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The European Port Industry: An Analysis of its Economic Efficiency

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THE EUROPEAN PORT INDUSTRY:

AN ANALYSIS OF ITS ECONOMIC EFFICIENCY

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Abstract

Because of their critical strategic role, ports have all traditionally been subject to some form of government control even if the legal form and the intensity of this control have varied across countries. The member countries of the European Union have not been different from the rest of the world in this respect. A significant difference however is the recurrent effort to integrate, in a coordinated way, the port sector in a transeuropean transport network (TEN-T) through the adoption of a common legal framework. In this context, if the objective of the reforms is to ensure that port networks, integrated in combined transport networks, become competitors of the road network, the concept of port efficiency becomes central. This paper provides an overview of the evolution of the European Port Legislation and shows how comparative economic measures can be used to highlight the scope for port efficiency improvements, essential to allow short sea shipping transport to compete with road transport in Europe. To our knowledge, this paper is also the first effort of estimating technical efficiency of European Port Authorities. The average port efficiency in 2002 was estimated to be around 60%, denoting that ports could have handled 40% more traffic with the same resources.

Keywords: Technical efficiency; European ports regulation; Trans-European transport networks; motorways of the sea.

JEL-Classification: C6, L9

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INTRODUCTION

There are 2.814 international ports catering to freight traffic registered in the world. Port traffic increases at an average rate of about 3% per year. Nearly 90% of goods exchanged through international trade in the world rely on maritime transport along the logistic chain that takes them from their origin to their destination. A large share of that trade would not exist without the port infrastructures which are at the interface between maritime transport and land transport or inland navigation. All this defines ports as economic and service units of notable importance in the global economy. This is why they are also at the center of all intermodal policy decisions.

The European port system is not different. It follows the world trends in the industry, adopting new maritime transport technologies as they emerge and searching for organizational forms which allow them to improve their efficiency and ease their integration in the transport component of the logistic chain. Simultaneous to the global evolution of maritime transport, there is a liberalization of transport markets proper in Europe. The European Union transport policy in fact considers that the transport liberalization decided in the 1980s and 1990s is concluded or about to be concluded. However, this is not the case for the European port industry. The debate is actually very much alive as demonstrated by the recent Directive proposal on the liberalization of port services (EU Commission, 2004b). The port sector is in fact the only component of the logistic chain without a European legal framework. Indeed, no agreement comparable to those reached in other transport modes has been reached for the port sector.

This paper presents an assessment of the European port policy with a focus on the efficiency of its ports authority in view of the fact that one of the declared objectives of the reform proposals is the improvement of the efficiency of the overall port system. To quantify the efficiency of the management of port infrastructures by port authorities, we utilize a *distance function*, the latest measurement technique increasingly adopted by experts in the field of efficiency measurement for performance evaluation.

The paper is organized as follows. The next section summarizes the main economic characteristics of the port industry relevant to the assessment of the efficiency of port

infrastructures as well as those of direct interest in the context of the European Commission policy. The third section analyzes the economic regulation of the industry in Europe as well as the various attempts to reach an agreement on the level and degree of its liberalization. In the next section, we highlight the importance of measuring the efficiency of the port system and the contribution that distance function can make given the limited information available. The fifth section provides the results. The last section concludes.

ECONOMIC CHARACTERISTICS AND COMPETITION IN THE PORT INDUSTRY

The assessment of the economic efficiency of a port needs to be quite clear about the dimensions of the industry to be analyzed. Indeed, the first obvious characteristic of the port industry is the diversity of its activities. The opportunities to introduce competition in the delivery of port services and the optimal way of doing so depends on the size of the port and the service considered. The calibration of the actual opportunities to liberalize and achieve efficiency gains thus depends on the detailed knowledge of the structure and nature of the various activities.[1]

The scope for efficiency improvements from the new competitive environment towards which the world port industry seems to be moving also requires a detailed assessment of the public institutions influencing the operation of the sector (ministries, public agencies and port authorities). In that context, there seems to be a trend towards a narrow number of strategic concerns in the industry: commercialization and corporatization; liberalization and deregulation; privatization and re-regulation, as discussed the 2007 version of the World Bank Port Reform Toolkit.[2]

The European experience is somewhat different from the experience in other parts of the world, in particular Africa, Latin America, The Middle East and South Asia. In those regions, the introduction of the private sector has however generally been through competition *for* the markets and the award of concessions to operate the port or terminals in the port, rather than through the sale of public port assets. This has allowed port authorities to reduce their role in the sector while keeping the assets formally under public ownership. In the process, ports have been transformed into *landlord* types of organizations.[3]

In Europe, reforms started with a gradual increase in the role of the private sector in port services, with a continuous control of the assets' ownership by the public sector. That is why, more than in other parts of the world, the European public sector has also often continued to provide subsidies to finance some of the investments needed. There has been for some time a debate as to whether subsidies should be eliminated or not. The main concern is indeed that with pervasive subsidies, it is likely to be difficult for the European Union (EU) to introduce competition equitably across countries since they have different abilities to give subsidies (Trujillo and Nombela, 2000).

In sum, the international experience suggests that the scope for an improved liberalization of the European port sector is real. Furthermore, the main issues associated with the introduction of an increased role for the private sector are well known. The main question is: Why has the European Commission (EC) not yet adopted for the port sector some of the liberalization measures already adopted for other transport activities?

