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## Portuguese Fish Producers' Organisations: Some Concerns\*

The Common Fish Policy (CFP) requires that each Fish Producer Organisation (hereafter PO) establishes its own rules and controls their execution. However, PO's members are locked in the logic of the Commons. "Mutual coercion which is mutually agreed upon" (the solution to the Commons proposed by Garrett Hardin) is a relevant statement whenever fishermen realise its necessity, i.e. when they are faced with a real fish scarcity.

This paper presents an overview of the Portuguese PO's and the main results of a survey answered by their members. The main results are: (1) Scarcity of fish is the chief concern, (2) the PO's role is emphasised, while PO's are generally viewed as organisations with several weaknesses. Through a factor analysis approach to several opinion items which express different PO's roles, three major dimensions were detected: "Service quality delivered by the PO", "PO as a supporting structure" and "PO as a regulating agent of the activity".

### 1. PRODUCERS' ORGANIZATIONS AND THE COMMONS

In his famous article "The Tragedy of the Commons" (1968), Garrett Hardin states that the problem of the Commons sustainability (Commons in the sense of free availability of resources)<sup>(1)</sup>, does not have a technical solution in the context of a high-density population. It is what is happening now, when more than 100 million tons are annually landed all over the world in order to feed a population of 6 thousands of millions. Over-fishing, along with

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\* The study, which this paper is based upon, was funded by the Portuguese Directorate of Fisheries and Aquaculture.

pollution and others factors, is one of the main reasons for the dilapidation of fish stocks.

As a matter of fact, the first fisheries economists — Gordon (1954), Shaeffer (1954)<sup>(2)</sup> — had already pointed out that the increase of the fishing effort with over-exploration of the common resource would be inevitable in the pure market economy. This was due to the externalities that led to the discrepancy between private and social marginal costs. Several methods to reduce those externalities, such as the Pigou taxes, the externality rights market or the individual property rights over the resource, were proposed but all of them are partially ineffective.

So some public regulation is require and the Law of the Sea has gradually extended the jurisdiction area of the coastal states. Paradoxically, this has been negative to Portugal, one of the world highest fish consumers per capita (61.6 Kg/year), because its large EEZ (1.7 MKm<sup>2</sup>) is poor in fish and the possibility of fishing in traditional banks has been restricted.

In the specific case of the EU, the EEZ under jurisdiction of the Members States are administrated by the CFP, where the POs belong to. Through the POs, their members must agree upon the common rules for the catching and commercialisation of specific species and are encouraged to act towards an improvement of their profit, the quality of their product and the responsible exercise of fishing. For this aim, the POs are funded during the first years of their existence and have financial compensations for the fish withdrawals.

Through its self-regulation, the POs are the nuclear institutions for a policy of mutual coercion which is mutually agreed upon by the majority of people affected. In a way, the goal here is to partially change the unmanaged free access to a communal managed resource. But this necessity must be really assumed by PO's leadership and their members and the POs must also have the required capacity for an efficient action in a more restricted regime of responsible fishing.

For this purpose, in 1998 we carried out a survey about PO's organisational capacity and the way their members viewed its services as well as its future growth. This paper summarises the main results.

## 2. PORTUGUESE PRODUCERS' ORGANISATIONS

In 1999, there were 16 officially recognised POs in Portugal, 2 of them only with a very small activity in the aquaculture. The study focussed on the 14 POs with fishing activity which are spread along the Portuguese coast (11) and on the Islands of Azores (2) and Madeira (1). All of them, except 4, were created in 1985, one year before Portugal became a full member of the EC.

The universe of the 14 POs is very heterogeneous as far as fishing characteristics (species, arts, kind of fishing) and dimension (number of members,

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number or fishing vessels, annual turnover, assets value) are concerned. Many POs also have a heterogeneous internal composition, which makes the reaching of consensus purposes a very difficult task.

