"ECONOMIC EVALUATION OF THE SPANISH PORT SYSTEM USING THE PROMETHEE MULTICRITERIA DECISION METHOD"

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Abstract:

Due to legislation changes during the Nineties, the Spanish Port System has gone through a series of changes that, simultaneous with a period of economic expansion and generalized marine traffic growth, have affected the Port System's composition, organization and operation. The gradual transformations produced by this context, give shape to a new model of operation for Port Authorities, which now start to be managed under business criteria and procedures of functional autonomy, competition, effectiveness and profit, moving away from State dependency, and at the same time allowing greater participation of regional governments. As a result, general purpose Spanish ports develop their activity in a very competitive market, where self financing and financial sufficiency prevail as high-priority management goals.

Our work considers these circumstances from the approach offered by multiple objective decision models, in order to study the performance evolution of Port Authorities, using certain ratios with economic meaning which will allow determining how their relative ranking within the national set has varied.

The great variety of available business ratios and the different concepts to analyze give the problem a discrete multicriteria dimension. Thus we have chosen the Promethee method for our analysis, given its results simplicity and easy understanding for the decision agent, the economic interpretation of its parameters, and the stability of its results. In addition, scale effects between different alternatives are eliminated, allowing the possibility of incomparability among them and offering a sensitivity analysis of the effects.

1. INTRODUCTION: GOALS

This work analyzes, from an economic and financial perspective, the evolution through the last decade of the twenty-seven Port Authorities that make up the Spanish Port System.

Our study is framed within the climate of transformations in which the Spanish Harbor System was generally immersed during the Nineties, facing the new economic challenges of the XXI century. To the changes occurred in this period, with respect to organization, operation and operation model of Port Authorities, we must also add a positive underlying economic situation, which influenced positively marine traffic evolution.

The most relevant changes during the last decade, were the ones introduced by new regulations, established by Law 27/92 (November 24) about State Ports and the Merchant marine, and Law 62/97 (December 26), which modified it. In a general sense, the application of both laws transformed basic operating conditions for the economic agents in the port space, contributing to reduce the high intervention degree existing until then.

Law 27/92 created the Port Authority figures, with legal ability and their own patrimony independent from the state, whose activity is coordinated by the public Office for State Ports (*Ente Público Puertos del Estado*), which has a holding role. In addition this law establishes a new economic-financial regime for Spanish ports, based on self-sufficiency of resources generated by the system itself. For this, our port system set of incomes is based on two pillars: incomes coming from concessions and commercial and industrial activities within the harbor precinct (considered public prices), and port service fees (private prices).

In summary, this law measures intend to promote the effectiveness, quality and safety of the services provided by each Port Authority, leading to greater agility and coordination among them, and establishing a system of harbor income that allows the financial self-sufficiency of system; in the mid term in the case of each Port Authority.

The change introduced by Law 62/97 represents a new attempt to adapt our port organization to an environment that is ever more changing and more competitive. To do that, a new organizational frame is defined that equips Harbor Authorities with greater functional and management autonomy. Also, Regional Governments are granted greater participation in Port Authorities decision making and naming of its governing boards.

Another fundamental aspect introduced by this law, is the greater acting autonomy of Port Authorities. This is translated into a considerable extension of their functions: approval of their own budget, performance program, investment and financing, deciding on their own human resource needs, self management of outer commercial decisions..., and, mainly, a wide range of price freedom, thus introducing a

high liberalization degree in the sector. The free fee-structure that each port can apply, granting a positive yield rate and avoiding as much as possible abusive or discriminatory practices, evidently provides a new environment of inter-harbor competition, which going beyond the self-financing of the harbor system as a whole, looks for profit in each individual Port Authority.

These legal changes are also reflected in the Spanish ports statistical information. In this sense, one can notice a lack of uniformity in the economic and accounting data we have consulted through our work. This shows the transition Port Authorities have gone through in this decade, from a public accounting regime to the general accounting plan, complying with the legal changes of the period, which were oriented towards a private business management model and a greater degree of financial autonomy.

Given all these circumstances, in this work we compare the relative position occupied by Spanish ports, based on certain criteria which represent their economic management and on certain traffics. In order to carry out this hierarchical structuring, we decided to use a multicriteria Promethee method, given the variety of concepts and alternatives to analyze.

Under these guidelines, the work has the following structure: first, we present the methodological bases of the study, commenting briefly on the Promethee method most important aspects, the sources used, and the definition of the variables considered. Then we present the elaborated ratios and the hierarchical structuring criteria proposed for the evaluation of the Spanish Port Authorities. Finally, we gather the results and the conclusions derived from them, considering the ports individually ports, and as a function of the various maritime facades that make the Spanish Harbor System.

2. METHODOLOGY AND VARIABLES USED

As we have mentioned, this work establishes an ordering relationship among the twenty-seven Spanish Port Authorities at different strategically-considered time points.