PORT REGULATION AND PORT POLICY IN THE EUROPEAN UNION

Since its creation, the European Community, which was reinforced by the creation of the Common Market, is governed by the rules laid down in the Treaty of Rome. These rules are essentially concerned with competition, monopolies and state aid. These are the basic rules against which the legal performance of the European port sector need to be benchmarked. Limitations to competition and restrictions to entry by private operators run the risk of being seen as a violation of the Rome Treaty (Fleming and Baird, 1999). This was already noted in the recommendations of the EU Parliament in 1993 when it suggested to the member countries to modify their legislation to remove anti-competitive practices in port services.

The EU has developed multiple instruments to promote competition in the European port industry. This started in 1997 with the publication of the Green Paper on ports and maritime infrastructures (EU Commission 1997). This document already suggested opening the debate on port and maritime infrastructure efficiency, the imposition of competition rules in the sector as well as the integration of ports into the multimodal vision of the sector in a European multimodal transport network. The Green Paper also suggested the development of a regulation

at European level to achieve a liberalization of the market for port services in the main ports.

The position of the Member States with respect to the role of ports in the EU decisions has always depended, as in many other fields, on the economic significance of ports in their own transport system. Traditionally, the member states and the most important ports appear to have resisted the launching of a common port policy, out of fear that the creation of a new European port structure would reduce their autonomy. The reactions to the Directive on the liberalization of access to port services were very diverse. While some countries opposed it, such as Sweden and the U.K., most of the states, in particular Spain, expressed their strong support (Editorial, 2002). Progress is however slow and the slowness of progress towards a common port policy does not reduce the interest of the EU in strengthening the role of short sea shipping in an effort to promote sustainable mobility.

The lack of significant progress towards a common policy probable also reflects the wide variety of political objectives, financial structures and patterns of ownership among European ports. ATENCO (2001) showed that there are substantial differences between the respective funding and pricing practices currently applied in ports across Europe.

This variety is indeed bound to have implications for any effort at integrating the sector's policy. Some countries have a clear commercial orientation in which users bear all the costs generated by the system. This is the Anglo-Saxon approach. Other countries consider ports as an instrument of macroeconomic policy. They are expected to generate jobs or to contribute to economic development. This is the dominating continental viewpoint. The differences in viewpoint are at the center of a debate on the financing and subsidization of ports, one of the main sources of friction in the effort to define a common port policy (Tovar *et al*., 2004).

In that way, Haralambides et al. (2001) emphasize that: "*The main question was whether, and how, an efficient pricing system, leading to cost recovery, could be implemented in practice in the port sector, taking into account a variety of relevant objectives and constraint including higher market based efficiency; increased cohesion; distributive goals; the development of short sea shipping; the improvement of safety and environmental protection, etc.*"

This process resulted in a Directive proposal to liberalize port services (EU Commission, 2001). It was rejected in 2003, later the European Commission re-opened the debate and resubmitted at the end of 2004 (EU Commission, 2004b).

This latest initiative aims at introducing clear and specific norms to open the access to markets of various services. It tries to integrate the various outstanding issues at the core of the definition of a common port policy. As indicated by the European Commission, they require the development of a common and consistent legal framework which will serve as reference for the various actors participating in the port industry. These themes, although different in many ways, are all strongly interrelated:

The Integration of Ports in the European Transport Network

Once the integration of ports in the transport network had been recognized, the main challenge was the definition of the modalities of integration. The inclusion of ports, as interconnection points, is critical to the performance of intermodal transport within a multimodal infrastructure network. The TENs will increase the options available to transport providers and users in terms of alternative door-to door intermodal logistics chains (Haralambides et al., 2001). However, at the moment, the only explicit modality of integration of ports is the creation of the "sea motorways" discussed below. The identification of the ports which will form part of these motorways has been avoided. This is because there is a concern the identification of specific ports of interest to the EC transport network could be viewed by some of the excluded ports as an interference with the effectiveness of competition between ports.

Multimodality

The purpose of the European transport network is to promote the integration of land and waterborne transport modes for both short and long distance transport (EU Commission, 1999b). The stimulation of multimodality in the design of transport policies is expected to favor maritime transport but requires a commitment to ease trans-shipment. This effort has to be addressed as part of port policy since trans-shipment takes place mostly at ports. This specific concern points to the commitment and interest of the commission in the monitoring of the efficiency of the port system as an integrator of transport policy. This is very clear in the efforts made by the Commission to complement the various existing Directives with the development

of a Directive which aims at the normalization of units of intermodal freight to facilitate intermodal transport (EU Commission, 2004a). This Directive introduces a system of normalized freight units which are safer, better performing and more appealing to shippers and are expected to contribute to the reduction of bottlenecks in ports.

Promotion of Short Sea Shipping

The Commission is also keen on promoting cabotage in Europe (EU Commission, 1999a) and has also issued some Communications to define all the commitments this entails (EU Commission, 2003, EU Commission, 2004c). The program consists of 14 specific measures.

