Price-quantity relations and choice of the geographical market size in Italian fresh seafood products

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Abstract

A correct planning and management of the fishing activities cannot ignore the market response to fish production. A wrong assumption about the market size during the empirical investigation can induce to errors in the preparation of the management plans. The purpose of this paper is to provide indications on the real extension (and therefore on the response) of the markets for some of the principal seafood species in Italy. An inverse system framework is followed to empirically investigate the price-quantity relations using a panel of five markets along the coast of the Adriatic Sea. The results confirm that considering only a large geographical size (e.g. national level) can be misleading if the markets are not integrated at this level (for example in the case of cuttlefish), while considering too limited geographical sizes (e.g. local level) can be misleading because the potential market integrations at regional (as in the case of hakes), national (anchovies) or international level are ignored.

Keywords: Price flexibility, market integration, seafood products.

Résumé

Afin d'assurer une programmation et une gestion appropriées des pêches, il est indispensable de prendre en compte la réponse du marché à la production de poisson. De fait, une estimation incorrecte de la taille du marché, déterminée au cours d'une enquête empirique, peut générer des erreurs dans l'élaboration des plans de gestion. Le but de ce travail est donc de donner des indications sur l'étendue réelle (et donc, sur la réponse) des marchés pour les principales espèces de poissons en Italie. Par ailleurs, le système inverse est appliqué pour évaluer empiriquement les relations prix-quantité en utilisant comme échantillon cinq marchés situés sur la côte de l'Adriatique. Ces résultats confirment que considérer exclusivement une dimension géographique trop grande (par exemple, l'échelle nationale) peut induire en erreur si les marchés ne sont pas intégrés à ce niveau (comme dans le cas de la seiche), alors que considérer une dimension géographique trop petite (par exemple, l'échelle locale) peut être fourvoyant parce que on ignorerait les intégrations des marchés potentiels au niveau régional (comme pour le merlu), national (pour les anchois) ou international.

Mots-clés: *Flexibilité des prix, intégration du marché, produits de la mer.*

1. Introduction

At present in Europe one of the major concerns for the fishing sector is the adoption of measures that limit the stocks' overexploitation. At the same time, the objective of a greater economic and social sustainability is not ignored.

A correct planning and management of the fishing activities cannot ignore the market response to fish production. The measurement of this response is conditioned by the market's size: a wrong assumption about the market's size during the empirical investigation can induce to misleading conclusions and errors in the preparation of the management plans. Currently in Italy there is considerable debate about plans for management of fish resources and the geographical extension that should be enclosed. The purpose of this paper is to provide indications on the real extension (and therefore on the response) of the markets for some of the principal seafood species in Italy. We will take as example a panel of five markets of Emilia Romagna region along the coast of the Adriatic Sea, an area that could be selected for the preparation of a fishery plan through shared management between institutions and operators.

Previous studies [1] underlined that the effect of actions looking for price stabilization (e.g. actions promoted by regional fishermen associations) depends on the extent of market integration (integration that could exist between different products and products of different places). Nielsen [2] added that a greater knowledge about the integrations of the markets is essential to foresee the result of stock-recovery policies and fishing effort regulation measures. It is in fact implicit that national or regional policies can have little impact on prices and incomes of the fishermen if the markets are integrated to higher levels.

On a more general level, an analysis of the demand is essential if the purpose of the national policy was the Maximum Economic Yield, rather than the Maximum Sustainable Yield [3-5].

2. The Adriatic Sea fishing industry and the ex-vessel markets of Emilia Romagna

The Adriatic is the sea between the eastern coast of Italy and the Balkan peninsula; the annual catch is approximately 150,000 tons, including fish, molluscs and crustaceans [6]. The stocks are shared among different nations although Italy and Croatia alone extract 98% of the resources (74% and 23% respectively), while less than 2% is caught by the other coastal nations (Slovenia, Bosnia Herzegovina, Montenegro, Albania). Over 80 commercial species are utilized by the fishing industry, but almost 80% of the catch consists of only eight species[1].

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[1] In order of importance: European anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*), striped venus (*Chamelea gallina*), mussel (*Mytilus galloprovincialis*), cuttlefish (*Sepia officinalis*), Europeane hake (*Merluccius merluccius*), spottail mantis squillid (*Squilla mantis*), red mullet (*Mullus barbatus*).