We have focused our study on certain economic aspects (described below) that define both their real and potential activity, and also on their traffics, with special attention to container traffic as we consider it quite representative of present and future international trends of marine transportation. Thus it is a proxy variable of a port competitiveness level. Economic information and traffic statistics for the whole Port System are available from the *Management Reports* and *Statistical Yearbooks* published

by the Ente Público Puertos del Estado, a division of the Ministerio de Fomento (Ministry of Public Works)

Despite of these publications, we emphasized that compiling the necessary data has been far from easy. Although we have enjoyed the collaboration and material support of the *Ente Público Puertos del Estado* from the start, we have in fact encountered a number of difficulties, sometimes unsolvable, that have largely limited our work's time horizon and goals. These obstacles are mainly due to the lack of uniformity in the harbor economic statistics, as a result of the changes happened throughout the Nineties in the information reporting procedures.

Due to this heterogeneity in the sources consulted, it has been impossible to work certain management ratios for the years considered despite their interest, either by lack of uniformity or the nonexistence of the statistical data. Thus we have decided to take three years as the basis of our study to which we will apply the Promethee multicriterion methodology:

- 1991: Year before the change introduced by Law 27/92, November 24, for State Ports and the Merchant Marine.
- 1999: After the opportune adaptations to this legal change have taken place.
- 2002: After Law 62/97, December 26, modification of Law 27/92 November 24 for State Ports and the Merchant Marine. It is also the last year for which all necessary economic data is available.

After presenting the basic aspects of our work, we now describe the main magnitudes we have used to calculate the ratios used in the evaluation of the Spanish Port System:

- BN: Net profit (Operation Result) = Operation Income - Operating expenses.

- AT: Total assets according to the balance sheet.

- TEUs: Number of containers equivalent to 20 feet moved in each port.

- $TRAF_i$: Total traffic (in thousands of tons) in port i.

- TRAF: Total traffic (in thousands of tons) moved by the Harbor System

- INMOV: Total Immobilized according to the Balance sheet.

- INGPM: Income of each port from fees due to passenger traffic (T-2) and merchandise traffic (T-3).

- INGTAR: Income of each port from port service fees = T-0, T-1, T-2, T-3, T-4, T-5, T-6, T-7, T-8 and T-9.

- CIFNEG: Total net amount of port business = Income from port service fees + Income from concessions.

- GTP: Personnel expenses.

As mentioned, we have chosen the PROMETHEE (Preference Ranking Organization for Method Enrichment Evaluation) method developed by Brans and Mareschal[1], because, according to Al-Shemmeri and others, it is the most adequate procedure for alternative ordering and it is easy to use, and also because of the importance of its parameter interpretation and the stability of its results. For calculations, we have used the Decisión Lab 2000 program.

This is one of most recent procedures in the Improvement Relations category of methods, whose main purpose is to help the decision-maker in problems involving selection or hierarchical structuring of possible alternatives subject to a multicriterion evaluation where there are in general conflicting criteria. Given that when one considers several criteria, establishing a total ordering in not possible and, thus there is no optimal solution (i.e. an alternative that simultaneously satisfies all the criteria), the method we use provides two ways of solving the ordering: a *partial preorder* (PROMETHEE I) and a *complete preorder* (PROMETHEE II), both over the set of feasible alternatives. Using both techniques, PROMETHEE makes a binary comparison of the alternatives, to sort them according to their dominance or weakness with respect to the others.

In general, we can formulate the problem as follows:

$$\text{Max} \ / \ \text{Min} \ \left\{ f_1(a), f_2(a), \ldots f_j(a), \ldots, f_k(a) / a \in A \right\},$$

where A is the finite set of feasible alternatives and $\left\{ f_j(.), j = 1, \ldots k \right\}$ the set of criteria under which the alternatives are evaluated[2]. From the combination of criteria and alternatives evaluated according to the criteria, we obtain a table called *decision matrix* $\mathbf{f_j(a_i)}$ (i = 1,2,... n; j = 1,2,... k), which the decision maker faces.

A generalized criterion or pseudocriterion is associated to each criterion **f**, which indicates the degree of preference of an alternative **a** over another **b** for **f** based on the deviation of these alternatives for that criterion **d = f(a) - f(b),** and which is defined by the pair (f(.), P(.,.)). Thus the deviation width between alternatives and scale effect are taken into account. There are six generalized criteria. To choose among them both the decision maker and the analyst have to contribute, taking into account the degrees of

[1] Brans, J. P. et al, (1984), Brans, J. P. and Vincke, P. H. (1985), and Brans, J. P., et al (1986).

[2] Note that although we refer to a maximization problem, usually the problem is a mixed optimization one, where several criteria have to be minimized and maximized simultaneously.

preference when choosing at most two parameters with a clearly economic meaning: a *preference threshold* and an *indifference threshold*.