The idea is that short sea shipping has two advantages. First, it is much less polluting than other transport modes, in particular road transport which continues to be the dominating transport mode in Europe. Second, it is more cost effective. According to a study conducted by the Spanish Association for the Promotion of cabotage, for 70% of the logistics chains analyzed, cost savings from the reliance on short sea shipping are above 10%. Moreover, in 35% of the connections, distances would shrink significantly and in 26% of the cases, time savings would add to the benefits of cost savings. Note that it is expected that cabotage will rely on the "sea motorways" but it is important to recognize that the concern for short sea shipping traffic deals with many more dimensions of Europe's port policy. The interconnection promoted by cabotage is not only across member countries, but also with other countries and regions of a same country and in particular between islands and the continent.

The "Sea Motorways"

To reduce traffic congestion on land and to better interconnect continental- and peripheral countries and islands, the EC recommends the creation of a network of "sea motorways" which would be fully integrated in the European Transport Network. This would entail identifying sea routes to avoid having to identify specific ports as hubs and the associated perception of anti-competitive consequences. These "motorways" would be integrated with the vision defined for roads and railways. The sea routes identified by the EC (EU Commission, 2004a) are the following:

- The Baltic Sea Motorway (connecting the member states of the Baltic sea with those of Central and Eastern Europe, including the route through the North Sea and Baltic

Sea Canal);

- The Western Europe Motorway (from Portugal and Spain through the Atlantic portion which includes the North Sea and the Sea of Ireland);
- The South Eastern Motorway (which links the Adriatic Sea with the Eastern Mediterranean Sea countries, including Cyprus);.
- The South-Western Motorway (which links Western Mediterranean countries, including Spain, France, Italy and Malta as well as the South Eastern Motorway, connecting the links with the Black Sea).

The April 2004 proposal (EU Commission 2004c) to allow government to subsidize these sea motorways has recently been approved. This will allow member states to subsidize with EC support the development of infrastructure and distribution systems. There is however still a major concern in some circles with the anti-competitive outcomes that such financing could engender, penalizing ports who may not have access to this type of financing.

Introduction of Competition in Port Services and Access to the Market

The main arguments given to limit competition in port services are usually the following: lack of space, maritime security, environmental protection, etc. While these are all important and serious considerations, it is also important to try to make the most of the gains that competition can generate. This is what seems to underpin the latest Directive proposal which recommends the full liberalization of services and the stimulation of competition on two issues:

- Between ports. In this context the main issue is to ensure the transparency of the national public financing of port infrastructures (see point below).
- Within ports: the idea here is to promote competition between the operators of a same service in a port. The idea is to stimulate the efficiency of service delivery to users. This means that any historical collusive practice or restriction to entry must be eliminated.

The Directive also suggests introducing more private sector participation through authorizations and concessions. The idea is encouraging the competition in the market when it

is possible or for the market and regulating the operators whenever competition in the market is not an option.

The procurement and bidding processes will have to be transparent and generate service delivery levels equivalent to those that would have been obtained in competitive markets. There are to be clear time limits to the contract durations (8 years if there are no investment and between 12 and 30 years when investments are mobile or fixed, respectively). Except for a few modest changes, overall, the new Directive is very similar to its previous version.

The proposal is however still controversial. One of the criticisms emerging from a recent study (ESPO, 2004) is that European ports are already among the most efficient in the world. This implies that the search for more competition is unlikely to achieve much in terms of efficiency gains in view of the initial conditions under which the proposal would have to be implemented. In fact, increased modal competition in Europe has placed European seaports in a much more competitive environment where they are now under greater pressure to find out the performance of their competitors through benchmarking (Haralambides et al, 2001).

Public Financing and Pricing of Port Infrastructures

Haralambides et al. (2001) recognizes that the conclusion of academic literature on port pricing was that pricing in ports can and should be based on costs. However there is a clear disagreement among European countries on the desirability of public sector financing of the sector. [4] For this reason, there is a substantial diversity prevailing among European Union port with regard to their financing practices.

The Anglo-Saxon preference for self financing of ports thanks to a pricing system that forces users to pay the full costs of the services they receive bets on the effectiveness of competition to generate efficiency gains. According to this vision, subsidies, by generating anti-competitive distortions, would reduce the scope for efficiency gains. Besides the usual arguments in favor of subsidies based on the associated growth and employment payoffs, some of the critics of this approach point to the fact that if ports were to rely on cost recovery, the maritime transport would be penalized. Indeed, cost recovery is not taking place in roads or railways where infrastructures tend to be highly subsidized. This would be inconsistent with the

efforts to promote a transport mode more environmentally friendly argued for elsewhere in the same Directive.

The Role of Ports in Maritime Security and in the Protection of the Environment

The terrorism fear that resulted from the September 11, 2001 in the US and March 11, 2004 in Spain and July 7, 2005 in UK is also very present in the latest EU port legislation. Two main actions are on the map since a February 2004 Directive on port security. The first is the security of ships on board and in port facilities. The second is the security of ports in general.

PORT EFFICIENCY

The Relevance of the Measurement of Efficiency

The common denominator of the EU objectives for the European port system is the efficiency of its service delivery. The concept of efficiency is explicit in most of the EU Directives and other EU documents concerning ports. For example, the EU Commission (2001b) report on public financing and charging practices in the community seaport sector states that efficient functioning of ports as part of the door-to-door intermodal chain is an essential prerequisite to stimulate the development of maritime transport.

