

# A multifunctional subsidy in aquaculture: an empirical application and its effects on the market\*

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## 1. Introduction

The consumption of fish products has been showing, for a long time, at an international level, a positive trend which is firmly consolidated although very differentiated in the various areas of the country. On average the annual family consumption has been proved to be around 23kg, corresponding to around 455 thousand tons and to a total expense of 4,3 thousand million €. More than a half of the family house purchases is represented by fresh fish; caught fish consumption represents 56% of the overall consumption, with a demand increase, in the last year, of 22% versus 3,6% of freshwater fish species.

As regards the distribution channels, organized large-scale retail trade has achieved, in the last two years, further room by reaching a market share of 35,3%. Among fish species, gilthead, anchovies, cod, sea bass, hake, dogfish, sword fish and mullet are added to the list of fresh products consumption. Among shellfish species, mazzancolle, shrimps, scampi, mussels, clams and squids have been added to the list; lastly, among freshwater species, salmon, trout, eel and perch have been added to the list. However, it is important to take into consideration that one of the discussion points of the new fish politics is the sustainability implications of the

## Abstract

Moving from the assumption that any productive activity wield influence over the environment, the human health and its socio-economic context, closely dependent on the production techniques, the aim of this work is to evaluate the effects of a subsidy that awards a prize to the fish breeders adopting production techniques which have a reduced impact on the environment thereby reducing the unemployment rate in the area where they work and supporting a further consumption of fish products. After having classified positive and negative external effects and the areas on which they have an impact, an indicator has been calculated as monetary value that a breeder would receive in case of a positive effect, or would give in order to pay damages in case of a negative effect. The market equilibrium effects of a support were studied by a direct survey that investigates the consumer willingness to pay a 'premium price' for a bred fish that does not pollute the environment.

**Keywords:** impact on the environment, willingness to pay (WTP), fish breeding.

## Résumé

*Ce travail vise à évaluer les effets des subventions sur les pisciculteurs qui adoptent des techniques d'élevage éco-compatibles, qui contribuent à réduire le taux de chômage et encouragent la consommation du poisson. Après avoir classifié les effets négatifs et positifs et les impacts sur les zones en question, on a élaboré un indicateur en tant que valeur monétaire qu'un pisciculteur recevrait en cas d'effet positif ou qu'il paierait en cas d'effet négatif. Les effets des soutiens économiques sur l'équilibre du marché ont été étudiés à travers une enquête directe sur la disponibilité des consommateurs à payer un «premium price» pour des poissons élevés sans polluer l'environnement.*

**Mots clés:** impact sur l'environnement, disponibilité à payer, pisciculture.

fish sector whose main objective is to control fish catches, objective carried out by means of reduction in fish efforts (such as, fleet reduction, biological hold, management plans, etc. ) and also by providing incentives and supporting fish breeding activities.

The strong competition of foreign productions has been taken into account in the last few years. This competition has been evident essentially in the exchanged volumes which are higher than the national ones; moreover, foreign producers are able to apply a lower price policy because they use means of production at a more convenient price both due to a «softer» regulation of fish catches

and to, mainly in the breeding sector, diverse techniques adopted, which vary from fry production, to the use of floating cages and, more specifically to the low cost of workforce.

It is necessary, therefore, to identify means which are suitable, on one side, for tracking a model of sustainable development for the fish productions sector and on the other, for identifying both those who could employ such a role and those forms of support to the production which could be the most appropriate for taking advantage of the national consumption's positive trend and for reducing the number of foreign products on our market.

However, the matter about the production support meets a range of obstacles regarding both the direction of the new EU agriculture policy of which de-coupling is one of the main points, and WTO since any measure to incentive the production and/or the import protection, would create sanc-

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tions and disputes, whose result would certainly be unfavourable. Therefore, although the necessity of a support, as previously described, is considered to be strategic for our productions, it is necessary to set the support system in such a way that is not directly linked to the production level but to the external effects produced, by identifying those multifunctional abilities of the fish production activity.

Thus, it is necessary that these abilities are transformed into a support that is related to the sole production level - more specifically to the external effects produced - able to integrate the breeders' income making them up for environmental and social activities which are offered to the community and penalizing for the negative external effects.

A company will be therefore supported not for what it produces but for how it produces.

