Maritime Policy & Management
An International Journal of Shipping and Port Research
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713694970

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Online Publication Date: 01 October 2007
To cite this Article: Acosta, Manuel, Coronado, Daniel and Cerban, M. Mar (2007) 'Port competitiveness in container traffic from an internal point of view: the experience of the Port of Algeciras Bay', Maritime Policy & Management, 34:5, 501 - 520
To link to this article: DOI: 10.1080/03088830701585381
URL: http://dx.doi.org/10.1080/03088830701585381

MARIT. POL. MGMT., OCTOBER 2007
VOL. 34, NO. 5, 501–520

Port competitiveness in container traffic from an internal point of view: the experience of the Port of Algeciras Bay

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The objective of this article is to analyse the factors that affect port competitiveness from the perspective of the agents and companies that operate in one of the Mediterranean ports most active in container traffic: the Port of Algeciras Bay (PAB). It is essential to understand the perspective of the suppliers of port services, in order to apply the necessary judgment when formulating policies to strengthen the competitive position of a port. The model selected to meet the objective outlined is based on the 'extended diamond' of Porter. The universe for the study comprises all the institutions and companies involved in the containerization process in the Port of Algeciras Bay. Within this methodology, two procedures are utilised. First, from the quantitative perspective, a survey has been conducted to obtain responses to two groups of questions, one dealing with situation and the other with perceptions. Second, and from a qualitative perspective, several open interviews have been conducted to corroborate the responses obtained to the questionnaire. From the data obtained in the survey, a model has been estimated that minimises the sum of the residuals in absolute value, utilizing the L1 regression; this model enables the competitive advantages and disadvantages of the PAB, from the point of view of the port operators, to be determined by an analysis of residuals. This analysis demonstrates that the variables representing greater competitive advantages are associated with trans-shipment, and with the maritime accessibility of the Port to vessels, whereas those generating greater disadvantages are associated with rail transport (which, according to those surveyed, has resulted in the diversion of significant volumes of traffic to other Spanish or European ports with better communications, particularly Valencia, Barcelona and Gioia-Tauro, and with the state of competition in container trans-shipment activities.

1. Introduction

It is well known that globalisation and international competition terms are topics that dominate discussion of the international maritime transport of containers. The growth of this traffic on the world scale, as the direct consequence of the internationalization of the economies of almost all countries, and of the intensive search for efficiency in the handling and transport of goods, has resulted in more intense competition and the adoption of new strategies by all the agents involved in the process of containerization. The adoption of these strategies in order to survive in a sector of fierce competition—between ports specialized in container traffic and between suppliers of associated services—is causing rapid and profound changes in

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Maritime Policy & Management ISSN 0308–8839 print/ISSN 1464–5254 online © 2007 Taylor & Francis
http://www.tandf.co.uk/journals
DOI: 10.1080/03088830701585381

world maritime commerce, with significant consequences for the design and planning of port policy. Some of these transformations, their trends and consequences have been emphasized in the recent scientific literature: the formation of mergers and new strategic alliances [1]; new methods of port management [2–4]; the effects of technological innovations [5, 6]; the strengthening of the quality of services [7, 8]; the evolution of intermodal transport and of logistics [9, 10].

In this context of changes and of fierce competition between container ports, it is essential to identify the determinants of competitiveness to be in a position to make judgments on competitive strategies and efficacious actions. It should however be taken into account that most of the studies on competitiveness have been undertaken from the point of view of the demand, generally by sounding the opinions of the customers [11–13]. In this paper, we study the competitiveness between ports but from the supply perspective, by surveying the suppliers of port services. The port chosen for our analysis is the Port of Algeciras Bay (PAB), first in the Spanish ranking by container traffic volume, and second in that of all the Mediterranean ports. To identify the particular ports considered competitors of the PAB in the Mediterranean, several factors have been taken into account: among these are whether the port is regarded as a *hub*, whether it is a port of entry for merchandise arriving in Europe, and whether it has a consolidated position in the world ranking of ports. Having chosen the competitive ports on this basis, the list selected was subjected to the opinion of the Port Authority of the Bay of Algeciras (specifically with the executive responsible for the Commercial Department). The nine ports finally selected were Gioia-Tauro, Marsaxlokk, Valencia, Barcelona, Malaga, Marseilles, Genoa, La Spezia and Piraeus.

The methodology applied is based on the 'extended diamond' of Porter, developed for the port field by Rugman and Verbeke [14]. Porter's 'extended Diamond' is a framework aims at identifying and quantifying the main factors that determine the competitive advantage of a maritime port. This version of Porter's Diamond includes four influential factors (resources or factor conditions; demand conditions; related and supporting industries; firm strategy, structure and rivalry) and two attributes (role of the government; chance events or risk factors). Following this generic methodology, we adopt a very similar approach to that applied by Haezendonck and Notteboom [15], who provide a very effective tool so that a port may protect itself from the competition generated by the range of ports linked with it; this also deals with the matter of the port choice. They apply the methodology they develop to the particular case of the Port of Amberes for both conventional and containerized cargo.

First, we start with a description of the volume of container traffic of the Mediterranean ports that are included in our analysis. Second, we detail some of the peculiarities in the physical infrastructure and logistics of each port that differentiate them. Third, we develop the methodology for identifying the determinants of competitiveness from the perspective of the suppliers of port services. Fourth and finally, the principal conclusions are drawn.

2. Container traffic through the PAB in the context of other Mediterranean ports

The Port of Algeciras Bay occupies first place in the container traffic ranking of the Spanish network of ports, and second place in the ranking of all Mediterranean ports. In 2003, the general merchandise traffic reached a total of 32.4 million tons,

accounting for approximately 57% of the total maritime traffic and representing a rate of growth of 12% over 2002. Of this traffic, 89.69% of the merchandise was in containers; this amounted to about 29 million tons and more than two and a half million TEUs, and represented a growth of 14.29% over the previous year. To evaluate the evolution and current position of the PAB in relation to its principal competitors in the Mediterranean, some data is provided next that reflect the behaviour of the traffic flows in recent years.

All the ports selected are situated on the mainland of the European continent, with the exception of Marsaxlokk, which is situated on the island of Malta. Three of the nine ports are Spanish, including the PAB; three are Italian, one is French, one Greek and one Maltese. From a brief descriptive analysis it can be seen that the Italian port of Gioia-Tauro, in the Straits of Messina, handles the largest volume although in the world ranking it has fallen three positions compared with the year 2002 and its rate of growth was 6.5%, two percentage points below the mean rate of growth of all nine ports (8.5%). The next three ports in the ranking by volume are Spanish: the ports of Algeciras Bay, Valencia and Barcelona. In the world ranking, the PAB is the only one that has held its position with respect to the previous year; Valencia and Barcelona have lost one and two places, respectively (table 1).

