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Public regulation and technical efficiency in the Spanish Port Authorities: 1986–2012

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ABSTRACT

This research analyses the impact of public regulation on the efficiency of the Spanish Ports Authorities during the last three decades. To this end, using Stochastic Frontier Analysis (SFA), an input-oriented distance model has been estimated for a sample of 26 *Port Authorities* during the period 1986–2012. This paper contributes to the literature by establishing a direct correlation between the reform and the change in efficiency.

Four regulatory changes have been carried out in the Spanish port system during the last three decades: Act 27/1992, Act 62/1997, Act 48/2003 and Act 33/2010. In line with other reforming countries around the world, the regulatory reforms rested on three key instruments: decentralisation (port autonomy), participation of private sector and introduction of competition.

This paper supports that Act 62/1997 and Act 48/2003 focused on the promotion of port autonomy, privatisation and inter-port competition and had a positive impact on the efficiency of the Spanish port system.

1. Introduction

Spain is the European Union country with the longest coastline (8000 km). Therefore, the Spanish maritime sector is an important part of the national economy, comprising a wide range of industries, including: maritime transport, ship building, shipping, fisheries, energy production, maritime leisure activities and marine environmental organisations. Ports are major actors within maritime transport. They handle nearly 60% of exports and 85% of imports, which account for 53% of Spanish foreign trade with the European Union, and 96% with other countries. Moreover, the State's port system's activity contributes to nearly 20% of the transport sector's GDP, which accounts for 1.1% of the Spanish GDP. Moreover, it generates direct employment of more than 35,000 direct jobs and around 110,000 indirectly (*Puertos del Estado*).

In the 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. In this sense, it is important to understand significant determinants of port efficiency gains over the medium to long term. In particular, as mentioned by Cheon et al. (2010), this understanding begins from an evaluation of dynamism in which institutional reforms influence port efficiency.

1.1. The port management model: Historical context

The Royal Decree dated 17 December 1851 included, for the first time in Spain's history, state ownership of certain Spanish ports, which were brought under the then Ministry of Public Works. This Royal Decree classified Spanish ports into categories that have remained largely unchanged. The classification established two categories of ports: "Ports of General Interest" and "Ports of Local Interest". The same regulatory criteria is used in the 1978 Constitution (Art. 149) and developed under subsequent laws and regulations which governed the port sector until Spain joined the European Economic Community in 1986.

Prior to the 27/1992 Law, Act 1/1966 and Act 27/1968 allowed the existence of two port management models in Spain. On one hand, the autonomous ports of Barcelona, Bilbao, Valencia and Huelva were governed by the corresponding regional statutes with a greater autonomy level. On the other hand, the remaining ports were managed by "Juntas del Puerto" (port assemblies) on a centralised, non-competitive and bureaucratic manner. Moreover, as noted by Coto-Millán (1996), in 1986, the Spanish Ministry of Public Works set minimum rate of return based on the net investment of fixed assets for the entire port system, in order to control the current expenditure and improve the internal management of the Port Assemblies.

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1.2. The reforms of the Spanish port management model

The reform of the Spanish port system started in 1992 and followed a pattern similar to that of many other reforming countries. From 1992 until now, the Spanish port system experienced four regulatory changes: Act 27/1992, Act 62/1997, Act 48/2007 and Act 33/2010. The 1992–2010 reforms rested on three key instruments: decentralisation (port autonomy and self-administration), privatisation (participation of private sector) and introduction of competition (between ports and between operators within ports) in the port system. Table 1 summarises the main changes made by each regulatory reform in the period.

The 1992 reform (Law 27/1992 of 24 November on State and Merchant Marine Ports) transformed the port management system, by abandoning the service ports in favour of a landlord model. Under this law, the name of the port governing body became the *Port Authority*, a term which is widely used in the international arena for the authorities responsible for managing ports, irrespective of who owns them and of their legal nature.

The port management model, implemented through Law 27/1992, is geared towards greater autonomy, in terms of management, and towards improving the port services provided. The terms “management efficiency” and “profitability” are repeated very frequently throughout the text of this law. Additionally, according to Nuñez-Sánchez and Coto-Millán (2012), this reform transformed the port model from a public system, based on strictly administrative criteria, to a commercial understanding of port services.

In order to give greater autonomy to each Port Authority, Law 62/1997 of 26 December, amending Law 27/1992, was adopted. This new reform was heading towards a port tariffs liberalisation and provided for greater participation by Spain's Autonomous Communities with Boards of Directors and in the appointment of the Presidents of Port Authorities.

Law 48/2003 of November 26, on the Economic System and Service Provision at Ports of General Interest, was approved as a continuation of the previous law. This Act amended its predecessor, but without completely repealing it, and represented another step towards providing Port Authorities with the tools to improve port efficiency. Furthermore, as mentioned by Laxe (2012), it is an attempt to meet the challenges of globalisation. This law adapted the port pricing system to the mandatory nature of taxes, made

Table 1
Summary of regulatory periods.
Source: Own elaboration.

	Decentralisation	Privatisation	Liberalisation/Competition
Law 27/1992	– Transformed the port assemblies into less-centralised *Autoridad Portuaria* (Port Authority) – *Autoridad Portuaria* (hereinafter PA): legally established public body with its own budget, but controlled and coordinated by the State Owned *Puertos del Estado* (Enterprise of National Ports, hereinafter ENP) – _Decentralised and simplified administrative processes and control	– Change of model for port management, from a tool port model to a landlord model – Permitted access to port activities and to loading/unloading firms through the system of administrative contracts	– Created the State-Owned Enterprise of National Ports to Co-ordinate and promote inter-port competition, for the entire system – The ENP gets financial resources from the whole port system
Law 62/1997	– Increased PA autonomy from ENP, by involving the autonomous regions and local authorities in port management – ENP gained autonomy from the Spanish Ministry of Public Works		– Limited liberalisation of port tariffs – The ENP gets resources from the whole port system and forms a compensation fund for investments within that system
Law 48/2003	– Increased PA capacity to outsourcing	– Limited PA activities: PA became a regulatory body and provider of infrastructure: PA would only provide cargo handling and other subsidiary services if no private firm were available – First attempt towards privatisation of the state owned cargo handling firm *Sociedad Estatal de Estiba y Desestiba* – Increased Harbour Pilot service privatisation	– Limited the areas of public domain – Adapted tariff system to the service nature – Promoted private sector participation in port infrastructure – Increased inter-port competition, but kept the uniform tariffs system
Law 33/2010	– Increased PA financial autonomy (based on the principles of economic self-sufficiency and cost coverage) – Flexible pricing model. Each Port Authority is able to adapt to the economic reality at any moment	– Advanced landlord model: landlord port authorities that do not carry out any kind of port services	– Competitive flexible pricing model – Reduced the concession contracts periods – Created the *Observatorio Permanente del Mercado de los Servicios Portuarios* to promote prize and quality competition

Table 2
Descriptive analysis of the data.
Source: Own elaboration.

