Spatial non-price competition in port infrastructure services

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Abstract

This study analyses the possible existence of spatial non-price competition in the port industry. We propose a dynamic two-stage model that allows: (1) to estimate the sensitivity of generation and diversion of traffic caused by port capacity expansions; (2) to quantify the degree of capacity competition; (3) to simulate a hypothetical scenario of cooperation agreements among different port authorities. The econometric specification is based on a structural model of demand, cost and market equilibrium. The empirical results suggest that non-price competition exists in port infrastructure services. Furthermore, using a simulation analysis, we show that incentives to invest in port capacity decrease under a cooperative setting.

JEL Codes: D4; D24; L9; L1.

Keywords: Strategic interdepence; imperfect competition; port capacity; port alliances.

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1. INTRODUCTION

This paper is concerned with two important aspects of the strategic behavior of firms. Firstly, the effect of informational externalities of conduct on the strategic interdependence among firms. For instance, when agents make decisions, they take into account their expectations about the response of the rest of agents (strategic interdependence). These expectations are based on the own experience and/or on the information available at that moment. Therefore, informational externalities of conduct occur when the available information about agents' behavior affects strategies of the others. Secondly, the effect of non-price strategies on firms' demand. In this way, pricing has been considered the main competitive strategy of firms. However, the existence of close substitutes or public pricing regulation might make non-price strategies relevant to increase their demand and compete among them.

We illustrate the method with an application to the port industry in Spain. Historically, port regulation in Spain has allowed to port authorities to plan their infrastructure investments under the supervision of the national port agency Puertos del Estado. As a consequence, they have adopted capacity expansion strategies in order to become more attractive to current and potential clients, and so to attract additional cargo traffic. In fact, during the period analyzed (1992-2011) Spanish port authorities carried out substantial investments in capacity, which required a great amount of financial resources.

The methodology proposed allow to measure the effect of port capacity expansion, considered as a non-price strategy, on port demand, under a spatial differentiation setting in the industry. In particular, the sensitivity of both cargo traffic generated and traffic diverted due to port capacity expansion is estimated. Additionally, our empirical especification allows to evaluate the level of capacity competition. This means that it is possible to determine whether port authorities take into account the information available regarding the other authorities' capacities when they take their capacity decisions. Then we present a structural model of demand, cost, and market equilibrium. We use panel data related to financial and traffic information of Spanish port authorities to estimate the demand of cargo, a cost function system and a first order equilibrium condition. Until the best of our knowledge, there are not previous studies that analyze jointly the effects of informational externalities and non-price strategies in the port industry. Finally, in spite of our model has been applied to the Spanish port system, the proposed methodology makes it possible to estimate the effect of port regulation and imperfect competition in an industry with spatial differentiation.

The rest of the paper is structured as follows. In Section 2 we set the stage by describing the structure and the regulation of the Spanish port industry. This is followed by a literature review about strategic interdependence in port industry and inter-port competition in Section 3. Section 4 develops our theoretical model, while Section 5 shows the econometric specification. In Section 6, the panel data used is described. Section 7 presents a discussion of the results. Finally, Section 8 offers concluding remarks and policy implications.

2. THE SPANISH PORT INDUSTRY

2.1. Regulation of the Spanish port system

In the early 90s, some relevant events, such us port privatization processes, the growth of maritime freight or the implementation of the European Single Market, showed that a new regulatory framework was necessary for the Spanish port industry in order to achieve a greater agility and flexibility to adapt to those changes and challenges. Then, the Act 27/1992 took into force with the aim of endowing Spanish ports with the tools to cope with these new challenges. This reform was considered as the beginning of the Spanish *port devolution process*.

Act 27/1992 followed those general principles of port management autonomy regading to the inter-port competition and the fact that port charges were linked to actual costs. Moreover, the Spanish port authorities and a central agency called Puertos del Estado (State Ports) were created in order to begin the liberalization process of port services with the introduction of private participation through a *landlord* port management system.

Port authorities were constituted as state-owned entities with legal personality, autonomous management and owing their assets. They must carry out their activity according to business rules and procedures. In turn, the state-owned central agency Puertos del Estado (State Ports) assumed global responsibility for the entire port system given that is set up in order to control and coordinate port authorities.

Finally, Act 27/1992 designed port charges for port services as private prices which were set by the central agency Puertos del Estado. These charges were identical for all port authorities. However, some correction coefficients in port charges were allowed within maximum and minimum boundaries in order to promote flexibility. As a result of this strong regulation, price competition was strongly limited. This pricing policy was justified in order to achieve self-financing for the whole port industry and to prevent of potential abusive practices regarding the captive traffic. Regarding investment decisions, port authorities were responsible for planning and justifying their investments as well as carrying out the corresponding complementary studies according to their traffic forecasts. Then, Puertos del Estado had to approve such investment plans.

Subsequently, the Act 62/1997, which modifies Act 27/1992, delved into the functional autonomy and management authorities. It also established policy measures to increase the intensity of participation of regional governments in the structure of authority in order to integrate more effectively the economic and territorial interests of regions. In addition, Act 62/1997 encouraged further private participation in the provision of port services and specified the achievement of self-financing for individual port authorities instead of the overall system. This reform aimed to endow port authorities to set their basic port charges with no limits. However, the 3rd Transitory Regulation of Act 1997 states that the Ministry of Public Works and Transport established the maximum and minimum boundaries for charges during the three years after coming into force Act 62/1997. Price competition among port authorities was restricted again.

After a decade since the adoption of the Act of 92, new developments and new economic realities justified legislative renewal with Act 48/2003. During this decade, there had been a significant growth in demand accompanied by an increment of inter-port competition -both national and international- and intra-port competition -among different providers of port services in a port-. In this environment, the new law set as main objectives: enhancing the competitive position of Spanish ports guaranteeing the principles of free competition; setting criteria about profitability and efficiency in exploiting the public port space; promoting participation of private companies in funding, construction and operation of port facilities jointly with the provision of port services; enhancing the quality and effectiveness of port services; and reducing the cost of passage of goods by the ports. Besides, this law goes a step beyond the target of self-financing and cost coverage by transferring them to users based in the recovery of operating costs, external costs and the costs of new investments. So, operational and investment expenditures must be covered by current incomes, European Union subsidies and external debt (Núñez-Sánchez, 2013). In Act 48/2003 any mention to the freedom of prices for port authorities was deleted. Minimum and maximum boundaries for the different charges were remained. However, with this reform these boundaries were determined by alternative technical, market criteria and the capacity of getting profits of port authorities. Finally, the last port regulatory reform took place in 2010. Act 33/2010 established wider correction coefficients in order to increase inter-port competition.

In summary, three features have characterized our period of study. Firstly, the evolution of self-financing objective from the self-financing for the overall system to the achievement of a minimum profitability objective for each individual port authority. Secondly, the strong regulation about setting port charges which weakens effective price inter-port competition. Thirdly, a higher autonomy to plan their infrastructure investments which encourages non-price competition among port authorities.

