Economic analysis tools and fisheries management: some methodological remarks

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Abstract

An analysis is given of some policy aspects in the fishery sector, with particular attention to the European Union situation. The possibility to adapt some traditional economic tools to fisheries management problems is dealt with, in particular the instruments usually used in agricultural economics (concerning demand analysis, production analysis, fishery supply chain analysis and market analysis). In particular some problems of fish production are considered: the problem of production function used to estimate fishing effort, with particular attention to multi-catch activity, typical of the Mediterranean and Adriatic Seas.

1. Introduction

The aim of this paper[**] is to analyse, from an economic perspective, some important aspects of the whole policy in the fishery sector with particular attention to the European Union situation. The core of the paper concerns the possibility to adapt some traditional economic tools, in particular the instruments usually used in agricultural economics, to fisheries management problems.

The economic analysis of fisheries concerns a wide range of aspects: (1) first of all the fish demand analysis on one side and the productive problems on the other side; and then (2) the analysis of market and the organisation of the entire fishery supply chain (See Table 1).

These fields of study are connected with the identification of the more efficient policies to improve the interaction between fisheries and the environment (natural resource in general and fish stock in particular) and to sustain the fishery sector.

This paper points out how, in many cases, the problem of sustainability of the fishery sector is approached mainly from a biological point of view, with the objective of fish stock conservation. However, there is a strong interaction between the social situation, fishing activity, market organisation on one hand and the environmental situation on the other; therefore each policy determines some answers of fishermen, market operators and consumers, which adapt their choices (fishing choices, market distribution choices, consumer decisions). These produce some feedback effects on the ecological situation. Therefore the importance of economic tools to predict operators (in particular fishermen) decisions should be highlighted.

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First of all this paper analyses the justification of public management in fisheries and the main common objectives of fisheries management, with particular attention to the European Union situation; then a overview of some critical aspects concerning the management measures are considered; finally some problems and strategies for market value enhancement of fisheries products are analysed.
The paper points out some instruments for economic analysis, developed in the agricultural sector, those can be adapted for the fishery sector, concerning demand analysis, production analysis, fishery supply chain analysis and market analysis.
In particular some problems of fish production are considered: the problem of production function used to estimate the fish effort, with particular attention to multi-catch activity, typical of Mediterranean and Adriatic Sea. Another problem considered is the risk management in the fishery sector, where the fishermen seem to have particularly strong risk aversion behaviour. Moreover some strategies to improve fish product value are emphasised. Implementation of these strategies requires a market integration analysis: in fact, it is necessary to know the integration degree of a market with regards to fish species, different products and geographical areas, to improve fishing revenues without increasing fishing effort.

Table 1. The economic fields of analysis for fisheries management

DEMAND ANALYSIS	Trade organisation: GATT/WTO, EU markets legislation Social and economic factors influencing fish consumption: a growing number of women in the employment market, new lifestyles (with less time for shopping and cooking), new family characteristics (increasingly elderly population, fall in the average number of members per family, increase in the number of people who live alone, etc.) Evolution of consumers' demand: shopping takes place on a limited basis both in space and time, increasing food consumption outside the home, growing demand for ready-prepared meals (frozen foods, pre-cooked food, etc.), food expenditure is following a downward trend in favour of non-domestic consumption (mainly the restaurant trade), diversification of fish demand (market segmentation), increasing demand for high quality products, increasing general attention to sanitary problems concerning food (BSE, animal feed systems, dioxin contamination, etc...) increasing attention to environmental protection
PRODUCTION AND FIRM MANAGEMENT ANALYSIS	Production function and fishing effort analysis Multi-product and multi-service productions: fisherman with/without possibility to control the species to catch District or local systems organisations development: - District analysis models (agricultural-industrial district, rural district; learning by doing, learning by interacting) - Conservation of traditional production process and local community - Enhancement of positive interaction between fishing activity and the environmental system Product differentiation on the market (PDO, PGI; Eco-labelling, organic products)

	Risk management: risk aversion analysis; portfolio analysis; the adoption of insurance instruments
ORGANISATION OF THE FISHERY SUPPLY CHAIN	Market organisation effects Transformations of food distribution chains Consolidation and growth of new marketing strategies for distributing foodstuffs (supermarkets, hyper-markets and discount stores) at the expense of the traditional retailers The functioning of companies in the food distribution sector brings substantial changes to commercial chains (alliances, mergers and take-overs of distribution companies; commercial concentration of retail distribution,…)
MARKET ORGANISATION	Market organisation analysis (market power) Market delimitation: type of product delimitation; space delimitation (geographical area); the market segmentation and arbitrage margin for fish firm (fishermen organisation); product differentiation strategies

2. Objectives and policies in fisheries management

2.1 Justification of public management in fisheries

Theoretical justification of public management in fishing activity is built on biological and institutional aspects of marine resource stocks that are both renewable and common. As for living resources, fishing resources are also renewable, and in the long run the scarcity of a resource is defined by the biological capacity of renewal with regard to the exploitation rate.
In general, since fish stocks are regulated by *res nullius* rules they are not appropriated before their exploitation by fishing firms whose activity determines the marine renewable resource allocation (Le Gallic and Le Floc'h, 2000). With reference to these aspects it is necessary to note that the introduction of exclusive individual fishing rights is unusual and the allocation of mobile fish stocks between several fishing boats appears very difficult to manage. Therefore, fish stocks can be defined as non-exclusive (absence of individual fishing rights) and rivalry (competition in the exploitation): each additional unit of species for a fisherman must be subtracted from the exploited stock by a group of producers. In other words the individual production functions are interrelated in that each fishing effort affects, through the flow of catches, the total production obtained from this stock for a given global fishing effort. In this situation common properties determine negative externalities between fishermen exploiting the same stock and scarcity of fishing stocks is a basic parameter in the characterisation of marine renewable resource as a "common resource". As in the other industries, in the fishery sector negative externalities create a deviation between private and social benefit. *Ceteris paribus*, a part of private profit, create by a single fishing firm through the increasing of its fishing effort, determines a profit reduction for the other fishermen. In this context a rational individual fisherman will increase his own fishing effort up to a point considered as too high for the entire fishery (Le Gallic and Le Floc'h, 2000). So the existence of negative crossed externalities and the absence of legal individual fishing rights for the resources are the fundamental incentives for each single fisherman to increase his fishing effort with consequential problems of overexploitation and overcapitalisation and related problems concerning equity issues. In this situation, the resource rent, which is a measure of the social wealth, can be dissipated with free entry to the fishery that determines a negative

impact on the revenue of other fishermen exploiting the same stock and is an important source of related conflict.
As a result of this analysis is possible to point out how an unmanaged fishery is inefficient with a sub-optimal exploitation of the fish stock and the public management is justified with the main objective, assigned to the decision-makers, of restoring the social wealth or the resource rent (Clark, 1985; Hannesson, 1993).