Variable name	Variable	Description	Unit	Mean	Std. Dev.	Max.	Min.
Intermediate consumption	x_N	Other productive factors cost of PA	Thousand Euro (constant 2001)	4838	4709	240	36,396
Capital	x_1	Stock of net fixed assets of PA	Thousand Euro (constant 2001)	7358	6159	11,026	1,399,000
Labour	x_2	Number of employees of PA	Employees	219	121	41	823
Berths	x_3	Berths necessary for ships' docking	Linear metres	10,395	5381	2006	48,019
Bulk solids	y_1	Bulk solids	Metric tons	3,056,779	3,259,497	6210	1,965,867
Bulk liquids	y_2	Bulk liquids	Metric tons	4,987,151	6,184,134	1	24,229,644
Containerised general cargo	y_3	Containerised general cargo	Metric tons	2,817,412	7,387,953	1	53,179,759
Non-containerised general cargo	y_4	Non-containerised general cargo	Metric tons	1,507,910	1,729,587	61,067	9,777,619
Passengers	y_5	Passengers	Number	704,956	1,287,287	0	5,793,708
Economic openness	C_1	Import-Export (% Region GDP)	Percentage	27.34	27.71	0.80	140.90
Trade	C_2	Merchandise trade (% of National GDP)	Percentage	40.38	4.88	25.57	47.22

progress in liberalising port services and included complete regulation of public ports in order to boost private participation. Again, the word “efficiency” featured prominently in the new law. To achieve efficiency, it stipulates that the private sector should have greater involvement, working with the public authorities, in order to generate greater competition between ports, both nationally and internationally, as well as fostering competition between services providers within the same port.

Until the adoption of 2003 reform, Spanish ports were subject to legislation which left them no true control over pricing policies. As a result, the competitive strategy of ports rested on the manipulation of those variables under the control of ports, mainly investment policy.

More recently, the Ports Act 33/2010 was approved, amending Law 48/2003. Under this Act, the principles and objectives of the economic system are that the port system should be self-financing, with a reasonable return on the average net non-current assets for the year, excluding assets in progress, deferred tax assets and non-current trade receivables, which allows for new investments needs to be covered and for any loans to be repaid. Furthermore, Law 33/2010 relaxed the tariff system in two directions; giving greater autonomy to Port Authorities, in terms of the fees, that each port can charge and allowing ports to specialise on services which they find attractive. The latter would also lead to an increase in the intra-port competency.

Law 33/2010 promoted a further liberalisation of services and infrastructures. In this regard, the private sector gets involved in the development of port infrastructure through management mechanisms such as leasing and concessions.

This paper contributes to the literature in two ways: on the one hand, by including all the legislative reforms that have taken place in the Spanish port sector in the last three decades (Act 27/1992, Act 62/1997, Act 48/2007 and Act 33/2010), and, on the other hand, by establishing a direct correlation between the reform and the change in Port Authorities efficiency.

The rest of the paper is organised as follows: In the second section, a brief literature review of port reforms and efficiency is presented. The third section proposes the theoretical model which will be subsequently estimated. In the fourth section, the statistical information used in this work is reviewed. Next, the proposed model is estimated and its main results are shown in the fifth section. Finally, the sixth section presents the main conclusions of this research.

2. Literature review: Port reforms and efficiency

Up until the 1980s, worldwide port services were exclusively operated and financed by public sector entities. This situation began to change in the 1990s, a time characterised by a massive policy redirection toward private participation in infrastructure and management of public sector (Cheon et al., 2010). This phenomenon was based on the coincidence of two distinct, but complementary trends.

On the one hand, governments began to see the private sector as an attractive and manageable solution to the problems posed by infrastructure services. The notion was that the private sector could both improve managerial efficiency and provide access to additional capital for service expansion and improvement.

On the other hand, the increasing level of international competition makes necessary the improvement of the competitiveness in the sector. Port efficiency is an important factor for a nation to achieve an internationally competitive advantage (Chin and Tongzon, 1998),

Based on the principal–agent theory, private ownership should be more efficient than the public one. Moreover, most studies analysing the private sector's participation and port efficiency find positive correlations between variables, although there are also some studies in which this relationship is not found or is negative.

In the context of no effects or negative effects findings, Liu (1995), using a translog function applied to a sample of 28 UK ports, did not find any significant advantage to private or public ownership, when the policy environment is competitive. Similarly, Notteboom et al. (2000) – using a Bayesian Stochastic Frontier Model – valued a diversity of ownership and administrative systems in the port sectors, and argued that port ownership does not have a significant effect on port performance.

Baird (2000) argued that, due to the specific nature of port investment (long term payback and high capital cost), principal–agent problems may also arise, in the private sector, as a result of capital market imperfections.

Coto-Millán et al. (2000) used a stochastic frontier cost function to estimate the economic efficiency of Spanish ports, through panel data of 27 Spanish ports, from 1985 to 1989. They found that the type of organisation has a significant effect on economic efficiency, but ports with autonomy are less efficient than the rest.

Contrary to the previous studies, various empirical studies support institutional reforms based on private sector participation, as an effective policy to achieve higher efficiency in port terminals. In this regard, Cullinane et al. (2002) used a port-function matrix to analyse the administrative and ownership structures of major container ports in Asia, concluding that size and private governance increase efficiency.

Estache et al. (2004) adopted an analysis of the Malmquist Productivity Index (MPI) for Mexican ports, and claimed that the reform of privatisation and decentralisation in Mexico generated large short-term improvements in the average performance of the port industry. Similarly, Barros (2003) concluded that the reform implemented in the Portuguese ports achieved substantial impacts on efficiency improvement. Tongzon and Heng (2005) examined similar issues with terminal level data and claimed that privatisation had become a necessary strategy to gain a competitive advantage in the current marketplace.

Cheon et al. (2010) used a Malmquist Index to measure how port institutional reforms influenced the efficiency gains between 1991 and 2004. They found that the world ports gained their efficiency based on three primary sources: improved management of container terminals, adjustment of production scales and technological progress.

Niavis and Tsekeris (2012) identified the major determinants of the technical efficiency of container seaports in South-Eastern Europe. They found that private terminals, when combined with the involvement of an international terminal operator, improved the efficiency score.

Yuen et al. (2013) investigated the operational efficiency of 21 major Chinese container ports. The authors concluded that there is a positive impact of Chinese ownership on the container terminal efficiency, but that the impact is negative when the Chinese party had the controlling stake. Furthermore, both intra-port and inter-port competition may enhance container terminal efficiency.