2.2. Investment in Spanish port industry

As we have mentioned in the previous section, port authorities have historically had a greater autonomy in planning their investments because of the strong port price regulation. This have led them to involve a great amount of financial resources in order to improve and extend their port infrastructure.

From 1992 to 2008, the aggregate port investment surpased 118,718 million euros, rising

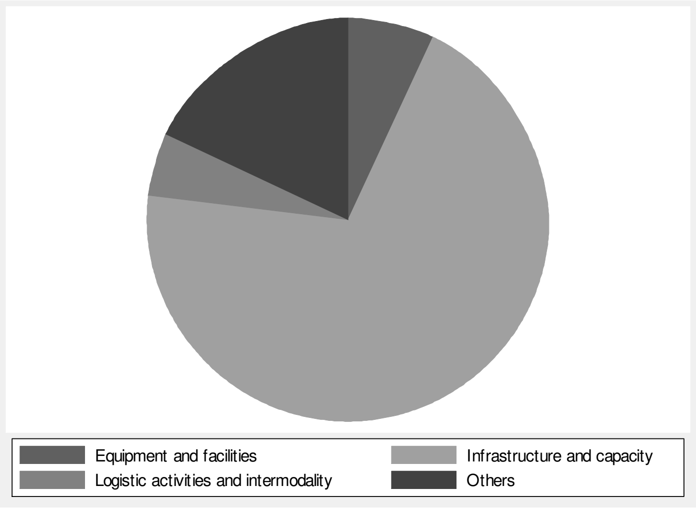

Fig. 1: Port investment distribution (1992-2008)

from 354 million euros in 1992 to 998 million euros in 2008. This investment process has endowed the Spanish port system with modern facilities, such as docks or storage areas. From 2002 until 2008 is considered the period of highest investment efforts. For instance, the expansion of Spanish port capacity for 4,131 million euros, which represented 76 percent of total investment in infrastructure and capacity. These facts led to Spanish port industry to duplicate its storage area from 17 million of square meters in 2002 to 32 million in 2008. Figure 1 shows the distribution of the aggregate port investment.

However, growth of port infrastructure investment has been higher than cargo movement, which has produced the existence of overcapacity in the system (Hidalgo-Gallego et al. 2015). Figure 2 shows both port investment and cargo traffic trends during the period of study. From 2002 to 2008, port investment went off, growing faster than traffic. However, when the global economic and financial crisis began in 2008, port investment dropped to similar levels to those of early 90s. This fact might be explained by two differentes factors: the reduction of public spending, on the one hand,and the notion that port supply does not necessarily create port demand (González-Laxe, 2012), on the other hand.

In this context, two questions arise. Firstly, which factors have boost the investment

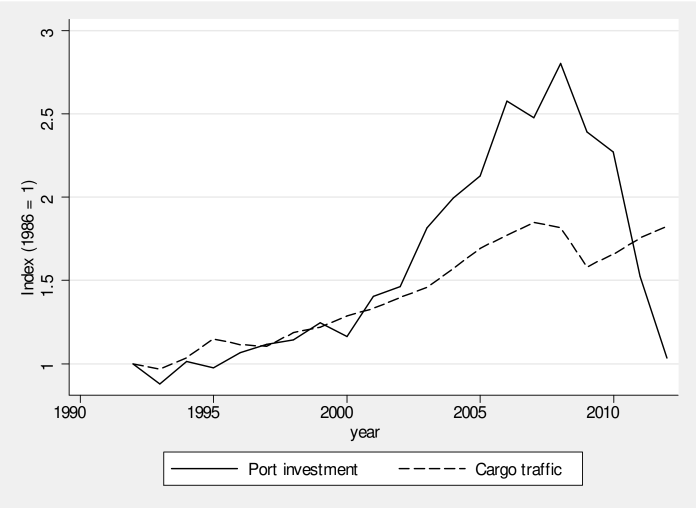

FIG. 2: Port investment and cargo traffic trends (1992-2012)

process experimented by Spanish port authorities? Literature identifies numerous factors that could lead port authorities to invest or over-invest, mainly in capacity. Haralambides (2002) identifies political issues related with the conception of ports as tools of regional development; technological issues, as capital indivisibilities, economies of scale in port construction, the increase in the size of vessels; or planning issues, as the over-optimistic demand forecasts as reasons for over-investment. Luo et al. (2012) consider that port authorities could be interested in having overcapacity as strategy to gain credibility and effectiveness of preemptive measures. Specifically for the Spanish port system, Castillo-Manzano and Fageda (2014) find that factors such as efficiency, the stock of port capital, a specialization in containerized cargo traffic or the coincidence of the same political party in both central and regional government in port's hinterland have effect on port investment decisions. Finally, the implementation of the landlord model that has given to port authorities more autonomy to plan their investments, the increase of intra and inter-port competition, the conception of expanding capacity as a competitive strategy to attract more traffic or the coincidence with a period of economic boom may also explain that trend.

Secondly, what has been the impact of these investments on freight traffic?. According

Verhoeff (1981), García-Alonso and Martín-Bofarull (2007), the answer is that the effect of investments on traffic is uncertain, i.e., improving port facilities do not guarantee that a port can compete successfully with other ports.

2.3. Port charges in Spanish port industry

Table 1 shows the incomes corresponding to the different charges charged by Spanish port authorities and the weight of each one. As we can see, this charges can be classified in three groups: general services charges, specific services charges and rents for the use of the public space. The first one comprises those incomes related with services provided to vessel, passengers, cargo, sport vessels or fresh fishing and signaling. With the entry into force of the Act 33/2010 a new fee related to the special use of transit zones has been added to this group. More than 50% of the Spanish port system incomes come from this group. However, over the years the importance of this group has decreased in favor of the rents for the use of public space. The second group consists of those incomes from specific services such as the use of cranes, storage areas or warehouses or the provision of energy supplies which represent the lower weight in total incomes. Finally, the third group is related to the rents obtained by the leasing of public space by port authorities to private firms characteristic of the landlord model. The increase of the importance of these rents is explained by the progressive implementation of the landlord model (Núñez-Sánchez, 2013).

3. RELATED LITERATURE

3.1. Strategic interdependence in the port industry

Game theory and industrial organization are very useful tools to analyze strategic interdependence in port industry decisions. They have been widely used in order to determine optimal levels of port capacity and seek the factors behind. But, to date, there are few studies that analyze explicitly the interdependence in setting port capacities (Hidalgo-Gallego et al, 2016).