After a generalized criterion has been established, the program defines a multicriterion preference index $\pi(a,b)$ of **a** on **b**, in all the criteria, as:

$$\pi(a,b) = \sum_{i=1}^{n} w_j P_j(a,b) \qquad \left(\sum_{i=1}^{n} w_j = 1 \right)$$

where $w_j > 0$ (j=1,...,n) are the criteria priorities, weights.

For each alternative the procedure defines two flows: the *outgoing flow*, representing the power of dominance of an alternative, its dominant character; and the *incoming flow*, that expresses its weakness, its dominated character. From these flows two orderings of alternatives are naturally deduced, which give rise to the *partial preorder*. Considering the *net flow* as the difference between the previous two flows, a *complete preorder* of the alternatives is deduced, in which all the alternatives are comparable, although it does not provide as much information as in the previous one.

This method also generates a powerful qualitative tool, as a visual complement to these orderings, that is, the *GAIA plane* (*Geometrical Analysis for Interactive Aid*), a bidimensional representation of the problem, where the location of the alternatives (points) with respect to the criteria (vectors), depending on their respective weights, can be observed.

The following keys are useful for the interpretation of its information: "good" alternatives with respect to some criterion will be located in the direction of the axis corresponding to that criterion. Criteria represented by axes with similar directions indicate that they have similar discrimination power with respect to the alternatives. If they appear in opposite axes, they are conflicting.

This descriptive plane also shows the k-dimensional vector, π, or *Promethee's decision axis*, which represents the objective resulting from weighing the criteria after making them homogeneous. If vector π has a large long length, it has a strong decision power, and the best alternatives are those further away in its direction. If π is short, it has a weak decision power. If π is almost orthogonal to the plane, there is a strong confrontation among criteria.

The fidelity of our ordering problem representation in plane GAIA is given by the δ parameter, which refers to the amount of information preserved by the resulting projection.

Finally, we note that the descriptive analysis of the GAIA plane is relatively stable. If the weights are modified, the locations of criteria and alternatives are not affected. However the decision axis π will reflect these changes, allowing us a visual examination of sensitivity.

In this sense, it is quite advisable to perform a *sensitivity analysis*, through the simulation of scenarios for different weight values for the criteria considered.

3. DEFINITION AND JUSTIFICATION OF DECISION CRITERIA.

We have developed various ratios to evaluate the different Port Authorities. These ratios are referred to economic management, port traffic and labor productivity. Basically, these ratios have the property of being easily interpretable in order to draw conclusions, and in addition they are closely connected to the economic aspects we want to analyze[3]. Still, as we mentioned before, their choice was largely conditioned by the available information.

Altogether we have used six criteria to order the ports considered:

- R_1: ECONOMIC YIELD = BN/AT

Among all the existing indices in the financial literature to quantify the business yield we have chosen a standard formulation. Based on it. we measure the operation influence on the business assets.

- R2: DYNAMISM OF PORT ACTIVITY = TRAFi $TRAF_{i\,t} - TRAF_{i\,t-1} / TRAF_{i\,t-1}$.

With this rate of relative growth of total traffic of port i along consecutive years, we can notice each Port Authirity's evolution, through the degree of dynamism in its activity. Thus a high value will be a symptom that a port has increased its movement, and viceversa.

- R3: SPECIALIZATION IN CONTAINERS = TEUs/ $TRAF_i$

The goal is to quantify the degree of relative specialization of each Port Authority in container movement. From all the usual harbor traffic classifications, we chose container traffic. Given the gradual increase of container use in international commercial navigation, container traffic contributes information about the greater or smaller participation of each port in this world-wide trend. We are aware of the a priori discriminatory character that this criterion could have, given that traditionally this traffic is not equally consolidated in every port. Nevertheless, we consider its use to be of great

[3] To construct these ratios we have used as orientating reference both Gil Lafuente, A. M. (2001): Nuevas estrategias para análisis financiero de la empresa and some management ratios used in some of the statistical data published on the State Ports.

interest in order to appreciate the greater or smaller ability of each port for integration in the world-wide circuits of this traffic.

- R4: CAPITALIZATION = INMOV/AT

Processes of fixed-capital investment are fundamental in this sector, so that the offering of infrastructures and port services can adapt efficiently to demand changes. Thus determining the fraction of port assets that stays in immobilized seemed relevant.

- R5: HARBOR BUSINESS = INGPM/CIFNEG

Port facilities offer a variety of services. Thus there are diverse income-producing fees. In this case we focused on fees T-2 and T-3, corresponding respectively, to passenger and merchandise traffic, given the traditional conception of port area as an "*element of connection between different means in the transportation chain, servicing merchandise and passenger transfer*."[4] Therefore, this criterion will evaluate ports based on the dependency of its total income (from fees and from concession or rented land surface) on the activities that constitute a port's traditional reason d'etre: the transport of passengers and merchandise.