With regard to Italy, it should be specified that, despite its small surface and the increasing Croatian competition, over half of the national catch comes from the Adriatic Sea. As expected, due to the high diversity of species, there are many fleets operating in the Adriatic Sea: bottom trawlers, pelagic pair trawlers, purse seiners, hydraulic dredges, and small-scale coastal fleet.

Pair trawlers and purse seiners are specialized in the catch of pelagic species, especially anchovies that amount to 85% of the catch (in lesser quantities sardines and other secondary species). The catch of the bottom trawlers is, on the other hand, broadly multispecies, the main ones being cuttlefishes, hakes, red mullets and spottail mantis squillids. Cuttlefishes and spottail mantis squillids are also the main catch of the small-scale coastal fleet. At present there is considerable debate regarding the preparation of management plans that should include all the above mentioned fleets and preserve the marine fishery resources from overexploitation.

Most of the Adriatic fishing resources are subject to remarkable fluctuations during the year, determined by specific biological cycles but also by the legislation that usually imposes an interruption of the fishing activity in August, in order to allow recovery of stocks. Peak catches of red mullets between September and October, and of spottail mantis squillids in November are typical examples.

The fluctuations in catches have a direct repercussion on the ex-vessel prices of the wholesale markets, where a part of the production (small or large according to the species) is sold. Besides the auctions in the institutional wholesale markets, landed fish can be exchanged through direct agreements between fishermen and buyers.

Among the buyers that attend them are wholesalers, retailers and restaurateurs; the presence of the large-scale retail trade, the processing industry and exporters is more unusual, as these buyers privilege direct agreements with the fishermen.

For this study six species were chosen for their economic importance: anchovies, sardines, hakes, red mullets, cuttlefishes and spottail mantis squillids. The anchovies, and with less importance the sardines, are the only exported product. Mullets, hakes, cuttlefishes and spottail mantis squillids are basically produced for the local or national market. With regard to hakes, the national production is not sufficient to satisfy the domestic demand, so this species must be imported (frozen, or filleted and frozen) [7]. Spain is Italy's main trading partner inside the EU for almost all seafood products, in fact around 90% of the Italian export of anchovies and around 80% of the export of sardines go to Spain; Spain is also the first European producer of hakes, and Italy imports more than 70% of its requirement from Spain (mainly frozen hakes). Outside the EU, one important partner is Croatia from which Italy imports anchovies, sardines and fresh hakes.

Emilia Romagna Region, which is the case study of this paper, is one of the seven Italian regions along the Adriatic coasts. As shown in Table 1, Emilia Romagna's catches of anchovies, cuttlefishes and spottail mantis squillids represent a meaningful quota of the Italian production (respectively 21, 20 and 26%); the quotas of mullets and sardines are lower (11% and 10%), while hakes represent a very small quota (3%).

Table 1 - *Catches, revenues and prices for species, Emilia Romagna, 2005-2008 average.*

Species	Catches (ton.)	Share on Emilia Romagna's fishery	Share on Italy's catches	Production value (000 €)	Share on Italy's production value	Prices (€/kg)
Anchovies	12,641	43.4%	20.6%	11,267	14.0%	0.89
Cuttlefishes	1,827	6.3%	20.0%	9,766	12.1%	5.35
Spottail mantis squillids	1,659	5.7%	26.0%	10,611	13.2%	6.39
Sardines	1,293	4.4%	10.1%	1,239	1.5%	0.96
Red mullets	915	3.1%	10.7%	2,622	3.3%	2.87
Hakes	400	1.4%	2.7%	2,706	3.4%	6.77
Total	29,098	100.0%	10.5%	80,618	100.0%	2.77

Source: our own calculations based on IREPA database.

Five wholesale markets, connected to the major ports, are located along the Emilia Romagna coast, with an annual total turnover of around 25 million euros. For each market there is an average of 106 registered buyers. All are classified as ex-vessel markets because the seafood products come from the local fisheries (the exchange of products coming from other regions or countries is limited).

Every ex-vessel market can be more or less specialized for some species and a single central market does not exist: Goro is, for example, the market where the largest quantity of anchovies is sold (45%), Cesenatico is the leader for mullets (49%) and sardines (57%), Rimini for hakes (54%) and cuttlefishes (49%), Porto Garibaldi for spottail mantis squillids (33%).