Table 1: Spanish port authorities incomes (1992, 2002 and 2011)

	1992		2002		2011	
	Thousand €	%	Thousand €	%	Thousand €	%
Signaling	–	–	3, 152.465	0.47	7, 013.27	1.03
Vessels	128, 104.51	20.74	129, 872.12	19.27	137, 605.63	20.24
Cargo	235, 709.69	38.16	285, 746.29	42.40	193, 824.15	28.51
Passenger	80, 204.63	12.98	35, 137.82	5.21	49, 606.58	7.3
Fish	15, 699.66	2.54	9, 225.59	1.37	4, 847.23	0.71
Sport vessels	4, 394.11	0.71	461.99	0.70	6, 383.57	0.94
Use trans. zones	–	–	–	–	1, 444.53	0.21
General services	46, 411.26	75.13	467, 826.30	69.09	400, 724.99	58.33
Cranes	3, 547.83	5.74	8, 124.55	1.21	–	–
Storage	1, 966.77	3.18	8, 773.59	1.30	–	–
Energy supplies	1, 496.01	2.42	14, 272.05	2.12	–	–
Other	1, 737.90	2.81	18, 302.45	2.72	–	–
Specific services	8, 748.51	14.16	49, 472.65	7.34	89, 572.56	13.17
Land Rents	6, 611.07	10.70	156, 683.53	23.25	189, 633.93	27.89

*Constant euros 2001=100

Authors as De Borger et al. (2008), Xiao et al. (2012) and Tan et al. (2013) have developed models which determine theoretically the optimal level of port capacity. The first ones base their model in a two-stage competition game where in first stage governments decide the levels of port and hinterland infrastructure capacity in order to maximize the welfare of their respective regions. In the second stage, port managers choose port charges in order to maximize port's profits. On the other hand, Xiao et al. (2012) analyze the optimal levels of port capacity and the optimal port charges for different forms of ownership by applying a one-stage integrated model. Finally, Tan et al. (2013) analyze pricing, capacity and localization decisions of an inland river port which competes with road transport for their customers, spatially distributed. In none of these models capacity decisions are affected by the capacity decisions of competitors, but by factors such as ownership, port charges, customers' localization...

In contrast, the models developed by Luo et al. (2012) and Anderson et al. (2008) explicitly consider strategic interdependence in capacity decisions. These models allow to assess whether ports should invest in capacity or not, taking into account investment decisions of their competitors. Both consider that the amount of capacity expansion is exogenously determined and is the same for both ports, being common knowledge. So, although these models explain when a port have to enlarge its capacity, the strict assumptions imposed do not allowed to measure the optimal capacity expansion as a function of rivals strategies. To the best of our knowledge, these authors are the only ones in port literature that consider explicitly strategic interdependence in setting non-price competition instruments -capacities-, but in their models, the best responses to capacity changes are not functionally derived.

3.2. Geographical scope for port competition

There is a vast literature related to the factors that affect port selection and ports' competitiveness. This literature can be classified in two groups. In the first one, we find those works that obtain the relative importance of those factors on the basis of surveys to shippers, carriers or shipper lines (Guy and Urly, 2006; Ng, 2006; Chang et al., 2008; Yue et al., 2012). A common finding in these articles is that port location is a key factor in port selection and port competitiveness. In the second group, the effect of the potential determinants of port selection on the probability of a port being chosen by shippers is estimated. Among these works, the studies of Malchow and Kanafani (2004) and Tiwary et al. (2003) are especially interesting for our analysis. Malchow and Kanafani (2003) analyze port selection among US ports finding that inland distance between shipment origin and port is the main determinant in port selection followed by oceanic distance between the port facility and the shipment destination. These two variables are beyond control of port manager and are related to the location. However, authors state that when ports are geographically close, other different factors may influence on shippers decisions. Then, for neighbour ports variables under control of port managers (such as port investment, marketing. . .) can be used in order to compete and to increase their port demand. In the same line, Tiwari et al. (2003) analyze the shippers' port choice in China. They obtain that distance between shippers and ports is an important determinant of port selection. In this sense, if a shipper location is far away from a given port, it will probably switch to other closer port. On the other hand, their findings suggest that variables related to capacity have a positive effect on the probability of a port being chosen.

3.3. Structural models

The New Empirical Industrial Organization (NEIO) approach offers tools to estimate strategic interdependence in capacity expansion by using conjectural parameters. Although this methodology does not allow us to derive a functional form for this interdependence, it allows us to obtain a measure when the model is applied to data. This methodology has been widely used in bank industry, where banks explicitly consider their own network and their expectations about rivals' branch network when they take branch decisions (De Pinho, 2000; Kim and Vale, 2001; Valverde and Guevara, 2009). These models allows banks take into account its rivals' future reaction to its network extension and the effects of such response on their demand or market shares (Kim and Vale, 2001). Our research adapts this methodology to the behavioral characteristics and structure of Spanish infrastructure port industry in order to estimate and evaluate non-price competition in these industry.

4. THEORETICAL MODEL

We propose a dynamic two-stage model which is solved by backward induction. In the first stage Spanish port authorities try to maximize their present and future cargo demand flows by setting port capacities in a given period. In the second stage, shippers choose the amount of cargo which pass for each port that minimizes their port generalized cost once they observe port charges and port capacities.

4.1. Second stage: Demand for differentiated port infrastructure services

In port literature coexists different approaches to obtain theoretically a port demand function. The most common approach is applying the Hotelling model to port industry (Czerny et al., 2014; Van Reeven, 2010; Kaselimi et al., 2011; Yu and Shan, 2013; etc). Other approaches used in this literature are the use of reduce-form of demand functions (De Borger et al., 2008, Zhang, 2008; Wan and Zhang, 2013) or a reciprocal dumping model (Matshumura and Matsushima, 2012). In all of these approaches the aim of a port customer is the minimization of its generalized cost. It comprises the monetary costs charged by a given port, the congestion or delay costs and transport cost of the cargo between the origin/destination point and the port facility.

In this study, we have followed the approach proposed by Pinkse et al. (2012) which presents some advantages. This approach, unlike other models such as those proposed by Hotelling (1929) or Salop (1979), allows that shippers might use more than one facility sharing their cargo among different ports. Moreover, their demands do not have to be unit, i.e., they could send different amounts of cargo to a given port.

Formally, suppose that there are n port authorities that supply horizontally differentiated port services. Port authorities and their respective port services are indexed by $i = 1, \dots, n$.

Their port services are measured as the amount of cargo handled, $q = (q_1, q_2, \ldots, q_n)^T$. These port services are supplied at the port charges $t = (t_1, t_2, \ldots, t_n)^T$. Finally, each port service presents a port capacity s_i.

On the other hand, there are k shippers who need to load/unload their cargo in a given seafront of Spanish coast so they demand q, these shippers are indexed by $k = 1, \ldots, K$. Each shipper is located at a point in the geographic space and, therefore, has a single cost function. Adittionally, shippers take port charges and capacities as given.

We assume that the k_{th} shipper wants to minimize its port generalized cost which includes: total monetary cost of passing cargo throught a given port, where $T = (T_1, ..., T_h)^T$ is the total unit cost of handling cargo in a given port in which port charges $(t_1, t_2, \ldots, t_n)$ are included and which can be interpreted as the total monetary price of using a given port; and cost of time that cargo is on port. We do not include other transport costs given that we assume that shippers' demand is a captive to the nearest seafront, so these transport costs are implicitly taking into account. Finally, the time cost of cargo in a port facility depends on port capacity, so the port cost function of the k_{th} shipper is:

$$P_k = P[T, f(s)] = P(T, s) \tag{1}$$

where P_k is the port generalized cost of the k_{th} shipper, T is the vector of port total prices, f is the time cost and finally s is the vector of capacities.