- R6: PRODUCTIVITY OF THE LABOR FACTOR = INGTAR/GTP

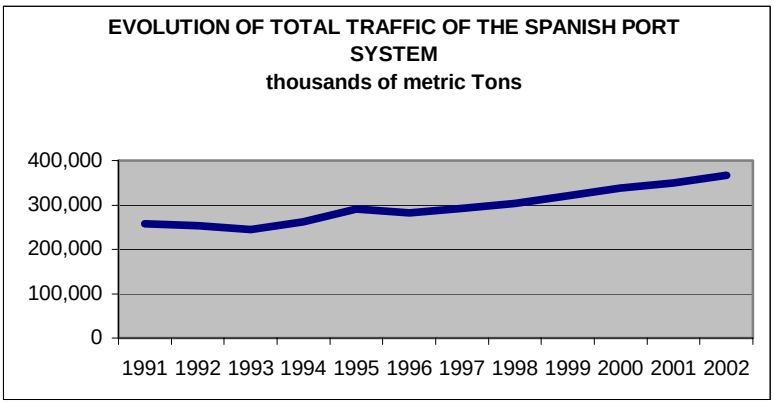
In order to quantify staff productivity, we chose the income from port service fees as an amount that represents the "port output" obtained.

Note that we perform an ordering of alternatives according to criteria expressed in relative terms. That is they are ratios indicative of each port's respective situation, of the activity each one performs in its own context. This is why the results must be interpreted with due caution. A high ranking of a small or medium size port can be deceiving with respect to its real situation in the port set. Thus we must consider that its place in the resulting arrangement corresponds with its relative activity volume, with its specificity.

We could repeat the analysis using absolute values, but the ordering would probably be different, as it would be a comparison of Port Authorities of different importance. In this case, it would be advisable to first group the ports considered, based on characteristics suitable to make variables homogeneous: business quota, specialization in each type of commercial traffic, area size, etc.

To locate this study in the evolutionary context of marine traffics, we show in figure 1 the Spanish Port System progress from a total traffic perspective.

[4] For details on this definition, commonly accepted by port orthodoxy, see Zubieta Irún, J. L., (1978): Teoría de los sistemas portuarios: una aproximación al sistema español.



Prepared by the authors.

FIGURE 1

It can be seen that the analyzed period has been one of generalized growth in port activity. This is mainly due to a growth trend in our economy and the fact is that port services demand has the nature of derived demand. The goal of our work is better understand the distribution of these gains and the evolution and current relative situation of the ports in the Port System.

Since most of the variables chosen (labor factor productivity, yield...) provide information on both the present context and the ports potential, the ordering presented here has a prospective side. Thus we have also attempted to measure possible future growth of the various ports.

4. SPANISH PORT SYSTEM ORDERING USING THE PROMETHEE METHOD AND THE TRADITIONAL CRITERION

This study of the Spanish Port System is based on the comparison of two types of orderings:

- A *traditional ordering* in Port Economics, which takes as criterion the relative weight of each port i on the port set total traffic: TRAFi/TRAF.

- An ordering using the *PROMETHEE method* and the six criteria already mentioned: economic yield, traffics rate of growth, container traffic specialization, capitalization, port business and labor factor productivity.

In the latter case, given that the criteria relative importance needs not be the same, when the Promethee multicriterion method is used the importance of the criteria has to be established by associating some weights to them. This weighing will depend

on the main ordering criterion. This article sets two possible Promethee ordering scenarios, depending on the characteristic we want to emphasize:

- SCENARIO I: Financial autonomy (resources self-sufficiency): given that the legal changes that have affected the Spanish Port System in general have introduced a private business management model, granting greater importance to yield, traffic dynamism and port business indicators seemed appropriate.
- SCENARIO II: Competitiveness: in this case we weighed heavier criteria of container traffic specialization, capitalization and labor productivity, as we considered them more significant in order to determine the port competitiveness degree.

Table 1 shows the traditional ordering for the years considered.

TRADITIONAL ORDERING OF THE SPANISH PORT SYSTEM

PORT AUTHORITIES	1991	RANKING 91	1999	RANKING 99	2002	RANKING 02
Algeciras, Bahía de	0,11518	2	0,14130	1	0,15084	1
Alicante	0,01009	24	0,00934	24	0,00833	22
Almería-Motril	0,03518	13	0,02762	15	0,02144	15
Avilés	0,01529	20	0,01094	21	0,01136	21
Baleares	0,02468	15	0,02940	12	0,03084	12
Barcelona	0,07274	4	0,08877	2	0,09005	3
Bilbao	0,12694	1	0,08425	3	0,07166	5
Cádiz, Bahía de	0,01238	23	0,01266	19	0,01280	19
Cartagena	0,05387	5	0,03883	10	0,06029	6
Castellón	0,02831	14	0,02827	14	0,02832	13
Ceuta	0,01893	16	0,00952	23	0,00655	24
Ferrol-S. Ciprian	0,01827	17	0,02645	16	0,02523	14
Gijón	0,05113	7	0,05737	6	0,05601	7
Huelva	0,03667	10	0,04887	9	0,05001	9
La Coruña	0,04992	8	0,03775	11	0,03549	11
Las Palmas	0,03653	11	0,05208	7	0,05034	8
Málaga	0,03562	12	0,02868	13	0,00660	23
Marín-Pontevedra	0,00288	25	0,00546	25	0,00548	25
Melilla	0,00214	26	0,00242	26	0,00229	27
Pasajes	0,01547	19	0,01418	18	0,01474	17
Tenerife	0,05172	6	0,04958	8	0,04752	10
Santander	0,01666	18	0,01643	17	0,01496	16
Sevilla	0,01319	21	0,01233	20	0,01284	18
Tarragona	0,09457	3	0,07915	4	0,08114	4
Valencia	0,04669	9	0,07500	5	0,09017	2
Vigo	0,01310	22	0,01093	22	0,01153	20
Villagarcía	0,00186	27	0,00244	27	0,00318	26