All together, these POs sum about 950 members and almost the same number of fishing vessels. Their global annual turnover reaches only about 10 millions Euros, because the PO only retains a small part (from 0.25 to 1%) of the transaction value in the auction market<sup>(3)</sup>. Few POs have their own fish shops, but, in recent times, several of them started negotiations with super-market chains as to a possible supply contract. Most of PO's also sell bait, ice and fishing-materials.

All the PO with diversified activities has the juridical form of co-operative, thus enabling an easier acceptance of innovative measures by a charismatic leader. In others forms, such as enterprises associations, the fewer members are more homogeneous and have a tighter control over the direction which difficult the PO's expansion towards new business areas, which are already done by some of their members.

The segment of PO's weight in the landed quantities (Fig. 1) was 1/2 of the total one in 1998 against 2/3 in 1994. This decrease is mainly due to the sardine, which has been submitted to a negotiated plan for capture's decrease since 1997, after alarming signs of the stock situation<sup>(4)</sup>.

Figure 1. Total landings proportion in the segments (PO, non-PO)

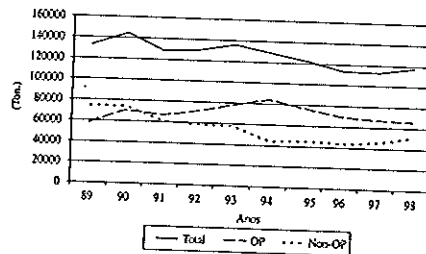
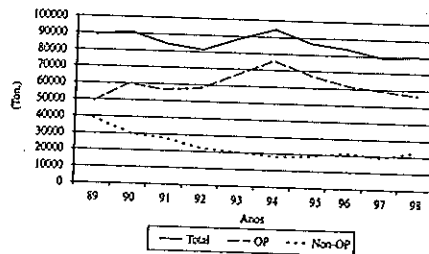


Figure 2: Evolution of the sardine landings



Sardine is the main species landed in Portuguese fish harbours and represents  $\frac{2}{3}$  of the total landing. In 1998 the amount of sardine fishing by the purse-seine fleet assigned to the POs represented more than 80% of that total. From that, 50% has been delivered to canned fish factories what enhances the strong interdependence between those activities (Dias & al, 1999). Atlantic horse mackerel and silver scabbard-fish are two another species with significant production in which the PO's have had a participation larger than 50%.

The evolution of the weighted average price ratio between Non-OP/OP shows a trend to equilibrium (Fig. 3). Applying CHAID (CHi-squared Automatic Interaction Detector) on 12524 transactions (Fig. 4), we have reached the same conclusion, since in 40.3% of the cases the ratio is between 0.9 and 1.1, i.e. a general price balance in both segments.

Figure 3: Weighted average price Non-PO/PO

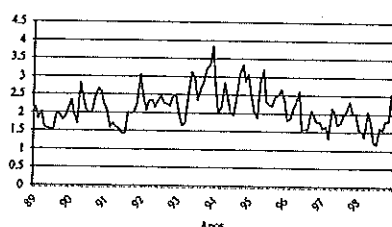


Figure 4: Average price Non-PO/PO

	Frequency	%
1. $\leq 0,5$	586	4,7
2. $[0,5; 0,9[$	3355	26,8
3. $[0,9; 1,1[$	5045	40,3
4. $[1,1; 1,5]$	2489	19,9
5. $> 1,5$	1049	8,4
Total	12524	100,0

The PO's organisational scheme is, according to Mintzberg (1979), the simple structure: few hierarchical levels, over-concentration of the decision competence in the direction, informal communication. Furthermore, there are less than 20 employees in almost all PO's. In general, management skills are scarce, mainly in the case of the vertically integrated POs. In those POs the systemic risk is very high and any destabilisation of catches will affect all other downstream activities, mainly processing ones.