Without loss of generality, by treating a collection of price taking shippers as a single price taking cost minimizing unit (Bliss, 1975, Pinkse et al. 2002), the aggregate cost function obtained is

$$P(T, s) = \sum_k P_k(T, s) \tag{2}$$

We assume that the aggregate cost function presents a flexible functional form as the quadratic cost function, which is a second order approximation to an arbitrary cost function that places no restriction on product substitution possibilities.

$$P(T,s) = \alpha_0 + \alpha_1^T T + \alpha_2^T s + \frac{1}{2}\left[T^T B^1 T + T^T B^2 s + s^T B^3 s\right] \tag{3}$$

where P is the port generalized cost, T is the vector of port total prices, s is the vector of capacities, α_0 is the coefficient associated to the constant term, α_1 and α_2 are $n \times 1$ vectors of the first order coefficients related to prices and capacities respectively and finally, B^1, B^2 and B^3 are $n \times n$ symmetric matrices which contains the second order parameters of the quadratic cost function.

Applying the Shephard's Lemma, we can obtain the optimal demand for each port service, i.e, the demand for cargo handled services of each port authority.

$$q_i = \frac{\partial P(T,s)}{\partial T_i} = \alpha_{1i} + \sum_j \left(b_{ij}^1 T_j + b_{ij}^2 s_j\right) \tag{4}$$

We observe that the amount of port services demanded (q) in the i_{th} port authority depends on their own port total price (T_i) and capacity (s_i) and the prices and capacities of their competitors (T_{-i} and s_{-i}).

4.2. First stage: Port capacity expansion

From the second stage we know that the quantity of demanded handled services (q_i) faced by a port authority in a given period is function on its own total port charge (t_i), competitors' total port charges (t_{-i}), own capacity (s_i) and competitors' capacity (s_{-i}):

$$q_{it} = q(T_{it}, T_{-it}, s_{it}, s_{-it}) \tag{5}$$

The demand or port services is expected to decrease with the increasement in its own total port price ($\partial q_{it}/\partial T_{it} < 0$) and its rivals' capacity expansions ($\partial q_{it}/\partial s_{-it} < 0$). Otherwise, port authorities' demand will rise with the increasement in its rivals' total port charge ($\partial q_{it}/\partial T_{-it} > 0$) and its own capacity investments ($\partial q_{it}/\partial s_{it} > 0$).

In this stage, we assume that port authorities set capacities[1] in order to maximize cargo traffic flows subject to achieve some level of profitability. So, we assume that maximization target is subject to a positive profit. Thus, the principle of financial self-sufficiency in the context of the Spanish port sector described in Section 2 is included in our model. This decision problem takes also into account the nature of public-owned facility, which tries to maximize the development of the port activity instead of maximizing its profits.

Then, from demands obtained in the second stage (5), the decision problem of a port authority can be described as follow:

$$\begin{aligned} &\max_{s_{it}} M_{i0} = \textstyle\sum_{t=0}^{\infty} q_{it} \\ &s.t. \quad t_{it} q_{it} - C_{it}(\mathbf{w}, q_{it}) \geq 0 \end{aligned} \tag{6}$$

where q_{it} is the amount of cargo services provided by the i_{th} authority in the period t, t_{it} is the port charge for those services, C_{it} is the total cost and w is the vector of inputs prices.

In addition, we assume that port authorities use a feedback strategy (Kim and Vale, 2001), i.e., at period t port authorities set capacities based in the information available at that time. In this case, it is the rival's capacity in the previous period. So, the i_{th} port authority knows that its competitors will react to its current capacity in the next period and this will affect its future demand. Then, ports authorities take into account rival's reaction effects on future demand when they set their present capacity, expecting rivals to react with a lag of one period. In this way, calculating the partial derivative of the objective function with the respect to the port capacity and equaling it to zero, we obtain the following first order condition:

$$\frac{\partial M_{i0}}{\partial s_{it}} = \frac{\partial q_{it}}{\partial s_{it}} + \frac{\partial q_{it+1}}{\partial s_{-it+1}} \frac{\partial s_{-it+1}}{\partial s_{it}} - \lambda \left(t_{it} \frac{\partial q_{it}}{\partial s_{it}} - \frac{\partial C_{it}}{\partial q_{it}} \frac{\partial q_{it}}{\partial s_{it}} \right) = 0 \tag{7}$$

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[1] As we stated in section 2, Spanish port regulation makes port authorities have higher autonomy or competence in planning their investments than in setting their port fees. Because of this regulatory context, we choose port capacity and not port fees as their decision variable in the objective function.

The terms $\frac{\partial q_{it}}{\partial s_{it}}$ and $\frac{\partial q_{it+1}}{\partial s_{-it+1}}$ reflect the effect of changes in its own and rivals' capacity on the i_{th} port authority's cargo demand, $\frac{\partial C_{it}}{\partial q_{it}}$ represents the marginal cost of port i_{th} in period t, while $\frac{\partial s_{-it+1}}{\partial s_{it}}$ capture the conjectural variation (or conduct parameter). This last term shows how port authorities react to their rival capacity strategies. Our model allows to the conjectural parameter to take zero, negative and positive values. However, we do not expect negative values of the conjectural parameter because of the port infrastructure's characteristics. A negative sign of the conjectural parameter would be interpreted as a signal of misspecification. On the other hand, a conjectural parameter equal to zero implies a Nash equilibrium, i.e., port authorities not take into account rivals' decisions when they set their capacities. Finally, positive values implies that competitors respond to increments of capacity, increasing their own capacity. In this case, a value equal to one implies imitation of the rival's strategy. So, we can distinguish two effects of increasing capacity in given period: a direct effect on current demand represented by the derivative $\frac{\partial q_{it}}{\partial s_{it}}$, and an indirect effect on next period demand measure by $\frac{\partial q_{it+1}}{\partial s_{-it+1}}\frac{\partial s_{-it+1}}{\partial s_{it}}$. Not taking into account this second effect could led to under/overestimate capacity effects on demand.

5. EMPIRICAL SPECIFICATION

The empirical specification of the above model is formed by a non-linear system of two equations jointly estimated: a cargo demand equation (5) and the first order condition (7) for the choice of capacity.

We assume that the cargo demand function is specified as a log-linear relationship:

$$\ln q_{it} = \alpha_i + \alpha_1 \ln T_{it} + \alpha_2 \ln T_{-it} + \alpha_3 \ln s_{it} + \alpha_4 \ln s_{-it} + \zeta_\tau \tau_t + \zeta_{\tau\tau}\tau^2 \tag{8}$$

where T_{it} is the i_{th} port charge related for a given port, T_{-it} represents the average port charge of i_{th} authority's competitors, s_{it} and s_{-it} are own capacity and the average of competitors' capacities, α_1 and α_2 are own and cross price elasticities, α_3 and α_4 are the elasticity effect of variations in own and competititors' capacity on port authorities cargo handled services demand respectively and finally, a quadratic trend (τ) has been added to account for technological change.