Prepared by the authors.

TABLE 1

Using the multicriteria Promethee method the *Decision Lab 2000* software provides the orderings corresponding to the years studied: 1991, 1999 and 2002. Out of the two resulting orderings for the Spanish Harbor System, we have considered the complete preorders, in SCENARIO I (financial autonomy), and in SCENARIO II (competitiveness). The appendix includes the graphs for both scenarios and the sensibility analysis obtained.

Comparing the three proposed orderings gives raise to the following comments:

- Respect to the scenarios analyzed using the Promethee method, there are no great differences. For each year the ports in first and last places of the ordering hardly vary between scenarios I and II, although in the middle positions, each port location varies from one to three places between both arrangements. In fact, one could think that there is a certain complementariness between both orderings, so that a port's competitiveness degree is closely tied with its flexibility of adaptation to the new legal model of business organization, and therefore with its ability for self-financing.
- Respect to the traditional ordering criterion, one can see in general certain discrepancies with the Promethee method results. Still these differences get reduced throughout the period studied, and in the last year considered there is a greater correspondence between the traditional ordering and the Promethee method's.

If we focus solely on the analyses using the multicriteria Promethee ordering, we see that (according to the results shown in the flow charts in the Appendix) the Algeciras Bay, Valencia and Barcelona port trio always remain within the first five places, throughout all the scenarios and years considered, exchanging places in turns. This fact reveals that these Port Authorities have adapted uniformly to the new business and competitiveness scheme in place, and none of them has lost the top places in the national ranking after the changes. Their primacy over the other ports in the System remains. This homogenous behavior calls our attention as these are ports within economies with different growth rates in theory. It leads us to reaffirm the role of port infrastructures as economic impulse factor, independently of the starting point of its area of influence.

In the orderings opposite end, there are no great variations either throughout the years. Port Authorities such as Villagarcía's always appear in the last are places of both scenarios.

Among ports that improve throughout the period considered, Huelva and Ferrol-San Ciprian are important to note. This is a symptom that their management has known how to deal with new features introduced by the legal changes. Other cases, such as Santa Cruz de Tenerife, are interesting because they remain in a similar place throughout the period, which means that through its particular adaptation to the new regulations in place neither its self-financing degree nor its relative competitiveness have been affected

Regarding ports that, on the other hand, still have to make a great effort to meet those requirements, the decrease suffered by the Malaga port is worth noticing, although some recovery signs regarding competitiveness can be glimpsed.

In addition to graphical orderings the Decision Lab 2000 software generates a photo, the *GAIA plane* that represents the location of all the alternatives (Port Authorities) with respect to the criteria (ratios) globally considered. The next figures show GAIA planes for year 2002, for the two Promethee scenarios considered.