Table 2 presents the evolution of market shares among these nine Mediterranean ports. Corresponding to the positions that they occupy in the ranking, Gioia Tauro currently has the largest share, 20%, followed by the PAB with a share of 16%. The historical evolution of market shares indicates, broadly, two well-differentiated periods, separated by the entry of Gioia Tauro in the container market. Coinciding with the entry of Gioia Tauro into full operation, Algeciras loses several points in its market share, as do Barcelona and Genoa; however, the hardest-hit port was La Spezia, whose volume of traffic fell to less than half its previous level. Marsaxlokk continued with approximately the same share, while Valencia and Piraeus even increased their market share.

3. Physical and logistical characteristics of the PAB in relation to its competitors

To evaluate the evolution and current situation of the PAB in relation to its principal port competitors, some data are provided below that illustrates the physical structure

Table 1. Container traffic in the principal Mediterranean ports.

World ranking	Port	Zone	TEUs 2002	TEUs 2003	% growth 2002–03
20 (17)	Gioia-Tauro	Western Mediterranean	2 954 571	3 148 662	6.57
26 (26)	B. Algeciras	Western Mediterranean	2 234 248	2 517 318	12.67
33 (32)	Valencia	Western Mediterranean	1 821 005	1 992 903	9.44
44 (42)	Barcelona	Western Mediterranean	1 461 232	1 652 366	13.08
47 (39)	Genoa	Western Mediterranean	1 531 254	1 605 942	4.88
48 (48)	Piraeus	Eastern Med./Black Sea	1 404 939	1 605 135	14.25
56 (55)	Marsaxlokk	Western Mediterranean	1 244 232	1 300 000	4.48
70 (68)	La Spezia	Western Mediterranean	975 005	1 006 641	3.24
73 (74)	Marseilles	Western Mediterranean	809 153	831 000	2.70
Total			14 435 639	15 659 967	8.51

Source: C.I. and authors' own elaboration.

Table 2. Evolution of market shares of the principal Mediterranean ports (%).[a]

	Algeciras	Barcelona	Genoa	Gioia Tauro	La Spezia	Marsaxlokk	Marseilles	Valencia	Piraeus
1990	22.23	18.02	12.48		18.11		7.04	15.58	6.54
1991	24.89	15.97	11.25		15.14		5.73	11.91	15.12
1992	15.65	11.08	6.77		11.95	5.20	7.03	7.43	34.89
1993	19.88	12.35	8.44		18.86	7.10	10.64	9.50	13.24
1994	21.08	12.72	10.76		17.54	8.05	9.18	9.81	10.86
1995	20.22	12.07	10.78		16.91	9.02	8.72	11.77	10.51
1996	19.32	11.34	12.21	8.46	12.88	8.77	8.05	10.47	8.50
1997	17.98	11.36	13.80	16.94	7.20	7.75	7.27	9.72	8.00
1998	17.11	10.24	11.86	19.92	6.86	10.04	6.13	9.10	8.74
1999	16.30	10.98	10.97	20.04	7.50	9.29	5.93	10.41	8.58
2000	15.83	10.94	11.83	20.91	7.17	8.14	5.72	10.31	9.15
2001	16.39	10.75	11.62	18.95	7.42	8.87	5.65	11.47	8.88
2002	15.48	10.12	10.61	20.47	6.75	8.62	5.61	12.61	9.73
2003	16.07	10.55	10.26	20.11	6.43	8.30	5.31	12.73	10.25

[a]Total of all the ports listed in each year = 100.
Source: C.I. and authors' own elaboration.

of these ports in comparison with the PAB. Table 3 presents details of the terminals, operators and the physical characteristics of the different types of wharf. It can be observed that both Gioia-Tauro and the PAB notably offer wharves with depths that allow the entry of large container carrier ships, and are dedicated exclusively to container traffic. However, it is also notable in the case of the PAB that the lengths of wharf available are less in comparison with the rest of the ports indicated. Other significant characteristics are the following:

- Concentration of activities. The PAB is characterized by a strong concentration of activities, in comparison with the rest of the specialized Mediterranean ports: the Ports of Valencia, Barcelona and Genoa all have more operators than the PAB and Gioia-Tauro: 4, 6 and 5, respectively; the numbers of *carriers* and lines are both lower in the PAB than in the other principal Mediterranean ports; the 10 principal world *carriers* account for 56% of the total lines, against 33% at Gioia-Tauro and 27% at Marsaxlokk (data from Containerization International).
- Distribution of lines. With respect to the lines that regularly call at the port, the PBA is the only one of all those studied which offers routes to all five continents; the long distance routes exceed those of short/medium distance. In the ports of Valencia, Barcelona and Genoa, the long-distance lines also have greater specific weight, although this distinction between longer and shorter distance lines is not as polarised as in the PAB. The opposite situation is seen in the Ports of Marseilles, Piraeus and Marsaxlokk (in order of importance), with the short distance lines having more specific weight, while in Gioia-Tauro the position is more balanced.

4. The 'internal' perspective of the Port Operators in relation to competitiveness

In this part, we identify the factors that affect the competitiveness of the PAB from the point of view of the suppliers of port services related to the container traffic.

Table 3. Physical characteristics of the principal Mediterranean ports.