The derivatives of cargo demand with respect ro the capacities are:

$$\frac{\partial q_{it}}{\partial s_{it}} = \frac{\partial \ln q_{it}}{\partial \ln s_{it}} \frac{q_{it}}{s_{it}} = \alpha_3 \frac{q_{it}}{s_{it}} \tag{9}$$

$$\frac{\partial q_{it}}{\partial s_{-it}} = \frac{\partial \ln q_{it}}{\partial \ln s_{-it}} \frac{q_{it}}{s_{-it}} = \alpha_4 \frac{q_{it}}{s_{-it}} \tag{10}$$

In order to obtain the empirical specification for the first-order condition, we first substitute previous derivatives (9) - (10) in equation 7 as we have seen in 11.

$$\alpha_3 \frac{q_{it}}{s_{it}} + \alpha_4 \frac{q_{it+1}}{s_{-it+1}} \frac{\partial s_{-it+1}}{\partial s_{it}} - \lambda \left(t_{it} \alpha_3 \frac{q_{it}}{s_{it}} - \frac{\partial C_{it}}{\partial q_{it}} \alpha_3 \frac{q_{it}}{s_{it}} \right) = 0 \tag{11}$$

We take out common factors (12) and we rearrange (13):

$$\alpha_3 \frac{q_{it}}{s_{it}} \left(1 - \lambda \left(t_{it} - C'_{it}\right)\right) + \alpha_4 \frac{q_{it+1}}{s_{-it+1}} \varphi^s = 0 \tag{12}$$

$$\frac{q_{it}}{s_{it}} = -\frac{\alpha_4 \varphi^s \frac{q_{it+1}}{s_{-it+1}}}{\alpha_3 \left(1 - \lambda \left(t_{it} - C'_{it}\right)\right)} \tag{13}$$

Equation 13 represents the empirical specification of the first-order condition, where φ^s is the conjectural parameter, i.e., the expected comptititors' responses to change in capacities, λ is the Lagrange's multiplier from the positive profits constraint and C'_{it} is the marginal cost of cargo. In order to estimate equation 13, the inclusion of an intercept which varies across port authorties allows to collect inobserved heterogeneity of port authorities. Thus, the resulting equation is:

$$\frac{q_{it}}{s_{it}} = -\frac{\alpha_4 \varphi^s \frac{q_{it+1}}{s_{-it+1}}}{\alpha_3 \left(1 - \lambda \left(t_{it} - C'_{it}\right)\right)} + \frac{\delta_i}{\alpha_3} \tag{14}$$

Finally, to estimate the marginal cost of cargo, we specify a quadratic cost system formed by the cost equation (15) and the input expenditure equations (16). All variables of the system are deviated from their means.

$$\begin{aligned} C_{it} = \beta_i + \beta_q(q_{it}-\overline{q}) + \tfrac{1}{2}\beta_{qq}(q_{it}-\overline{q})^2 + \sum_{r=1}^{R}\beta_r(w_{rit}-\overline{w}) + \\ \sum_{r=1}^{R}\sum_{s=1}^{R}\beta_{rs}(w_{rit}-\overline{w})(w_{sit}-\overline{w}) + \sum_{r=1}^{R}\beta_{qr}(q_{it}-\overline{q})(w_{rit}-\overline{w}) + \\ \beta_\tau\tau_t + \tfrac{1}{2}\beta_{\tau\tau}\tau_t^2 + \sum_{r=1}^{R}\beta_{r\tau}(w_{rit}-\overline{w})\tau_t + \beta_{q\tau}(q_{it}-\overline{q})\tau_t + \epsilon_{it} \end{aligned} \tag{15}$$

The input expenditures equations can be obtained by applying the Shephard's Lemma to the cost function.

$$E_{rit} = w_{rit}\frac{\partial C_{it}}{\partial w_{rit}} = w_{rit}\left[\beta_r + \sum_{s=1}^{R}\beta_{rs}(w_{sit}-\overline{w}) + \beta_{qr}(q_{it}-\overline{q}) + \beta_{r\tau}\tau_t + v_{rit}\right] \tag{16}$$

where C is the total cost, q is the amount of output, w_r is the price of variable input r ($r = 1, 2, 3$), E_r is the input r expenditure, τ is a time trend that captures the possible existence of non-neutral technical change.

Finally, $i = 1, \ldots, N$ relates to the $i - th$ authority and t relates to the time period . Those variables which have a bar on the top correspond to the sample means.

6. DATA

The model is estimated with data from a sample of 21 Spanish port authorities over the period 1992-2011. We do not include those authorities located in an island; Seville, which is a river port and Ceuta and Melilla, which are just strategic ports on the north of Africa. We remove them because we consider that these authorities, due to the described characteristics, do not follow the same competitive patterns than the other ones. Hence, the sample used consists of 420 observations.

The data is collected from the annual reports published by Puertos del Estado (several years, a and b) which provides homogeneous information about the performance of Spanish port authorities.

Firstly, for the estimation of the quadratic system (15)-(16) we use the following variables.

First, the dependent variable in equation 15 (ctr) is the total cost calculated as the sum of labour, capital and intermediate consumption costs. Second, the input prices are: labour price (w_1), variable capital price (w_2) and intermediate consumption price (w_3). Labour price (w_1) is defined as the ratio of annual labour expenses by total employees. Capital price (w_2) has been approximated by multiplying a building index price of public works (obtained from the reports of Confederación Nacional de la Construcción, SEOPAN) by the sum of long-term interest rate and the depreciation rate the port's property and equipment. The depreciation rate is calculated as the annual depreciation expenditures of each port authority over the total assets. Intermediate consumption price (w_3) is defined as the ratio resulted by dividing intermediate consumption expense by intermediate consumptions, measured in physical units. And third, dependent variables in expense equations are labour (E_1), capital (E_2) and intermediate consumption (E_3) expenses.

Secondly, the estimation of the non linear system 8- 14 needs information about cargo demand (q), own port total charge (T_i), competitors' port total charge (T_{-i}), own capacity (s_i) and competitors' capacity (s_{-i}). On one hand, demand for cargo services (q) is proxied using the cargo handled by port authorities, whereas capacity (s) is measured as the square metres of storage area for cargo. On the other hand, regarding port total charge (T) and competitors' variables (T_{-i} and s_{-i}), a detailed explanation about their construction is needed.

Due to the information about total cost of passing a unit of cargo for a given port (port total price, T_i and T_{-i}) is not available, it is approximated using port authorities' charges (t_{it} and t_{-it}). In practice, it is observed that the variability of port charges and the total port costs in a given port follows a quite similar pattern. Moreover, port charges are one of the most relevant decision variables when shippers choose a given port (Trujillo and Nombela, 2000). Then, it is expected that they have a relevant effect on port demand. With this pricing structure mentioned in Section 2.3., the main charges that affect cargo traffic are those related with vessels and cargo. So we combine them to approximate the cost of a ton of cargo passing for a given port. Specifically, t_{it} and t_{-it} are built as the sum of the incomes per ton from cargo and vessels services.