SCENARIO I

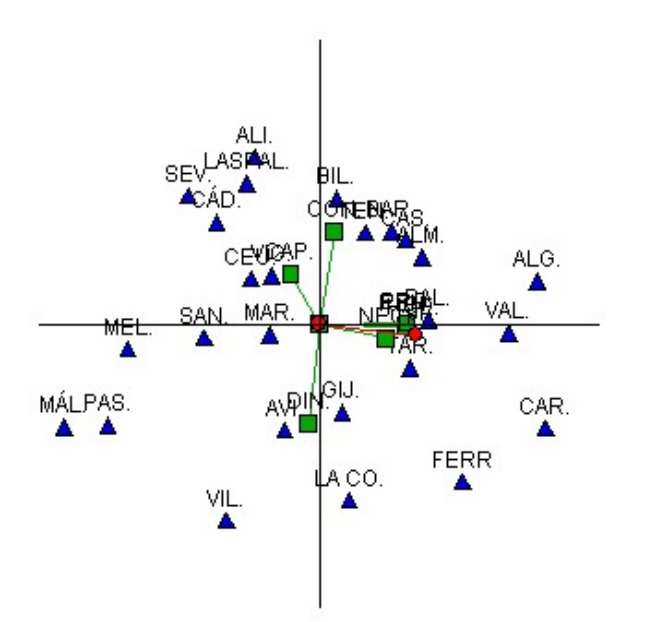


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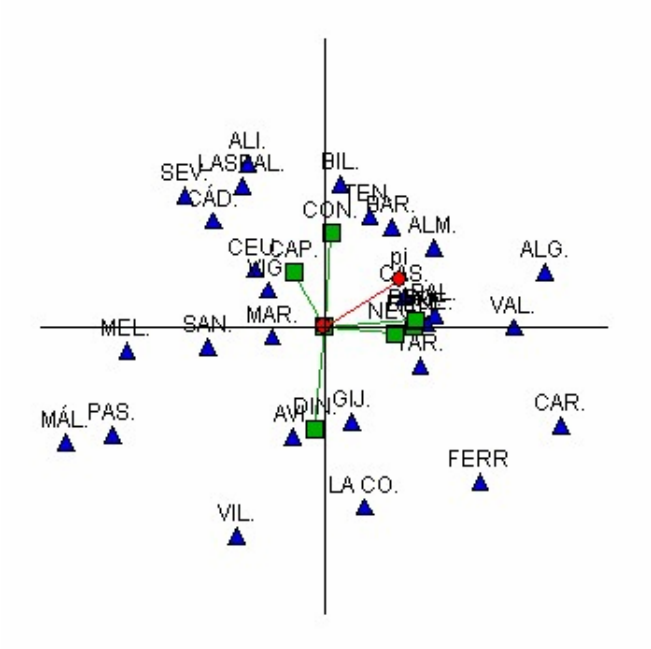
FIGURE 2

SCENARIO II



Prepared by the authors.

FIGURE 3

In both cases, the ratios studied are represented by a green square, whereas the alternatives are blue triangles. The red circle refers to vector π, which captures all the criteria considering their weights, and helps us visualize the relative situation of the alternatives.

Note that the yield, port business and labor productivity are very close, which shows their similar discriminatory behavior over the alternatives. One can verify on the first scenario plane that the location of global axis π is determined by the yield and port business criteria. The global axis in the second scenario is further from both criteria and has a higher inclination degree indicating a greater degree of conflict in the problem studied. The container, dynamism and capitalization ratios show an opposite behavior, which could mean that Port Authorities are delayed in providing immobilized with respect to recorded container movement.

Regarding the position of the alternatives, in addition to the ordering shown in the Appendix for 2002, the following needs to be taken into account: the larger the distance between a port's location on the plane and the coordinate origin (in the direction and orientation of vector π), the better situated the port is. The opposite is also true. It is easy to see, as mentioned above, that the Valencia and Algeciras Bay ports predominate (triangles further away in the π vector direction) and that the Villagarcía and Malaga ports are the worst positioned ones (triangles located further to the left

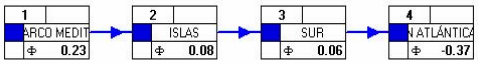
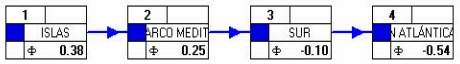
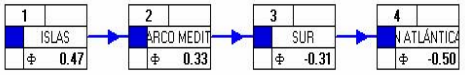
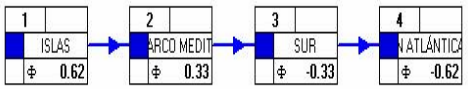
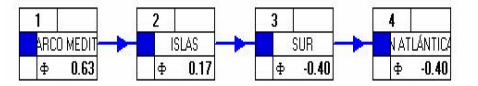
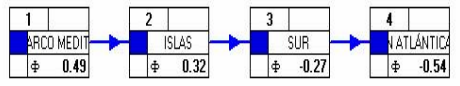
opposite to the vector). The Huelva and Barcelona ports, on the other hand, display similar behaviors, as they are represented by points close in the plane.

5. EVALUATION OF THE SPANISH PORT SYSTEM USING MARINE FACADES

We can extend our multicriterion analysis from another perspective, considering the natural ascription of the ports studied to the different marine facades that make up the Spanish Port System. We now present how they are composed, considering that there is certain heterogeneity in their integrating elements:

- *North-Atlantic Facade*: composed by the Avilés, Bilbao, Ferrol-San Ciprián, Gijón, Coruña, Marín-Pontevedra, Pasajes, Santander, Vigo and Villagarcía Port Authorities
- *Islands Facade*: composed by the Baleares, Las Palmas and Santa Cruz de Tenerife Port Authorities.
- *Southern Facade*: including the Almería-Motril, Algeciras Bay, Cadiz Bay, Ceuta, Huelva, Malaga, Melilla and Seville Port Authorities.
- *Mediterranean Arc Facade*: including the Alicante, Barcelona, Cartagena, Castellón, Tarragona and Valencia Port Authorities. For the accomplishment of the analysis we such maintain methodologic assumptions explained in the beginning of this work, applying again the decision procedure multicriteria Promethee. The arrangement obtained for the scenes of financial autonomy and competitiveness, are exposed next.