3. The price-quantity relationship

To measure a relationship between prices and quantities within a market, a definition of what a market is first of all necessary. In general it can be said that different goods compete in a market if they are substitutes of each other, and this can be measured through the cross-price effects. Although concepts like integration, substitution, and cross-price effects can be applied to competitive goods with quality differences (e.g. different seafood species) [8], in this paper we will focus on the existing competition between identical products sold in different geographical places.

The theoretical definition of the markets does not resolve the difficulty of identifying a market from an empirical point of view. Depending on the quality of the data, empirical studies can look for price-quantity relationships (for example, by measuring the elasticity or the flexibility) or, if data on quantities are of poor quality, they can focus exclusively on the relationships between prices. In this second case, to define the extension and integration of the markets, it is possible to test for the correlation or causality among time series, to test for the Law of One Price (LOP) or, when time series are nonstationary, to test for the co-integration as done in [1,2,9]. Tests on the prices can show whether products sold in distinct geographical markets are substitutes (perfect or imperfect) or whether they do not compete[2]. For example, a very simple empirical specification, proper for stationary time series, is the following:

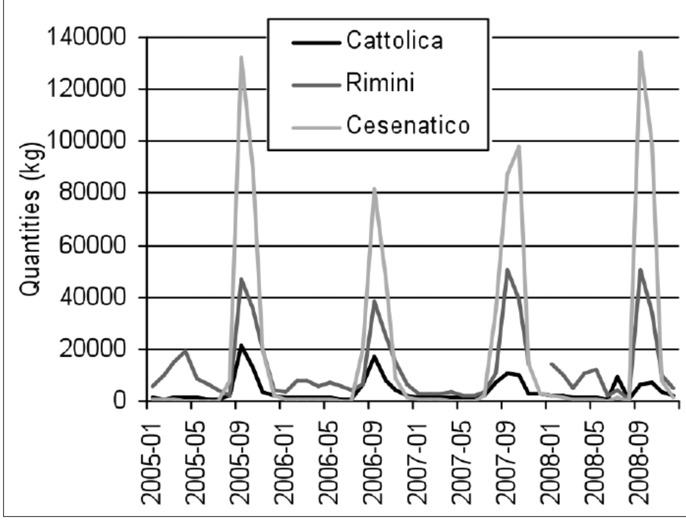
$$p_{yt} = a + bp_{xt} + e_t \qquad (1)$$

where p_{yt} and p_{xt} are the logarithmic price series of two different markets. If b=0 the two markets (goods) do not compete; if b=1 then the substitutability is perfect and the LOP is in force. The constant term a can be interpreted as a transportation cost[3].

This assumption could, however, be misleading in the case of seasonal productions, as happens for some seafood products. For example, take the case of the mullets sold in three wholesale markets of Emilia Romagna (figure 1): the production, and consequently the sales, accumulate in the autumn months. If, let us say, these markets were independent, not in competition, then applying the regression (1) we would still obtain indications of a high-level of integration and substitutability, which is not correct because the prices of each market could exclusively respond to the variation of the corresponding supply.

According to the Neo-classical theory, price formation is determined by the equilibrium between demand and supply; in this process, production quantity and price are determined interactively, although this only happens when the production quantity is influenced by the changing price. On seafood ex-vessel markets, production quantity is not greatly affected by the prices, since the supply is closely connected to exogenous factors such as biological cycles, the weather, and fishing regulations [11]; furthermore, seafood products are perishable goods that must be sold quickly [12]. In this case the supply is exogenously determined and

Figure 1 - *Mullet sales in three ex-vessel markets of Emilia Romagna.*



the price represents the dependent variable [11,13,14]. It is therefore correct to apply an inverse demand model that can be written, in a generalized functional form, according to the following equation:

$$p_i = f(m, q_i, q_j) \qquad (2)$$

where p_i is the price of product i; q_i and q_j are respectively the quantities of product i and of other products sold on the same market; m is the income.