Focusing on the impact of Spanish ports reforms, Castillo-Manzano et al. (2008) used a structural change analysis methodology to analyse the effect of the 1992 and 1997 reforms on the levels of traffic of the Spanish port system. The authors found a positive impact of legislative changes on port traffic.

Gonzalez and Trujillo (2008) used a translog distance function to analyse the effect that port reforms, which took place in the 90s, had on the efficiency of the major Spanish container Authorities Ports. They found significant improvements in technological change, but weak effects on technical efficiency change.

Rodríguez-Álvarez and Tovar (2012) used a cost function to investigate the efficiency of Spanish Ports Authorities, over the

Table 3
Descriptive statistics by PA.
Source: Own elaboration.

PA	Capital (euros)	Labour (number)	Berths (m)	Bulk solids (ton)	Bulk liquids (ton)	Containerised gen. cargo (ton)	Non-containerised gen. cargo (ton)	Passengers (number)
A Coruña	5,994,375	190	8150	3,059,459	8,127,779	24,265	582,939	35,258
Alicante	3,042,996	164	6480	1,187,312	361,957	784,528	354,912	207,927
Almería-Motril	3,410,835	151	6315	6,399,587	908,879	13,892	552,419	665,810
Aviles	2,768,262	135	4254	2,233,253	625,182	20,329	1,296,313	86
Baleares	9,110,788	313	35,377	1,515,620	2,099,079	1,237,690	4,673,192	2,752,259
Barcelona	21,716,802	550	20,249	4,074,415	9,082,753	12,169,320	4,818,936	1,579,378
Bilbao	18,003,985	322	18,740	4,987,512	16,309,773	3,877,679	3,157,317	109,192
Cartagena	5,538,705	188	9443	2,951,942	13,332,225	368,239	303,429	20,428
Castellón	3,006,441	97	4903	1,634,371	7,085,242	519,599	421,517	94
Ceuta	2,845,880	140	4656	65,899	1,871,401	53,389	769,667	2,321,660
Gijón	10,738,299	320	8682	13,693,797	1,323,558	145,134	457,233	5646
Huelva	7,763,735	219	7155	5,026,635	10,797,391	525	547,744	378,309
Las Palmas	12,917,839	306	16,368	999,454	3,880,080	6,854,075	2,676,329	962,573
Málaga	5,005,302	194	5687	1,200,125	3,788,988	768,063	451,164	398,591
Marin-Pontevedra	1,842,437	73	3479	640,300	8079	244,187	443,317	1
Melilla	2,064,487	79	2907	43,471	65,925	132,599	461,289	442,194
Pasajes	4,377,058	233	5369	2,101,131	310,776	45,516	1,837,768	82
S. Cruz de Tenerife	10,763,399	223	15,087	1,152,688	8,177,958	2,468,626	2,597,071	3,596,070
Santander	6,319,664	222	11,044	3,229,191	477,063	23,810	1,045,455	142,867
Tarragona	9,546,493	291	11,760	8,630,985	18,132,792	601,906	684,879	5037
Valencia	17,807,687	375	13,831	4,216,247	2,430,789	18,582,319	4,687,513	348,626
Vigo	5,745,816	231	12,809	493,897	341,818	1,336,812	1,226,846	70,688
Vilagarcía	1,270,504	64	3194	394,789	202,212	22,217	171,868	3253
Bahía de Algeciras	10,964,196	295	14,495	2,052,756	18,640,538	22,099,544	3,230,064	4,134,977
Bahía de Cadiz	6,506,004	220	12,445	1,521,791	376,008	854,774	1,328,775	146,124
Ferrol-S. Cibrao	2,227,467	90	7398	5,969,635	907,693	3669	427,697	1717
Average	**7,357,671**	**219**	**10,395**	**3,056,779**	**4,987,151**	**2,817,412**	**1,507,910**	**704,956**

period 1993–2007, and found evidence of inefficient behaviour, with inefficiency worsening from 2003. The authors argued that, until the year 2003, Spanish ports were subject to legislation, which left them no control over pricing policies.

Nuñez-Sánchez and Coto-Millán (2012), using a parametric distance function approach, presented a study of the impact of public regulation on ports' economic efficiency for the period 1986–2005. They found that technical progress and scale efficiency gains improved the total factor productivity in the period, where as technical efficiency losses reduced the total factor productivity.

Finally, a recent paper by Coto-Millán et al. (2015) analysed the technical efficiency of seven sub-sectors operating under the Spanish port system. They found that 2003 port reform promoted greater efficiency among all port sectors.

3. Econometric specification

The distance function, introduced by Shephard (1953), allows estimation of the relative efficiency of ports in relation to the technological frontier, described by the distance function. The use of the distance function is especially important in the context of the Spanish Port Authorities (hereinafter PA), which is a highly regulated, state-owned sector. Moreover, it is not necessary to have information on factor prices (Coelli et al., 2005). The existence of price regulation for some inputs, makes this feature important for the estimation of efficiency in the Spanish ports infrastructure. Furthermore, the distance function allows estimation of multi-output processes, which represent an important advantage compared to the use of production functions. The latter is particularly relevant for the study of the port sector, because of the diversity of activities developed at ports.

Mathematically, the production technology of the port using the output set, $L(y)$, which represents the input set, $y \in R_+^M$, which can be produced using the input vector, $x \in R_+^K$, that is:

$$L(y)=\left\{ x \in R_+^K : x \quad \text{can} \quad \text{produce} \quad y \right\} \tag{1}$$

Distance functions can be input-oriented or output-oriented. The choice of an input-oriented distance function, instead of an output-oriented distance function, can be easily justified by the conditions under which the PA develop their activities. PA do have control over inputs, such as labour, capital and intermediate consumption, but do not have control over the output (cargo traffic that uses their facilities).

An input-oriented distance function is mathematically expressed as follows:

$$D_I(x, y)=max_\delta\{\delta :(x/\delta)\epsilon L(y)\} \tag{2}$$

where y is the output vector, x represents the vector of factors and $L(y)$ the input set, which defines the groups of all inputs, x, that can be used to obtain the output vector, y. A value of $D_I(x, y)$ equal to one reveals that production is efficiently carried out, whereas a value of $D_I(x, y)$ greater than one will indicate the existence of technical inefficiency.

Input-oriented distance functions are required to meet the following theoretical properties (Färe and Primont, 2012): homogeneity of degree 1 in inputs, non-increasing in outputs, quasi-convex in output, non-decreasing in inputs and concave in inputs.

The formulation of the input distance function, defined in Eqs. (1) and (2), can be specified following the True fixed effects model[2] (Greene, 2005) as:

$$D_I(x, y)=f(x, y, \delta)e^{\lambda+\nu} \tag{3}$$

where δ is a vector of unknown coefficients to be estimated. The term λ represents the port-specific fixed-effect that accounts for port characteristics that are not captured by the included variables[3], and term ν is the random disturbance term, capturing the statistical noise, which is assumed to be $iidN(0,\sigma_v^2)$.

