the p value of the Hansen test for over identifying restrictions; Diff Hansen is the Hansen test for over identifying restrictions of the instruments of the level equation. Instruments: lnEmp, Output, Net Output and Passengers (when included in the regression) dated T-2 in the first differenced equation in columns 1-5 and 7-8 and T-3 and T-4 in column 6; ΔEmp, ΔOutput, ΔNet Output, ΔPassengers (when included in the regression) dated T-1 in the level equation in column 1-5 and 7-8 and T-2 and T-3 in column 6. ***, **, *= statistically significant at 1%, 5% and 10%, respectively. Standard errors robust to heterosckedasticity and to serial correlation within regions. All regressions estimated with the XTABOND2 routine in STATA.

Estimates of the baseline specification of equation (1) are reported in Column 6 where the effect of net throughput varies according to port governance structures. As parameter estimates suggest, some heterogeneity is found in the effects of port throughput on regional employment: for instance, the Hanseatic and Latin governance models are associated with a lower employment impact of port net throughput, while port activity seems to boost more regional employment under the other and private models. This can be rationalised by the location of the ports: the other and private models are mainly located close to the biggest UK cities (Belfast, Bristol, Liverpool, London, Manchester) or owned by industrial users. These types of local situations could influence the results.

Finally, in the last two columns of Table 3 total regional employment was replaced with industry and service employment, respectively, using the model otherwise identical to that reported in Column 3. The results show that the impact of net throughput is slightly larger in the case of industry employment – these results might depend on the peculiarity of many maritime service activities that tend to be relatively mobile. Furthermore, passenger numbers are almost significant in the service employment regression. However, the test statistics reported in Table 3 show that there are signs of both serial correlation (the AR(2) test is significant at 5%, reflecting first order serial correlation in the error term) and invalidity of the over identifying restrictions for the service employment regression. This suggests that the instruments could not be interpreted as exogenous. For these reasons, the results reported in Column 8 should be viewed with some skepticism.

5. CONCLUSION AND FURTHER RESEARCH

The results in this study are consistent with the case study findings conducted within the framework of the OECD Port-Cities Programme. The underlying hypothesis of this programme is the existence of a global-local mismatch in port-cities between "costs" and "benefits" of the presence of a large port, with costs, such as environmental and social costs, mostly localised; and benefits, such as employment and value added, having important spillovers to other regions (*e.g.* Musso *et al.,* 2000; OECD, 2010). This hypothesis was elaborated and confirmed in several case studies on northwestern European ports: the Seine Axis (Le Havre/Rouen/Paris/Caen), Hamburg and Rotterdam/Amsterdam (Merk *et al.,* 2011; Merk and Hesse, 2012; Merk and Notteboom, forthcoming). These case studies calculated the backward linkages of port clusters in a multi-regional input-output-analysis, allowing for indication of main sectors connected to the port cluster, as well as an assessment of the main regions where these effects occurred (regional embeddedness or inter-regional spillovers). Despite considerable differences in the extent of regional embeddedness, a general finding for the four port clusters of Rotterdam, Antwerp, Hamburg and Le Havre/Rouen was the existence of substantial spillovers to other regions (a comparison of these four cases is given in Merk *et al.* (forthcoming).

The main research goal was to investigate the impact of port activities on the regional economy. This was done by estimating a set of employment equations with the Blundell and Bond (1998) GMM System estimator for a sample of 560 EU regions observed over the period 2000-06, detailing throughput information for the main 116 ports. Evidence suggests a positive and significant impact of seaport activities on employment levels in the hinterland regions. Parameter estimates suggest that, for instance, in a region with one million workers, an increase of 1 million tonnes of port throughput determines an immediate increase of about 400-600 jobs, depending on the model specification; in turn, over the long run, the impact is much higher, and it could amount to about 7 500 new jobs.

These results are robust to the use of different definitions of output. They are confirmed when passenger traffic is controlled and when the employment effect of ports activity varies with governance model. An interesting observation is the difference in effect on regional employment between governance models: private ports seem to have a larger effect on regional employment compared to ports governed by Hanseatic and Latin models. This result deserves further scrutiny, however, as it might related to the heterogeneity of port functions and localisation of ports, as well as to the need to control for other regional characteristics, such as regional accessibility and attractiveness. Another interesting finding is the relationship between port activities and service employment. Port activities have a lower impact on service employment because port related services are not necessarily localised in the port regions. This finding should be analysed further to better understand the effects of delocalisation of maritime services and how it can affect the port impact on the local communities.

The relatively limited employment effects of additional port throughput could be explained by the fact that service or high value added employment related to the ports sector is localised somewhere else. This could be particularly relevant for port regions that are relatively close to a much larger metropolitan area without a port. Such a constellation exists between Le Havre (having a large port but small city population), which is located relatively close to Paris (being a large metropole without a seaport). Merk *et a*l.,2011 found that in similar cases high value-added, port-related employment is located in the metropolitan area, rather than in the smaller port-city.

The findings in this paper do not prove economic spillovers, rather they indicate that certain cargo categories (liquid bulk) and passengers do not have significant employment effects in the port-region. This could give rise to reflections on whether these employment effects occur somewhere else. This paper also indicates that there are employment effects for the more labour-intensive cargo categories, such as dry bulk and general cargo, in line with the comparisons between the different ports within the Seine Axis (Merk *et al.*, 2011). Further research should (1) take into account the possibility of splitting the effects of different traffic categories, (2) conduct a deeper analysis of the effect of local characteristics (*e.g.* port governance, port function, port localisation), (3) compare different realities (*e.g.* European and South American regions) in order to better understand possible geographical differences in port effects.

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NOTES

[1] See Afraz *et al.* (2006) for a recent literature review on the quantification of transportation infrastructure on long-run growth and development processes.

[2] France, Italy, Spain, Belgium, Germany, Ireland, Netherlands, Norway, Sweden, and United Kingdom.

[3] E.g. Gripaios and Gripaios, 1995; Castro-Villaverde and Millan-Coco, 1998; Haezendock *et al.*, 2000; Notteboom and Winkelmans, 2001.

[4] Regions are classified as "port regions" if they have one or more port

[5] Ferrari *et al.* (2010) employs a similar approach in an Italian study, which finds that regional employment is positively correlated with port output.

[6] In other words, in the case of port activity variables, the identification assumption is that current levels of port activity are not correlated with future shocks to employment levels, which seems to be a reasonable hypothesis to defend.

[7] In practice, when a series is very persistent, its changes are often a poor predictor of its levels, making the GMM difference estimates imprecise.

[8] In the GMM-SYS estimator the lagged changes of endogenous variables are used as instruments for their levels.

[9] See Bottasso and Conti (2010) for an empirical application in a study of the economic effects of transport infrastructure.

[10] The positive effect of motorway networks on regional employment is confirmed if we address possible endogeneity concerns by instrumenting it with its own lags. Results are available from the authors upon requests.

[11] The positive correlation between regional employment and the number of patents is not very robust to different specifications of equation (1).