



Can ports increase traffic while reducing inputs? Technical efficiency of Spanish Port Authorities using a directional distance function approach



Beatriz Tovar^a, Alan Wall^{b,*}

^a *Infrastructure and Transport Research Group (EIT), Department of Applied Economics, University of Las Palmas de Gran Canaria, Campus Universitario de Tafira, Modulo D, Las Palmas de Gran Canaria 35017, Spain*

^b *Oviedo Efficiency Group, Department of Economics, University of Oviedo, Avenida del Cristo s/n, Oviedo 33071, Spain*

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ABSTRACT

The focus of this paper is on the productive efficiency of ports. We estimate a directional technology distance function using parametric techniques to analyze the production technology and technical efficiency of a set of Spanish Port Authorities observed over the period 1993–2012. Technical inefficiency is conceived as the ability of ports to simultaneously expand a given output and contract variable inputs while maintaining quasi-fixed inputs and other outputs constant. Thus, for containerized cargo we address the following question: *Given the amount of quasi-fixed inputs used by the firm and given the volume of the other outputs (liquids, solids, non-containerized cargo and passenger traffic), could ports increase their containerized merchandise while simultaneously reducing their variable inputs?* Similar questions are asked for solid bulk and non-containerized general cargo. Our results show evidence of technical inefficiency among the ports in our sample. In particular, if the ports operated efficiently, we find that containerized cargo could be expanded by an average of over 6.4%, with an equivalent reduction in variable inputs. Solid bulk cargo and general non-containerized cargo could be increased by 4.1% and 6.1% respectively, with corresponding reductions in variable inputs. An implication of our results is that there is ample scope for specialization on the part of ports with no increase in infrastructure costs. Given that large investments in infrastructure have been made in Spanish port over the last decade, this opens the possibility of moving towards a management model based on taking advantage of existing capacity rather than new investments.

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1. Introduction

As interchangers between sea and land transportation modes, ports constitute a central element within any transportation system and, by extension, for the economy as a whole. Ports are of particular importance to Spanish economic performance. Spain has the longest coastline of all European Union countries (8,000 km) and its geographical location, close to one of the world's main shipping routes, has led it to becoming an increasingly important strategic area in terms of international maritime transport and as a logistics platform for the south of Europe. Thus, 15% of the internal trade flow passes through Spanish ports, as does 60% of exports and 85% of imports, accounting for 53% of foreign trade with the European Union (EU)

* Corresponding author. Tel.: +34 985 10 4872.

E-mail addresses: btovar@daea.ulpgc.es (B. Tovar), awall@uniovi.es (A. Wall).

and 96% of trade with non-EU countries. Moreover, the state port system accounts for 20% of the transport sector's contribution to GDP, representing 1.1% of Spanish GDP, and generates 35,000 direct jobs and 110,000 indirect jobs.¹

In a context of increasing international competition, the figures above highlight the importance of measures to improve the management and efficiency in ports in order to increase their competitiveness. Spanish port law has followed this line since a major reform in 1992 (Law 27/1992)² which established that Port Authorities' management should be based on criteria involving efficiency, economy, productivity and safety. This line continues to be followed as can be seen from the recently passed 33/2010 Law which recognized the relative advantages of maritime transport over other modes from the perspective of economic, social and environmental sustainability. This provides justification for policies for strengthening maritime transport and the port system at European level, for which Spain is one of the main promoters. The 33/2010 Law concludes by pointing to the need for efficient ports with good accessibility by rail in order to give more weight to maritime transport.