The main argument for the inclusion of ports in the European Transport Network is, *de facto*, the increase in the efficiency of the European transport system. The Marco Polo program clearly defines the role of maritime transport as a key instrument of the development of a transport system that is both efficient and environmentally friendly. To deliver on that agenda, to allow the "sea motorways" to perform as a real alternative to "land motorways", ports need to be efficient. They require the providing of an effective cost and time alternative to the currently preferred transport modes.

This also requires a more efficient interconnection of ports with the other transport modes to contribute to the reduction in the total logistic cost (e.g. reducing waiting time associated with transshipment). This is one of the goals to be achieved by the standardization of freight loads since standardization should reduce intermodal handling costs. This could also be reinforced by more competitive port services and more and better choices of service providers.

As has been showed, all these issues point to the central role of port efficiency in the

European debate on transport policy. This is why this paper focuses on providing a baseline performance assessment of the efficiency levels observed today in Europe's main ports. However, the analysis of today's port efficiency is limited simple because access to the right level of information is limited too, particularly when it comes to costs[5]. Ideally, a database providing all the outputs and inputs and their costs in all major ports should be available. However, the port sector is notable for its lack of information relating to costs. In other words, there is no tradition in general, not only in Europe, to monitor the cost effectiveness of the sector.

Without even beginning to assess the performance of the industry, it is easy to argue that the evaluation of the efficiency of the sector requires a strong commitment of port authorities to generate comparable information on the various non-competitive activities that take place in the industry. In many instances, this will require the unbundling of the accounting of operators delivering both competitive and non-competitive services. The monitoring of the generation of this kind of information needs to be assigned to an independent institution. In some countries, this will require independence from some of the current actors who control the ports (port authority in most part of ports).

Ultimately, it is unclear whether be short of information is at the course of the lack of discussions and decisions on port reforms in Europe or if its cause is.

Activities Assessed

Within the limitations imposed by the data available, a partial database was developed in preparation for this paper. The database focuses on the production side of the port infrastructure business and covers a sample of 22 European port authorities. This sample size is sufficient to provide a first baseline assessment and to give a sense of the potential that the analysis of economic efficiency measures can have for policymakers[6].

Many actors share the responsibility for service delivery, from the port authorities to the operators responsible for services as diverse as handling, pilotage, storage, and ship repair and maintenance (see Trujillo and Nombela (2000) for a detailed presentation). These activities are far from constituting a homogenous group. They differ according to the nature of the services, the level of skills needed, or the level of regulation required. This is why the

economic analysis of each of the components deserves a differentiated treatment which would account for these peculiarities.

Under most current port organizational structures, even private operators enjoy some degree of protection from competition and they are not required to report much information relevant to the assessment of the economic efficiency of their activity, in particular the efficiency of their costs. This is why little can be said about it –and why there is so little literature on the topic. A few authors have been able to assess the efficiency of terminals within ports—which account for 80% of the handling business and often drive the choice of a port by a shipper according to De Rus *et al*. (1995). These include Notteboom *et al*., 2000; Cullinane *et al*., 2002; Cullinane *et al*.,2003; Cullinane *et al*.,2004 and 2006; Rodríguez Álvarez *et al*. 2005; Wang and Cullinane, 2006 and Tongzon and Heng, 2006. All of them only measure technical efficiency and consider that technical efficiency is time-invariant, except Rodríguez Álvarez *et al*. (2005) which estimate time varying technical and also allocative efficiency.

The information on the infrastructure side of the port business is however much more common. Analytically, this is not a difficult exercise. It has been conducted for specific countries in a wide variety of contexts thanks to much easier availability of information. (i.e. Liu, 1995; Baños-Pino *et al*., 1999; Martínez Budría *et al*., 1999, Coto Millán *et al*., 2000; Valentine and Gray, 2001; Martin, 2002; Estache *et al*., 2002; Bonilla *et al*., 2002; Barros, 2003; Barros and Athanassiou, 2004; Estache *et al*., 2004; González and Trujillo, 2004; Barros, 2005 and 2006 and De, 2006).[7]

This is the main focus of this section. The exercise is however not free of problems when trying to apply it to a multi-country setting rather than to a specific country, simply because there is no homogeneous information system yet. Note also that even if the exercise only covers one of the dimensions of the port activity, the management of port infrastructure, it focuses on one of the activities that may be the most representative of each port and also the one that tends to be the most common source of inefficiency in most modern ports.

Indeed, for a given level of access to modern technologies, the efficiency of the infrastructure management is often the margin on which port authorities can work to compete with each other. Of course, not all ports are created equal and the environment in which they

function needs to be taken into account since for a given handling technology and given levels of skills in the management of the infrastructure, two ports may not necessarily be able to compete on an equal foot. One of the main variables driving the differences is the degree of containerization which we model explicitly in our analysis.

A final, somewhat more subtle challenge in the assessment of efficiency is the definition of the products and of the inputs needed to deliver those products. Port authorities tend to cater to two types of clients: the ship-owners who need to "park" their ships in a safe environment and the private operators servicing carriers to load and unload passengers or freight and using the infrastructure provided by the port authority to do so. This implies that the natural measure of product needs to distinguish between ships, passengers and freight. The use of ships as a measure of output is not without problems. Ships differ in size and in recent years, these sizes have tended to increase. This has resulted in a reduction in the number of ships going through ports in spite of an increase in the volume of goods and passengers handled. This is why we focus only on the volume of different type of merchandises and the number of passengers, when relevant, in this paper.