There is also a general lack of biological advice. In nearly every PO, catch management is done in online time, based on the price behaviour in the auction market. By means of a phone call, the ships are advised by the PO's director in order to bring more or less fish. Bearing in mind that the major

concern of POs is the biological

From a financial point of view, usually insufficient costs have been incurred to meet the

The PO's lack of uncertainty about the difficulties with Morocco.

### 3. EMPIRICAL

#### 3.1. THE SAMPLE

The data for PO's members, including those with insufficient replies were received. So, the

concern of PO's members is fish scarcity, it is vital to give more emphasis to the biological dimension, without losing sight of commercial constraints.

From a financial point of view the situation is difficult. The cash-flow is usually insufficient, because the revenues have been decreasing and the labour costs have been increasing, and in many POs the long-term debt and equity do not meet the needs.

The PO's leaders have expressed a major concern with fish scarcity, some uncertainty about international fish agreement renegotiations, in particular with Morocco. Further causes for worry are the sportive fishing contests and the difficulties of crew recruitment.

### 3. EMPIRICAL STUDY

#### 3.1. THE SAMPLE

The data for this study were obtained from a questionnaire mailed to 908 PO's members, that is to almost the entire list supplied by the POs (the few others with insufficient address information were not included). 197 copies were returned because of the person was unknown in the address. In all, 175 replies were received, of which 11 responses with incorrect answers were discharged. So, the response rate, without the devolution, was 23%.

Table 1: Profile of questionnaire respondents

Type of Finishing	
Local	24.3%
Coastal	67.8%
Long distance	7.9%
Caught species (1 <sup>st</sup> . Species)	
Small Pelagic	46.4%
Deferrals	22.9%
Octopus	15.7%
Trunkfish	5.9%
Others	9.1%
Sales	
< 1.5 M Euros	28.6%
1.5 M Euros - 5 M Euros	18.8%
> 5 M Euros	52.6%
Geographic regions	
North of Portugal	35.0%
Center of Portugal	28.5%
South of Portugal	21.2%
Islands (Madeira & Azores)	15.3%



Based on the results (Table 1), we drew the following conclusions:

- the heterogeneity of the sector, in terms of dimension, fish types and species;
- the importance of the small pelagic;
- the adequacy of the sample that appears to represent a fair cross-section of the population studied.

### 3.2. THE QUESTIONNAIRE

The questionnaire design aimed at two main goals:

- It should request short answers, limiting its dimension to one page;
- Selected questions should be incisive and allow a quantification, by comparison, of the heterogeneous opinions in relation to several relevant aspects.

The questionnaire, pre-tested by 10 respondents, presented 4 sections, as follows:

- I. General characterisation of fishing ship owner's activity (*e.g.*, Type of fishing activity, main species caught, turnover, etc). Some of these results were presented in Table 1;
- II. Chief concerns about his fishing activity, expressed by means of an open-end question;
- III. Opinions about his PO activity as well as other issues that are not relevant here. A five-point Likert scale (from 1 — Strongly disagree to 5 — Strongly agree) was applied;
- IV. General comments.

### 3.3. METHODS AND RESULTS

The questionnaire inquired about the main problems in the fishing activity, ordered by their importance. The answers were grouped in 13 categories, according to their nature (Table 2). The results show that the main problems are: scarcity of fish (35.9%), difficulties with fishermen recruitment (25.5%), legislation inadequacy (22.2%) and selling difficulties/prices (11.1%).

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Table 2: Main problems in the fishing activity

Concerns	1 <sup>st</sup> indication	2 <sup>nd</sup> indication	3 <sup>rd</sup> indication	Total	%*
Scarcity of fish	50	4	1	55	35,9%
Inadequate legislation	25	7	2	34	22,2%
Unfair competition	6	1		7	4,6%
Insufficient or unskilled staff	25	13	1	39	25,5%
Commercialisation problems	8	7	2	17	11,1%
Entrepreneurial/financial difficulties	7	4	1	12	7,8%
Infrastructural problems	4	1		5	3,3%
Suspension of fishing activity	4	4		8	5,2%
Entrepreneurial productivity/ efficiency	9			9	5,9%
Environmental concerns	6	1		7	4,6%
Lack of surveillance	4	4		8	5,2%
Lack of technical and scientific support	2	1	1	4	2,6%
International Agreements	3	3		6	3,9%
Total	153	50	8	—	—