2.2 The objectives of fisheries management

Most fisheries management policies around the world have almost identical overall aims, e.g. the FAO (Food and Agriculture Organization of the United Nations) Code of Conduct for Responsible Fisheries, the US Magnuson-Stevens Fishery Conservation and Management Act and the Common Fisheries Policy (CFP) of European Union (EU) (Mardle *et al.* 2001).
Generally in natural resource management cases, objectives are categorised under three main headings: environmental (including biological and conservational), economic and social[1]. Some of the most commonly declared objectives in fisheries management are: (i) resource conservation; (ii) food production; (iii) generation of economic wealth; (iv) generation of reasonable income for fishers; (v) maintaining employment for fishers; and (vi) maintaining the viability of fishing communities.
It's evident that these objectives determine a multi-disciplinary approach: so the fisheries management needs environmental (usually biological), economic and social analysis to describe the problem, identify the specific objectives, to pursue the target levels to achieve and, consequently, to choose a coherent set of measures to adopt. It is important to remember that the theory for optimal management of the renewable fishery resource includes several species and analyses different types of interactions as: (1) biological interactions; (2) harvest technological interactions; (3) market interactions. Despite of this multi-disciplinary scenario, we can note that in several instances, research on the biological and studies on the interaction between harvest technologies dominate the market interaction analysis.
In addition, as in almost all policies, when there is a multiple objective context, some of the objectives may be naturally conflicting and cannot be simultaneously optimised, so there is a trade-off between them[2]. In practice the most evident conflict concerns jobs and catch, especially where overcapacity is an issue.
In other words there is a decision problem that in many cases decision makers do not face it in the correct way. In fact the decision makers often do "not set priorities or trade-offs between the various objectives nor do they set measurable targets for individual objectives". This makes it difficult to determine whether the objectives have been achieved or not. They do not understand the concepts of objectives and accompanying goals and targets, which lead to broadly defined goals without substantial justification. Hanna and Smith (1993) concur that different goal orientations are a major source of conflict in fisheries management, as well as structural effectiveness, biological changes and cultural (i.e. interest group) characteristics. In particular, there is a sort of "basic" conflict between objectives in fisheries management definable as long-term biological or conservation objectives versus short-term economic

[1] Some authors considered a fourth objective category of political objectives (Mardel *et al.,* 2001)
[2] Many studies have considered the multiple objectives of fisheries management and the potential incompatibilities and inconsistencies associated. See Mardle *et al.* (2001) for a survey.

objectives (Lane, 1989)[3]. It represents succinctly the main issues faced by fishery managers and therefore the goals to be achieved derive directly from this.
If these conflicts are not recognised then one main objective is pursued. Currently, one of the most important objectives in the "green" debate is to safeguard sustainable fish stocks that usually leads to the concept of Maximum Sustainable Yield (MSY)[4]. Some authors (Cunningham, 1980) make the distinction between MSY and Optimum Sustainable Yield (OSY), the level used by ICES[5]: OSY is a level of fishing below MSY, with the aims of reducing risk of stock depletion and reducing fluctuations of yearly catch. But even though there is now the recognition of multiple objectives, MSY still appears as a prominent objective[6].
The objective is peculiar, viewed from a socio-economic angle (at microeconomic level), because it is not an objective but rather a restriction for the activities of the fishing fleet. In general, the consequence could be that the whole fishing activity should stop or alternatively be carried out using the vessels in an inefficient way.
The restrictions for fisheries can be physical, biological or economic: the kind of restriction determines the options for the decision makers and the values of the endogenous variables in a economic model. As is well known, among the most important restrictions are (Andersen and Frost, 2000):

- The yield from the stocks (implicit quotas) must not be exceeded
- A certain number of fishing days per month must not be exceeded
- Economic restrictions e.g. minimum contribution to the margin or minimum profit
- A certain fleet structure be maintained for income distributional reason

The type of restriction depends on the time period: short term or long term. In the short term the natural capital (stock abundance) and vessel capital is assumed constant. So for example in the short term the decision makers have only the number of fishing days allocated to each vessel as an instrument when regulating the fishery; in the long term they have the number of fishing days and number of vessels at their disposal.
As answer to the restrictions adopted, the fishermen face a decisional problem consisting in maximising the fixed profit: a traditional microeconomic problem that can be well interpreted with a neoclassic model. The fishermen's behaviour and feedback effects, in many cases, are not sufficiently considered in the fisheries policy.

2.3 The Common Fishery Policy (CFP)

In accordance with overall management policy, the general objectives of EU fisheries management are clearly stated in the CFP. Article 2 of Council Regulation (EC) 3760/92 embodies these key objectives with respect to the resource conservation and management system:

[3] Data or information may not be available in all instances (e.g. species mortality or ecosystem dynamics) or even crucial to an individual management problem (e.g. pollution or enforcement).
[4] This is not surprising as at the International Law Commission Conference on Sea Law in 1958, MSY was recognised as the basic objective in fisheries management.
[5] International Council for the Exploration of the Sea, Copenhagen, Denmark.
[6] For example, in the FAO Code of Conduct for Responsible Fisheries (1995), Article 7.2 on Fisheries Management states that measures should be adopted that are "capable of producing maximum sustainable yield, as qualified by relevant environmental and economic factors".