All these issues point to the central role of port efficiency in the Spanish transport policy. However, there are good reasons to suspect that port authorities in Spain have not been acting in a technically efficient manner over the last couple of decades. [Rodríguez-Álvarez and Tovar \(2012\)](#) investigated the efficiency of Spanish ports over the period 1993–2007 and found evidence of inefficient behavior, with inefficiency worsening from 2003. Overinvestment in capacity is likely to be the main driver of this result. Until the year 2003, Spanish ports were subject to legislation which left them no control over pricing policies. As a consequence, the competitive strategy of ports rested on the manipulation of those variables under the control of ports, the most relevant of which was investment policy. This led to a massive increase in infrastructural investment over the period 1993–2008, resulting in significant expansions of port capacity over this period ([García et al., 2010](#)). [Díaz-Hernández et al. \(2014\)](#) calculated the efficiency of the provision and utilization of infrastructure of Spanish ports for the period 2000–2007 and found evidence of inefficiency determined primarily by the improper use of quasi-fixed inputs which increased costs by an average of almost 8%. These authors concluded that the infrastructure investment process undertaken by Spanish Port Authorities was not optimal during the period analyzed.

Recent legislation has introduced important changes, and the 33/2010 Law and 2/2011 Decree have endowed Port Authorities with increased autonomy and control over policy. Moreover, investment in infrastructure has been falling since 2009 as a consequence of central government cutbacks in public expenditure and the desire of Port Authorities to reduce debt, and this is likely to continue in coming years. As a consequence, therefore, of recent legislation and the ample capacity of ports, Spanish Port Authorities are now operating in a scenario where they can tailor their policies to differentiate themselves according to their needs and rely less on investments in infrastructure.

The question then arises as to the extent to which Port Authorities can differentiate themselves by, for example, specializing in certain services and increasing traffic in these while maintaining present levels of capacity. In other words, can Port Authorities expand traffic in one or more types of cargo with their present infrastructural endowments? We could even go further and ask whether on top of increasing traffic without changing capacity they could also reduce their use of non-infrastructural (i.e., variable) inputs, accentuating the increases in productive efficiency. This is important in order to avoid the cost of any inefficiencies that may exist being passed on to ports' clients, with the consequent loss of competitiveness this would entail. Moreover, as pointed out by [Díaz-Hernández et al. \(2014\)](#) it is important to distinguish between inefficiency due to excess variable input use and inefficiency due to excess quasi-fixed input use, as variable inputs are more directly under the control of the port management and can be adjusted more easily whereas adjustments to quasi-fixed inputs require a policy review of investments in port infrastructure.

These are the questions we address in this paper, where we measure technical efficiency for a set of 20 Spanish ports observed over the period 1993–2012. To do so, we use a frontier technique – the directional distance function, introduced by [Chambers et al. \(1996, 1998\)](#) – which has not previously been used to estimate port technology and which is particularly suitable for answering the questions posed above in that it permits us to determine the extent to which these ports – *for given levels of quasi-fixed inputs* – are capable of simultaneously reducing variable input use and expanding their outputs.

We estimate three models where different individual outputs are permitted to expand while variable inputs are reduced. Our estimates show clear evidence of technically inefficient behavior by many of the ports in our sample. For example, we find that ports could increase either containerized cargo or solid bulk cargo by over 6% on average with a corresponding reduction of over 6% in variable inputs, maintaining the existing level of capacity fixed. Similarly, we find that general non-containerized merchandise for these ports could be increased by over 4% on average while simultaneously reducing variable inputs by the same percentage. This indicates that capacity is not an issue for Spanish ports: there is substantial scope for specialization in individual services and traffic can be substantially increased without new investments in infrastructure. Not only that, variable input use could also be substantially reduced.

The paper is structured as follows. In Section 2 we provide a brief but comprehensive review of studies of port efficiency using parametric frontier techniques. In Section 3 we discuss directional distance functions and how they can be used to measure technical inefficiency. The data and the specification of the model to be estimated are presented in Section 4. In Section 5 we present and discuss the results obtained. Section 6 concludes.

¹ http://www.puertos.es/sistema_portuario/presentacion.html

² The 27/1992 Law envisaged one single organization and management model for general interest ports that delegated management to a legally established public body, the Port Authorities.

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