\*In percentage of valid answers (153) Missing answers (11)

### 3.3.1. Factor analysis

#### Introduction

To identify the most important dimensions of PO's activity (section III of the questionnaire), factor analysis was employed. The main purpose of factor analysis was to reduce the original 18 items to fewer underlying and meaningful factors in order to define conceptual dimensions.

Factor analysis refers to a class of statistical techniques which purpose usually consists of data reduction and summarisation (Johnson, 1998; Sharma, 1996). Used in this way, the objective is to reduce a large number of observed variables to a smaller set of underlying factors (latent variables) that preserve as much as possible the essential nature of the original variables. Some exactness of descriptions is sacrificed to obtain a simplified understanding of numerous variables.



The rationale for using factor analysis includes:

- Identification of underlying constructs or "factors" that explain the association among the original set of variables.
- Concentration of a large number of variables in a smaller number of derived variables.
- Determination of the number of dimensions required to represent a set of variables.

The most important assumptions are that factors do indeed underlie the variables, and that the variables completely and adequately represent these factors. This means that the number and scope of the variables to be analysed should be as inclusive as possible, to the extent that, among them, each factor is measured at least once, and hopefully several times, from different perspectives. If the list of variables is incomplete, research will need good luck to produce useful results. The major limitation is that factor analysis involves subjective judgement about the number and the interpretation of the factors.

*Items description and summarization.*

Factor analysis was applied to 18 opinion items associated to activities that the PO does or should do. For those 18 variables tested: mean, standard-deviation and the percentage of respondents rating them as 'strongly agree' are presented in Table 3.

*Portuguese Fish Producers' Organizations: Some Concerns*

**Table 3: Descriptive statistics of items**

Items	N	Mean	S.D.	Strongly agree (%)
1. Production and commercialisation rules which have been set by the largest PO of a given area should oblige everyone operating in that area, being or not affiliated to the PO.	156	3,85	1,13	32,7
2. The PO should limit its action to the strict essential, thus enabling its members to have compensations.	157	2,94	1,38	14,3
3. The PO should concentrate and sell on their behalf the total catch of its members.	156	2,76	1,40	17,3
4. The PO should set commercialisation rules for the species which are not entitled to compensations.	160	3,79	0,91	21,3
5. The PO should have contracts with supermarkets, retailers and traders.	159	3,99	1,07	35,8
6. The PO should have its own fish shops.	159	3,16	1,35	18,2
7. The PO should actively support the fishing activity, by selling ice, bait, nets, fishing-gear, diesel oil, assurances etc (or negotiating better buying conditions for its members).	160	4,29	0,94	50,6
8. The PO should supply services in the accountancy, professional training and project sectors.	159	4,26	0,92	47,8
9. The PO should set the rules for on-board conditioning.	158	3,46	1,08	12,0
10. The PO should set limits to the catches per fishing vessel, due to the conditioning capacity on-board.	158	3,31	1,31	18,4
11. The PO should limit, by its own initiative, the catch of species facing extinction.	160	3,92	1,20	41,3
12. The PO should impose heavy penalties on everyone who fails to respect the rules set by the PO.	161	3,88	1,11	34,8
13. The PO encourages the modernisation of the fleet and of the catch procedures.	158	4,03	0,84	28,5
14. The PO is most helpful at all times when I come up with a problem.	158	3,69	1,00	15,8
15. The PO sends my share of financial and forfeit compensations within an acceptable deadline.	152	3,23	1,05	7,9
16. I would not mind an increase of my PO membership fee, in exchange for better services.	154	3,35	1,04	10,4
17. The PO direction brings the really important issues to the general meetings.	160	3,75	0,91	16,9
18. The information supplied by the PO is most useful.	158	3,87	0,93	22,8

Scale: 1 - Strongly disagree; 5 - Strongly agree. S.D. (Standard deviation).