As concerns the exploitation activities the general objectives of the common fisheries policy shall be to protect and conserve available and accessible living marine aquatic resources, and to provide for rational exploitation on a sustainable basis, in appropriate economic and social conditions for the sector, taking into account its implications for the marine ecosystem, and in particular taking into account the needs of both producers and consumers.

But some relevant conflicts between the declared objectives clearly emerge. Moreover instruments to pursue CFP aims derive from a complex set of specific policies concerning fisheries. In fact, the whole CFP consists of a number of policy areas, mainly: Resource Policy, Structural Policy, Market Policy, Control Policy. On top of the main policy areas we have a number of policy issues, which are becoming more and more important for the fisheries policy and need to be treated within the fisheries policy framework. Issues such as sustainability, precautionary approach, discards, regionalisation of policy, just to mention a few key words already widely in play. In this situation is very difficult to identify a clear correlation between objectives and tools. Nevertheless the main objectives of the Common Fisheries Policy (CFP) can be summarised as follows:

- Stock conservation and socio-economic viability of fishing firms
- Relative stability of the situation (equilibrium)

To pursue these conflicting objectives the EU adopts a regulation system that includes catch limitation, effort limitation and incentives for definitive withdrawals, a range of tools that are correlated.

More precisely the initial fisheries policy, agreed in 1970, dealt primarily with allocation issues, providing for equal access to all Community waters (except within existing national 6-mile and 12-mile limits). Then a more comprehensive policy, agreed in the early 1980s after prolonged negotiations on the definition and allocation of national fishing rights, established two types of quota systems.

- following similar lines to landings restrictions already agreed by international organisations (such as the North Atlantic Fisheries Organisation (NAFO)) catch quotas were introduced under EU Conservation Policy. This system deals the allocation of output production rights, specifying the maximum permissible weight of fish that could be landed within a Total Allowable Catch (TAC) set for a specific stock.
- in addition a Multi-Annual Guidance Programmes (MAGPs), licensing, "effort" and "capacity" controls introduced under EU Structural Policy, allocated input exploitation rights restricting aggregate engine power, tonnage and other factors influencing catches such as time at sea, in an attempt to achieve a balance with fishing opportunities.

In this context of regulation it is relevant to consider the effect of CFP on production systems, pointing out some methodological instruments of economic analysis that can be adopted.

3. The effects of fisheries regulation management system on firms: a brief overview

In this paragraph, we give a brief overview of the main critical aspects of the fisheries regulation management systems (with particular attention to CFP), without attempting to achieve a systematic analysis of this complex problem.

First of all, we should point out a methodological problem: the conflicting definitions and measures of fishing capacity often prevail as a result of economic, biological and technical impartiality. These definitions and measures have also often been adopted to agree with objectives of fishery managers[7]. Capacity has tended to be more often than not expressed in relatively simple and easily monitored technological (input) terms. These could include number of vessels, physical characteristics of vessels, gear and fishing methods used, and the time available for fishing. However, capacity has also been defined in terms of catch (output) or in economic terms (e.g. capital costs). Defining capacity in economic terms has been less widely used due to the relatively large demand for data collection. The use of an output definition may, however, be more applicable on a global basis. The current FAO initiative seeks national mangers and administrators to measures fishing capacity in output terms. "Fishing capacity is the maximum amount of fish over a period of time that can be produced by a fishing fleet if fully utilised, given the biomass and age structure of the fish stock and the present state of the technology" (FAO, 1998).

3.1 The TAC (Total Allowable Catch) system

Concerning the TAC system, it is useful to remark on the failure of the quota management system, or its near-inefficiency, as several authors have shown. An initial problem concerns the difficult to reach an agreement on quota share (i.e. country quota), with all the countries getting more demanding and the TAC getting smaller; moreover there is less than optimum implementation of the system (e.g. in the Mediterranean Sea for tuna). In particular Andersen and Frost (2000) point out that in some cases the objective to secure fish stock at some arbitrary level, in the case of quota management system, is carried out on an imperfect economic basis or in total absence of economic considerations. Therefore it could very easily be better for the society if no regulation was implemented at all. Of course, the economic results are very dependent on the fleet structure and the costs of fishing. Hence society could work with preservation of fish stocks but no one knows whether society would be better off in economic terms compared to a non-regulated system. As consequence general enforcement and control in terms of economic gains to society are very uncertain, given that these gains depend on the structure of the fleet. In addition the administrative costs of enforcement and control reduce the social benefit.

Some other studies show the possibility to leave the quota management system and introduce some sort of unrestricted fishery based on effort regulation (Andersen and Frost, 2000). The wish to move from quota management to effort management is based on three reasons: (1) Effort management is in accordance with the fishery's nature being a multi-species fishery; (2) Discard could be decreased; (3) Misreporting of landings could be avoided or reduced.

Moving from quota regulation towards effort regulation in the long run is affected by the quota systems' incentive to compose landings in a way that reflects the relative size of the quotas with little or no regard to costs of fishing (Andersen and Frost, 2000). In an effort management system no quotas exist, only guidelines for maximum catches, but it is very uncertain as to whether the catch composition would remain the same. A relatively strong and detailed management is needed to assure that landings of certain species are not reduced too

[7] In order to assist a global recognition of the fishing capacity issue, the FAO initiated an extensive consultation programme in 1998 with the aim to discuss the many conflicting definitions of fishing capacity and the possible means of measuring and managing fishing capacity.

much and others are not greatly exceeded. The most endangered species at the highest prices will be the most critical species except where cost of fishing for those species increases strongly with decreasing stocks. However the decision makers have the possibility to change fishing patterns through price incentives systems.
A detailed effort management system as a substitute for quota management reduces flexibility in terms of where the fishermen could fish, but it's very difficult to control when the fishermen can fish. Another problem concerns who determines the number of days at sea: in the quota management system it is the decision makers who does that, but in the case of distribution of fishing rights is to a large extent determined by the fishermen.
To analyse the effect of this management system at a fixed level and to predict the fishermen's reactions (in qualitative or quantitative way) it is possible to adopt some microeconomic models.