Ports	Wharf[a]	Name	Operator	No. of wharves	Length (metres)	Depth (metres)
Gioia-Tauro	2	Medleft Container Terminal	Medleft Container Terminal	1 CONT[c]	3011	13.5–15
B. Algeciras	2	APM Terminals	APM Terminals	2 CONT3	1494	9–16
	1	Terminal Contenedores Algeciras	Terminal Contenedores Algeciras	1 CONT3	375	14.5
Valencia	S/D[b]	Trans-Balear				
	2	Terminales del Turia	Terminales del Turia - Terpoval	1 MULTI[d]	665	9–12
	3	Multipurpose Terminal	Terport—Combiterminal—Cesa (TCV)	1 MULTI	308	7
	2	Valencia Public Container	Marítima Valenciana SA	3 MULTI	1226	9–14
			Terminal	1 CONT	1500	16
				1 CONT	340	16
Barcelona	2	Terminal Catalunya	Terminal Catalunya SA	1	1448	8.7–14
	1	Estibadora de Ponent	Unioi Terminals Estibadors Llevant SL	1 GNRAL[e]	580	12
	7	Saport Terminal	Estibadora de Ponent SA	2 G/CNT[f]	300	6.5
				2 CONT	330	11
	3	Terminal Port-Nou	Terminal Port-Nou SA	2 G/CNT	160	9.5
	S/D	Muelle Principe España	Terminal Catalunya SA	1 CONT	190	11
	2	TCB Terminal	T Contenidors Barcelona	1 CONT	1362	12–16
Génova	7	Voltri Terminal	Voltri Terminal Europa	4 CONT	1200	15
	1	Southern European Container Hub Terminal	Terminal Contenitori Porto di Genova	1 CONT	526	14.5
	1	Genoa Metal Terminal	Genoa Metal Terminal	1 MULTI	1000	10.5
	5	Genoa Port Terminal	Genoa Port Terminal	5 MULTI	1200	9–70
	6	Messina Terminal	Ignazio Messina	6 CONT	1215	9–12
Piraeus	9	Venizelos Container Terminal	S/D	9 CONT	3100	11.5–16.5
	3	St George Terminal (RO-RO)	S/D			

(*Continued*)

Table 3. Continued.

Ports	Wharf[a]	Name	Operator	No. of wharves	Length (metres)	Depth (metres)
Marsaxlokk	2	Terminal One	Malta Freeport Terminal	1 CONT	1000	15.5
	3	Terminal Two	Malta Freeport Terminal	1 GNRAL	168	9.5
				1 CONT	480	15.5
				1 CONT	660	15.5
				1 CONT	118	15.5
La Spezia	7	Terminal Golfo	Terminal Golfo	2 CONT	310	S/D
	5	La Spezia Container Terminal	La Spezia Container Terminal	3 CONT	520	13
				2 CONT	467	14
Marseilles	S/D	Leon Gourret Mole	Port Autonome de Marseille			
	5	Brule-Tabac Quay	Port Autonome de Marseille	3 GNRAL	650	10.8–11.5
	6	Mourepiane Container Terminal	Port Autonome de Marseille	6 G/CNT	920	11.7
	1	La Pinede Dock (RO-RO)	Port Autonome de Marseille			
	5	Fos Container Terminal	Port Autonome de Marseille	5 CONT	1180	14

Source: Authors' own elaboration from Containerisation International, 2004.
[a]'Wharf' refers to the number of wharves that are dedicated in that port to general merchandise, containerised and non-containerised, and to ro-ro. Subsequently, 'N° of Wharves' refers to the container wharves, general merchandise or *multipurpose* for each operator.
[b]S/D: no data available.
[c]CONT: Container wharves.
[d]MULTI: Multi-use or *multipurpose wharves*.
[e]GNRAL: Wharves for general merchandise.
[f]G/CNT: Wharves for general merchandise and for containers.

After identifying the various entities, institutions and companies involved in the process of containerization, a representative sample has been extracted. The choice of the sample of the companies and institutions to survey has not been random, but rather intentional according to the specific weight of the particular company or institution in port activity. The specific weight has been assessed in function of the number of employees of the company, of its area of activity, and of the length of time it has operated in the PAB, taking into account that the sample is intended to cover all the activities related to port operations for the movement of containers: official bodies, associations, customs and forwarding agents, container terminals, ships' agents and merchandise agents, stevedores, suppliers, land transport companies, and tugs. Specifically, 25 were selected, representing approximately 40% of the total of institutions and companies directly related with the container traffic, but accounting for more than 90% of the employment in the sector [16].

All these companies have been surveyed using a questionnaire structured in three parts. The first part of the questionnaire contains questions on the identification or situation of the company, its number of employees, the subsector to which it belongs within the area of port activity, its particular area of activity, and the length of time it has been operating in the PAB. The second part of the survey is the more important and is presented on the basis of the matrix of competitiveness. The groups of questions of this part are divided, as Porter suggests in his structure of the extended diamond, in function of the factor conditions, the demand conditions, the support industries, the competence of the Port, and the role of the public sector at its various levels (local, regional and national). The responses to the questions asked in this questionnaire are requested on a scale of estimated intensity/importance, in function of which the person interviewed, based on their own perception, must rate at one of five levels, between -2 and $+2$, a series of variables according to whether they constitute a disadvantage or an advantage for the competitiveness of the Port: -2: very unfavourable (variables that constitute an important competitive disadvantage for the PAB); -1: unfavourable; 0: neutral (variables that constitute neither an advantage nor a disadvantage for the competitiveness of the port); $+1$: favourable; $+2$: very favourable (variables that constitute an important competitive advantage for the PAB).

The third part of the survey consists of a series of open questions to explain in detail the data of the preceding part and to corroborate them qualitatively. The survey as a whole, including the three parts, was conducted with the director or most senior executive/manager/official of each organisation in its head offices. The duration of the interviews ranged from one to one-and-a-half hours.

The survey matrix presents the perceptions obtained from the second part of the questionnaire. It combines the functional activities performed in the Port, from a perspective of logistic chain, with the determinants of port competitiveness [17]. The functional activities performed in a port (the horizontal axis of the matrix) are subdivided into:

- Activities related to the *foreland*.
  Maritime accessibility (ACCES)
  Maritime transport (SHIP)

- Activities concerning the port sector itself.
  Trans-shipment (LOAD)
  Storage (WARE)
  Logistics that provide value added (VAL)
  Manufacturing industry (MANU)
  Activities of the maritime transport agents (EXP)
  Activities of distribution within the port community (DISTR)
- Activities linked to the *hinterland*.
  Road transport (ROAD)
  Rail transport (RAIL)

The determinants of port competitiveness are represented on the vertical axis. These determinants are structured in accordance with the components of Porter's extended diamond, as follows:

- Factor conditions.
  Infrastructure (INFR)
  Superstructure (SUP)
  Human capital (LAB)
  Technology and communications systems (LOG)
- Competition in the Port.
  State of the internal competition in the port community (ICO)
  State of the external competition or of competition from other ports considered competitors (ECO)
  Cooperation or collaboration of the institutions and companies involved in the port activity (ICOOP)
  Cooperation or collaboration of the institutions or companies not involved in the port activity (ECOOP)
- Demand conditions.
  Relationships of the customers currently using the Port with the port community (ICLI)
  Relationships of customers who are potential users of the Port, with the port community (ECLI)
- Government or public sector.
  Intervention or position of the Port Authority (GOAP)
  Intervention or position of the Junta de Andalucía (GOREG)
  Intervention or position of the Central Government, in respect of political decisions (GONAT)
  Intervention or position of the various State Administrative authorities involved in the port activity (GOAE)
  Intervention or position of the various Municipal Authorities within whose boundaries are situated the Port itself and the activities directly associated with it (GOLOC)
- Support industries.
  Services provided by companies supporting the port activity (SERV)

The matrix has been adapted to the specific case of the Port of Algeciras Bay. With respect to the columns, in the original matrix utilized for the study of the Port

of Amberes, inland navigation was included (INAV); this factor has not been considered in this study because it refers to navigation along rivers to reach this Port, which does not apply in the case of the PAB. Regarding the rows, differentiation has been made between the political decisions of the State (GONAT) and the actions of the various different Public Administrative authorities subordinate to the State and directly associated with the port activity (GOAE): this distinction was not made in the study of the Port of Amberes. In addition, the role of the Municipal authorities (GOLOC) has also been included.