The work, attempting in the first place to assess the external effects of fish breeding in order to identify the amount of aid forecast for the various company types, has analyzed the market effects that a subsidy institution can make by proving the chance to increase both the producer's and the consumer's income. More specifically, it has been evaluated the evolution of fish products' supply and demand - depending on the possibility of having a subsidy - by taking into consideration the following:

- higher production costs that companies will have to sustain in order to use eco-compatible production technologies and adapt them, consequentially, to the productive structures;

- possibility of getting an environmental certification for the goods produced;

- consumer's availability to pay at a higher price a certified product which has «a reduced environmental impact».

Then, supply and demand curves have been drawn by considering production costs and market prices: based on this theoretical model, the effects on equilibrium price and quantity have been estimated in the diverse cases characterized by the presence or absence of a subsidy, and lastly, in the case in which sustainable production techniques are guaranteed and are perceived by the consumer as an environmentally certified brand.

## 2. Multifunctional subsidy

The external effects of aquaculture, as of any other productive activity, are linked to their impact on the environment, on the human health and on its socio-economic context, whose origins are closely dependent on the production techniques used. For this reason, the subsidy is a sort of 'premium' for those breeders who manage to adopt production techniques which have a reduced impact on the environment, to help to reduce the unemployment rate in the area in which they work and to support a further consumption of fish products, whose beneficial effects on health can help to reduce the expenses of the public welfare system.

After having classified positive and negative external effects and the areas on which they have an impact, as reported in the following chart, it has been necessary to cre-

ate an indicator which is proportional to the money that a breeder would receive in case of a positive effect, or would give in order to pay damages in case of a negative effect.

Overall, the multifunctional subsidy has been calculated as the sum of the indicators - mentioned earlier - as follows:  $S_m = e + ge + ap + dns + e + hh$

Each space will be filled in by the economic value of each damage/benefit created and by specifying the following:  $e$ =eutrophication,  $ge$ = greenhouse effect,  $ap$ =atmospheric pollution,  $dns$ = damages on natural stocks,  $e$ =employment,  $hh$ =human health.

It has been described earlier that the origin and the quality of external effects depend on the breeding techniques used; based on this, after having identified in our Apulia region the main breeding techniques used, some breeding systems of companies have been selected as case studies, such as: an extensive breeding in floating cages and two types of breeding in tanks with or without alevins. There have been obtained some interesting data in each of them, such as those regarding the amount produced per species, water volumes used, energy consumption, workforce employed and production costs per unit.

These data have been inserted in a matrix that, considering the suggested evaluation and conversion coefficients pattern, as developed earlier, calculates the economic values for each external effect and, therefore, the subsidy which would be assigned to each company according to their different productive techniques used, such as: introduction of alevins and fattening in tanks with company production of alevins.

The following chart indicates the economic values for each external effect. These values have been calculated by considering the conventional case characterized by techniques used and, more specifically, by the energy sources actually used by each company. Lastly, the chart shows the result of this quantification, in other words, the actual subsidy.

It is evident that the most relevant negative effects are those regarding the effluent waters intake in water bodies and therefore their eutrophication.

This effect, closely linked to the volumes of water used, to the fishes bred and to the conversion index of feed given, is clearly evident in the production of alevins, for which it has been calculated that the value for the external effect is 2,02 euro/kg; the value for fattening in tanks (1,58 euro/kg) and for the complete cycle has been lower than the previous one. The negative effect is not present in the breeding in floating cages thanks to the marine streams that hinder effluent accumulation at the bottom of the cages, avoiding from developing the phenomenon.

A further penalty for those firms which produce alevins is linked to a strong need of electric energy necessary for the taking away of water from walls, for its transportation and for the environment conditioning which is necessary for creating the best conditions for the various breeding steps.

The positive external effects are, instead, very evident for the alevins, mainly as a consequence of the high absorption

of the workforce requested, above all in the selection phases of those to get fat in which a specialization is not requested and allowing thus the hiring of workforce generally in redundancy in the agricultural sector; therefore, it has been calculated that the production of only alevins allows a subsidy of 21euro/kg. Naturally, also in the case of a complete cycle, the e is present and has been estimated to be valued at 0,18euro/kg for produced fish.

In the case of companies that only do the fattening, both in floating cages and in tanks, the positive effects on the reduction of fish stocks, have been esteemed to be as 0,03euro/kg of produced fish, have been taken into consideration and quantified. As regards the effects on human health, it has been considered that the content of omega 3 in sea bass could imply a saving in terms of welfare expense that would be obtained from the advantages that this substance has on the cardiovascular system and therefore on the number of patients assisted; it has been calculated a subsidy of 0,730euro/kg produced fish.