The Model

The Data Envelopment Analysis (DEA) and the Stochastic Frontier Analysis (SFA) represent two alternative methods to measure port efficiency based on frontier models. Both techniques allow derivation of relative efficiency ratios within a group of analyzed units, so the efficiency of the units is compared through an *efficient envelopment.* However, while frontier function estimation uses econometric methods, the DEA is a non-parametric technique based on linear programming. These methods apply to cross-section samples but if panel data are available; they can also be used to measure technical change and the change in efficiency.

Both methods have advantages and drawbacks. DEA does not impose any functional form to the frontier nor does it assume a distributional form for the inefficiency error terms. It can easily handle multiple outputs; but, it could be influenced by noise and traditional hypothesis tests are not possible except by using bootstrapping techniques (Simar and Wilson, 2000). On the other hand, SFA involves the cost of imposing a particular functional form and making particular distributional assumptions for the one-side error term associated with

technical efficiency, which could introduce a potential source of error. However, SFA has also advantages. To begin with, it is capable to manage random shocks and/or measurement error. Moreover, traditional hypothesis tests could be used and, finally, environmental variables are easier to deal with.

We have chosen SFA in order to make our estimation of EU ports efficiency because, in our case due to the heterogeneity of the sample, the advantages of this method outweigh its disadvantages. Furthermore, we select the distance function to estimate the relative efficiency of EU ports. The reason behind the selection of this function lies in the advantages it presents: It allows capturing multi-output processes. It does not require the use of optimizing assumptions. It only uses physical data and, therefore, it is not necessary to have information on outputs or factor prices.

The distance function can take an input orientation or an output orientation. The analysis of the conditions under which port authorities develop their activities led us to the estimation of an output-oriented distance function. As Gonzalez (2004) states when analyzing technical efficiency of Spanish port authorities "…in the provision of infrastructure services, port authorities have some power to decide on the production level through the use of two mechanisms: commercial policies and concessions. Considering this capacity to influence output, port authorities encounter certain challenges in adjusting the productive factors used in the provision of infrastructure services, basically: berths, area and labor. The first two are quasi-fixed factors that, due to their indivisibility, find it difficult to adapt to changes in production, especially if the change is downward . As regards labor, this is generally made up of port authority officers and thus the difficulty of making adjustments, particularly when numbers need to be reduced".

An output-oriented distance function is defined as the smallest scalar by which all outputs can be proportionally divided, using the same level of productive factors. The general formula for an output stochastic distance function is written as:

$$1 = D_o(y_p, x_p, d_p; \alpha, \beta, \psi) \cdot \exp\{v_p - u_p\}$$

where $D_o(y_p, x_p, d_p; \alpha, \beta, \psi)$ is the output distance function; *y* is an output vector,

x is an input vector, d is an environmental variable, p denotes port and α, β, ψ are parameters to be estimated. The v_p and u_p error components represent statistical noise, and the magnitude of technical efficiency (TE) respectively.

The empirical econometric application of a distance function calls for the definition of an appropriate functional form. It is desirable that the functional form presents the following advantages: it must be flexible, it must be easy to calculate and, lastly, it must allow imposition of the homogeneity condition. The translogarithmic functional form meets these conditions and this is the reason why, at present, most authors use it in all research fields.

In order to determine the frontier, D_O needs to be equal to one and, in this case, the term on the left of the equation, according to the neperian logarithm, will equal zero. Consequently, it is necessary that outputs meet the homogeneity condition of degree 1. On the other hand, to estimate the equation, it is necessary to determine the random disturbance term. The most common method to do so was developed by Battese and Coelli (1988); it applies an additive term as suggested by Cuesta and Orea (2002), to account for the fact that we are estimating an output oriented distance function. The error term thus has the following form: v_i+u_i, where, v_i is a symmetrical error term, iid (independent and identically distributed) with a zero average (which represents the random variables un-controllable by the operator) and u_i is a one-sided negative error term and is distributed independently of v_i.

Applied to the distance function, this yields

$$-\ln\left(y_{Mi}\right) = TL_o\left(x_i, y_i / y_{Mi}, \alpha, \beta, \delta\right) + v_i + u_i$$

This equation can be estimated by the maximum likelihood method which requires distributional assumptions on the random shock. This assumes that v_i follows a $N(0, \sigma_v^2)$ distribution and u_i follows a $\left| N(0, \sigma_u^2) \right|$ distribution (Ritter and Simar, 1997).

EMPIRICAL EVIDENCE ON THE ECONOMIC EFFICIENCY OF EUROPEAN PORTS

Data

This section reports a first set of estimates of the efficiency levels in Europe. As already mentioned, the database is partial. The main sources of data are the websites of port authorities.

We also relied on EU transport statistics to complement or verify some of the information on these websites.[8] Whenever possible, we also obtained copies of the annual reports and balance sheets of port authorities. We also did a direct follow up by phone and email with many of the port authorities.