An appropriate functional form, $f(\bullet)$, in Eq. (3), should ideally be flexible, easy to calculate and permit the imposition of homogeneity. A commonly used functional form of production is the translog form, which satisfies the above criteria and has been widely adopted in previous studies (Lovell et al. 1994; Coelli and Perelman, 2000)[4]. The translog distance function, with M outputs and K inputs in the year t is:

$$\ln D_{Iit}=\alpha_0+\sum_{r=1}^{M}\beta_r \ln y_{rit}+\frac{1}{2}\sum_{r=1}^{M}\sum_{s=1}^{M}\beta_{rs}\ln y_{rit}\ln y_{sit}+\sum_{j=1}^{K}\gamma_j \ln x_{jit}+\frac{1}{2}\sum_{j=1}^{K}\sum_{h=1}^{K}\gamma_{jh}\ln x_{jit}\ln x_{hit}+\frac{1}{2}\sum_{r=1}^{M}\sum_{j=1}^{K}\rho_{rj}\ln y_{rit}\ln x_{jit}+\Omega_1 \ln C_{1t}+\Omega_2 \ln C_{2t}+\lambda_i+v_{it} \quad i=1,\ldots,N \quad \text{and} \quad t=1,\ldots,T \tag{4}$$

where D_I is the input-oriented distance function, y is the r output vector, x is the j input vector, i relates to the PA and t relates to the time period. C_{1t} and C_{2t} are two *control variables*[5], (C_{1t}) related to Foreign Trade and (C_{2t}) account for the Domestic Trade, and $\alpha_0, \beta_r, \beta_{rs}, \gamma_j, \gamma_{jh}, \rho_{rj}, \Omega_1, \Omega_2$ are parameters to be estimated. Finally, in line with the work of Aigner et al. (1977), one can assume that v_{it} is a symmetric error term, *iid* with a zero mean representing a random variable that cannot be controlled by the operator.

The restriction of homogeneity of degree 1 in inputs requires:

$$\sum_{j=1}^{K}\gamma_j=1, \quad \sum_{h=1}^{K}\gamma_{jh}=0, \quad \sum_{j=1}^{K}\rho_{rj}=0, \quad (j=1,\ldots,K), \quad (r=1,\ldots,M) \tag{5}$$

Symmetry is given if the second order coefficients satisfy:

$$\beta_{rs}=\beta_{sr},\ \gamma_{jh}=\gamma_{hj},\ (r, s=1,\ldots,M),\ (j, h=1,\ldots,K) \tag{6}$$

The input distance function in (4) is transformed into an econometric model which can be estimated by Stochastic Frontier techniques. Imposing homogeneity by deflating $K-1$ inputs by the $K-h$ input leads to:

$$\ln D_{Iit}-\ln x_{Kit}=\lambda_i+g\left[\left(\ln x_{kit}-\ln x_{Kit}\right), y_{rit}, C_{1t}, C_{1t}\right]+v_{it} \tag{7}$$

where $g(.)$ represents the translog functional form. To estimate the input distance function, this expression is rearranged as:

Table 4
Input distance estimation and efficiency effects (period 1986–2012).
Source: Own elaboration.

Variable	Parameter	TFE Model Coefficient	TFE Model Standard error
$\ln(x_1)$	γ_1	0.086	(0.017)***
$\ln(x_2)$	γ_2	0.599	(0.021)***
$\ln(x_3)$	γ_3	0.255	(0.020)***
$\ln(y_1)$	β_1	−0.059	(0.012)***
$\ln(y_2)$	β_2	−0.018	(0.006)**
$\ln(y_3)$	β_3	−0.020	(0.004)***
$\ln(y_4)$	β_4	−0.036	(0.013)**
$\ln(y_5)$	β_5	−0.014	(0.003)***
$\ln(x_1)\ln(x_1)$	γ_{11}	0.001	(0.046)
$\ln(x_2)\ln(x_2)$	γ_{22}	0.200	(0.064)**
$\ln(x_3)\ln(x_3)$	γ_{33}	0.014	(0.059)
$\ln(x_1)\ln(x_2)$	γ_{12}	−0.048	(0.036)
$\ln(x_1)\ln(x_3)$	γ_{13}	0.060	(0.038)
$\ln(x_2)\ln(x_3)$	γ_{23}	−0.107	(0.048)*
$\ln(y_1)\ln(y_1)$	β_{11}	−0.003	(0.006)
$\ln(y_2)\ln(y_2)$	β_{22}	−0.001	(0.001)
$\ln(y_3)\ln(y_3)$	β_{33}	−0.003	(0.000)***
$\ln(y_4)\ln(y_4)$	β_{44}	−0.001	(0.014)
$\ln(y_5)\ln(y_5)$	β_{55}	−0.004	(0.000)***
$\ln(y_1)\ln(y_2)$	β_{12}	−0.011	(0.003)**
$\ln(y_1)\ln(y_3)$	β_{13}	0.001	(0.001)
$\ln(y_1)\ln(y_4)$	β_{14}	0.000	(0.002)
$\ln(y_1)\ln(y_5)$	β_{15}	0.018	(0.009)¨
$\ln(y_2)\ln(y_3)$	β_{23}	0.000	(0.000)
$\ln(y_2)\ln(y_4)$	β_{24}	−0.001	(0.000)
$\ln(y_2)\ln(y_5)$	β_{25}	0.003	(0.004)
$\ln(y_3)\ln(y_4)$	β_{34}	0.001	(0.000)*
$\ln(y_3)\ln(y_5)$	β_{35}	0.001	(0.001)
$\ln(y_4)\ln(y_5)$	β_{45}	0.003	(0.002)
$\ln(x_1)\ln(y_1)$	ρ_{11}	−0.002	(0.011)
$\ln(x_1)\ln(y_2)$	ρ_{12}	0.009	(0.007)
$\ln(x_1)\ln(y_3)$	ρ_{13}	−0.003	(0.002)
$\ln(x_1)\ln(y_4)$	ρ_{14}	0.000	(0.003)
$\ln(x_1)\ln(y_5)$	ρ_{15}	0.034	(0.018)¨
$\ln(x_2)\ln(y_1)$	ρ_{21}	−0.016	(0.016)
$\ln(x_2)\ln(y_2)$	ρ_{22}	0.004	(0.007)
$\ln(x_2)\ln(y_3)$	ρ_{23}	0.009	(0.003)**
$\ln(x_2)\ln(y_4)$	ρ_{24}	0.004	(0.004)
$\ln(x_2)\ln(y_5)$	ρ_{25}	0.071	(0.024)**
$\ln(x_3)\ln(y_1)$	ρ_{31}	0.025	(0.013)¨
$\ln(x_3)\ln(y_2)$	ρ_{32}	−0.014	(0.008)¨
$\ln(x_3)\ln(y_3)$	ρ_{33}	−0.009	(0.003)*
$\ln(x_3)\ln(y_4)$	ρ_{34}	−0.006	(0.004)
$\ln(x_3)\ln(y_5)$	ρ_{35}	−0.108	(0.025)***
$\ln C_1$	Ω_1	−0.011	(0.001)***
$\ln C_2$	Ω_2	0.000	(0.000)***
Efficiency effects			
Law92	δ	*−0.022*	*(0.016)*
Law97	δ_2	*−0.063*	*(0.021)***
Law03	δ_3	*−0.060*	*(0.022)***
Law10	δ_4	*−0.010*	*(0.025)*
Constant	δ_0	*13.106*	*(0.090)****
Sigma[2]	$\sigma^2=\sigma_v{}^2+\sigma_\mu{}^2$	0.120	(0.006)***
Gamma	$\gamma=\sigma_u{}^2/(\sigma_v{}^2+\sigma_u{}^2)$	0.579	(0.001)***
Number of observations		702	
Number of PA		26	
Log-likelihood function		726.63	