Overall, the sum of penalties and premiums proves to have positive values on the global benefit for alevins (17,541 euro/kg) and fattening in cages (0,745euro/kg). The assumed high value obtained by the subsidy on the alevins can be better understood if relating it to the alevins price which is around 95euro/kg; the subsidy would represent, thus, around 18% of the product value, which is close to the value of sea basses bred in cages, for which the subsidy would be calculated for 11%. It is necessary to penalize, instead, those firms which do the fattening in tanks by using both alevins of industrial production (-1,435euro/kg) and buying them from specializing companies (-0,819euro/kg) because of the high negative effect linked to eutrophication.

It has been assumed that, following the presence of a regularized subsidy, as described previously, companies could do some structural changes for taking advantage of it. Therefore, there have been supposed new scenarios characterized by the adoption of effluent filtration systems, by the use of electric energy obtained either by alternative sources (wind or sun) or by both technologies.

As described in chart n. 3, the subsidies' results previously calculated can be modified according to the impacts avoided.

### 3. Market hypothesis

The introduction of a support has clear effects on the existing market equilibrium, above all if, in order to obtain it, it is necessary an adaption of the production ways through the introduction of technologies with different costs; also from the demand's point of view it is necessary an awareness action of consumers towards «ecological productions» and an action to introduce means that guarantee the production environmental quality. It is, however, necessary to start from an analysis of the real situation in order to suppose the effects which can be created by the structural adjustments and initiatives of support, as hypothesized previously.

In order to study the demand of fish products, it has been necessary to carry out a direct survey on a random sample of 100 Apulia consumers who are responsible for family domestic purchases and who are resident in cities located on the coast and in the hinterland. The following descriptive variables of the sample have been taken into consideration: number of family components, number of under 10 years-old children, fish marketplace, frequency of fish products' consumption and family revenue.

The sample is mainly made up of four-components-families without under 10 years-old children with a family revenue ranging between €15.000 and €30.000. By comparing the reported information with the latest population census, a sample's representativeness has been proved to be good. Then, we have tried to evaluate how the sample's socio-economical characteristics can influence the choices and above all, determine different ways to pay (WTP) for an eco-compatible fish product.

The survey has been carried out with the technique of the direct interview which is based on the assignment of a questionnaire made on purpose and divided into two parts: the first one allowed to get information about the socio-economic characteristics of the interviewee and of his family (such as family revenue, type of family, presence of under - 10 years - old children, etc.), frequency of purchases and consumption of fish products in general; the second part of the questionnaire enabled to point out the purchases' modalities of bred sea basses (frequency and market place) and quantities purchased regarding the various market prices. Then, it has been asked to indicate which is their availability to buy a different price (€/Kg) a sea bass obtained with breeding techniques respectful of the environment (use of renewable energy, filters, etc.).

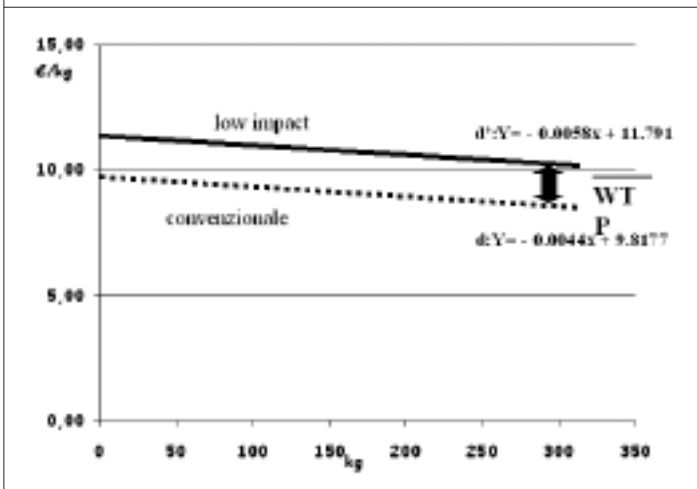
As regards fish consumption, it has been proved that the majority of the consumers are to be defined 'regular', meaning that they are used to buying fish one-twice a week. More than a half of the interviewees buy fish at the superstore; besides, it has been proved that the consumer can find the lowest price for bred sea bass at the superstore; the highest price can be found at the fishmonger's and an intermediate price can be found in the local market.

To the question regarding the motivation of the consumer to pay a 'premium price' for a bred sea bass that does not pollute the environment, 87% of the interviewees has shown their willingness to accept a supplementary price which has resulted to be around 2euro/kg.