In order to set the geographical scope of inter-port competition we have reviewed the literature related.to this topic. This literature is scarce and it is formed by a few studies about port hinterlands and port selection. The main contributions for the Spanish context are García-Alonso and Sanchez-Soriano (2009) and Villaverde and Maza (2015). The results of these works are in line with those from other countries and they can be summarizing as follow. (1) Distance plays an important role in the port selection process, being the main determinant of the hinterland follow by the attractiveness of the port. (2) The relation between distance and port traffic is not linear, since there is a limit beyond which the relationship between these variables is null. For the Spanish context is about 200 kilometers[2]. (3) The area of influence of each port is formed by the geographical environment of the province in which the port is located and Madrid, which is part of the hinterland of all of them. (4) Regions tend to be linked to the nearest port and this trend has not changed over the years.

Finally, according to the literature reviewed, data on competitors' fees and capacities are computed taking into account the spatial aspect of port competition. Due to its characteristics, the intensity of competition may be stronger and better locally identified among those port authorities that are closely located. In this sense, we have defined five seafronts (Figure 3). (1) *Galicia*: which comprises port authorities of A Coruña, Ferrol, Villagarcía, Marín y Ría de Pontevedra and Vigo. (2) *North*: formed by port authorities of Avilés, Gijón, Santander, Bilbao and Pasajes. (3) *Catalonia*: which includes Barcelona and Tarragona port authorities. (4) *East*: formed by port authorities of Castellón, Valencia, Alicante and Cartagena. (5) *South*, which integrates port authorities of Almería-Motril, Málaga, Cádiz, Bahía de Algeciras and Huelva.

Thus, if a given port authority i is located in a given seafront that integrates n port authorities, i's demand depend on n fees and n capacities (its owns and its rivals'), which implies at least $2n + 1$ (intercept) parameters to be estimated. In order to reduce the dimensions of the problem, instead of including the competitors' $n - 1$ fees and $n - 1$

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[2] This means that it is very difficult to attract cargo traffics when the distance between port and origin / destination region is longer than 200 kilometers.

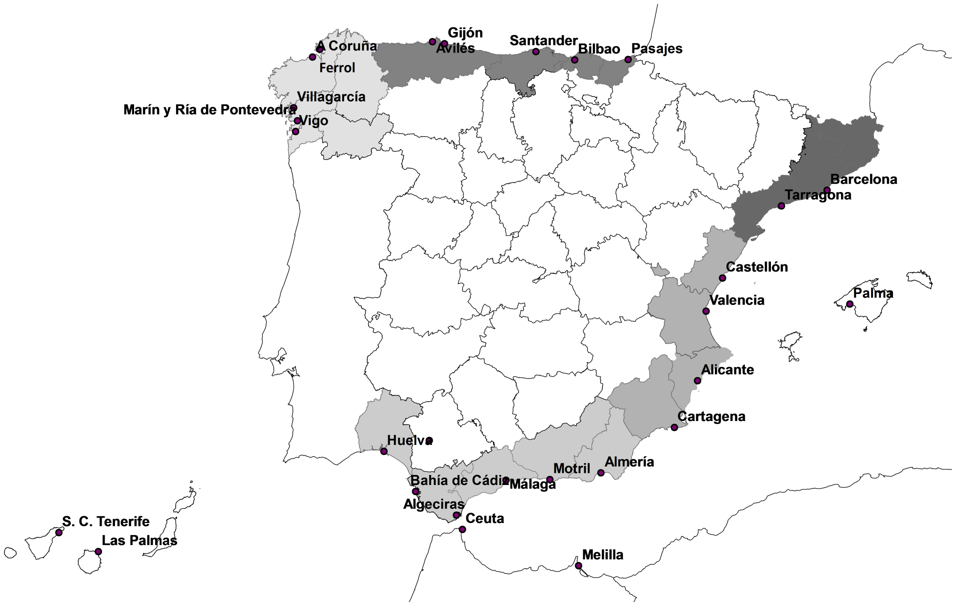

Fig. 3: Seafronts at the Spanish port industry.

capacities, we replace them by their means[3].

Finally, table 2 shows the descriptive statistics of the variables included in the model. All economic variables have been deflacted and are expressed in constant euros of 2001.

7. ESTIMATION AND RESULTS

The procedure of estimation is as follow: first, the quadratic cost system 15 and 16 is estimated by using a three stage least squares (3SLS) model and applying a fixed effects estimator, in order to collect the existing heterogeneity among port authorities. Due to

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[3] This approximation is based in spatial econometric techniques. A common specification for the spatial weights in this methodology is the use of contiguity weights, where all agents/jurisdictions that are contiguous geographic neighbors to a particular agent/jurisdiction are weighted equally (Cohen, 2010).

Table 2: Descriptive statistics

Variable	Mean	Units	Standard deviation	Min.	Max
q	$1.44E+07$	Ton	$1.47E+07$	515442	$7.72E+07$
t_i	1.41	Constant Euros 2001	0.74	0.27	3.99
t_{-i}	1.40	Constant Euros 2001	0.51	0.64	2.99
s_i	$849,199.3$	Squared-meters	958190.4	60395	4824550
s_{-i}	$852,641.5$	Squared-meters	716849.4	143046	4824550
ctr	$1.99E+07$	Constant Euros 2001	$1.56E+07$	2768417	$9.39E+07$
w_1	31278.69	Constant Euros 2001	5922.206	14166.57	57664.24
w_2	5.87	Constant Euros 2001	2.24	1.38	16.46
w_3	43.14	Constant Euros 2001	31.50	2.45	215.76
E_1	$6,819,902$	Constant Euros 2001	4731022	1449932	$2.73E+07$
E_2	$7,988,428$	Constant Euros 2001	6529388	779807.3	$3.62E+07$
E_3	$5,054,906$	Constant Euros 2001	4969310	353238.3	$3.64E+07$

the endogeneity of the cargo[4] (q), we instrument it using a one-period lag of the variable[5]. Additionally, variables from the cost system have been transformed in order to correct the serial correlation. In this sense, we have applied the Cochrane and Orcutt (1949) transformation. This approach has been applied before in cost system estimations by Sung and Gorth (2000) and Botasso and Conti (2012). The parameters obtained in this first estimation are used to calculate the marginal cost of cargo services. Secondly, we estimate jointly the demand equation (8) with the first order condition equation (14), where the estimated marginal costs in the first stage are included as a regressor. In this case, we use a non-linear three-stage least squares estimator (N3SLS) which applies the Gauss-Newton algorithm. Starting values have been obtained from the estimation of the equations separately. Parameter standard errors are robust to heteroscedasticity. Again we use instruments in order to correct the endogeneity of capacity[6].

Table 3 displays the results of the quadratic cost system estimation, and table 4 shows the port authorities' average marginal costs for the studied period. The estimated parameters present the expected signs. The mean of the marginal cost of cargo across the 420 observations is 0.268 with a standard deviation of 0.194. In the period covered, for all observations, the average cost lie above marginal cost, so Spanish port authorities operate in a region of scale economies. Specifically, the economies of size in the mean of the sample are

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[4] According to the assumptions of our model, port authorities port have some power to decide on the production level through port capacities. So cargo is considered as endogenous variable in our model.