Signif. codes: 0 "***", 0.01 "**", 0.05 "*", 0.10 "".
Notes: CI variable has been used as x_{Nit} variable.

[2] Frontier literature is rather extensive and may be roughly divided into two groups according to the method chosen to estimate the frontier production function, namely, Deterministic frontiers versus Stochastic frontiers. Both methods have advantages and drawbacks. In this study, SFA methods have been chosen in order to estimate the best practice frontier. Due to the heterogeneity of the sample, the advantages of this method outweigh its disadvantages (Greene, 2008).

[3] Following the "true fixed effects model" of Greene, 2005. The heterogeneity of activities developed at ports, makes necessary the treatment of the *unobservable heterogeneity* among Port Authorities. If this heterogeneity among them exists and it is not explicitly picked up in the model, a problem of omitted variables will exist and the estimated coefficients of the included variables will be biased (Rodríguez-Álvarez and Tovar, 2012).

[4] The Cobb–Douglas form is the alternative functional form that satisfies only the latter two criteria, because of the restrictive elasticity of substitution and scale property. This study used the likelihood ratio (LR) test to identify whether the Cobb–Douglas functional form, or the translog specification, was the most adequate.

[5] The variables C_{1t} and C_{1t} had been introduced as control variables in order to track observable heterogeneity and to isolate the effects that other factors, other than public regulation, can have on technical efficiency

Table 5
Average technical efficiency scores by PA and rates of variation.
Source: Own elaboration.

PA	TE	Change rate (%)
Bahía de Algeciras	0.932	6.7
Alicante	0.932	2.0
Almería-Motril	0.938	7.0
Aviles	0.939	12.0
Bahía de Cadiz	0.949	8.7
Barcelona	0.924	12.2
Bilbao	0.927	22.0
Cartagena	0.842	−0.2
Castellón	0.865	8.1
Ceuta	0.904	6.9
Ferrol-S. Cibrao	0.938	14.7
Gijón	0.913	6.0
Huelva	0.906	26.2
A Coruña	0.910	9.8
Las Palmas	0.901	8.6
Málaga	0.921	5.6
Melilla	0.940	9.9
Baleares	0.927	9.7
Pasajes	0.933	2.2
Marin-Pontevedra	0.923	8.1
S. Cruz de Tenerife	0.929	11.4
Santander	0.904	−0.8
Tarragona	0.951	3.8
Valencia	0.928	13.8
Vigo	0.901	8.2
Vilagarcía	0.922	0.6
Average TE	0.919	8.6

$$-\ln x_{Kit} = \lambda_i + g\left[(\ln x_{kit} - \ln x_{Kit}), y_{rit}, C_{1t}, C_{1t}\right] + v_{it} - u_{it} \tag{8}$$

where $u_{it}=ln\ D_{Iit}$. The parameter u_{it} follow a non-negative truncated normal distribution $(u_{it}{\sim}iidN^{+}(\mu,\sigma_u^2))$. The firm-specific fixed effect λ_i is assumed to enter the mean of the inefficiency term, μ_{it}, of the ith *PA* in the tth observation (Belotti et al., 2012), which is defined as a function of the regulatory periods:

$$-\mu_{it} = (\lambda_i + \delta_0) + \delta_1 Law92_t + \delta_2 Law97_t + \delta_3 Law03_t + \delta_3 Law10_t + \omega_{it} \tag{9}$$

In (9) the disturbance parameter ω_{it} represents a random variable $(\omega_{it}{\sim}N(0,\sigma_\omega^2)$, but not necessarily identically distributed.

The conditional expectation of u_{it} is used to obtain the predicted value of the ports inefficiency (Jondrow et al.,1982):

$$\hat{u}_{it} = E\left[\exp\ (-u_{it})|\ \varepsilon_{it}\right] \tag{10}$$

where $\varepsilon_{it}=v_{it}+u_{it}$. Eqs. (8) and (9) can be estimated, using a one-step procedure, by maximum likelihood method (Coelli and Perelman, 2000).

4. Data

To estimate the parametric input-distance function, data panel information of the 26[6] Port Authorities during a 27 year period, from 1986 to 2012, was collected. This provides a panel of data of 702 observations. The PA considered in this paper mobilise the 99% of the total traffic of cargo moved by the state owned *Enterprise of National Ports* (hereinafter, ENP) during the period of study. The database was gathered from the audited financial statements published annually by the ENP in their Annual Reports. Regarding the traffic information, the data was obtained from the Annual Traffic Reports carried out by the ENP. As noted in the previous section, to estimate the distance function, variables for inputs and outputs are needed, as well as a measurement of quasi-fixed input.

To describe port technology and estimate the frontier model, five outputs, four inputs and two control variables were needed. Additionally, four variables were used to evaluate the effect of reforms on the port efficiency.

4.1. The output

At port facilities, passengers and cargo are exchanged (Gonzalez and Trujillo, 2008). Nevertheless, cargo represents the most immediate and important source of revenue for PA. The merchandise handled at ports cannot be considered as a homogenous good, since the different cargo types are so diverse that they require specialised facilities. This fact leads us to consider that port activities are developed in a multi-output context. Therefore, five types of outputs for PA have been identified: solid bulk (y_1), liquid bulk (y_2), containerised general cargo (y_3), non-containerised general cargo (y_4) and passengers[7] (y_5).