The inverse demand model can assume different forms, including, in the case of a static model, the linear, the logarithmic, the Rotterdam form and other more complex forms [15][4]. The logarithmic form of (2) is given by the equation (3)

$$\ln(p_i) = a_0 + a_m \ln(m) + a_i \ln(q_i) + \sum_j a_j \ln(q_j) \qquad (3)$$

In this paper, however, income will not be considered: because of the fact that products are sold in the landing ports and then partly consumed in the neighbouring zones, partly distributed toward other regions of Italy and partly exported (as in the case of anchovies and sardines), it is not possible to define a geographical level on which income can be applied.

With regard to the products j, as mentioned above, relationships between different seafood products will be ignored, considering instead the relationships between products of the same kind sold in different places[5].

Using this model, the empirically esteemed coefficients a_i and a_j can be interpreted as price flexibility[6], describing the effects that production changes have on prices.

Nielsen [2,11] observed that when price flexibility is estimated in specific markets, for instance distinct countries, wrong interpretations are possible because we do not consider the consequences that a change in quantity can have on the prices in other countries. Nielsen [11] takes as an ex-

2 Nielsen [2] proves that, at European level, a partial but not perfect integration exists in the market of different species of white fish. His study in any case shows an absence of integration for Italian hake.

3 See [10] for a theoretical and bibliographical review of the models used for demand analysis and market integration.

4 For this study both the linear and the logarithmic form were used, but only the last one will be shown as a better statistical fit was obtained for all series, with one exception, that is the hake series.

5 Another element that is sometimes considered, as in [3,16], is the effect of months and festivities through temporal dummies.

6 The price flexibility is defined as the percentage change associated with one percent change in quantity, other factors remaining constant [17].

ample the case of a small market A (e.g. Italy) that is perfectly integrated within a larger market B (e.g. Europe). Let's assume that the Italian production of anchovies is 200 tons, representing 20% of the European production (1000 tons). If an economist estimated the price flexibility coefficient on market A, he could for instance find a value of -0.3; this means that a 10% decrease in Italian production (20 tons) should cause a 3% price increase. Assuming perfect integration of the markets, however, this increase of prices in Italy is followed by a 3% generalized increase on the whole European market B (LOP is in force). The 20 ton Italian production drop corresponds, on the whole market, to a 2% decrease: this means that at a European level the price flexibility is not -0.3 but -3%/2% = -1.5. In other words, if an economist estimates price flexibility on a small market forming a part of a large perfectly integrated market, he undervalues the total effects of the price-quantity relationship.

Therefore, knowing the market share of the species caught in A with respect to B, assuming perfectly integrated markets, the price flexibility for B can be calculated using equation 4.

$$f_{pB} = f_{pA} / w \tag{4}$$

where f_{pB} is the price flexibility for the total market B; f_{pA} is the price flexibility empirically estimated for A; w is the market share of the species caught in A with respect to B. It is implicit that quantity changes in other sub-markets (e.g. Spain) have effects on prices in A too.

The correction factor w is accurate only if markets are perfectly integrated. If the goods produced in A and in B are, instead, not perfect substitutes, the LOP is not in force and the price in B will adjust less than proportionally in comparison to the price in A. In this case the correction factor is no longer given by w, but by a higher value; at the limit case, when A and B are completely independent markets, the correction factor approaches infinity, fpB is zero, and the prices in B do not depend on the production of A, and vice versa.

Nielsen [2] is conscious that it is necessary to also consider the characteristics of the fishing calendars and the existing correlation between the landed quantities. If, for biological and climatic reasons, or due to management policies, the catches follow similar courses, it is not possible to assert that the price flexibility calculated for a sub-market (A) underestimates the price flexibility of the total market (B), since the changes in the quantities occur contemporarily in the whole area B. The characteristics of the system are evidently conditioned by the size of the area: if we are studying a set of nearby markets, with similar climate and managed with the same rules, it is obvious that there will be a greater correlation between landed quantities than in the European or global market.

4. The choice of the empirical model

Nielsen [11] and Asche, Bjørndal and Gordon [10] have completed in-depth reviews of the empirical studies and the models employed to analyze price-quantity relationships of the seafood products, beginning from [16] that was probably the first to estimate a demand equation[7].

A recent and interesting study is the one by Bose [3] where price flexibility is estimated by using the seemingly unrelated regression (SUR).

For this paper, with the objective of verifying at which geographical level catches affect the formation of local prices, the double logarithmic inverse demand system suggested by Nielsen [2] will be used, where the product price on a market is a function of the local catches and the larger market's catches.