The unit of analysis is the port authority. This is driven by the availability of information and the conviction that port authorities provide a good proxy for the performance of overall port activities. We were able to collect data on 22 port authorities for the year 2002.The port authorities covered by the sample are Rotterdam, Amsterdam, Antwerp, Hamburg, Bremen-Bremenhaven, Marseilles, Le Havre, Algeciras, Barcelona, Tarragona, Valencia, Bilbao, Göteborg, Stockholm, Piraeus, Thessaloniki, Lisboa, Setúbal, Helsinki, Arhus, Copenhagen and Belfast.

We tried to get a sample size providing a fair representation of the members of the EU. The sample includes all EU countries with a coast, except Italy (see Appendix 1 for the location of ports in the sample and Appendix 2 for a brief overview of the EU Port System). We also tried to get enough representativeness of the main types of organizational structures of port authorities in terms of their specialization (freight or passenger) and type (e.g. transit port).

We focus on technical efficiency because there is no data on costs. Information on outputs is quite good along all quality and coverage dimensions. For each of these port authorities, we have collected the information on the composition of the freight and passenger traffic. We did not obtain information on the other services provided by port authorities such as equipment or land rental. This information served as a proxy for the output of the port authorities.

Unfortunately, the information available about inputs only allows us to consider capital and labor. Labor is approximated by the average number of persons employed by the port authority. Capital is approximated by the surface of land occupied by the port. We also include an environmental variable: the containerization rate.

The 22 port authorities comprising the sample are extremely heterogeneous. They differ in terms of size as well as specialization. Some are specialized in passengers; others cater only to passenger as a residual traffic. Moreover, among ports dealing mainly with freight, the

differences are also significant. They differ in terms of specific merchandises (including share of liquid vs. solid bulk) as well as in terms of the importance of containerization. They also differ in terms of their role as distribution centers vs. ports of final destination. The only source of heterogeneity we have been able to capture correctly here, to minimize the consumption of degrees of freedom, is the containerization rate since this is one the main characteristics reflecting the modernity of the ports that can be picked up in a cross section analysis for benchmarking purposes.

Table 1 summarizes all the relevant statistical information. The spread between the maxima and minima gives a good sense of the heterogeneity of the sample. It suggests that we are estimating the performance of an average port authority which handles annual container traffic of 15,034,000 tons, 36,654,000 tons of other freight loads and 2,073,124 passengers. This authority faces a containerization rate of 56%, delivers its activities on 10.777 square kilometers and employs an annual average of 698 workers. R above you called them PA officials.

INSERT TABLE 1 ABOUT HERE

Econometric Model Estimated

The model we rely on to estimate the efficiency of European ports is the model presented before. We have eliminated the possibility to provide an estimate of the evolution over time of the performance since we were not able to generate data on various points in time. This means we can only do a benchmarking exercise in which the efficiency of a port is assessed against the efficiency of all other ports in the same year. Nothing can be said about technological change for instance.

In spite of translogaritmic functional form being, theoretically, the first best, in our application the log-linear Cobb-Douglas function worked better, maybe due to the limitation of the data base. The information collected is sufficient to estimate various models, depending on how much outputs are aggregated. The best econometric results were obtained from a Cobb-Douglas with three products, two factors and one environmental variable which is specified as:

$$\ln D_O = \alpha_0 + \alpha_1 \ln C_p + \alpha_2 \ln OF_p + \alpha_3 \ln PAS_p + \beta_1 \ln E_p + \beta_2 \ln S_p + \psi_1 d_p + v_p + u_p$$

where C, OF and PAS denote three outputs: containers and rest of the traffic, measured in thousand of tons, and number of passenger, respectively. On the other hand, E and S denote two factors: number of employees and km^2 of surface, respectively. Finally, p relates to the *p-th* port authority; d is the environmental variable: the containerization rate; α, β, Ψ are the coefficients to estimate; v_p is an error term and u_p the magnitude of technical efficiency. Variables are expressed in relation to their deviation from the geometric mean; therefore, the estimated coefficients can be construed as elasticities at the sample mean.

Results

For the sake of brevity we only report the results obtained from the estimation of the best model: an output oriented *Cobb-Douglas* distance function. They are summarized in Table 2. The variables are taken as deviations from their geometric averages so that the function estimated is an approximation in Taylor of the actual but unknown distance function measured at the data average. The parameters are expected to be non-negative in products and inputs. These parameters can be used to get an estimate of the elasticity of the distance of a specific port authority with respect to the average of the sample.

Table 2 shows that all parameters estimated have the expected sign and are statistically significant, except for the parameter corresponding to passengers which has the right sign but is not significant statistically. This implies that the distance function estimated complies with all the expected theoretical properties. It is non-decreasing in outputs and non-increasing in inputs.

INSERT TABLE 2 ABOUT HERE

Figure 1 shows the technical efficiency of European ports, estimated to be on average at 58.7%. This average, however, hides very significant differences across ports. Indeed, the performance ranges from 28% to 90%.