3.2 The fishing effort management system

The definition and consequently the determination of fishing effort is a basic question in bio-economic models, public regulation, relative resource assessment, and literature has given special attention to this matter (del Valle *et al* 2000). From a methodological point of view the concept of fishing effort has been subject to several theoretical analyses based on a production functions approach. First of all it is necessary to note that, in general, fishing activity is based on exploitation of fish stocks by fishing firms whose production functions can be interpreted as a combined result of the fish stock and the fishing effort.
Therefore the production function for each fishing boat is defined by the size of capital, labour and the abundance of resource stock that is exploited. But if the production of fishing effort is composed of many input factors, not all of them are equally important (two different technologies can exploit a fishing ground in different way and with consequently different productivity measured by catch rates). In addition, one problem that limits of the use of a production function concerns the estimation of the parameters: if the parameters are estimated for certain well-defined fisheries the results are not generally applicable (Andersen and Frost, 2000). Following this approach, the relationships considered will become a production function with Landings as dependent variable and Effort and Fleet Capacity as independent variables. This relationship must also include the stock size, because it affects the average and the marginal productivity of the effort and of the factors. This kind of relationship, between landing, effort and stock has been classified as catch effort model by fisheries literature[8].
Classic regulation programs based on directly limiting effort have shown to require the restriction of one or more of its components, which in turn demands empirical knowledge of the effort's internal structure, that is to say, the relationships between the individual production factors that make up effort.
In this context different analyses applying a traditional microeconomic approach can be adopted.

[8] Furthermore, it also can be useful to distinguish between short-term analysis and long term analysis. In the first case the analytic specification of the production function is developed. In this contest the efficiency of the analysis is also improved. In the long run analysis of the dynamics of each factor, stock included, have been considered. This kind of analysis can also be studied using the neoclassic Growth theory approach.

3.2.1 The optimal input mix

From the point of view of the traditional microeconomic analysis, the fish stock can be considered as an exogenous variable and therefore the production function for fishing effort determination is based on a mixture of different inputs factors. The dimension of these, that is the level of each input, can be expressed in terms of boat days, horsepower of boat, tonnage of boat, and so on; the fishing effort is the result of a combination of these factors that effects output (catch). It is possible to show this kind of relationship through the neoclassic approach to the optimal input mix, using the concepts of iso-cost and iso-production curves.

In Figure 1a, it is possible to see the optimal solution (point E) for fisherman that combines only two input factors: e.g. boat days and horsepower. Clearly this is a realistic example for a medium term analysis (horsepower can not change in the short term) and only for some types of fisheries; moreover the analysis concerns a situation with only one output (one species composition).

If the fisheries authorities put a constraint on inputs, e.g. a limitation on vessel horsepower, this restriction can be irrelevant for fishing effort reduction if the limit allowed is too high (Figure 1b), or can change the fishermen's optimal solution if the level of the constraint is sufficiently low (Figure 1c). In the later the original solution is not optimal after the input limitation decision and the fishermen change the input combination (Figure 1d), so the new solution (point E') derives from a partial replacement of one input with another: a horsepower reduction and an increasing of boat days. This example show how a limitation in vessel horsepower can lead to a reduction of this input but can induce the fishermen to increase the use of another input or change another dimension of the input used. There is also a reduction in output because the iso-production curves, that the fishermen can reach, are lower than the original (before input restriction). In other words an objective of fish stock conservation should be obtained, but there is also a revenue reduction for fisherman. The effects on costs are uncertain. Horsepower limitation determines some added costs for fleet reorganisation and in some cases a reduction of fixed costs (e.g. tax on boat correlated to horsepower). But horsepower reduction together with the increase of total boat days and of trips can determine higher variable costs (e.g. flue and boat upkeep). Therefore it is likely that the net profit will suffer a reduction. As a consequence the fisherman could probably use more inputs factor to obtain the original revenue level or a value very close to it (Figure 1e). In other words, the fisherman is induced to increase his fishing effort also forcing the legal limitations.

Figure 1a. Optimal input mix without input restriction

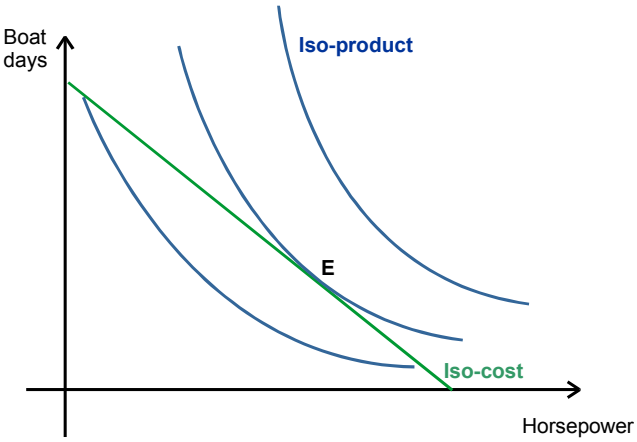


Figure 1b. The introduction of an input restriction without effect on fishing effort

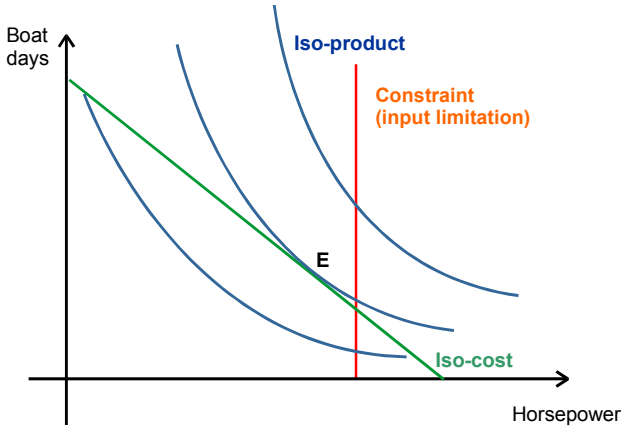


Figure 1c. The introduction of an input restriction with effect on fishing effort