With the results obtained from the surveys, a matrix $X^{(m)}$, composed of 16 rows and 10 columns, has been constructed for each company or institution interviewed 'm'. It is evident that some of those surveyed may give responses more biased towards the upper or lower extreme rating than others. This might be due to variations in the personality or attitude of the person interviewed, rather than a real difference related to the competitiveness of the Port. To avoid these distortions the responses to each question have been typified in the following way:

$$z_{ij}^{(m)} = \frac{[x_{ij}^{(m)} - \mathrm{AVE}_{ij}(x_{ij}^{(m)})]}{\mathrm{SD}_{ij}(x_{ij}^{(m)})},$$

where $i = 1, 2, \ldots, 16$ and $j = 1, 2, \ldots, 10$.

Subsequently, the 'm' matrices were reduced to a single matrix (Z) by calculating the mean of each cross value from the typified data. Analysis of the key factors of competitiveness reveals which rows and columns correspond to a positive or negative assessment, and if there is any interaction between particular rows and columns. Those extreme factors can be detected, as suggested by Hubert and Rousseeuw [18], by calculating the deviation of each cell of the response matrix, previously typified, from the mean behaviour of all cells. To calculate the mean behaviour of rows and columns, the values of the matrix will be related with two groups of regressors constituted by fictitious variables. The first group reflects the mean behaviour of each column (functional activities undertaken in the Port), while the second reflects the mean behaviour of each row (determinants of the competitiveness of the port). Sixteen fictitious variables for the rows and 10 variables for the columns are constructed. Logically, since the model includes an independent term, 15 regressors for the first group and nine for the second are introduced in the model. The model thus takes the following form:

$$z_{ij} = \grave{e}_0 + \sum_{k=2}^{16} \acute{a}^{(k)} I_{ij}^{(k)} + \sum_{l=2}^{10} \hat{a}^{(l)} J_{ij}^{(l)} + u_{ij}$$

where $I_{ij}^{(k)} = 1$, for $i = k$, and $I_{ij}^{(k)} = 0$for the rest of the various possibilities. Similarly, $J_{ij}^{(l)} = 1$for $j = 1$, and $J_{ij}^{(l)} = 0$ for the other values. The independent term is $\grave{e}_0$ and u_{ij} is the random perturbation.

It is very simple to estimate the model by ordinary least squares; however, this method is very sensitive to the existence of extreme observations. To prevent their

influence from distorting the results, the model has been estimated minimizing the sum of the residuals in absolute value.

The equation finally obtained corresponds to the formula (L1 regression):

$$\hat{z}_{ij} = \hat{\theta}_0 + \sum_{k=2}^{16} \hat{\alpha}^{(k)} I_{ij}^{(k)} + \sum_{l=2}^{10} \hat{\beta}^{(l)} J_{ij}^{(l)} = \hat{\theta}_0 + \hat{\alpha}^{(i)} + \hat{\beta}^{(j)}$$

From here, the residuals are generated from the differences between the real values of the matrix of standardised scores and from the values estimated using the model: $e_{ij} = z_{ij} - \hat{z}_{ij}$. The estimation of the model provides as many residuals as we have boxes in the matrix of competitiveness (160). From the analysis of the residuals, in terms of whether they are considered atypical or strange and of their position in the matrix, we will obtain the competitive advantages and disadvantages.

If any of the residuals e_{ij} obtained are unusually large, this can be taken to mean that the real value of the dependent variable is not completely explained by the mean effect of the rows and columns. Thus, following Haezendonck and Notteboom [15] it can be stated that there is an interaction between row i and column j, that is, between functional activities undertaken in the Port and resources needed for the port operation.

Therefore, the detection of extremely high residuals, both positive and negative, enables the detection of advantages and disadvantages, respectively, in terms of competitiveness. The best way of detecting in which observations the interactions take place is by representing the standardized residuals graphically, $\hat{e}_{ij} = e_{ij}/\hat{\sigma}$ against the estimated values $\hat{z}_{ij}$. If the residuals are distributed approximately as a normal distribution, 95% of them will fall between -2.5 and $+2.5$. Values above and below that range can be taken as extreme observations, indicating positive or negative interaction, respectively.

The results of the application of this procedure are presented below. In the analysis conducted, all the questionnaires have been treated as equal; that is, attaching equal value to all the responses and extracting from them the perceived competitive advantages and disadvantages of the PAB.

The matrix of competitiveness (table 4) is obtained employing the methodology described in the preceding part. From these data, the regression model is estimated, which will enable us to identify the competitive advantages and disadvantages (table 5).

The residuals of the econometric model are presented in table 6. The detection of the extremely large residuals, positive and negative, as already commented, reveals the competitive advantages and disadvantages of the PAB (Annex III). The extreme standardised residuals will be those that fall outside the bands of ± 2.5 in figure 1. Table 7 shows the position of the extreme residuals and their sign [19].

The residuals obtained in table 7 whose values exceed ± 2.5 standard deviations are placed and ranked in the matrix of competitiveness in table 8, to analyse their position with respect to the functional activities undertaken in the Port (columns) and to the resources needed to operate the port (rows).

Table 4. Matrix of competitiveness.