INSERT FIGURE 1 ABOUT HERE

European Port Authorities showing higher technical efficiency than the average are: Algeciras (90%), Rotterdam (84%), Valencia (82%), Marseille (80%), Setúbal (79%), Le

Havre (79%), Göteborg (77%), Amsterdam (73%), Aarhus (72%), Bilbao (71%), Estocolmo (69%), Amberes (68%), Belfast (64%), Barcelona (63%), Copenhagen (62%). Finally, Port Authorities who show a lower technical efficiency than the average are: Lisboa (55%), Hamburg (54%), Bremen (47%), Thessaloniki (44%), Helsinki (41%), Piraeus (34%) and Tarragona (28%). R; please careful and consistent with how you spell cities/ports; ie Lisboa or Lisbon.

It is very likely that this large variance is related to the heterogeneity of our sample. A larger sample would have allowed us to introduce more environmental variables and conduct tests of the relevance of the heterogeneity of European ports.

Finally, the results show the appropriateness of this technique to help policymakers identify the ports which could belong to the sea motorways network as well as those which could ease short sea shipping. The analysis of the efficiency has to be understood in a dynamic context, i.e. the fact that ports relatively inefficient today could be much more efficient tomorrow and become part of the logistic chain, in particular if today' s efficiency analysis provides insights on the weaknesses of the port. Of course, to be effective, this analysis has to be able to rely on good data, including data which allows an assessment of the heterogeneity across ports' circumstances. The generation of this data should be a high priority if Europe's policymakers are to deliver on their goals for the sector.

CONCLUDING COMMENTS

The main role of a port is to transfer goods between two transport modes. This requires the coordination of a large number of activities which can be organized in many different ways. As pointed out Friedrichsen (1999), the assessment of the performance of a port must thus be able to address the efficiency of the overall port system. This concern should be at the core of the benchmarking of the performance of today's EU ports. In many ways, the reform options considered for the EU ports reinforce this vision of ports at the interface of various dimensions of the integrated European Transport Network, including the hope for an increased share of maritime transport in total transport, more systematic reliance in multimodality, the creation of "sea motorways" and the reliance on price signals which provide the right economic incentives,

recognizing that more macroeconomic choices may differ across countries.

The common denominator which will drive the EU success in achieving these goals is the ability to rely on an efficient port industry. Efficiency is indeed at the core of all these policy considerations and hence needs to be quantified today if the EU is to be able to monitor progress in the engine supporting its policy vision.

As a contribution to this monitoring effort, the paper relies on a distance function to generate an initial benchmarking assessment of the performance of European port authorities in 2002. The process followed in developing this benchmark amply illustrates the need for a much more policy oriented database than currently available for European ports. In a recent diagnostic on information availability, Adler *et al*. (2003) argue that ports have little interest and few incentives to provide information and that when they do so data tends to be scarce and not really up to date. All this implies that as part of the reform process, it may be rational to try to assign a clearer mandate to the authorities responsible for the economic regulation of ports to generate the data needed to ensure that the captive users and tax payers are not required to finance unduly expensive port operations though user fees or subsidies. We need statistics on the port industry similar to those available for other regulated industries such as electricity, telecoms or railways.

In spite of the very serious data limitations which restricted the strength of the econometric analysis quite significantly and in spite of the fact that the analysis could only cover port infrastructures and not port services, the study has generated useful preliminary insights on the current efficiency levels of the EU ports—these results will be revised as the sample size increases and additional information is collected through an on-going consultation process. Assuming that the efficiency of their infrastructure is a reasonable approximation of each individual port system for a cross-section of 22 ports, the paper provides indeed a first quantitative estimate of port efficiency accounting for all key inputs and outputs. However weak it may be, this is the best estimate available today.

This paper fails to generate information explaining differences in performance across ports. The lack of data has unfortunately not allowed us to assess the sources of the large variance in performance observed. This means that until this can be done, it would not be

realistic to draw strong policy conclusions. There are many reasons why the poor relative performance of some ports may be easy to explain with the right information.

With all these limitations in mind, the main policy lessons from the paper can be summarized as follows. First, the average port efficiency in 2002 was estimated to be around 60%, with performances ranging from 28% to 90%. This would imply, as a first approximation that on average, ports could have handled 40% more traffic with the resources they had at their disposal. Second, the EU goals of replacing some road transport by sea transport require Short See Shipping to be competitive. One of the components of this competitiveness is the efficiency of the port system. Getting ports to deliver more, better and at lower costs to the users and to taxpayers is essential to the EU overall transport objectives.

An estimate of the scope for improvements along those lines is precisely what efficiency measures are intended to deliver. Third, there seems to be a reasonable concern by some users and taxpayers that they are not getting the service they are paying for. This does not mean that the concern is always and everywhere justified. Indeed, the underperforming operators should be granted a fair chance to show that there may be good reasons for their underperformance. Finally, the paper has shown that the port industry in general and the EU in particular could benefit from the reliance on a method (i.e. efficiency measurement) that has proven to be a useful guide for policy decisions in other public service industries.