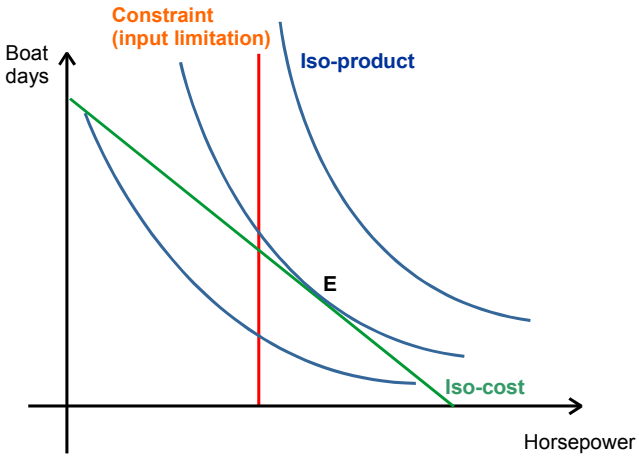


Figure 1d. The effect of an input restriction on fisherman optimal solution

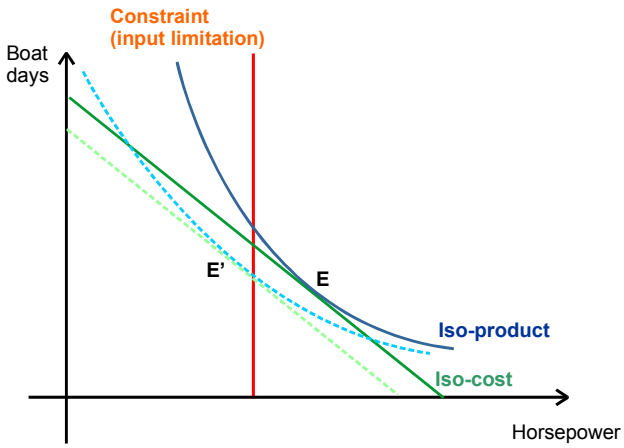
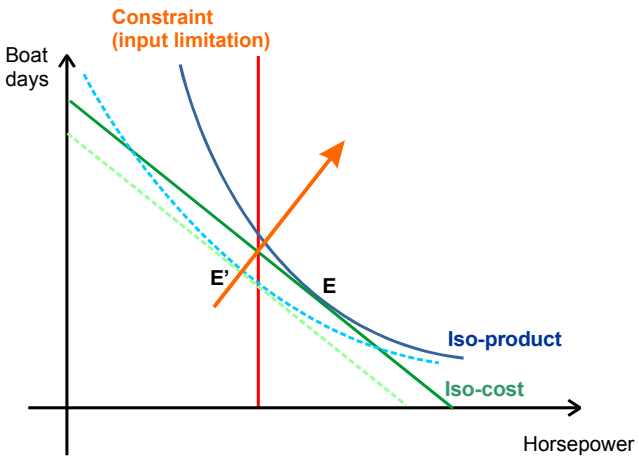


Figure 1e. The fisherman reaction to an input restriction



3.2.2 The optimal product mix

Another traditional approach used for analysis is the optimal product model mix. The fisherman can substitute in some cases the catch of one species of fish with another. With more than one output (species composition) the output is determined by the possibilities of the fisherman to control the species composition. We consider that the fisherman can catch two species on each trip and the mix depends first of all on the possibility to select the species of fish and then on the degree of substitution and on the prices of species. In Figure 2a the fisherman cannot choose which species to catch: the two species are caught in a fixed relationship and he can only decide whether to fish with a certain effort or not. In Figure 2b given a production technology and a certain effort level, the fisherman can choose which species to catch. If the fisherman has this option, effort regulation will have the unfortunate consequence that some species are only caught in lower quantities, even if it could be profitable for society to catch them without damaging the biomass (Andersen and Frost, 2000).

Figure 2a. The production possibility curve: fisherman without control on the species to catch

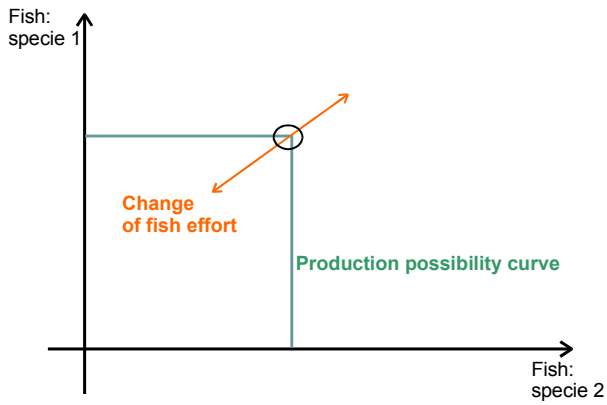
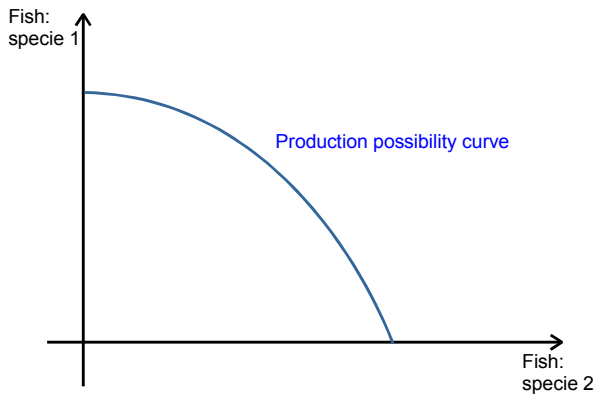


Figure 2b. The production possibility curve: fisherman with control on the species to catch



3.2.3 Fishing effort and production function: an alternative approach

Some authors suggest other approaches to estimate fishing effort and to manage it, in particular the calculation of the Allen Elasticity of Substitution (AES) could be valuable to predict inefficient expansions in response to a hypothetical input restrictions program. Del Valle *et al* (2000) point out that the fishing effort, can be interpreted as an aggregate input that can be consistently formed only under the condition of weak separability of the production technology. So fishing effort can be interpreted as an aggregate index of different production factors. Therefore, the conditions of the production technology must be determined in order to reduce the production function to the expression

$$Y=F(E(X1,\ldots Xn),Xz),$$

where Y is the output, (1,..Z) are the inputs and E (the fishing effort) is a consistent aggregator function.

This approach allows us to test an aggregated index of fishing intensity and vessel characteristics.