	ACCE	SHIP	LOAD	WARE	VAL	MANU	EXP	DISTR	ROAD	RAIL
INFR	1.2788	0.7978	1.5287	0.3484	−0.2467	−0.9962	0.5511	0.5392	−0.5488	−0.9473
SUP	1.1488	0.6958	1.1679	0.0440	−0.0256	−0.7648	0.0789	−0.0342	−0.2376	−0.8176
LAB	0.7672	0.8031	0.7697	0.4659	0.0771	−0.5122	0.4331	0.3511	0.4847	−0.2481
LOG	1.1754	0.9224	1.2552	0.4822	0.2868	−0.3313	0.6743	0.3541	0.1884	−0.4616
ICO	−0.4011	−0.4211	−0.9771	0.0303	−0.0516	−0.6077	1.0387	0.2706	0.4266	−1.2189
ECO	−0.0663	−0.8067	−0.3554	−0.5901	−0.5762	−0.8562	−0.4886	−0.2405	−0.4797	−0.8188
ICOOP	0.8975	0.1923	1.1592	0.3216	−0.1455	−0.5227	0.1320	0.1701	0.0015	−0.5592
ECOOP	−0.0632	−0.1581	0.0570	−0.2278	−0.3558	−0.4328	0.0363	−0.0650	−0.4439	−0.6169
ICLI	−0.0967	−0.2643	−0.1078	−0.1440	−0.1342	−0.5872	0.9166	0.3810	0.2397	−0.4370
ECLI	−0.0671	0.1946	−0.1273	0.0170	−0.1282	−0.3463	0.9191	0.4690	0.4923	−0.1329
GOAP	0.4388	0.4120	0.2920	−0.04676	−0.0733	−0.5162	−0.1470	−0.2420	0.0009	0.0988
GOREG	−0.2308	−0.1496	−0.1576	−0.1117	−0.1794	−0.4245	−0.1060	−0.1913	−0.2553	−0.6231
GONAT	−0.0957	−0.0028	−0.0798	−0.1022	−0.2912	−0.5284	−0.1526	−0.0974	−0.4737	−0.9581
GOAE	0.0479	−0.1074	0.2593	0.0978	−0.0813	−0.0924	−0.2916	−0.04909	−0.1311	−0.1440
GOLOC	−0.1711	−0.1814	−0.1254	0.02764	−0.1215	−0.2938	−0.04429	−0.1578	−0.4191	−0.3448
SER	0.2167	0.3866	0.5512	0.2719	0.2463	−0.0290	0.4982	0.3120	0.0931	0.0288

Functional activities performed in a port: ACCE: Maritime accessibility; SHIP: Maritime transport; LOAD: Trans–shipment; WARE: Storage; VAL: Logistics that provide value added; MANU: Manufacturing industry; EXP: Activities of the maritime transport agents; DISTR: Activities of distribution within the port community; ROAD: Road transport; RAIL: Rail transport.
Determinants of port competitiveness: INFR: Infrastructure; SUP: Superstructure; LAB: Human capital; LOG: Technology and communications systems; ICO: State of the internal competition in the port community; ECO: State of the external competition or from other ports; ICOOP: Cooperation or collaboration of the institutions and companies involved in the port activities; ECOOP: Cooperation or collaboration of the institutions or companies not involved in the port activities; ICLI: Relationships of the customers currently using the port with the port community; E CLI: Relationships of customers who are potential users of the Port with the port community; GOAP: Intervention or position of the Port Authority; GOREG: Intervention or position of the Junta de Andalucia; GONAT: Intervention or position of the Central Government; GOAE: Intervention or position of the various State Administrative involved in the port activity; GOLOC: Intervention or position of the various Municipal Authorities within whose boundaries are situated the Port; SER: Services provided by companies supporting the port activity.
Source: Authors' own elaboration from the surveys.

Table 5. Estimations made utilising the 160 observations 1–160. Dependent variable: datum.

Variable	Coefficient	Std. deviation	Statistic *t*	*P* Value
Const	0.354979	0.409539	0.8668	0.387602
C2	−0.0444529	0.189422	−0.2347	0.814815
C3	0.120268	0.202379	0.5943	0.553326
C4	−0.00656337	0.176992	−0.0371	0.970474
C5	−0.195476	0.172815	−1.1311	0.260006
C6	−0.644597	0.206586	−3.1202	0.002210
C7	0.0283768	0.186707	0.1520	0.879425
C8	−0.0667196	0.181844	−0.3669	0.714264
C9	−0.235439	0.185105	−1.2719	0.205588
C10	−0.517916	0.217859	−2.3773	0.018843
F2	−0.304462	0.409962	−0.7427	0.458979
F3	0.117455	0.389745	0.3014	0.763601
F4	0.127282	0.379667	0.3352	0.737960
F5	−0.318073	0.444636	−0.7154	0.475625
F6	−0.655846	0.37445	−1.7515	0.082132
F7	−0.118188	0.376933	−0.3136	0.754346
F8	−0.418212	0.374502	−1.1167	0.266100
F9	−0.293695	0.398013	−0.7379	0.461854
F10	−0.0567167	0.404369	−0.1403	0.888664
F11	−0.183276	0.383438	−0.4780	0.633438
F12	−0.460146	0.372371	−1.2357	0.218708
F13	−0.450659	0.369138	−1.2208	0.224275
F14	−0.2506	0.378002	−0.6630	0.508487
F15	−0.427648	0.376938	−1.1345	0.258582
F16	0.0759926	0.370882	0.2049	0.837961

Mean of the dependent variable = −6.09449e–014.
SD of the dependent variable = 0.501571. Sum of absolute values of the residuals = 36.4227.
Sum of squares of the residuals = 18.6352.
Source: Authors' own elaboration.

From the analysis of these points, and of the interactions that they reflect, the following conclusions can be drawn:

4.1. *Port conditions factor*

- Infrastructure

Among the variables that contribute to the competitive advantage of the Port, one of the most notable is the infrastructure dedicated to the trans-shipment of containers (INFR-LOAD: 1.0535). This variable has taken the second highest value of all those analysed. The reasons put forward by those surveyed for making this assessment are, among others, that the large investments in infrastructure made by the Port Authority of PAB and, to a less extent, by the company Maersk in its container terminal, have increased the area available for movement and storage of containers. The principal objective of these investments has been to avoid choking off the growth of container traffic.

The second variable related to the infrastructures that promotes the competitiveness of the Port refers to those variables that facilitate the maritime access to the port by large vessels (INFR-ACCES: 0.9238). In this respect, the respondents stressed the

Table 6. Matrix of competitiveness with the values of the residuals.