To do the analysis we maintain the same methodological assumptions describe at the beginning of this paper, and apply again the Promethee multicriteria decision procedure. We now present the ordering obtained for the financial autonomy and competitiveness scenarios.

SCENARIO I FINANCIAL AUTONOMY	SCENARIO II COMPETITIVENESS
YEAR 1991 	**YEAR 1991** 
YEAR 1999 	**YEAR 1999** 
YEAR 2002 	**YEAR 2002** 

Prepared by the authors.

TABLE 2

From the net flow charts it is clear that the Mediterranean Arc and Islands facades are the predominant ones, throughout all years and scenarios. This is surely due to the fact that their ports are always individually well positioned in the orderings shown in the Appendix and there are no elements that can counterbalance the optimum position of the facade. The South Facade is the next best positioned one, which shows it is not a very compact group, with great disparities. Despite the natural strength of the Algeciras Bay port, others facade members, such as Malaga, occupy the last places in the national set.

Doubtless the most important conclusion from the results comes from the comparison among the facade net flows. One can see a relative increase in the interval width between maximum and minimum net flow. This shows a not very uniform behavior of the different facades in the Port System and the differences among them become more significant.

6. CONCLUSIONS

To summarize we emphasize that the legal changes that affected the Spanish Port System during the nineties hardly had any repercussion in the ports that traditionally were first or last in the national ranking. This was different for ports in intermediate positions.

Looking at their joint behavior, the growing size of the intervals between maximum and minimum net flows of each ordering leads us to state that both individually and as Marine Facades, the general interest Spanish ports show a more

diverse different behavior after the changes mentioned. This conclusion derives from the different Port Authorities adaptation rate to the new management and organization context.

These results should not lead one to think that a port´s higher ranking means its absolute superiority. It simply shows that the port is managed according to the legal changes mentioned.

Finally, the complementarily between the orderings based on Port Economics traditional criteria and those using the multicriteria decision method is worth mentioning. The latter orderings add information that extends the feasible study field considerably. Thus they allow a far better characterization of Port Authority performance.

APPENDIX: FLOW DIAGRAMAS AND SENSITIVITY ANALYSIS

This Appendix contains the first the net flow charts showing the orderings obtained using the Promethee method, for scenarios I and II, through the years studied, from an individual port perspective. Next, we present the sensitivity contrasts for the Promethee method solution orderings for both scenarios. In each case the resulting graphical representation allows determining the solution stability interval, based on the maximum and minimum variation allowed in the weighs assigned to the different constructed ordering criteria.

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ANEXO

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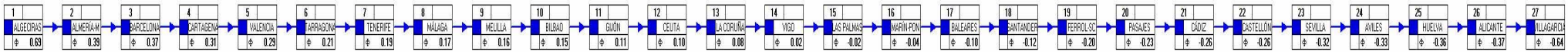

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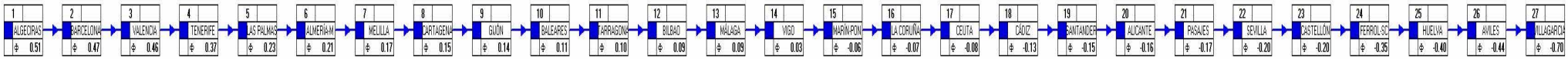

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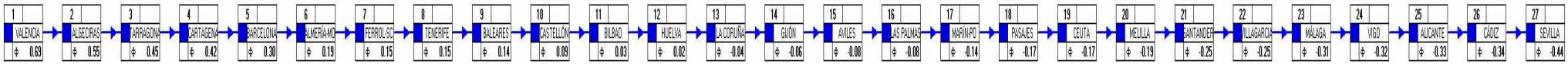

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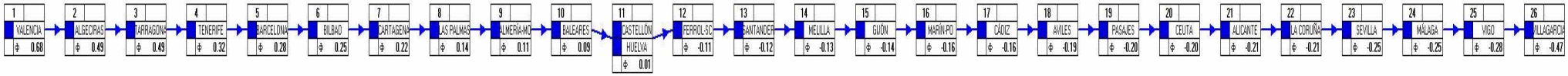

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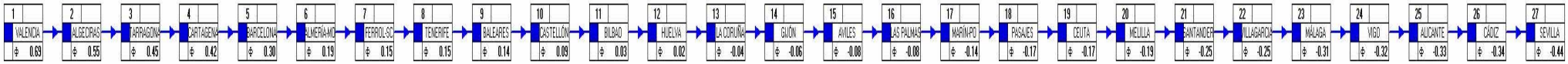