[5] One period lag of cargo traffics is used as instrument because of: firstly, there is a strong correlation between the endogenous variable and its instrument; secondly, total cost in one period depend on the flows of cargo of that period, but not on previous one, so it is very difficult that a correlation between the errors term in the equations of the system and the instrument exists.

[6] As we explained in section 2, capacity decisions could be influenced by factors which differ from increasing demand. This fact could cause endogeneity problems. We carried out a Haussman test to check if capacity is actually a endogenous variable, not being able to reject the nule hiphotesis of endogeneity. In order to obtaint consistent estimators, we use the one period lag of the own variable as instrument. On one hand, there is a strong correlation between both variables. On the other hand, according to our model, when shippers choose a given port, they take into account present prices and capacities, not previous ones. So there should be no correlation between the one period lagged capacity and the error term in demand equation.

equal to 0.182. This finding suggest that capturing new traffics has a double attractiveness: first, it increases revenues and second, reduce average costs taking advantage of those scale economies.

We now use the estimates of marginal costs from previous to estimate the nonlinear system formed by the first-order condition (14) and the demand equation (8). In both equations, we allow the existence of different intercepts for all authorities in order to control time invariant heterogeneity among them. This individual dummies have not been display in order to simplify the presentation of the results. As we can see in table 5, three different estimations are carried out to test the robustness of the model. In the first specification we do not include technical change, in the second one we include a lineal trend and finally, we include a quadratic trend in the third specification. The estimated coefficients in the different specifications are very similar.

In the demand equation the coefficients of lt_i and lt_{-i}, which represent price elasticity and cross price elasticity, have the expected signs, positive and negative respectively, being both significant at 1% level. We find that price elasticity is unitary since the coefficient associated is statistically equal to 1 in all of the specifications. The cross-price elasticity is always smaller than the absolute own-price elasticity, thus cargo demand is more sensitive to variations in the own price rather than rivals'. The elasticities associated to the capacities have the expected sign and both are significant at 1% level. The own capacity elasticity is positive, it means that shippers respond positively to increases of capacity. On the other hand, increases in rivals' capacities decreases the demand of a given port. This fact is represented by the negative sign of cross-capacity elasticity. This result shows, as our model explains in section 4, that shippers not only take into account the monetary costs of moving their cargo but also non monetary cost, such as time cost, which depends on capacity since the more capacity the less probability of suffering congestion problems (Basso and Zhang, 2006; De Borger and Van Dender, 2006).

The joint significance F test does not allow to reject the null hypothesis. Then, the parameters associated to the quadratic trend in specification 3 are jointly equal to zero. As a consequence, we focus on the specification 1.

Table 3: Cuadratic cost system estimation

Parameter	Coefficient	Parameter	Coefficient
Constant	9294310***	$w_1 w_3$	0.00003*
	(8.5)		(1.88)
w_1	192.71***	$w_2 w_3$	0.45***
	(32.01)		(3.4)
w_2	796973.9***	$w_1 q$	0.000009***
	(15.04)		(13.01)
w_3	6.28***	$w_2 q$	0.04***
	(13.93)		(7.3)
q	0.26***	$w_3 q$	0.00000005***
	(3.27)		(0.43)
$trend$	−60704.28***	$trend^2$	45848.67
	(−0.81)		(1.06)
${w_1}^2$	−0.002**	$w_1 trend$	−12.97***
	(−2.53)		(−6.05)
${w_2}^2$	−4.013.05	$w_2 trend$	−118208***
	(−0.31)		(−5.5)
${w_3}^2$	0	$w_3 trend$	−0.59***
	(−1.01)		(−5.12)
q^2	0	$qtrend$	0.03**
	(0.09)		(2.23)
$w_1 w_2$	12.51***	Individual dummies	Included
	(5.35)		

R^2	Cost eq.	0.84	E_2 eq.	0.46
Standard dev.		2857432		3497413
R^2	E_1 eq.	0.79	E_3 eq.	0.40
Standard dev.		1601477		2673459
Number of observations				441

t-statistics for the parameter estimates in parenthesis (*** = significant at 1% level; ** = significant at 5% level;* = significant at 10% level)

Table 4: Port authorities' average marginal cost (1992-2012)

Port authority	Marginal cost	Confidence intervals	
Algeciras	0.23***	0.18	0.27
Alicante	0.33**	0.24	0.42
Almería	0.24***	0.20	0.28
Avilés	0.28***	0.22	0.33
Cádiz	0.25***	0.20	0.30
Barcelona	0.30***	0.26	0.35
Bilbao	0.39***	0.34	0.43
Cartagena	0.26***	0.21	0.31
Castellón	0.31***	0.25	0.37
Ferrol	0.31***	0.23	0.38
Gijón	0.30***	0.25	0.36
Huelva	0.33***	0.26	0.41
A Coruña	0.23***	0.19	0.28
Málaga	0.25***	0.20	0.30
Pasajes	0.33***	0.28	0.39
Pontevedra	0.23***	0.18	0.28
Santander	0.34***	0.25	0.43
Tarragona	0.27***	0.22	0.31
Valencia	0.33***	0.27	0.38
Vigo	0.24***	0.20	0.29
Villagarcía	0.35***	0.27	0.42

*** = significant at 1% level; ** = significant at 5% level; * = significant at 10% level

Table 5: Nonlinear system estimation

Parameter	Specification 1	Specification 2	Specification 3
Demand equation			
Constant	17.73***	17.81***	17.24***
	(39.41)	(25.97)	(23.56)
lt_i	−0.93***	−0.93***	−0.92***
	(−18.26)	(−17.87)	(−17.77)
lt_{-i}	0.24***	0.25***	0.26***
	(4.28)	(3.53)	(3.74)
s_i	0.11***	0.11***	0.11***
	(3.46)	(2.97)	(3.20)
s_{-i}	−0.16***	−0.17***	−0.14***
	(−4.89)	(−3.77)	(−3.14)
$trend$	–	0.0082	0.02**
		(0.15)	(2.03)
$trend^2$	–	–	−0.0014***
			(−2.24)
Individual dummies	Included	Included	Included
First order condition equation			
Conjectural parameter	0.17**	0.16**	0.21*
	(2.36)	(1.85)	(1.81)
Lagrange multiplier	0.50***	0.50***	0.50***
	(1262.99)	(1256.97)	(1447.79)
Number of observations			420

t-statistics for the parameter estimates in parenthesis (*** = significant at 1% level; ** = significant at 5% level;* = significant at 10% level)

Conjectural variation or conduct parameter reflects the intensity of non-price competition. We observe that the conjectural parameter is significantly different from zero, so port authorities take into account the capacity strategies of their rivals when they set their own capacity. Thus, our results show that capacity competition exists but it does not seem too much intense if we compare our result with those achieved by Kim and Vale (2001) and Valverde and Guevara (2009) in bank industry.