The purpose of the empirical model is therefore to calculate own and cross price flexibility in the five ex-vessel markets of Emilia Romagna Region, affected by changes in local production (seafood products landed in each of the five ports) and national production. For products that are traded with foreign countries (anchovies, sardines and hakes) an additional variable was considered, this being the production of Spain, which is Italy's main trade partner.

Time series of single species were used because aggregation (e.g. whitefish) would reduce price flexibility [19] and would hide the effect of fishing calendars.

We have then to analyze six panel data sets, one for each seafood product, composed of five time series (monthly data from 2005 to 2008 of each ex-vessel market). Since the objective is not to define the behaviour of the single markets but the average behaviour (for each product), the whole panel data set can be analyzed taking advantage of differences in time and space; so we will not estimate price flexibility for each market but a general price flexibility of the sample.

Due to the large number of data points (increasing the degrees of freedom) and the presence of variability in two directions (time and markets in this case), estimators that use panel data sets are generally considered more efficient than those using cross-sectional or time series data sets, they have reduced problems of collinearity among explanatory variables, and are more robust in the case of missing and unobserved variables [20-21].

Models applied to panel data sets have been used for a long time to study price-quantity relations in consumers (for instance [22]), but it is rather uncommon to find these kinds of analyses at higher levels of the supply chain[8]. To the authors' knowledge this is the first time that an analysis using panel data sets has been carried out to study price-quantity relations in ex-vessel markets.

The panel data literature distinguishes two basic models: the fixed-effects model and the random-effects model. For our analysis, both the fixed-effects model and the random-effects model can take the form of equation (5), with the difference that the fixed-effects model uses the within-group

[7] See[18] too for a review of the empirical models used to study price-quantity relations.
[8] See [23] and [24] for applications to international trade of seafood products.

estimator, while the random-effects model uses the generalised-least-square (GLS) estimator.

$$\ln p_{it} = m + b \ln q_{it} + g \ln x_t + a_i + e_{it} \qquad (5)$$

In both models $\ln p_{it}$ and $\ln q_{it}$ are the logarithms of prices and quantities sold on market i in month t; x_t is the quantity caught in Italy in month t[9]; m is the "mean intercept".

The key difference is that in the fixed-effects model the individual effect a_i represents the deviation of the ith market from the common mean m (in practice for each market there is a different intercept given by $m + a_i$) and e_{it} represents the error term. In the random-effects model instead, $a_i + e_{it}$ is considered a composed error term with two components: a specific component of the individual i, constant over time, and a residual component [20,21,26].

What is important to note is that the fixed-effects model focuses on the differences within each market (it tries to explain why p_{it} is different from the mean price p_i but does not explain why the mean price of market i, p_i, is different from the mean price of market j, p_j), while in the random-effects model the GLS estimator (like the OLS estimator but in a more efficient way) at the same time considers the differences within the markets and the differences between the markets.

The choice of the most appropriate estimator is not always simple. Sometimes it could be worthwhile to use a statistic test (the Hausman test); from a theoretical point of view, however, when the panel data set is composed of few individuals that represent the totality of the population, then the fixed-effects model is more appropriate. If, instead, the individuals are just a sample of a greater population and we want to make inferences on the effects of the whole population, then the random-effects model is more appropriate.

In this case, considering all Emilia Romagna's ex-vessel markets, and with the purpose of making inferences conditioned on the effects that are in the sample, the fixed-effects model looks more appropriate. Another reason to use the fixed-effects model is that it is not possible to be sure that the proportion between sold quantities (on the institutional whole sale markets) and landed quantities is the same for all the locations. Using the random-effects model we would implicitly assume that the proportion is the same one.

Data on prices and sold quantities on the ex-vessel markets are from the database of the Emilia Romagna's Regional Centre of Fishery Economics (OREI); data on national production are instead from IREPA[10] [27]. All the data are monthly for a four year period from 2005 to 2008.

On the basis of what has been said so far, for a correct specification of the econometric model, we will assume the following hypotheses regarding the data:

a) Monthly prices in each market are not merely determined by the quantities sold on the markets, but by total landed quantities, including the quantities exchanged through direct agreements between fishermen and buyers.

a) The monthly quantities sold in each market are directly proportional to the landed quantities in the contiguous ports.

a) The proportion between landed quantities and quantities sold on the markets, is not necessary the same for every location.