Based on these pieces of information there have been spotted, through a linear regression, the demand's function both for functional products and for low impact ones. In the next chart (Fig. 1). there have been reported two different demand curves and their corresponding equations. The special gap between the two curves indicate the average WTP as reported by the consumers' sample.

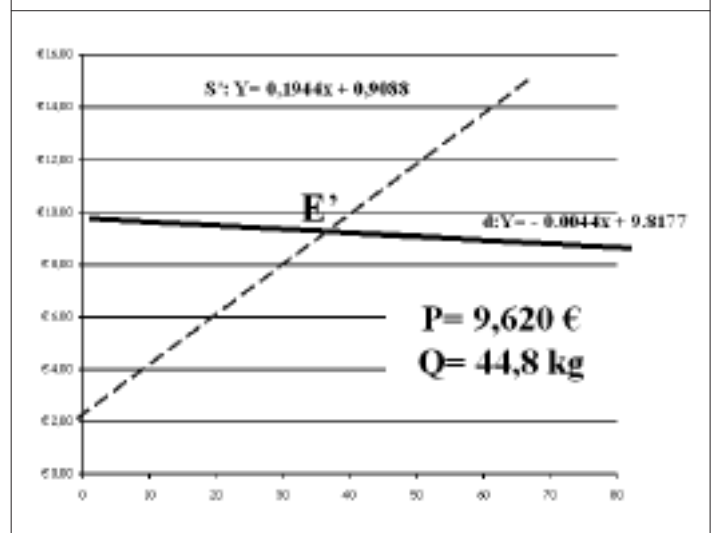
In order to determine the supply curve, there have been taken into consideration some methodological assumptions regarding the use of the suggested model.

Figure 1 – Market demand.



First of all, bred sea bass market can be very competitive on the market since the product is substantially uniform as the compulsory labelling does not provide with enough information that can differentiate the product from the others and the law is not always respected; besides, quality brands and certifications for fish products are still not much widespread, as the quantities of bred product – guaranteed by a voluntary certification - are still not high volumes, mainly because there is a substantial lack in information on the main certification patterns and on their spread in the fish sector. Since it has been planned to work for a short period, technological innovations taken into account do not have direct effects on the volumes produced, triggering therefore an economy of scale. Moreover, the cost for innovation can be made up for the energy saving obtained by alternative renewable sources and/or by reusing effluent water in agriculture. Therefore, it is possible to take into account the curve of the marginal costs which are substantially superimposable to the

Figure 3 – Market equilibrium - subsidy = penalty.



one of the aggregated offer of those companies specializing in Apulia aquaculture. There have been analyzed the production costs of companies considered for the first part of the survey and, through a regression, the supply curve has been drawn. The following charts show the equilibrium conditions on the base-line (Fig. 2), in the case of a penalty (Fig. 3) and in the case of a premium (Fig. 4).

In the conventional case the market equilibrium sets a consumption of almost 46 kg of fish per annum at the price of 9,617€/kg. In the case of introducing hypothetical support mechanism, according to the sustainable performance of the aquacultures, the subsidy will turn into a penalty translating the supply curve towards the higher part and building an equilibrium of 44,8kg per 9,620€/kg (chart n. 3) or (chart n. 4) in a premium translating the supply towards the lowest part and shifting the equilibrium towards 46,3kg per family at the price of 9,613/kg.

Figure 2 – Market equilibrium - base line.