According to descriptive statistics of opinion items presented, we concluded that, in average, this opinion is positive (agreement) to the majority of items. We realise an agreement as to the following points:

- PO as a support organisation (item 7, 8, 13);
- PO as a regulator and supervisor (item 11, 12), including for non-members in its area (item 1);
- PO as a quality promoter and regulator (items 9 and 10).

But there are disagreement with the integration of the members' landings in their OP offer (item 3).

#### Methodology used in applying factor analysis

Since the ratio  $N/p$  is 8,8, sample size shows adequacy to apply a factor analysis procedure (MacCallum *et al.*, 1999). The Kaiser-Meyer-Olkin (KMO) value of 0.67 indicates that the correlational structure among items is reasonably strong to justify factor analysis adequacy (Sharma, 1996; Reis, 1997). Based on the Bartlett's test of sphericity we reject that items are not correlated ( $p < 0,05$ ). In the case of items missing value treatment, we decided to replace them with mean value.

Eight factors were used to group the 18 items under consideration through a principal component analysis (PCA). This describes a set of associated variables in terms of a set of mutually not correlated linear combinations of the same variables. The linear combinations (factors) are chosen in a way so that the first set describes as much of the total variance of the original data as possible, the next as much of the remaining variance as possible, and so on. Once several factors had been identified, we adopted the usual procedure of considering those with eigenvalues of less than 1.0 to be too irrelevant to be part of the overall analysis (Kaiser criterion) assuming standardised data analysis (correlation matrix instead of covariance matrix analysis). The eigenvalue for each factor is the sum of the squares of its factor loadings (thereby measuring the absolute variance explained by that factor), and indicates how well any given factor fits the data from all the respondents on all the variables (Sharma, 1996). However, as Sharma (1996) also states, this criterion should be not used blindly. Indeed, it should be used in conjunction with other rules or heuristics such as Cattell criterion (*scree plot*), variance explained by solution or solution interpretability. In *scree plot* analysis (plot of eigenvalues against the number of components), the number of factors which need to be retained, is suggested by the 'elbow'. Since the *scree plot* suggests 3 factors, which only explain 43.2% of variance, this heuristic rule was not considered hereafter. In general, a factor analysis accounting for 70 per cent or more of the total variance is considered a very good fit to the data (Sharma, 1996).

Table 4: Factor analysis results (rotated factor matrix)

Items	Factors								Explained variance (%)	
	1	2	3	4	5	6	7	8		
Factor 1 - Service quality of PO										
Item 14	0.78									
Item 15	0.67									
Item 17										17,5

Table 4: Factor analysis results (rotated factor matrix)

Items	Communalities	Factors								Explained variance (%)	
		1	2	3	4	5	6	7	8		
<b>Factor 1 - Service quality of PO</b>											17,5
Item 14	0,78	0,85									
Item 15	0,67	0,77									
Item 17	0,70	0,76									
Item 18	0,74	0,74									
<b>Factor 2 - PO as support</b>											14,9
Item 8	0,77	0,82									
Item 7	0,74	0,79									
Item 13	0,57	0,55									
<b>Factor 3 - PO as regulator</b>											10,9
Item 11	0,72	0,86									
Item 12	0,69	0,79									
<b>Factor 4 - PO as quality promoter</b>											7,6
Item 9	0,78	0,83									
Item 10	0,66	0,71									
<b>Factor 5 - PO growth</b>											6,7
Item 3	0,62	0,74									
Item 16	0,58	0,68									
<b>Factor 6 - PO as seller</b>											6,1
Item 5	0,62	0,84									
Item 6	0,68	0,71									
<b>Factor 7 - PO and compensation</b>											5,1
Item 2	0,72	0,82									
Item 4	0,56	0,60									
<b>Factor 8 - PO as regional supervisor</b>											4,8
Item 1	0,78	0,86									

Rotated loadings: VARIMAX rotation with Kaiser normalization.