The first hypothesis is based on a theoretical assumption that commodities exchanged on the institutional wholesale market constitutes only a sample of a larger market regulated by the same interaction of demand and supply, so that prices on the institutional market and prices existing out of it are strictly correlated (in other words we presume that the law of one price is in force).

The second hypothesis can be assumed to be on an empirical basis, analyzing some graphs (as in figure 2, comparing the national production of anchovies and mullets and the exchanges on Emilia Romagna's markets) from which it can be inferred that the exchanges on the regional markets are not only proportional to the regional catches, but proportional to the trends of the national catches too.

The last hypothesis, involving the preference for the fixed-effects model, is based on experience, on the opinion of the sector specialists and on a simple analysis of the data. At every location, in fact, each fishermen's cooperative or association is organized in a different way, privileging either the direct agreements with the buyers or the exchanges on the institutional wholesale market. Moreover, the sold quantities on the wholesale markets are not proportional to the size of the contiguous port's fleets [28]. This consideration also involves the impossibility of studying price-quantity relationships using total regional exchanges (through the institutional markets) and weighted average prices: in this way, in fact, the relationship would be conditioned by the institutional market that gathers the largest quantity of product, and not necessarily the location with the largest production.

Using the data available on the Eurostat database (shorter monthly series from 2005 to 2006) [29], the cross price-quantity relationship between Emilia Romagna's ex-vessel prices and Spanish production was tested for anchovies, sardines and hakes, considering that Spain is Italy's main trade partner in the EU. The model, however, does not recognize any significance in these price-quantity relationships.

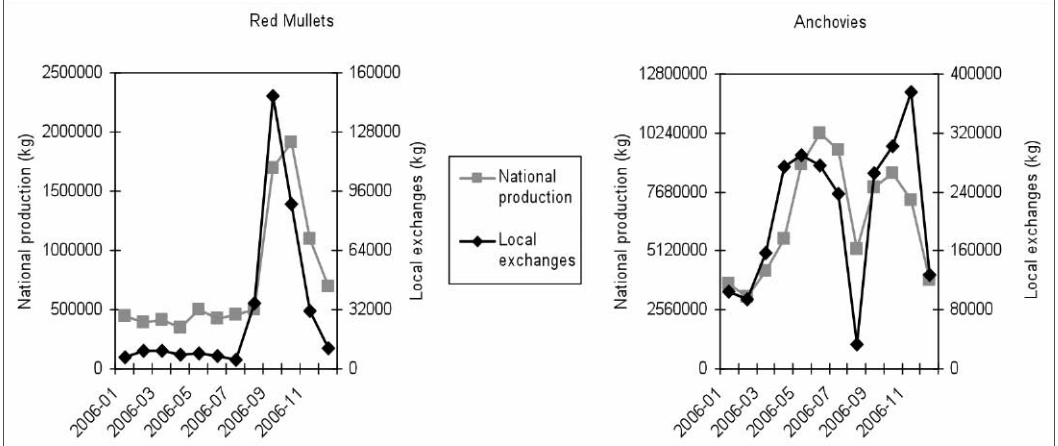
Tests indicated the presence of heteroskedasticity for some series (anchovies, sardines, spottail mantis squillids and hakes)[11]; to avoid misleading conclusions on the statistical significance of parameter estimates, the fixed-effects model was therefore calculated with Beck and Katz's estimator that uses "Panel-Corrected Standard Errors" (PCSE). However, apart from one case (the effect of local production on the price of anchovies), the use of robust standard errors does not change the statistical significance of parameter estimates.

5. Results

The results of the model are shown in table 2. In all cases the sign of the parameters is negative, conforming to theoret-

[9] Italian catches obviously change only in time dimension and not across markets (see for example the application in [25]).
[10] Istituto Ricerche Economiche per la Pesca e l'Acquacoltura.
[11] Also the presence of autocorrelation is probable although more difficult to test for the presence of missing values.

Figure 2. *Exchanges in Emilia Romagna's markets and Italian production: anchovies and mullets (2006).*



tected statistical significance of both parameters: local production (price-flexibility of -0.12) and national production (-0.42). For the spottail mantis squillids, finally, only the national production is statistically significant (price-flexibility of -0.74).