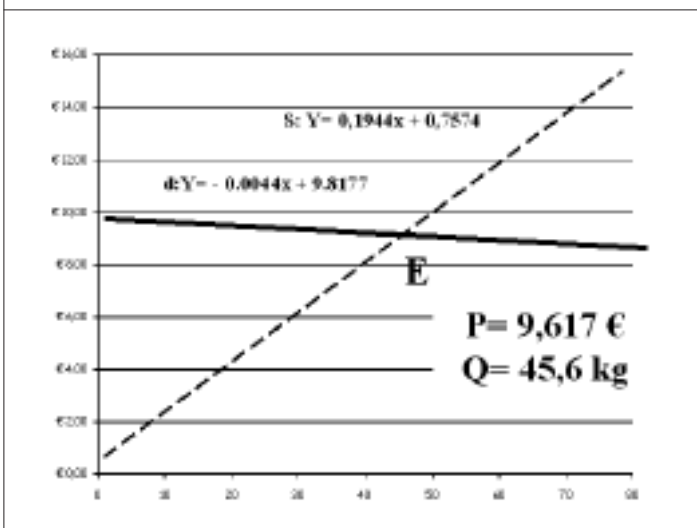
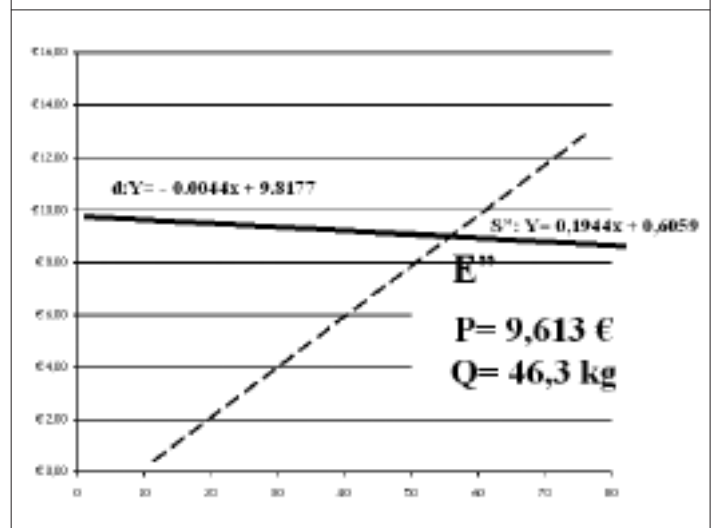


Figure 4 – Market equilibrium - subsidy = premium.



## 4. Conclusions

The results achieved make us assume that the first effect obtained by paying a penalty proportional to the negative impacts on the environment will be represented by an increase in costs for more polluting companies that employ traditional technologies of production. This very likely will imply the exclusion of these companies from the market since the tax penalty effects will be represented by a demand contraction as a consequence of the price increase. At the same time, the possibility to get a benefit means, for those virtuous companies, an incentive to implement technologies of production in respect of the environment. This would be communicated to the consumer through the adoption of a certification that is able to convey to the market information on environmental performances of their products and to provide the consumer with the possibility of making choices of sustainable purchases whose 'environment' variable is the main factor to determine a choice. The most immediate and relevant positive consequence will be an improvement of the environmental state of health, above all as regards the water corpses, considered as receptor of effluent, and the atmospheric pollution.

It would be possible to carry out in a long-term period actions aimed at making aware consumers of environmental problems and, more specifically, of a concept of sustainable productions, in order to encourage them to buy products in respect of the environment but essentially to involve them in the resolution of environmental problems through a declared availability to pay a further price for environmental friendly productions.

In this case, by using as demand function the one expressed by WTP of the consumers interviewed, an equilibrium with the offer of 'eco-friendly' producers (Fig. 5) would be obtained: this would imply an increase both in quantity (54,4kg) and price (11,47€/kg).

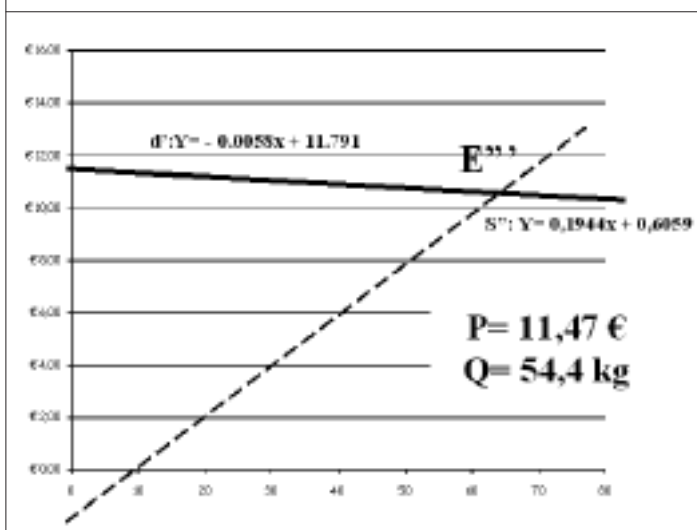
The new market equilibrium obtained will be characterized, as said, by prices and quantities that are much more higher than the traditional product and, above all, by a further efficiency. This is obtained also by the calculus of the producers and consumer's revenue in the different scenarios supposed (chart n. 4).

The last consideration is about the possibility that the new way of consume and 'environmental' production puts down roots in such a way that it consolidates the last equilibrium that would gradually and progressively cancel the benefit by causing a minor tax burden on the community resources.

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Figure 5 - Market equilibrium - premium + promotion.



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