Although the Kaiser criterion suggests extracting 6 factors, this solution only explains 63.6% of variance in original data (Table 4). Based on both criteria — interpretability and explanation of variance — we decided to extract 8 factors accounting for 73.6% of variance in original data. Therefore, the cost of data reduction from 18 items to 8 factors results on losing approximately one quarter of the original information.

Varimax rotation was then applied to the 8 factors. This procedure rotates the set of individual scores within the space defined by principal component axes, thereby creating a new set of factor loadings (increasing the difference between high and low loadings) for the factors which have already been found. The rotated factor matrix is presented in Table 4.

#### *Interpreting the data and characterizing the factors*

The nature of each factor is determined by the characteristics of the items, which have high loadings on these factors (loading being the correlation of the item with the factor). It should be noted that the correlation can be positive or negative, and that it is possible for a factor to have important positive and negative loadings at the same time. The loadings that determine the factor's character are presented in Table 4.

Factor 1 has heavy loadings on items 14, 15, 17 and 18, while focussing on the "Service quality of PO". Factor 2 is related to items 8, 7 and 13 which describe some types of services that PO can offer; hence the name of "PO as support". Factor 3 is based on items 11 and 12, relating to "PO as regulator". These main factors (each one with an explained variance larger than 10%) are followed by other four also with interpretability significance.

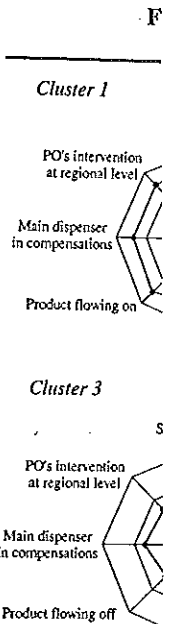
Factor 4 centres on items 9 and 10, which refers to some PO's rules, such as packing, making possible to label the factor as "PO as quality promoter". Factor 5 is associated to items 3 and 16, associated to the new activities, a "PO growth" factor. Factor 6 is heavily loaded on items 5 and 6, relating to "PO as seller". Factor 7 is based on items 2 and 4, related to financial compensation of the withdrawal fish, as "PO and compensation". Finally, factor 8 is largely loaded exclusively on item 1, so "PO as regional supervisor".

Analysing the 8 factors above in a general framework, we can detect opposite meanings between some pairs of them. Quinn (1991) proposed a competing values framework because the organisational criteria seem to initially carry a conflictual message. He states that "we want our organisations to be adaptable and flexible (INNOVATION) but we also want them to be stable and controlled (RULES). We want growth, resource acquisition, and external support, but we also want tight information management and formal communication. We want an emphasis on the value of human resources (SUPPORT), but we also want an emphasis on planning and goal setting (GOAL)".