Table 1: Summary Statistics for the Sample of 22 European Port Authorities (2002)

Variable	Measurement Unit	Average	Maximum	Minimum	Standard Deviation	Coefficient of variation
Solid bulk	000 of tons	11,789	83,429	152	19,523	1.66
Liquid bulk	000 of tons	19,445	155,925	32	34,307	1.76
General Merchandise (1)	000 of tons	5,419	20,319	595	4,900	0.90
Containers	000 of tons	15,034	65,849	70	19,776	1.32
Throughput	000 of tons	51,687	322,107	5,151	69,292	1.34
Passengers	Number	2,073,124	8,871,000	600	2,732,479	1.32
Containerization rate	%	56	95	3	29	52
Surface	Km^2	10,777	49,400	796	15,409	1.43
Employment	Number	698	1,709	121	569	0.82

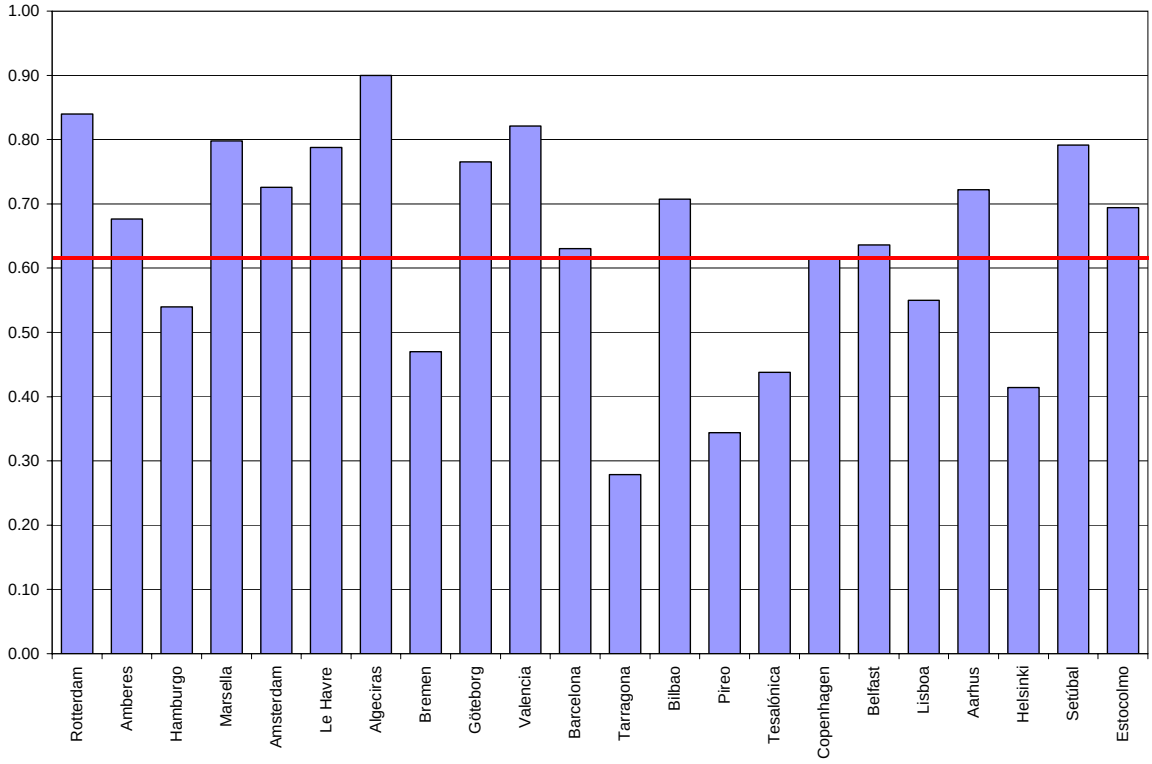
(1) Does not include general cargo in containers

Table 2: Estimates of the Distance Function for European Port Authorities

Variable	Coefficient	t-test
Constant	-0,4638	-2,3341
L(C)	0,7460	6,6469
L(OF)	0,2497	2,2285
L(Pas)	0,0044	0,1198
L(containerization rate)	-1,1023	-5,1066
L(S)	-0,4214	-5,2797
L(E)	-0,4476	-3,3338
Sigma-squared*	0,3981	1,7585
Gamma*	0,0522	3,3117

* The model was estimated by maximum likelihood methods relying on the parameterizations method proposed by Battese and Corra (1977), estimating $\sigma^2 = \sigma_v^2 + \sigma_u^2$ and $\gamma = \sigma_u^2/(\sigma_v^2 + \sigma_u^2)$.

Figure 1: Technical Efficiency of European Port Authorities (2002)



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ENDNOTES

[1] De Rus *et al*. (1995) provide a detailed diagnostic conducted for the Spanish Competition Tribunal.

[2] The readers are referred to Everett (1996); Haralambides et al. (1997); Baird (2000); and Notteboon and Winkelmans (2001). For a review of the existing literature on the menu of reform options in the port sector see World Bank (2007).

[3] In this model, the Port Authority owns the facilities and either rents or gives in concession these facilities to private operators, leaving as many activities as possible in the private sector's hands.

[4] This debate is actually not new; see for instance Suykens (1986); Suykens *et al*. (1998); Haralambides *et al* (2001) and Haralambides and Veenstra (2002).

[5] See Coelli *et al*. (2003a y b) for a discussion of the data requirements to assess performance in infrastructure industries.

[6] This analysis is usefully complemented by a recent equivalent assessment of the Spanish experience with a similar methodology but with a much complete database. See Gonzalez and Trujillo (2004).

[7] For more information see a survey on efficiency measures in González and Trujillo (2007)

[8] http://europa.eu.int/comm/eurostat/newcronos/reference/display.do?screen=welcomeref&open=/&product=EU_transport&depth=1&language=en).