	ACCE	SHIP	LOAD	WARE	VAL	MANU	EXP	DISTR	ROAD	RAIL
INFR	0.9238	0.4873	1.0535	0	−0.4062	−0.7065	0.1677	0.2510	−0.6684	−0.7844
SUP	1.0983	0.6898	0.9971	0	0.1193	−0.1708	0	−0.0180	−0.0526	−0.3502
LAB	0.2947	0.3751	0.1770	0	−0.1998	−0.3401	−0.0677	−0.0546	0.2477	−0.2026
LOG	0.6931	0.4846	0.6527	0.0065	0	−0.1689	0.1636	−0.0614	−0.0584	−0.4260
ICO	−0.4380	−0.4136	−1.1343	0	0.1070	0	0.9734	0.3004	0.6251	−0.7379
ECO	0.2345	−0.4613	−0.1748	−0.2826	−0.0798	0.0892	−0.2162	0.1271	0.0566	0
ICOOP	0.6607	0	0.8021	0.0913	−0.1869	−0.1148	−0.1331	0	0.0001	−0.2780
ECOOP	0	−0.0504	0	−0.1580	−0.0971	0.2751	0.0712	0.0649	−0.1452	−0.0358
ICLI	−0.1580	−0.2812	−0.2894	−0.1987	0	−0.0039	0.8269	0.3864	0.4139	0.0196
ECLI	−0.3654	−0.0592	−0.5458	−0.2747	−0.2310	0	0.5925	0.2375	0.4295	0.0868
GOAP	0.2671	0.2848	0	−0.2119	−0.0495	−0.0433	−0.3471	−0.3470	0.0646	0.4450
GOREG	−0.1256	0	−0.1727	0	0.1212	0.3252	−0.0292	−0.0194	0.0853	0
GONAT	0	0.1373	−0.1044	0	0	0.2119	−0.0853	0.0650	−0.1426	−0.3445
GOAE	−0.0564	−0.1673	0.0346	0	0.0098	0.4478	−0.4244	−0.0867	0	0.2696
GOLOC	−0.0984	−0.0642	−0.1729	0.1069	0.1466	0.4235	0	−0.0184	−0.1110	0.2457
SER	−0.2143	0	0	−0.1525	0.0108	0.1847	0.0389	−0.0522	−0.1025	0.1157

Functional activities performed in a port: ACCE: Maritime accessibility; SHIP: Maritime transport; LOAD: Trans–shipment; WARE: Storage; VAL: Logistics that provide value added; MANU: Manufacturing industry; EXP: Activities of the maritime transport agents; DISTR: Activities of distribution within the port community; ROAD: Road transport; RAIL: Rail transport.
Determinants of port competitiveness: INFR: Infrastructure; SUP: Superstructure; LAB: Human capital; LOG: Technology and communications systems; ICO: State of the internal competition in the port community; ECO: State of the external competition or from other ports; ICOOP: Cooperation or collaboration of the institutions and companies involved in the port activities; ECOOP: Cooperation or collaboration of the institutions or companies not involved in the port activities; ICLI: Relationships of the customers currently using the port with the port community; E CLI: Relationships of customers who are potential users of the Port with the port community; GOAP: Intervention or position of the Port Authority; GOREG: Intervention or position of the Junta de Andalucia; GONAT: Intervention or position of the Central Government; GOAE: Intervention or position of the various State Administrative involved in the port activity; GOLOC: Intervention or position of the various Municipal Authorities within whose boundaries are situated the Port; SER: Services provided by companies supporting the port activity.
Source: Authors' own elaboration from the surveys.

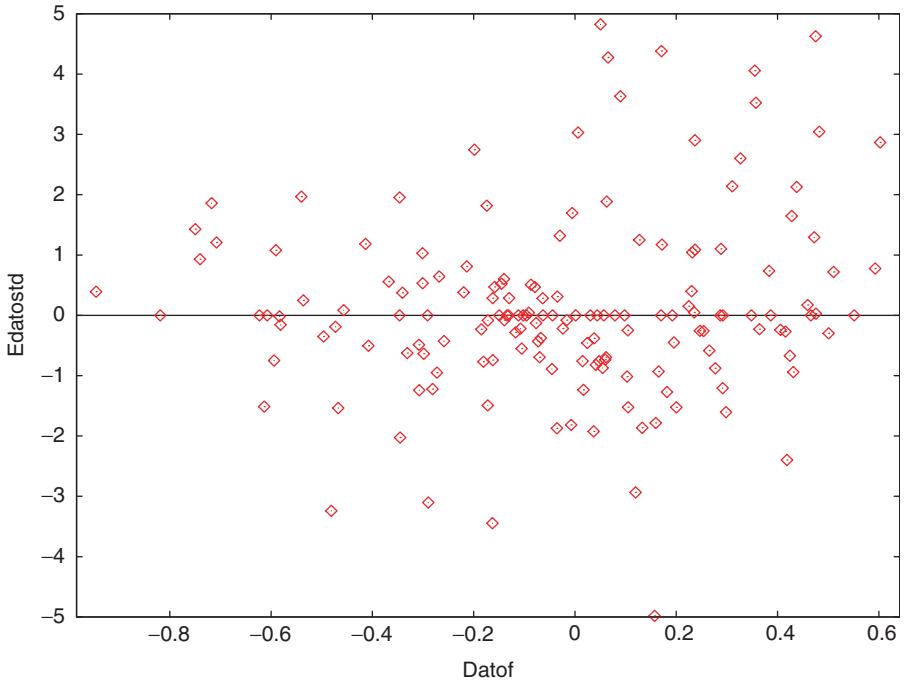

Figure 1. Values estimated against standardized residuals.
Source: Authors' own elaboration.

Table 7. Standardized residuals exceeding ±2.5 × standard deviation.

	Position	
Order	Positive residuals	Negative residuals
1	11	43
2	3	10
3	13	50
4	47	6
5	1	9
6	87	–
7	63	–
8	31	–
9	12	–
10	61	–
11	33	–
12	49	–
13	97	–

Source: Authors' own elaboration.

excellent conditions of depth and natural shelter possessed by the Bay of Algeciras, allowing the easy entry and berthing of large container carrier ships.