Despite being aware that tons of the containers should be measured in teus instead of tons we have preferred to use tons for all kind of goods. The reason for this is to homogenise in tons all goods treated as outputs. Table 2 shows the main descriptive statistics of the variables described above. The standard deviation in the sample shows a high degree of heterogeneity, in terms of the size and specialisation, of the port being managed. Table 3

[6] Regarding the port sampling criteria, efforts have been made to cover all the public PA under the ENP. Nevertheless, Sevilla Port Authority was finally excluded from the sample due to the lack of financial information covering all period. This decision should have a residual effect. Sevilla port is an inland port whit difficult access (Castillo-Manzano et al., 2007), representing less than 1% of the total traffic of cargo moved by the ENP during the study period.

[7] Some ports in the sample have zero passengers, presenting a problem since the natural logarithm of zero in undefined. Due to "zero cases" is an insignificant proportion of the total number of sample observations, it has been substituted the value of one for zero for the ports concerned. According to Battese (1997), in this type of cases, this procedure should not affect the estimates of the basic parameters.

presents information for each port in more detail. Table 3 may help to corroborate the evidence of specialisation found by González-Laxe (2012). The 26 PA included in the sample vary widely in terms of size, specialisation and location characteristics, so individual heterogeneity is an issue which will need to be dealt with in an empirical specification.

4.2. The inputs[8]

Regarding input variables, capital (x_1) comprises all the components of net tangible assets of the PA (including buildings, machines, vehicles, etc.). Labour (x_2) is defined as the total annual number of employees. Finally, intermediate consumption (X_N) is measured as the expenditure on all productive factors, aside from labour and capital, including office supplies, water and electricity. All monetary variables are expressed in euros, as of year 2001. As quasi-fixed input, one considers the berths necessary for ships' docking (x_3). Berths have been measured in linear metres and this paper considers not only the berths owned by PA, but also by private entities (for example, shipyards). Only those berths not reaching a 4-m depth have been excluded, since they are places basically intended for water-sports activities.

4.3. Control variables

This paper also includes two control variables in order to isolate the effect of exogenous shocks that might have influenced Spanish maritime traffic in the analysed time period. These variables were "Economic openness", obtained as the percentage of the monetary volume of Regional foreign trade, within Regional GDP, and "Trade", obtained as the percentage of the monetary volume of domestic trade, within National GDP (data reported in consistent currencies of the Bank of Spain).

4.4. Efficiency effects: The reform variables

It should also be pointed out that Table 2 also includes variables *Law92*, *Law97*, *Law03* and *Law10*. These are dummy variables that cover the effects of public regulation. *Law92* variable takes value 1 in the years 1993, 1994, 1995, 1996 and 1997, and value 0 otherwise. *Law97* variable takes value 1 in the years 1998, 1999, 2000, 2001, 2002 and 2003, and value 0 in the remaining years. Variable *Law03* takes value 1 in the years 2004, 2005, 2006, 2007, 2008, 2009 and 2010; and value 0 otherwise. Finally, Variable *Law10* takes value 1 in 2011 and 2012 and value 0 in the remaining period.

5. Results

5.1. Input distance function estimation

Based on the econometric specification described above, we proceeded to estimate the distance frontier function input oriented using the maximum likelihood method (Table 3). Presented on the right, in brackets, are the standard errors. The first-order coefficients of Table 4 may be interpreted as elasticities evaluated on the data average, since each of the variables has been divided by their respective geometric mean.

It can be seen that all the first-order coefficients were statistically significant and had the right sign. The parameters of input variables are positive and, thus, indicate that distance from the frontier decrease when input diminishes. This implies that the estimated distance function complies with all the expected theoretical properties.

One can therefore confirm, that the greatest input elasticity corresponds to labour (0.599), followed by the quasi-fixed input, berths (0.255), and lastly capital (0.086). These results coincide with those obtained by Nuñez-Sánchez and Coto-Millán (2012), in which labour was the factor of production with the highest importance. Rodríguez-Álvarez et al. (2007) obtained a similar result, estimating a distance function oriented to the inputs for port operators in the port of Las Palmas.

Liquid bulk is the variable with the highest output-elasticity in the model (0.056). Moreover, the sum of the first-order output coefficients was lower than 1 in absolute value, indicating the presence of increasing returns to scale.

The regression results also show, that Foreign and Domestic Trade variables pick up the effects that other factors (other than public regulation) can have on technical efficiency.

The parameter γ lies between zero and one and indicates the importance of the inefficiency term. If γ is zero, the inefficiency term u is irrelevant. In contrast, if γ is one, the noise term v is irrelevant and all deviations from the production frontier are explained by technical inefficiency. As the estimate of γ is 0.58, it is possible to conclude that both statistical noise and inefficiency are important for explaining deviations from the distance function, but that inefficiency is more important than noise.

5.2. Regulatory effects on port efficiency

Since it is found that inefficiency is significantly present in this sample of ports, there is room to investigate its determinants, i.e., reforms with an impact on sample ports' efficiency and, hence, on the total factor productivity. The analysis is based on an Eq. (8), whose estimates are shown at the bottom of Table 4 (*Efficiency Effects*). This paper includes public regulations as explanatory variables, being that this is the main difference, with respect to previous papers.

Since inefficiency in Eq. (8) is measured in terms of the distance from the frontier, a negative impact indicates an increase in efficiency (i.e. catching up towards the frontier).

Law92, *Law97*, *Law03* and *Law10* have negative coefficients, indicating that these reforms have positive effects on technical efficiency. Two of them (*Law97*, *Law03*) are found to be statistically significant.

The coefficient on *Law97* has the greatest negative sign and is statistically significant. Law 62/1997 focused on the autonomy of PA. Thus, it is safe to conclude that port autonomy – decentralisation – has been the most important factor to improve efficiency in the Spanish ports system during the last three decades. This conclusion is in concordance to that found by Gonzalez and Trujillo (2008), Rodríguez-Álvarez and Tovar (2012) and Nuñez-Sánchez and Coto-Millán (2012). Nonetheless, this study takes a step beyond previous works, by establishing a direct correlation between the reform and the efficiency.

The coefficient on *Law03* has a negative sign and is statistically significant. Law 48/2003 focused on the encouragement of private investment and the promotion of intra-port competition. Therefore it can be concluded, that the promotion of privatisation and inter-port competition had a positive impact on the efficiency of the Spanish ports. This conclusion is in concordance to that found

[8] Some previous papers (Nuñez-Sánchez and Coto-Millán., 2012; Rodríguez-Álvarez and Tovar, 2012; Núñez-Sanchez, 2013) have considered the surface area as quasi-fixed input. However, due the high levels of correlation found between this variable and other input and output variables, the *surface* variable has been discarded to avoid collinearity problems in the estimation (Farrar and Glauber, 1967). Instead, according whit some others papers (González and Trujillo, 2008; De Oliveira and Cariou, 2015) the length of berths is taking as quasi-fixed input.

by Nuñez-Sánchez and Coto-Millán (2012) and Coto-Millán et al. (2015).