It should be pointed out that the model is in logarithmic form, so the coefficients represent a ratio between percentage variations. Since the local production represents only a part of the national production, when a 10% reduction is presumed for the two variables we are actually speaking of very different quantities. Take the case of the mullets, for which the regional production constitutes around 10% of the national production; therefore, on an average, 2% of the Italian production is landed in one of Emilia Romagna's 5 ports. A 10% reduction of the national production (on an annual basis) corre-

ical expectation, i.e. price decreases when production quantity increases and vice versa. Moreover, all coefficients are, in absolute value, smaller than one, thereby indicating price inflexibility.

The most interesting element is, however, verifying whether prices respond more to the quantity sold on the local market, to the national production or to a combination of both.

In the case of anchovies the effect of the national production proves rather influential (price-flexibility of -0.19), while the effect of the local production (with a coefficient of -0.03) is not statistically significant[12]. This is consistent with what was expected: being an important exported product, with buyers that are particularly active on the national territory, it was logical to assume a large integration of the anchovies market. It must also be considered that 20% of the national production is landed in Emilia Romagna, evidence of a marked surplus, in comparison to the local demand, that supports trade and export.

The case of sardines, another exported product is different, and apparently contradictory. Sardine catches have actually drastically decreased in comparison to the recent past and, similarly, exports have dropped so that, in 2007-2008, the exported quantities were practically identical to the imported ones. Moreover, and contrary to the anchovies, Emilia Romagna catches represent only 10% of the national production and therefore have a greater importance for local consumption. This could explain why the model excludes any influence of the national production on the formation of local price. The only effect should thus be that of local production (price-flexibility of -0.11).

For the cuttlefish series, the local production effect is statistically significant (price-flexibility of -0.12), while national production is not. The situation of the hakes is similar: price-flexibility of -0.10 for local production is statistically significant, while price-flexibility for national production is not.

The mullets are the only product for which the model de-

Table 2 - *Estimated price function parameters for selected seafood products.*

Product	Coefficients and Standard Errors[1]	
Anchovies[2]		
Constant	3.073	(1.000)***
Local sold quantity	-0.026	(0.021)
National production	-0.193	(0.070)***
Cuttlefishes		
Constant	3.620	(0.743)***
Local sold quantity	-0.124	(0.018)***
National production	-0.076	(0.060)
Spottail mantis squillids		
Constant	11.468	(0.985)***
Local sold quantity	-0.001	(0.044)
National production	-0.742	(0.094)***
Sardines[2]		
Constant	-0.416	(0.892)
Local sold quantity	-0.106	(0.023)***
National production	0.100	(0.068)
Red mullets		
Constant	8.188	(1.058)***
Local sold quantity	-0.123	(0.024)***
National production	-0.418	(0.088)***
Hakes		
Constant	3.054	(1.849)
Local sold quantity	-0.103	(0.026)***
National production	-0.028	(0.135)

****/**/* = significance at 1%. 5% and 10% levels.*
[1] Robust Standard Errors have been calculated.
[2] The estimation is undertaken without 4 outlier observation for the anchovies series and 2 for the sardines series.

[12] The parameter is statistically significant if robust standard errors are not used.

sponds to around 900 tons, while a 10% reduction in the local production (of one port) corresponds to 18 tons.

It is evident that, if we consider variations in absolute terms rather than in percentage terms, the weight of the local production is larger than the total production. To go back to the previous example: an 18 ton reduction in the local production of mullets causes a 1.2% increase of the local price (the price-flexibility is -0.12). An 18 ton reduction in the national production (local production assumed constant), that is a -0.2% change, considering the cross price-flexibility of -0.42 obtained from the model, should cause a poor +0.084% price increase.

This means that, although market integration exists for mullets at national level, the local production still has a strong influence on price formation.

It is important to also verify the proportion of variance explained by the model. R^2 values are shown in table 3 (see [21] for the different R^2 meanings). The higher proportion of variance is explained for spottail mantis squillids and mullets, the two products whose price is more affected by the national production. It is not by chance that these two species are those with stronger seasonality and catches accumulated in just a few months. In these circumstances the whole national production is put on the market at the same time, with a considerable effect on prices.