The flexibility of a selected functional production form makes the estimation of the elasticity possible of substitution between the inputs that make up effort. This transformation can be

very useful for policy makers, especially for a fishery with clear evidence of regulation failure via TAC/licensing and the foreseen reduction in the spawning biomass. In addition, although ignored in many studies, the difference in skill of fishing skippers explains a considerable portion of the variation in fishing potential/capacity among units. There are many instances where the physical inputs and even the fishing intensity are less important than those related to the skill of the fisherman in making managerial decisions such us how to fish, when to fish or when to stop fishing.

The result of these studies point out as the elasticity of substitution between inputs (tonnage and boat days, or horsepower and boat day for example) is in many cases positive and less than one (see del Valle *et al* 2000), therefore, despite tonnage or horsepower are a substitute for boat days, the substitution possibilities are low. Thus, if policy makers decided to adopt input restriction to enforce the non-operative TAC/licensing system, fishermen could answer a limitation of boat days with capacity or horsepower increments.

3.2.4 Fishing effort in practice

As mentioned above there is strong evidence of failure of the TAC/licensing system: too many vessels competing against a population with high a risk of suffering a collapse. Although policy makers have the difficult job to decide the way, limitation of fishing effort, directly (via licensing restriction and input restriction) or indirectly is considered to be strictly necessary in many cases. So the reduction of fleet capacity in the EU is an important objective of the EU's Common Fishery Policy and the success of such programmes depends both on the variation and the level of efficiency within the fishing fleets. So the concept of fishing effort became central to fisheries economics and management. But the term fishing effort has frequently been used in a seemingly simplistic way which implies a certain intensity or magnitude in relation to the activity of the fishermen (number of boat days, number of trips, etc) or the gear of equipment that the fishermen use to extract the catch (number of hooks set, number of shots made, etc). Most cross sectional production analysis also involves physical attributes of fishing vessels (tonnage, horsepower) or different intermediate inputs like fuel or ice.

Concerning the fishing effort reduction approach is important to note that mainly fishing effort reduction is obtained by sweeping less economical efficient firms away from the market and consequently the authority must face a so-called re-conversion problem (Del Gatto *et al*., 2001). In this way it is possible to improve the global efficiency of fisheries but this policy sacrifices operators in the name of only hypothetically correct resource management with relevant negative effects from a social point of view. Good economic action should obtain the greatest output from resources but not defend them at any cost. In other words the number of operators could be reduced only if their re-conversion can be assured, though difficult and expensive it may be.

This approach derives from the application of a catch-effort model that implies a policy of control-invested capital through some steps (Del Gatto *et al*., 2001):

(a) a close relationship exists between catch and fishing effort;
(b) a close relationship exists between fishing effort applied to resources and fishing capacity (seen as the highest attainable level with available equipment) and
(c) fishing capacity can be measured through invested capital. Therefore if there is a strong relationship between over-exploitation and over-capitalisation then a catch-effort model requires capital reduction or limitation.

The incoherent aspect of such logical procedure that acts mainly on invested capital for managing fishing capacity is evident. The reason for such inconsistency has to be found in the above-mentioned double goal: on one side the objective to manage resources (i.e. fleet reduction, according to catch-effort model) and on the other side the objective to protect operators' interests. The regulation obliges the establishment of a system (meant to use resources in the best way) which depends on structural policies. In this context such policies have been asked to fulfil both the aims to support fishing operators (financing re-conversion and equipment renewal) and to induce definitive withdrawals. At the same time tax policies have been used in several countries (according to the programme guidelines settled by EU) for helping fishing segments with a small fiscal capacity (small-scale fishing)[9].
In addition in classical fishery economics most attention is given to long-term investment decisions with the basic assumption that fishing effort will adjust by reallocating to the most profitable fisheries and withdrawing from those which are non-profitable instantaneously or after an adjustment period (Gordon, 1954; Eggert and Tveterås 2001). However, these models have dealt with single species of fish and focused on optimal solutions with implicit assumptions of complete effort control. In reality, fisheries are often multi-species, not perfectly enforced and fishers may not solely focus on maximizing expected profits, as they have to deal with a considerable level of risk[10].

3.3 Risk management

The previous approaches concern the decision problems in a deterministic framework, but the reality is characterised by risk. In fact, as long as total effort cannot be completely controlled, a more thorough understanding of fishers' supply response decisions will be beneficial for fishery managers. The results of some studies indicate that fishers have a strong tendency to choose the same gear used on the previous trip, while in general they react to changes in economic and biological conditions by responding positively to increases in expected landing values and negatively to increases in the variability of the expected landing values, indicating risk aversion (Eggert and Tveterås, 2001).
Therefore in fisheries management the risk analysis should assume a relevant role, the portfolio analysis should be used to evaluate the risk preference structures of fishermen and predict their choices. Finally, the adoption of insurance instruments, also under public control or with public insurance companies, could be very useful to mitigate the risks for fishermen, in a similar way to the insurance policies in the agricultural sector.

[9] Some studies (Del Gatto et al., 2001) remarked the bad aspects of a high fiscal charge and a more rational use of subsidies and taxes in the case of Italy.
[10] See the paragraph titled *Risk management*.

3.4 Some conclusive remarks

The exploitation of common pool fish stocks is traditionally characterised by externality problems among fishers. That is, a fisher's individual production function is interdependent, with his realised catch depending on the catches of other fishers. Because fishers do not have the incentives to conserve fish stocks, they tend to over-invest in capital to harvest fish. The theory of fisheries economics indicates that fisheries can be regulated efficiently if market forces are allowed to dictate the evolution of fishing fleets, discouraging the competitive build-up of excessive capacity. A management strategy that is based on output constraints and the internalisation of externality problems, through the use of landing taxation and individual property rights for example, would lead to a gradual optimisation of fleet capacity.
However, most global fisheries are in regulated open access conditions, where management strategies have been based on difficult input control measures. These measures fail to address the eternality problem and, hence, management has been forced to address the issues of fishing capacity and overcapacity in order to implement fleet adjustment programmes to optimise fleet capacity levels. As a result, to create effective adjustment programmes one has to be able to define and measure fishing capacity correctly and ensure that the concept can be correctly linked to the concepts of fishing effort and fishing mortality, concepts that management measures are often based upon. Although there are interesting alternatives to the classic input restrictions such as those based in co-management, the difficulty to get a consensus between different states could be an important barrier to major changes.
We can summarise the above remarks as follows: to implement correct fisheries management a fisheries authority should (a) consider the companies' conduct and their reaction to public policies, in particular in the case of constraints on input factors or activity as a whole; (b) increase the firms' revenues, and consequently the profit, through the market system avoiding or limiting the high and inefficient direct payments to fishermen.
Therefore an analysis of consumer demand and market organisation has become critical to implement sustainable fishing activity.