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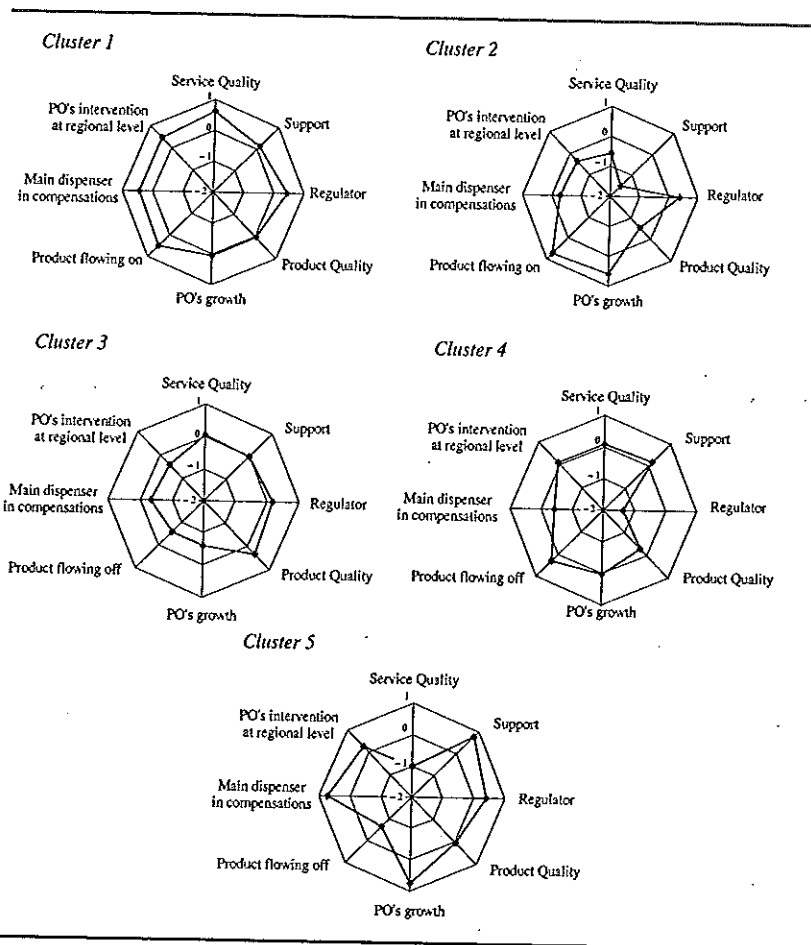


Internal consistency among the items in each factor was evaluated using Cronbach's coefficient alpha. Excepting factors 5 and 7, all factors (with at least two indicator items) present reliability coefficients (Cronbach alpha) greater than 0,6<sup>(5)</sup>.

3.3.2. Cluster analysis

Cluster analysis based on the previous identified factors was performed, by applying the Ward' clustering algorithm to the matrix of distances (squared Euclidean distances based on factor analysis' solution). Dendrogram analysis suggests a 5 clusters' solution. Furthermore, based on cluster size, this solution also seems to be balanced.

Figure 5: Cluster profile based on factor scores





Since PO members who belong to the same cluster have a homogeneous profile, it is important to identify which opinions are shared within each cluster (Fig. 5).

**Cluster 1.** Its members are small and medium fishing ship owners from the North and the South of Portugal that go fishing small pelagic. They see all factors as relevant, but they put a special emphasis on the service quality delivered by PO's and its activity as regulator (which should be enlarged at regional level), and on fish selling.

**Cluster 2.** Its members, mainly from Central and Southern Portugal, show a certain heterogeneity and their activity is predominantly the long distance purse-seine fishing. They emphasize PO's actions in the fish selling sector but are not interested in other supporting activities.

**Cluster 3.** Its members are medium and large fishing ship owners from Northern and Central Portugal whose activity is the fishing of demersal species. They restrict the PO's activities to regulation and promotion of product quality.

**Cluster 4.** Its members are small and very small fishing ship owners from the North and the Centre of Portugal. They strongly disagree with the regulating function of the PO.

**Cluster 5.** Its members are mainly from the Centre of Portugal and the islands of Madeira and Azores. They are interested in all the PO's activities but do not have a good opinion of the service quality delivered by the PO.

In short: the PO as regulator is well received by all, except by cluster 4 where very small and small fishermen are predominant; small and medium PO's fishing ship owners are more interested than the other groups in the supporting activities offered by the PO; cluster 5 has a very negative view on the service quality delivered by the PO.

## CONCLUSION

Fish scarcity (eventually exaggerated for some species) is the greatest concern of both the PO's leadership and members. Therefore, it seems to exist a psychological and social acceptance of restrictive decisions on catching policy, to which implementation POs must be partners.

However, Portuguese PO's have, in general, severe weaknesses in their financial and management capabilities. They need to become stronger to execute more efficiently their auto-regulation activities.