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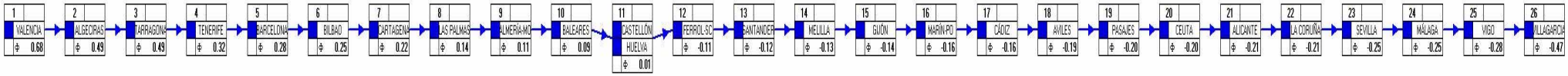
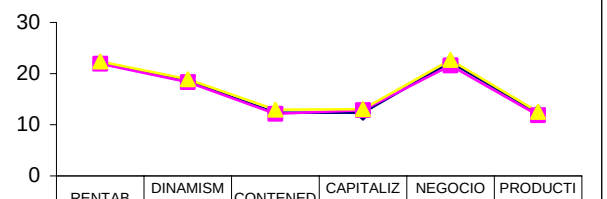
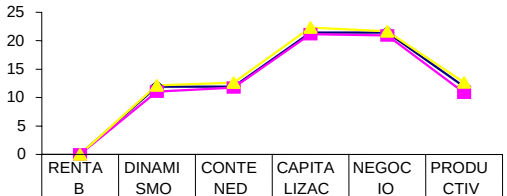


ANÁLISIS DE SENSIBILIDAD 1991 ESCENARIO I



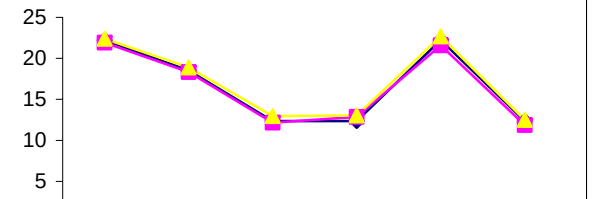
	RENTAB	DINAMISMO	CONTENED	CAPITALIZAC	NEGOCIO PORT	PRODUCTIV LAB
PONDERACIÓN	22,22	18,52	12,35	12,35	22,22	12,35
MIN	21,92	18,32	12,15	12,87	21,58	11,87
MAX	22,38	18,89	12,96	13,03	22,67	12,5

ANÁLISIS DE SENSIBILIDAD 1991 ESCENARIO II



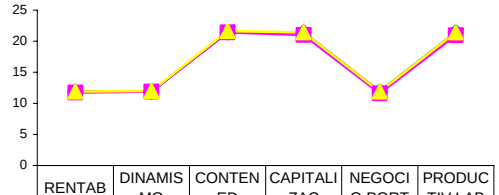
	RENTAB	DINAMISMO	CONTENED	CAPITALIZAC	NEGOCIO	PRODUCTIV
PONDERACIÓN	11,9	11,9	11,9	21,43	21,43	11,9
MIN	0	11,02	11,74	21,12	20,91	10,84
MAX	0	12,14	12,6	22,29	21,64	12,65

ANÁLISIS DE SENSIBILIDAD 1999 ESCENARIO I



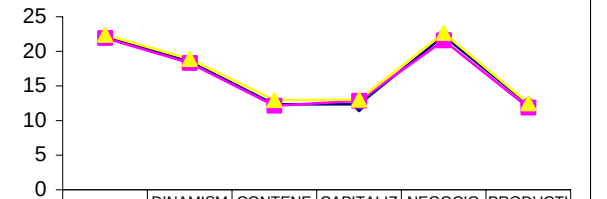
	RENTAB	DINAMISMO	CONTENED	CAPITALIZAC	NEGOCIO PORT	PRODUCTIV LAB
PONDERACIÓN	22,22	18,52	12,35	12,35	22,22	12,35
MIN	21,92	18,32	12,15	12,87	21,58	11,87
MAX	22,38	18,89	12,96	13,03	22,67	12,5

ANÁLISIS DE SENSIBILIDAD 1999 ESCENARIO II



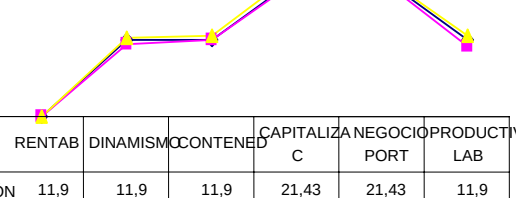
	RENTAB	DINAMISMO	CONTENED	CAPITALIZAC	NEGOCIO PORT	PRODUCTIV LAB
Ponderación (%)	11,9	11,9	21,43	21,43	11,9	21,43
MIN	11,73	11,9	21,43	21,01	11,6	20,96
MAX	11,9	11,99	21,62	21,43	11,9	21,43

ANÁLISIS DE SENSIBILIDAD 2002 ESCENARIO I



	RENTAB	DINAMISMO	CONTENED	CAPITALIZAC	NEGOCIO PORT	PRODUCTIV LAB
PONDERACIÓN	22,22	18,52	12,35	12,35	22,22	12,35
MIN	21,92	18,32	12,15	12,87	21,58	11,87
MAX	22,38	18,89	12,96	13,03	22,67	12,5

ANÁLISIS DE SENSIBILIDAD 2002 ESCENARIO II



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PONDERACIÓN	11,9	11,9	11,9	21,43	21,43	11,9
MIN	11,9	11,02	11,74	21,12	20,91	10,84
MAX	12,34	12,14	12,6	22,29	21,64	12,65