However, under the heading of infrastructures are found three variables that detract from the competitiveness of the PAB: the lack of infrastructures to facilitate the transport of merchandise by rail (INFR-RAIL: −0.7844), a weakness

Table 8. Matrix of competitiveness with residuals higher than ±2.5 × SD.[a]

	ACCE	SHIP	LOAD	WARE	VAL	MANU	EXP	DISTR	ROAD	RAIL
INFR	0.9238 (5+)	–	1.0535 (2+)	–	–	−0.7065 (4−)	–	–	−0.6684 (5−)	−0.7844 (2−)
SUP	1.0983 (1+)	0.6898 (9+)	0.9971 (3+)	–	–	–	–	–	–	–
LAB	–	–	–	–	–	–	–	–	–	–
LOG	0.6931 (8+)	–	0.6527 (11+)	–	–	–	–	–	–	–
ICO	–	–	−1.1343 (1−)	–	–	–	0.9734 (4+)	–	0.6251 (12+)	−0.7379 (3−)
ECO	–	–	–	–	–	–	–	–	–	–
ICOOP	0.6607 (10+)	–	0.8021 (7+)	–	–	–	–	–	–	–
ECOOP	–	–	–	–	–	–	–	–	–	–
ICLI	–	–	–	–	–	–	0.8269 (6+)	–	–	–
ECLI	–	–	−0.5458 (6−)	–	–	–	0.5925 (13+)	–	–	–
GOAP	–	–	–	–	–	–	–	–	–	–
GOREG	–	–	–	–	–	–	–	–	–	–
GONAT	–	–	–	–	–	–	–	–	–	–
GOAE	–	–	–	–	–	–	–	–	–	–
GOLOC	–	–	–	–	–	–	–	–	–	–
SER	–	–	–	–	–	–	–	–	–	–

Source: Authors' own elaboration from the surveys.

[a]The position ranked in function of the most extremes values or those close to ±2.5 appears in brackets.

Functional activities performed in a port: ACCE: Maritime accessibility; SHIP: Maritime transport; LOAD: Trans–shipment; WARE: Storage; VAL: Logistics that provide value added; MANU: Manufacturing industry; EXP: Activities of the maritime transport agents; DISTR: Activities of distribution within the port community; ROAD: Road transport; RAIL: Rail transport.

Determinants of port competitiveness: INFR: Infrastructure; SUP: Superstructure; LAB: Human capital; LOG: Technology and communications systems; ICO: State of the internal competition in the port community; ECO: State of the external competition or from other ports; ICOOP: Cooperation or collaboration of the institutions and companies involved in the port activities; ECOOP: Cooperation or collaboration of the institutions or companies not involved in the port activities; ICLI: Relationships of the customers currently using the port with the port community; E CLI: Relationships of customers who are potential users of the Port with the port community; GOAP: Intervention or position of the Port Authority; GOREG: Intervention or position of the Junta de Andalucia; GONAT: Intervention or position of the Central Government; GOAE: Intervention or position of the various State Administrative involved in the port activity; GOLOC: Intervention or position of the various Municipal Authorities within whose boundaries are situated the Port; SER: Services provided by companies supporting the port activity.

traditionally considered by the port community to be one of the most important for the Port; the absence of infrastructures suitable for companies fabricating or manufacturing merchandise that could be containerized in volume (INFR-MANU: −0.7065), where the respondents emphasized the shortage of land in the industrial estates of some municipalities of the region, together with the lack of a Logistic Activities Zone that could promote the transformation of merchandise to generate value added, among other functions [20]; and last, the insufficient infrastructures in the form of roads (INFR-ROAD: −0.6684), although this is a problem that is already being tackled.

- Superstructure

In this part, three variables that promote the competitiveness of the Port are highlighted. The first, which has been considered by respondents to be the factor contributing the most competitive advantage to the PAB of all the variables analysed, is the superstructure related to the maritime accessibility of the Port to vessels (SUP-ACCES: 1.0983). The companies and institutions interviewed have rated positively the installations of the Harbourmaster's Office, those of Marine Salvage, those of the Port Authority and those of the container terminals that facilitate the access of vessels to the Port.

The second variable that, under this heading, enhances the competitiveness of the PAB is the superstructure that facilitates the trans-shipment of containers (SUP-LOAD: 0.9971), that is, the cranes, the warehouses, the offices, the refrigerated stores, etc. noting that some of the container-handling cranes available in the Port are among the largest in the world, which enable more movements per hour and hence high rates of productivity in the handling of containers.

Last, the superstructure available for promoting the development of the shipping lines that include the PAB as a port of call (SUP-SHIP: 0.6898) is another variable that enhance the competitiveness of the PAB. In this respect respondents emphasise the availability of cranes, warehouses, offices, etc. that allow the port activity to continue growing, and the work done by COMPORT (Comunidad Portuaria de La Bahia de Algeciras) and the Port Authority to increase the number of lines that call at this Port.

- Technology and communications systems

Two variables that represent a competitive advantage for the Port stand out. The first is the technology and communications systems related to the maritime access of vessels to the Port (LOG-ACCES: 0.6931), where those surveyed emphasised the good functioning of the technologies and communications for access to the Bay, and for controlling the movement of vessels in the Straits of Gibraltar, which could be related to reduced maritime accidents. The second positive variable in the technology and communications systems related to the trans-shipment of containers (LOG-LOAD: 0.6527), where the companies interviewed reported reduced waiting times for vessels in port and the fast handling of containers.

4.2. *Competition in the port*

- State of the internal competition in the port community

The respondents identified four significant variables in the analysis of the internal competition in the Port, two of them representing a competitive advantage and the

other two a disadvantage. In the first case there is the internal competition in relation to the activities of the maritime transport agents (ICO-EXP: 0.9734). In the second case, the internal competition in road transport services (ICO-ROAD: 0.6251), in respect of which it is considered, according to the interviews conducted, that the large number of companies offering these services has resulted in the provision of a better service at a lower cost.

With respect to the variables that reduce the competitiveness of the PAB, it is noted that the lack of internal competition in the trans-shipment of containers (ICO-LOAD: −1.1343) is the variable that, according to those surveyed, is the biggest obstacle to increased competitiveness for the Port in container traffic, in the year in which the study was carried out (in the year 2004 with respect to respondents' perception in the year 2003). The effective monopoly held by the company Maersk in the provision of trans-shipment services means that prices for these services are held at high levels, resulting in the diversion of traffic to other competitor ports, particularly to Valencia. The other variable that represents a competitive disadvantage for the PAB is the lack of internal competition in rail transport (ICO-RAIL: −0.7379), due to the regime of monopoly in the provision of service; this disadvantage, common to all the Spanish ports, is in process of changing with the privatization initiated in rail transport.

- Cooperation or collaboration of the institutions and companies involved in the port activity.

The variables that relate internal cooperation or efficiency in operations with container trans-shipment (ICOOP-LOAD: 0.8021) and with maritime accessibility (ICOOP-ACCES: 0.6607) are those that the interviewees considered promoted the competitiveness of the Port. The first, efficient internal operations in the trans-shipment of containers, has allowed high levels of productivity to be achieved in the terminal and, with this, reduced costs of merchandise handling, and shorter stays in port for the vessels. The second variable, efficiency in internal operations for the access of vessels to the port, has been attributed to the rapidity in the actions of the various public institutions and companies involved with the berthing of the vessel in the Port, such as the Harbourmaster's Office, Marine Salvage, Port Authority, Pilots and Mooring Services, among others.