Table 3 - *Proportion of variance explained by the fixed-effects model.*

	Anchovies	Cuttlefishes	S.M.Squillids	Sardines	Mullets	Hakes
R^2	0.593	0.425	0.619	0.275	0.646	0.154
Adjusted R^2	0.578	0.409	0.609	0.247	0.633	0.129
Within R^2	0.462	0.337	0.542	0.231	0.624	0.119

On the other hand, the proportion of variance explained is low for hakes. In this case the chosen model is perhaps incorrect both in the form and in the selected variables. According to several tests[13], the more correct functional form is not the logarithmic but the linear one, and the variables previously used (national production and local sold quantities) should be replaced by the regional production. This result, though complicating the situation, is particularly interesting because it confirms that market integration can have different geographical sizes. In the case of the hakes it seems that market integration does not exist at national level (the national production does not affect the local prices), but it is not even correct to conclude that prices are exclusively affected by the local production: market integration may exist at a regional or other intermediate level.

A separate consideration should be made for the spottail mantis squillids. As we have seen the model does not seem to reveal any influence of local production on prices. Actually, looking for an mean value, the result conceals substantial differences at the level of individual markets. Considering the markets independently, it can be observed that three of them are affected by local production (statistically speaking), but it is enough for the price-quantity relationship not to be significant for the other two to extend the result to the whole panel data set. It is not by chance that the two ports where the local production effect is not statistically significant, are those where price-flexibility due to national production is higher, a sign of a greater integration on a larger geographical level.

In table 2, the coefficients a_i, that according to equation (5) represent the deviation of each market i from the common intercept m , are not shown. Without looking in detail at the individual a_i values, it is worth observing that one market, Goro, shows marked negative variations for all the seafood products, indicating prices that are lower than on the other markets (production being equal). Differences of this nature cannot be explained by the model; it is only possible to hypothesize that structural (related to the ports and to the markets) or organizational (related to the fishermen and to the buyers) reasons affect the prices. One element that can have an influence and is not considered in the model is, for example, the number and nature of the buyers for each product [30].

6. Concluding remarks

The results confirm that the choice of the geographical market size, on which to measure production quantities, can considerably bias the results of price-quantity studies on ex-vessel markets.

Considering only a large geographical size (e.g. national level) can be misleading if the markets are not integrated at this level (for example in the case of cuttlefishes) or, even if integrated, the important effect of local production is ignored (mullets).

Obviously also considering too limited geographical sizes (e.g. local level) can be misleading because the potential market integrations at regional (as in the case of hakes), national (anchovies) or international level are ignored.

It is necessary to consider that the ex-vessel markets are attended by both wholesalers who supply other regions of Italy or export to Spain, and local buyers such as retailers and restaurateurs. We can thus recognize two categories of buyers: some that are active on an elevated number of markets (at regional or national level) privileging the locations where the price is lower, and others that purchase exclusively on the local market and are therefore more conditioned by local catches.

This situation can be valued observing own price flexibility of local products sold in ex-vessel markets. Where the relationship is very inflexible (e.g. anchovies) the price is indifferent to the local production, probably because there is a large proportion of buyers who are active on larger geographical levels and have the possibility to differentiate their choices. A less pronounced inflexibility (e.g. cuttlefishes) is instead interpretable as a market where the local buyers, conditioned by the local production, are predominant.

It must also be noted that the applied methodology, seeking a mean value of price-flexibility for a set of markets, can conceal some existing differences among them. This is, for example, the case of the spottail mantis squillids for which more detailed analysis can show that every individual market has a different degree of integration at national level.

All these considerations must be taken into account when talking about the appropriate geographical level for fish management plans. The European legislation is, in this respect, very elastic, conjecturing plans at local, national or interna-

[13] Lagrange Multiplier Test, Ramsey Reset Test and White Test.

tional level [31-33] and also attributing an important planning role to the producer organizations [34]. In the case of Emilia Romagna's fishing industry, many solutions are still possible: it is in fact probable that the whole region could fall within a management plan including all or part of the Adriatic Sea, but the adoption of nested management plans at regional or even single port level cannot be excluded.

If, besides the protection and recovery of overexploited stocks, the fish management plans intend to influence price levels and stability, the geographical size where the price-quantity relationships are determined cannot be ignored. In the case of highly integrated markets, a management limited to local levels would prove ineffective, requiring at least some common coordination among all the areas within the market boundaries.

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