4. Trend of fish market and consumers' demand

4.1 International trade organisation and its impact on the European union market

In European Union the customs' regulations on fish products is characterised by the total or partial suspension of duties on products which are destined to the processing industry (raw material provisions) and, by the existence of border protection mechanisms (reference prices and safeguard measures) to protect against foreign products. This situation is, partially a consequence of GATT negotiation[11]. The general principles of the Uruguay round of negotiations, which affected fish products, can be summarised in two points[12]: reduction of

[11] The dismantling of customs tariffs in the EU prior to the Uruguay Negotiation Agreements was widespread and new tariff exemptions regarding raw materials were added to already existing ones in order to guarantee supply to the internal market, or the application of a tariff benefit linked to compliance with international trade agreements within the framework of autonomous and conventional EU trade policies.
[12] Basically, the intention was to make progress in trade liberalisation, making access to markets more flexible, reinforcing free competition (with the elimination of subsidies) and eliminating artificial obstacles imposed by means of different regulations.

tariff peaks (tariffs equal to or higher than 15%) by 50% and average tariff reductions of at least 33% for all the other products. Therefore, the decisions taken under the agreement of the World Trade Organisation and the new applicable regulations on the common organisation of markets in the fish products sector only consolidate the open commerce trend which, for some years now, has been seen in fish products and which has made the European Union the most important world market for these products.

4.2 Global trend of fish markets

In the last few decades, world fish production has experienced a growing trend in catches accompanied by a process where production has become even more concentrated to just a few countries. According to information given by the FAO, developing countries are playing an ever more important role in this process, increasing their participation both with regard to production and consumption. In spite of this, the developed countries still have a higher consumption per capita ratio and, within such countries, there are significant differences insofar as habits and diet are concerned. The increase in production in Developing Countries and in consumption in Developed Countries has favoured the development of the international fish trade and the opening of markets in the latter, where the majority of imports are concentrated (between Japan and the EU, imports represent more than 60% of the world total) (Cannata and Forleo, 1999). The EU depends on external supply (except Denmark, Ireland and the Netherlands), which has facilitated the establishment of a customs regime distinguished by its degree of true openness and the existence of minor protection measures (reference prices and safeguard measures)[13]. Both the regulations of the WTO as well as the new regulations on the common organisation of markets are moving towards a consolidation of this open trend. In European domestic markets we are witnessing great vitality and trends which must be followed carefully. Thus, within the general downward trend of the portion of income given over to food, differences between countries and types of products can be clearly seen.

Within this context, in the last few years interesting modifications have taken place, affecting food distribution in the European domestic market which should be taken into account when talking about fish products. The strategic management which companies within the food distribution sector have adopted has been characterised by the search for economies by means of mergers and acquisitions applied by leaders in the sector to small companies, cuts in trade channels or circuits and reductions in the costs of distribution companies based on greater negotiating power.

The distribution of fish products is related to these trends. The European consumer, with an average income increase, is spending a smaller proportion of his/her expenditure on food consumption.

The growing number of women in the employment market and new lifestyles (with less time for shopping and cooking), together with family characteristics (increasingly elderly population, fall in the average number of members per family, increase in the number of people who live alone, etc.), only favour trends whereby shopping takes place on a limited basis both in space and time, food consumption outside the home increases and the demand for ready-

[13] In the EU it is possible to identify three groups of countries according to their average consumption: high (Portugal, Spain and Finland), moderate (France, Denmark, Sweden, Greece, UK and Denmark) and low (Ireland, Germany, the Netherlands, Belgium and Luxembourg).

prepared meals grows (frozen foods, pre-cooked food, etc.) (Liniero, 1998, 1999). In many countries we can see that food expenditure is following a downward trend in favour of non-domestic consumption (mainly the restaurant trade) (Trevisan, 1998).

These new lifestyles and family characteristics favour the concentration of shopping, the demand for new products and non-domestic consumption. This combination of elements brings about an increase in the market quota of new forms of trading (supermarkets, hyper-markets and discount stores) to the detriment of traditional retailers (fishmongers and markets). In order to respond to this new reality, companies have adopted new dynamic commercial strategies (alliances, mergers and take-overs of distribution companies, high level of concentration of companies, expansion of new technologies, etc.) with a significant impact on traditional distribution circuits. Although fish distribution lags behind somewhat where other food products are concerned, these trends will have serious repercussions on the sector as a whole.

The functioning of companies in the food distribution sector brings substantial changes to commercial chains. Alliances, mergers and take-overs of distribution companies; the appearance of shopping and trade centres (for obtaining groups of goods and services in advantageous conditions both within the EU and outside it); the commercial concentration of retail distribution; the development of the small organised business (small and medium size distribution companies which join the ranks of cooperation networks and establish purchasing groups and affiliation chains with the aim of strengthening their position with respect to the suppliers); and the growth of the new technologies applied to trade (related to electronics and the possibilities it offers: commercial transactions, data exchange, access to sources of information, easy communication with the end consumer, control with regard to product rotation, etc.); all clear symptoms of the transformations which food distribution chains are experiencing increasingly and which will influence fish markets.

4.3 Market and fishery sector organisation

As is well known, in neo-classical theory, price formation for a normal goods is considered as a process where demand and supply meet, thereby reaching the equilibrium and market clearing price. In this process, production quantity and price is determined interactively. However, this process only applies for normal goods where production quantity which would not usually be affected by changing price. On ex-vessel fish markets, production quantity is not expected to be affected by changing prices to a considerable extent, partly as it is supposedly determined by exogenous factors as biological factors, weather, fisheries regulation, and partly since fish has to satisfy the basic human need for food. Therefore, another market clearing process is taking place on ex-vessel fish markets, where these factors determine production quantity in a first step and production quantity determines price in the second step.