Although *Law92* and *Law10* have negative coefficients, we cannot conclude that these reforms were important, enhancing efficiency in the Spanish port system. Castillo-Manzano et al. (2008) argue that, because of the experience accumulated, the effect of Law 27/1992 was more important in the case of autonomous ports than in the case of non-autonomous ports. The growing rate of the ports of Barcelona, Bilbao, Huelva and Valencia (Table 5) seems to confirm this hypothesis.

Law 33/2010 goes even further in the same direction: decentralisation, privatisation and liberalisation. In this case, the limited lifetime (2011–2012) appears to be the main reason for its lack of statistical significance.

Table 5 displays the average efficiency scores by PA and the rates of variation in the period addressed. The average technical efficiency for the overall port system was 91.9% during this period, with a very strong stability over time. These results are in line with those obtained by Gonzalez and Trujillo (2008), Nuñez-Sánchez and Coto-Millán (2012) and Rodríguez-Álvarez and Tovar (2012). The average technical efficiency per PA varied from 95.3% for the most efficient (Tarragona) to 84.1% for the least efficient (Barcelona).

6. Conclusions

As happened in other countries around the world, the port system in Spain underwent a series of deep legislative reforms starting in the early 1990s. Four regulatory changes have been carried out in the last three decades: Act 27/1992, Act 62/1997, Act 48/2007 and Act 33/2010. These reforms rested on three key instruments: decentralisation (port autonomy, self-administration), privatisation (participation of private sector) and introduction of competition (between ports and between operators within ports) in the port system. As mentioned by Cheon et al. (2010), these reforms intended to increase port efficiency, enhance service quality through more responsiveness to the needs of port users and cope with the global market pressures more effectively.

Using stochastic frontier methods, this paper evaluates the impact on port efficiency and the legislative reforms that have taken place in the Spanish port sector in the last three decades. To this end, an input-oriented distance model has been estimated for a sample of 26 port authorities during the period 1986–2012. This paper contributes to the literature by establishing a direct correlation between the reform and the change in efficiency. Furthermore, this paper contributes to the literature by analysing all the port regulatory changes from 1986 until now.

The results highlight the positive impact of *Law92, Law97, Law03* and *Law10* on port technical efficiency. Two of them (Law97, Law03) are found to be statistically significant. Law 62/1997 focused on the autonomy of port authorities. Thus, it is safe to conclude that port autonomy – decentralisation – has been the most important factor to improve efficiency in the Spanish ports system during the last three decades. Law 48/2003 focused on the encouragement of private investment and the promotion of intra-port competition. Therefore it can be concluded, that the promotion of port autonomy, privatisation and inter-port competition had a positive impact on the efficiency of the Spanish ports system.

These results are meaningful to policymakers. The above findings are significant in terms of deepening in the sector reform process. Policies promoting further autonomy, deregulation and intra-port competition will benefit port efficiency.

Appendix. Additional information

See Appendix Tables 6 and 7.

Table 6
Fixed effect parameters.
Source: Own elaboration.

Variable	Parameter	Modelo TFE	
		Coefic.	Error Estd.
Fixed Effect PA Bahía de Algeciras	λ_1	−1.1234	(0.087)***
Fixed Effect PA Alicante	λ_2	−1.2749	(0.071)***
Fixed Effect PA Almería-Motril	λ_3	−1.1543	(0.087)***
Fixed Effect PA Aviles	λ_4	−1.1796	(0.084)***
Fixed Effect PA Bahía de Cadiz	λ_5	−1.4616	(0.077)***
Fixed Effect PA Barcelona	λ_6	−1.6891	(0.091)***
Fixed Effect PA Bilbao	λ_7	−1.6306	(0.086)***
Fixed Effect PA Cartagena	λ_8	−1.3033	(0.082)***
Fixed Effect PA Castellón	λ_9	−1.1274	(0.082)***
Fixed Effect PA Ceuta	λ_{10}	−1.5162	(0.055)***
Fixed Effect PA Ferrol-S. Cibrao	λ_{11}	−1.2686	(0.085)***
Fixed Effect PA Gijón	λ_{12}	−1.3956	(0.095)***
Fixed Effect PA Huelva	λ_{13}	−1.3823	(0.086)***
Fixed Effect PA A Coruña	λ_{14}	−1.3279	(0.079)***
Fixed Effect PA Las Palmas	λ_{15}	−1.4769	(0.083)***
Fixed Effect PA Málaga	λ_{16}	−1.2406	(0.070)***
Fixed Effect PA Melilla	λ_{17}	−1.3938	(0.075)***
Fixed Effect PA Baleares	λ_{18}	−1.3475	(0.099)***
Fixed Effect PA Pasajes	λ_{19}	−1.3805	(0.087)***
Fixed Effect PA Marin-Pontevedra	λ_{20}	−1.1557	(0.074)***
Fixed Effect PA S. Cruz de Tenerife	λ_{21}	−1.3690	(0.082)***
Fixed Effect PA Santander	λ_{22}	−1.4841	(0.081)***
Fixed Effect PA Tarragona	λ_{23}	−1.2948	(0.084)***
Fixed Effect PA Valencia	λ_{24}	−1.5028	(0.091)***
Fixed Effect PA Vigo	λ_{25}	−1.5514	(0.078)***
Fixed Effect PA Vilagarcía	λ_{26}	−1.2708	(0.070)***

"***", Significance at the 100% level. "**",Significance at the 99% level. "*", Significance at the 95% level. "". Significance at the 90% level.

Table 7
TE by Port Authority and by year.
Source: Own elaboration.