This study has also identified the core dimensions of PO's activities as their members see them. Knowing which *benefits* are sought by a given group of members, PO's leadership can do a better management.

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## NOTES

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NOTES

- (1) Coelho (1999) analysed the distinction between 'Commons' in the sense of an unmanaged free available resource, as used by Hardin and Scott, and in the sense of a managed communal resource.
- (2) The Gordon Model assumes that the resources growth ( $F$ ) is a function of its dimension, which can be measured by the resource's biomass ( $X$ ). Usually, we accept that  $F(x)$  behaviour follows a logistic curve, with two points of stationarity  $X_{MIN}$  e  $X_{MAX}$ . The function  $F(x)$  is equal to 0 before  $X_{MIN}$  and after  $X_{MAX}$ , because of, respectively, the scarcity or excessive density of individuals.  $X_{MAX}$  is known as the carrying capacity. In the compensated models,  $F(x)$  is related to the natural physiological balance ( $r$ ) and the carrying capacity  $X_{MSY}$ , so  $F = rX(1 - X / X_{MAX})$ . The maximum value of  $F(x)$  occurs when  $X = X_{MSY}$ . In this single curve,  $F(X)$  increases between  $X_{MIN}$  and  $X_{MSY}$  and decreases between  $X_{MSY}$  and  $X_{MAX}$ . If the catch rate  $h(t)$  is equal to  $F(X)$  the exploitation is sustainable ( $dX / dt = 0$ ), and the Maximum Sustainable Yield ( $MSY$ ), occurs when  $h = F(x = X_{MSY})$ . In fact, the population level that maximises the biological yield is  $X_{MSY}$  and not  $X_{MAX}$ . But  $h(t)$  is proportional to the state of the resource ( $X$ ) and the fishing effort ( $E$ ), so  $h(t) = q \cdot E \cdot X$ . In every point of sustainable effort ( $dX / dt = 0$ ),  $r \cdot X \cdot (1 - X / X_{MAX}) = qEX \rightarrow X = X_{MAX}(1 - q \cdot E / r) \rightarrow h = q \cdot X_{MAX} \cdot E(1 - q \cdot E / r)$ .

The Shaeffer model assumes some more hypothesis: there are neither entry or exit barriers nor transaction costs; the total fishing costs are related to the fishing effort ( $TC = c \cdot E$ ) and the sustainable revenue is related to the fish market price and yield. ( $TY = pY$ ). So, the profit  $p = TY - TC = pY - cE$ .

In a monopolistic scenario the economic equilibrium occurs when the marginal revenue equals the marginal cost. And at this point of maximum profit, the fishing effort ( $E^*$ ) is smaller than the  $MSY$ . So there is not biological over-fishing. But in a free access regime, at that point there is an over-profit (because the individual cost is smaller than the social cost) and the point of equilibrium only occurs when the profit is zero. At this new point, the effort ( $E^{**}$ ) can be, or not, after the  $X_{MSY}$ , depending on the marginal costs. The technological developments tend to decrease the marginal costs, so over-fishing is the usual result.

This Gordon-Schaeffer model has become more and more sophisticated. In the Beverton-Holt model the unit is not the population  $X$ , but the cohort, that is, an age class of the population. So, it is possible to be more specific about the reproduction, natural mortality and catch rates and to reproduce several aspects of biological dynamics in a more reliable way.

- (3) Under Portuguese legislation, all the landings of fresh and chilled fish must be sold in the auction markets, that are managed by public concessionaires, one in each administrative area – Portugal, Madeira and Azores. This regime guarantees the payments to fish owners and fishermen, but prevents market experience and innovation.
- (4) A successful "Action Plan to the Sardine 1997-1999" was negotiated between the PO and the Portuguese Administration after ACFM-Advisory Committee on Fishery Management reported in 1995 to the EU Commission that the Iberian sardine stock was being exploited above biological security limits.
- (5) Even in a 6 factor solution, item 1 still stays alone.