Next, we check these results with a simulation. We assume an average port authority, which current capacity is 849,199.3 square meters and moves an average of 14,389,150 tons of cargo in period t, expands its capacity in 10,000 square meters, which implies increasing its capacity by 1.177%. An expansion of 1.177% implies increasing demand by 0.129%, i.e., 18,593 tons. On the other hand, this capacity expansion has a response in period $t+1$, rivals' increase their average capacity in 1,749.71 square meters (0.21%), which reduces demand by 0.034% (4,874 tons, approximately). Hence, the expected net effect on an average port authority's demand if it expands its capacity by 10,000 meters is an increase in its demand by 0.095% (13,718 tons).

Once we have analyzed the effect of capacity competition in port authorities' demand, we ask what would happen whether this authorities instead competing, cooperating when they set the extend of their facilities. We carry out a counterfactual analysis to estimate the consequences of the conduct's change. To model this, we have to change one of our assumptions regarding the procedure of response of rival authorities. In this case, our new assumption requires that authorities arrange to set the capacity and the variation in capacities are in the same extend. So the new conjectural parameter is defined as follow:

$$\varphi^* = \frac{\partial s_{-it}}{\partial s_{it}} = 1 \tag{17}$$

This fact changes the first-order condition (13), which is transformed as follow:

$$\frac{\partial M_{i0}}{\partial s_{it}} = \frac{\partial q_{it}}{\partial s_{it}} + \frac{\partial q_{it}}{\partial s_{-it}}\frac{\partial s_{-it}}{\partial s_{it}} - \lambda\left(t_{it}\frac{\partial q_{it}}{\partial s_{it}} - \frac{\partial C_{it}}{\partial q_{it}}\frac{\partial q_{it}}{\partial s_{it}}\right) = 0 \tag{18}$$

Thus, the econometric specification of equation 18 is:

$$\frac{q_{it}}{s_{it}} = -\frac{\alpha_4 \frac{q_{it}}{s_{-it}}}{\alpha_3 \left(1 - \lambda \left(t_{it} - C'_{it}\right)\right)} + \sum_{i=1}^{N-1} \frac{\delta_i}{\alpha_3} d_i \tag{19}$$

Then we estimate a new nonlinear equation system formed by equation 8 and 19. Table 6 shows the results of the counterfactual analysis using the same specifications than table 5. In the first specification we do not include technical change, in the second one we include a lineal trend and finally, we include a quadratic trend. As we can see the coefficients of demand equation do not vary too much with respect those displayed in table 5, with the exception of the parameters associated to the capacity. If we assume that port authorities form alliances to set capacities, i.e., decide at the same time with their 'competitors' to change their capacity in the same extend, the cross-capacity elasticity decreases considerably, so shippers demand of a given port became more inelastic to changes in rivals' facilities.

Now, using a simulation, we approximate the net effect of capacity changes in a cooperative framework. As we have done before, we take our average port authority which increases its current capacity in 10,000 square meters, i.e. an increment by 1.177%. This increment of capacity implies demand increases by 0.102% (14,637 tons) in a direct way. On the other hand, the capacity of my rivals increases too in 10,000 which implies a reduction of my demand by 0.035% (5,071 tons), so the net effect of capacity changes on the cargo demand of our average authority is an increment of 0.066% (9,566 tons). Comparing with competition frame, gains of expansion are lower when competitors become allies, i.e., the incentives to invest in capacity are reduced. These results should be interpreted with caution, as they lie on restrictive and general assumptions, such as that all authorities which belong to the same seafront joint the alliance or that the creation of an alliance implies set the same capacity expansion for all their members.

8. CONCLUDING REMARKS

During the last decades, Spanish port legislators have tried to set the instruments to promote competition among ports allowing higher flexibility in making decisions about

Table 6: Counterfactual analysis estimation

Parameter	Specification 1	Specification 2	Specification 3
		Demand equation	
Constant	16.27***	16.02***	15.72***
	(52.51)	(45.94)	(42.74)
lt_i	-0.88***	-0.93***	-0.92***
	(-17.38)	(-17.71)	(-17.61)
lt_{-i}	0.31***	0.19***	0.22***
	(5.52)	(2.73)	(3.21)
s_i	0.09***	0.13***	0.13***
	(2.71)	(3.68)	(3.81)
s_{-i}	-0.03***	-0.04***	-0.04***
	(-2.21)	(-2.71)	(-2.73)
$trend$	–	-0.01***	0.02*
		(-2.98)	(1.75)
$trend^2$	–	–	-0.002***
			(-2.9)
Individual dummies	Included	Included	Included
		First order condition equation	
Lagrange multiplier	0.50***	0.50***	0.50***
	(1559.36)	(1462.64)	(1634.92)
Number of observations			420

t-statistics for the parameter estimates in parenthesis (*** = significant at 1% level; ** = significant at 5% level;* = significant at 10% level)

port charges or giving port authorities more autonomy to plan their investments. However, reality seems to show that an effective competition in charges has not been reached. This fact has led port authorities to seek other ways to compete and attract new cargo traffic, being the capacity expansion a feasible competitive strategy. This has led to the overcapacity of the system, because of traffics' growth has been lower than capacity's.

This study analyses the existence of non-price competition produced by information externalities of conduct jointly with the effectiveness of non-price strategies in increasing port demand. Moreover, by a counterfactual analysis, we evaluate non-price strategies when port authorities come into agreements about these strategies instead of competing.

For these purposes, we build a two-stage dynamic model. In the first stage, Spanish port authorities try to maximize their present and future cargo flows by setting their capacities in a given period. In the second stage, shippers observe port charges and capacities, and, in order to minimize their port-generalized cost, they chose the amount of cargo that pass for each port authority. The main results show that both, port charges and capacity, affect shippers' decisions. Thus, we demonstrate that non-price strategies affect port demand, although in less extend than prices. Moreover, charges and capacities of closer ports also affect demand of a given port authority. Hence, capacity expansion of a given port affect its own demand and neighbors'. On the other hand, we demonstrate that port authorities react when they know that neighbors' capacities have changed in the previous period. This implies that informational externalities produce capacity competition in the Spanish port system. However, we show that capacity competition is not too intense by carrying out a numerical simulation. Finally, the net effect of capacity strategies on demand is lower when closer port authorities come into an agreement about setting their capacity.

Until now, there are not similar studies to our in port literature. This study is the first one that explicitly measure and evaluate port capacity competition using a new methodology based in two different approaches. Other advantage of our model is that it tries to reflect as much as possible the Spanish port legislative context, but also it can be adapted to other sectors and/or contexts. In our opinion, this study has important implications in terms of transport policy. First, our structural model allows us to empirically estimate the effect of port infrastructure investment on port traffic generated and deviated. These are key elements in a Cost Benefit Analysis (CBA) that is used in many countries in order to identify how to use scarce resources to obtain the greatest possible benefits of them.in transport policy. Second, the counterfactual analysis allows to evaluate the effects of future alliances or even mergers in the Spanish port industry, which were proposed in 2011, but finally were rejected by the Ministry of Transport.

We are conscious about the limits of this research based in some restrictive assumptions imposed in order to simplify our model or because the data available. However, this analysis is a good starting point for future research in this topic.

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