P.A.	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	TE (PA)
A Coruña	0.85	0.90	0.92	0.94	0.93	0.92	0.91	0.86	0.94	0.96	0.96	0.96	0.96	0.93	0.96	0.94	0.94	0.94	0.96	0.96	0.97	0.97	0.96	0.87	0.89	0.93	0.94	**0.93**
Alicante	0.92	0.93	0.93	0.91	0.93	0.88	0.89	0.84	0.90	0.93	0.94	0.95	0.97	0.96	0.95	0.96	0.97	0.96	0.97	0.97	0.97	0.97	0.96	0.87	0.89	0.92	0.94	**0.93**
Almería-M	0.90	0.93	0.95	0.95	0.92	0.84	0.87	0.92	0.95	0.95	0.96	0.96	0.97	0.93	0.95	0.95	0.93	0.96	0.97	0.98	0.97	0.97	0.96	0.87	0.92	0.95	0.96	**0.94**
Aviles	0.86	0.91	0.95	0.94	0.94	0.90	0.88	0.89	0.94	0.97	0.98	0.97	0.97	0.95	0.96	0.96	0.95	0.95	0.96	0.96	0.97	0.97	0.96	0.83	0.93	0.94	0.97	**0.94**
B. de Algeciras	0.89	0.90	0.90	0.97	0.97	0.96	0.96	0.95	0.97	0.95	0.96	0.95	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.85	0.88	0.93	0.95	**0.95**
B. de Cadiz	0.87	0.87	0.88	0.90	0.93	0.88	0.86	0.85	0.93	0.93	0.94	0.93	0.95	0.94	0.96	0.96	0.95	0.96	0.97	0.97	0.97	0.97	0.96	0.84	0.91	0.94	0.94	**0.92**
Baleares	0.86	0.89	0.93	0.90	0.88	0.90	0.84	0.94	0.97	0.94	0.91	0.89	0.94	0.94	0.96	0.97	0.97	0.95	0.97	0.96	0.97	0.97	0.97	0.85	0.91	0.92	0.95	**0.93**
Barcelona	0.78	0.78	0.78	0.78	0.78	0.78	0.77	0.63	0.71	0.75	0.83	0.82	0.90	0.86	0.91	0.92	0.91	0.89	0.95	0.95	0.95	0.96	0.95	0.87	0.79	0.84	0.88	**0.84**
Bilbao	0.74	0.82	0.89	0.87	0.88	0.94	0.92	0.55	0.62	0.66	0.76	0.80	0.94	0.93	0.96	0.94	0.94	0.94	0.96	0.96	0.96	0.96	0.92	0.89	0.85	0.90	0.90	**0.87**
Cartagena	0.91	0.93	0.94	0.93	0.95	0.92	0.91	0.77	0.87	0.88	0.77	0.84	0.92	0.94	0.95	0.94	0.93	0.93	0.95	0.96	0.96	0.96	0.95	0.76	0.85	0.89	0.91	**0.90**
Castellón	0.90	0.92	0.94	0.89	0.94	0.92	0.91	0.93	0.96	0.96	0.96	0.95	0.96	0.90	0.92	0.89	0.95	0.89	0.96	0.95	0.95	0.97	0.98	0.91	0.95	0.96	0.97	**0.94**
Ceuta	0.89	0.92	0.96	0.93	0.93	0.91	0.88	0.87	0.94	0.82	0.72	0.80	0.90	0.94	0.96	0.96	0.95	0.95	0.97	0.97	0.96	0.96	0.95	0.85	0.90	0.93	0.96	**0.91**
Ferrol-S. C.	0.83	0.84	0.79	0.81	0.76	0.67	0.96	0.96	0.91	0.97	0.96	0.97	0.96	0.92	0.95	0.94	0.92	0.90	0.94	0.97	0.98	0.98	0.95	0.84	0.89	0.93	0.96	**0.91**
Gijón	0.90	0.91	0.93	0.91	0.90	0.92	0.89	0.87	0.92	0.72	0.72	0.90	0.96	0.97	0.91	0.93	0.94	0.85	0.96	0.95	0.97	0.97	0.96	0.86	0.95	0.95	0.95	**0.91**
Huelva	0.76	0.80	0.90	0.89	0.91	0.91	0.83	0.81	0.87	0.82	0.83	0.86	0.89	0.91	0.95	0.96	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.87	0.89	0.94	0.96	**0.90**
Las Palmas	0.87	0.91	0.94	0.92	0.94	0.93	0.93	0.85	0.92	0.77	0.86	0.86	0.95	0.96	0.97	0.96	0.96	0.96	0.95	0.97	0.97	0.97	0.96	0.83	0.89	0.94	0.95	**0.92**
Málaga	0.91	0.94	0.95	0.94	0.95	0.94	0.95	0.95	0.96	0.94	0.84	0.90	0.94	0.95	0.97	0.96	0.94	0.94	0.97	0.96	0.97	0.97	0.96	0.85	0.91	0.95	0.96	**0.94**
Marin-Pont.	0.90	0.92	0.94	0.96	0.93	0.91	0.92	0.86	0.88	0.87	0.89	0.82	0.88	0.95	0.97	0.96	0.97	0.96	0.97	0.96	0.97	0.97	0.96	0.86	0.92	0.95	0.97	**0.93**
Melilla	0.86	0.91	0.96	0.96	0.96	0.94	0.95	0.91	0.94	0.97	0.93	0.90	0.93	0.92	0.96	0.95	0.94	0.94	0.95	0.95	0.95	0.95	0.95	0.83	0.89	0.93	0.95	**0.93**
Pasajes	0.94	0.93	0.94	0.94	0.94	0.92	0.85	0.77	0.91	0.93	0.92	0.93	0.95	0.93	0.96	0.96	0.91	0.93	0.97	0.96	0.97	0.96	0.94	0.73	0.93	0.95	0.96	**0.92**
Tenerife	0.87	0.91	0.93	0.93	0.93	0.92	0.92	0.81	0.90	0.96	0.94	0.93	0.93	0.92	0.91	0.94	0.94	0.96	0.97	0.97	0.97	0.97	0.97	0.86	0.92	0.96	0.97	**0.93**
Santander	0.95	0.94	0.91	0.88	0.85	0.81	0.82	0.75	0.89	0.89	0.88	0.88	0.93	0.93	0.96	0.95	0.93	0.93	0.95	0.96	0.96	0.95	0.95	0.81	0.87	0.93	0.94	**0.90**
Tarragona	0.93	0.94	0.95	0.94	0.95	0.94	0.93	0.90	0.93	0.94	0.96	0.95	0.97	0.94	0.97	0.96	0.95	0.96	0.97	0.97	0.97	0.98	0.97	0.91	0.95	0.97	0.97	**0.95**
Valencia	0.85	0.89	0.92	0.90	0.89	0.89	0.88	0.86	0.93	0.92	0.83	0.90	0.96	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.97	0.84	0.93	0.95	0.97	**0.93**
Vigo	0.88	0.90	0.89	0.88	0.91	0.85	0.85	0.73	0.86	0.82	0.70	0.87	0.94	0.94	0.96	0.96	0.95	0.95	0.97	0.96	0.97	0.97	0.96	0.83	0.91	0.94	0.95	**0.90**
Vilagarcía	0.96	0.97	0.97	0.92	0.94	0.79	0.89	0.92	0.83	0.87	0.84	0.90	0.90	0.84	0.95	0.97	0.97	0.96	0.97	0.97	0.96	0.97	0.97	0.83	0.94	0.95	0.96	**0.92**
TE (year)	**0.88**	**0.90**	**0.92**	**0.91**	**0.91**	**0.89**	**0.89**	**0.84**	**0.90**	**0.89**	**0.88**	**0.90**	**0.94**	**0.93**	**0.95**	**0.95**	**0.95**	**0.94**	**0.96**	**0.96**	**0.97**	**0.97**	**0.96**	**0.85**	**0.90**	**0.93**	**0.95**	**0.92**

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