Far away from this theory, several fish markets are increasingly organised through binding relationships. More contracts, vertical integration and long term trading relationships are taking place along the seafood value chain. The stabilisation and convergence of prices and margins would however tend to demonstrate that markets have never been so efficient in spite of the numerous intermediate traders and processors; information is shared on the markets at a broader level due to globalisation. This apparent paradox might be resolved as long as markets are seen as a social construction. Institutional arrangements at the downstream levels

are designed to cope with the volatility of prices at the upstream stages (Guillotreau and Le Grel, 2001). But this process doesn't concern all "geographical" markets, in fact in many cases, especially in the case of small local markets, suppliers and demanders would meet freely under the auction markets, thus setting up the price of fish. So depending on the species of fish and geographical markets it is possible to meet various situations that are closer to perfect competition models or to imperfect competition models (oligopoly or monopoly competition), with connected, different market power of the operators (Gallenti, 1998, 1999; Mauracher, 1999; Prestamburgo, 1998, 1999; Trevisan and Mason 1999).
Therefore one important economic problem consists in the definition of market for a product and their organisation, in particular the relationship with other markets. A market can be defined as "the area in which price is determined" (Stigler and Sherwin, 1985), giving price the principal role in defining market boundaries. So two products are considered part of the same market if they are close substitutes and their relative prices maintain a stable ratio. In addition, prices for these products must be part of a long-run equilibrium system, although significant short-run deviations from equilibrium conditions may still be observed. From methodological point of view one relevant problem concerns the structure of data series: in fact most macro-economic time series data are inherently non-stationary. That is, their means, variances or co-variances depend on time. Regressing such non-stationary time series to estimate the parameters of a demand function some spurious correlations will probably be obtained, where strong relationships between two or more variables is caused by statistical fluke or model specification issues rather than by meaningful causal relationships. In these cases it is possible to adopt a co-integration analysis that permits inference of causal long term relationships between non-stationary variables and has become one of the most commonly used methodology for delineating markets[14]. When co-integration is verified, variables exhibit stable long term relationships, which indicate that a price parity equilibrium condition exists and variables are part of the same market[15].
The knowledge of price determination and market boundaries allows for the orientation of the catch quantity of a group of fishermen and influences the price to varied extents. The income can increase depending on the price flexibility[16]: if this value is less than –1 the price is flexible[17] and the reduction of quantity sold determines an income increment with fishermen's profit improvement[18]. This type of supply control operated by producer associations can be at the same time a measure to correct fish stock management and a market policy able to sustain fishermen revenue. Other alternative/complementary strategies concern the quality policy such as product differentiation.

[14] On this aspect see Ardeni 1989; Asche and Hannesson, 1997; Asche and Sebulonsen, 1998; Asche *et al*. 1998; Baffels, 1991; Bjørndal e Asche, 1995; Bjørndal *et al*., 1996; Hannesson, 1994a; Hannesson, 1994b; Hartmann and Perez Agundez, 2000; Gordon *et al*. 1993; Ravallion, 1986; Zanias, 1993.
[15] More precisely the economic interpretation of cointegration is that "if two (ore more) series are linked to form an equilibrium relationship spanning the long-run, then though the series themselves may contain stochastic trends (i.e., be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (i.e. stationary)" (Hartmann and Perez Agundez, 2000).
[16] Price flexibility is defined as the percentage change in the price of a good, as the quantity purchased on the market of that good increase by one percet.
[17] The normal, uncompensated, price flexibility contains both the direct quantity induced price effect, and the indirect quantity induced price effect, caused through changes in total expenditure. Therefore it is necessary know the whole market relationship to predict the effect of a quantity change supplied.
[18] This effect is well know in agricultural sector where is called by agricultural economists "King effect".

4.4 Product differentiation strategies

There is a considerable interest in the adoption of strategies for market differentiation in the fishery sector, in particular the use of eco-labelling to improve management of natural resources by allowing consumers to make informed purchasing choices. More precisely, this approach concerns the range of measures that regulate fisheries with market driven instruments such a price differences on fish that are caught in a sustainable manner contrary to a non-sustainable manner. Basically, the approach relies on the consumers' willingness to pay a relatively higher price for fish that are caught in a "responsible" way. On this aspect see, in particular, Idrissi (1997) on Seafood, Peacey (2000) on certification methods, and Frost and Michelsen (2001) on fisheries in the Baltic Sea. There is evidence, for the most economically developed countries, of some relevant price differences between certified and non certified fish, but also there is a lack information among fishermen about this situation. In addition the problem is highlighted of whether the whole process towards sustainable fishing could be started by use of certification only. In particular, "if certification is used together with other types of regulation, the interdependency between the various restrictions and the fishing technology could lead to unexpected results, that may even be undesired" (Frost and Michelsen, 2001)[19].

In this context a growing role is played by the specialisation of some areas that have particular characteristics such as environmental characteristics (protected areas, natural areas), traditional fishing methods, traditional life style of the local community. All these elements related to sustainable fisheries, from an environmental, social and economic point of view, are even more appreciated by consumers. In these cases some fisheries districts can be developed where there are traditional small fishing activities. The consumers' demand is correlated to these characteristics and to tourist flows (Trevisan, 1998, 1999).

These considerations also lead to a consideration of a multi-sector approach in a methodological context in which the exchange between different sector activities can be analysed through the externalities of each activity.

5. Conclusions

This paper should have pointed out how fisheries management cannot be reduced to fish stock control in a direct way, but needs a more complex analysis including market and sector analysis studies, fishermen behaviour prediction, local specialised fisheries areas (fisheries districts) and overall a multidisciplinary and multi-sector approach. Therefore single policies that do not consider the complexity of the fisheries world have a great probably of failure as shown by CFP.

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[19] Another important market differentiation concerns organic aquaculture production, see Aarset *et al.* (2000) for the demand for organic salmon in EU.

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