4.3. *Demand conditions*

- Relationships of current and potential customers of the Port with the port community.

With respect to the current and potential customers, the variables that the interviewees underlined as generators of competitiveness were the relationships of the current customers of the Port with the maritime transport agents (ICLI-EXP: 0.8269) and those of potential customers with these same agents (ECLI-EXP: 0.5925), considering that they represent competitive advantages in terms of the quality of services offered, at prices similar to those charged by their possible competitors. Alternatively, they consider that the relationships with the Port of potential customers for container trans-shipment services (ECLI-LOAD: −0.5458) reduce the competitiveness of the PAB, because practically the only company providing these

services, 'Maersk', is the one that chooses their customers and unilaterally determines the traffic flows that are profitable for it, and those that are not.

4.4. *Government or public sector*

The interventions or positions of the Port Authority of the PAB, of the Junta de Andalucía, of the Central Government and of the Local Authorities within whose municipal boundaries the Port and directly related activities are located, are not considered by respondents to generate any significant competitive advantage or disadvantage for the Port, since all the residuals of the variables are within the range of −2.5 to +2.5.

4.5. *Support industries*

The interviewees did not identify any significant variables in relation to the services provided by supporting companies, like finance and insurance entities, feeders, warehousing companies, etc.

5. Conclusions

The following conclusions in respect of the determinants of the matrix of competitiveness have been obtained from the analysis conducted.

- Infrastructure. This is the part that includes the most variables that have a significant effect on the competitiveness of the Port of Algeciras Bay; five specific variables are identified, two representing advantages and three disadvantages. The two variables that, according to the operators of the PAB, enhance the competitiveness of the Port (the infrastructure dedicated to the trans-shipment of containers and the infrastructure that facilitates the access of vessels to the Port), rank second and fifth among the thirteen variables analysed, in terms of the score awarded as generators of competitive advantages. With respect to the variables that reduce competitiveness, one of the most important is the rail transport infrastructure. According to those surveyed, this has led to the diversion of substantial volumes of traffic to other Spanish and European ports with better rail communications (Valencia, Barcelona, Gioia-Tauro, etc.).
- Superstructure. The variables under this heading follow a similar pattern to those of the preceding part in relation to the factors that enhance the competitiveness of the Port. The most significant elements of superstructure are those related to maritime accessibility, which is the highest rated variable as a generator of competitive advantages, to trans-shipment services, and to the development of the shipping lines that include the PAB as a port of call.
- Technology and communications systems. Two variables are outstanding as factors that enhance the competitiveness of the Port: the technology applied to maritime accessibility and that applied to trans-shipment. Therefore, it can be concluded that the level of technological development related to the access of vessels and the handling of the cargo is rated highly.
- Internal competition. Under this heading is the variable to which respondents assigned the worst score: the state of internal competition in trans-shipment services, where reference is made to the negative effects that the monopoly of Maersk has on the movement of containers. This monopoly situation is

currently subject to modest change because of the increasing activity of the public Terminal 'Terminal de Contenedores de Algeciras', although its relative position always will be subordinate with respect to its competitor, Maersk, which belongs to the world's leading group of container terminal operators. The companies and institutions interviewed also underlined the loss of competitiveness represented by the monopoly that exists in Spain in rail transport of merchandise, although this is a problem now being resolved.

- Cooperation of the institutions and companies involved in the port activity. In this part the significant variables are the internal cooperation that facilitates the accessibility of the Port to vessels to the Port, and the trans-shipment of containers; according to those surveyed, this has contributed to reduced levels of maritime accidents, to minimum waiting times for vessels in port, and to faster handling of the merchandise.
- From an analysis of the matrix of competitiveness by columns, it can be seen that the variables representing the biggest competitive advantages are those related to trans-shipment services, to maritime accessibility of vessels to the Port, and to the provision of services by the maritime transport agents. Those that generate the biggest disadvantages are those related to deficient rail transport, and to the lack of competition in container trans-shipment activities.

Acknowledgements

The authors are grateful for the useful comments provided by two anonymous referees on an earlier draft of this paper. We would also like to thanks the Port Authority of the Port of Algeciras Bay and the members of the Port Community for their time in the interview's process. This research has been granted by the Ministry of Education and Science SEJ2005/08972ECON and the Junta de Andalucía P06-SEJ-02087.

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16. The list of those interviewed, by activities, is the following: Official bodies (Customs, Animal Health, Plant Health, SOIVRE); Associations (Asociación de Empresas de Servicios de la Bahía de Algeciras: AESBA; Asociación Comarcal de Empresarios de Transporte y Maquinaria Auxiliar Obras Públicas del Campo de Gibraltar: ACETM; Cámara de Comercio Industria y Navegación del Campo de Gibraltar); Customs Agents (Gonzalez Gaggero, SL; Agencia Paublete SL); Forwarders (Algeciras Puerto Import & Export SL; NAYPEMAR SL; Universal Forwarding SL); Ships' agents (Alfaship Bacomar, A.M. Condeminas Cádiz, SA, COTRANSA Andalucia SA, Maritima del Estrecho, SA, Naviera del Odiel, SA, Romeo & Cia, SA, Sea—Spain Andalucia, SA); Container terminals (Maersk España, SA, Terminal de Contenedores de Algeciras: TCA); Stevedores (SESTIBALSA); Auxiliary Services, Supplies and *Bunkering* (Barwil Ship Services SL, Compañía Ibérica de Remolcadores del Estrecho, SA; Shell Lubricantes Marinos).
17. The sequence in which they are presented below is that which appears in the matrix of competitiveness.
18. Hubert, M. and Rousseeuw, P., 1997, Robust regression with both continuous and binary regressors. *Journal of Statistical Planning and Inference*, **57**(1), 153–163.
19. The extreme points obtained by the minimisation of the sum of the residuals in absolute value coincide approximately with those obtained by the method of Ordinary Least Squares.
20. The Consortium that is constructing and that will manage the Logistic Activities Zone of the 'Campo de Gibraltar', comprising the public company 'Puertos de Andalucia', the Port Authority of the Bay of Algeciras and the Local Authorities in whose municipalities this zone is situated, has forecast that it will enter into operation in mid 2006.