Market integration between wild and farmed seabream and seabass in Spain

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Abstract

Gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) production from aquaculture has been increasing since the 1990s. Nowadays, about 95% of their production comes from aquaculture. In this study we analyze if the rapid growth in the aquaculture production of both species has affected the capture fisheries prices of both species. In other words, we investigate if there is market integration between wild and farmed gilthead seabream and European seabass. In order to do this analysis, we use data from the main gilthead seabream and European seabass markets in Spain. Results show that there is no or limited market integration between wild and farmed gilthead seabream and European seabass. This implies that capture fisheries are not significantly affected by increases in the aquaculture production of both species. But gilthead seabream and European seabass aquaculture producers face a smaller demand that explains the difficulties this aquaculture segment is facing.

Keywords: market integration, price competition, aquaculture, fisheries, Spain.
JEL codes: Q22, Q21, D49, C22.

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1. Introduction

Gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) production reached 173 thousand tonnes and 161 thousand tonnes in 2013, respectively. About 95% of the gilthead seabream and European seabass production comes from aquaculture and almost all from Mediterranean countries (about 96%). Gilthead seabream and European seabass are the most important farmed species in the Mediterranean. Together they represent 63% in quantity and 80% in value of all the aquaculture production in the Mediterranean basin. The main producers are Turkey, Greece, Spain and Egypt, while the main markets are in Northern Mediterranean countries: Spain, France, Italy, Greece and Turkey. The €5 to €10/kg retail price for seabass and seabream is too high for a large proportion of the population living in the Southern Mediterranean countries (Monfort, 2007).

First sale prices of farmed gilthead seabream and European seabass stabilised at around €4.5/kg in 2003, after they achieved their minimum historical level in 2001 and 2002 (ex-farm prices for gilthead seabream and European seabass in 2002 reached €2.9 and €3.2/kg, respectively) (see figure 1) (FAO, 2016). This crisis was due to major investments in the industry that led to an increase in supply from 2000 that the demand could not absorb at the prevailing prices (Ernst & Young, et al., 2010). As a result, prices fell below cost of production, resulting in a rationalisation of the industry (University of Stirling, 2004; STECF, 2014).

(Figure 1 to be placed around here)

Wild gilthead seabream catches have been oscillating between 6,000 and 10,000 tonnes annually since the early 1990s. European seabass catches increased to almost 12,000 tonnes in the early 2000s but since then they have suffered a decreasing trend to around 9,000 tonnes annually during the last years (FAO, 2016). These quantities are very small compared to farmed production. Thus, capture fisheries only supply a small share of the gilthead seabream and European seabass production, and no significant supply increases from the capture sector can be expected.

In this study we analyse if the rapid growth in the production of farmed gilthead seabream and European seabass has affected the prices of both species from capture production fisheries. In other words, we investigate if there is market integration (competition) between wild and farmed gilthead seabream and European seabass. Market integration between capture fisheries and aquaculture can be observed, for the most part, when increased aquaculture supply leads to decreases in wild-caught seafood prices (Anderson, 1985). When market integration is verified, it means that there is substitutability between wild-caught and farmed products.

If two products (wild and farmed) are close substitutes, and considering that aquaculture is probably the fastest growing food-producing sector in the world, farmed produce will win market share from the wild produce. If demand is not perfectly elastic, the price of both products will decline, as will the income of fishermen. However, if the two products are not substitutes, so that there are no market effects, the increase in the supply of the farmed product will only lead to a price decrease for farmed product and not affect the price of wild-caught product (Asche et al., 2001).

Current knowledge on market competition between aquaculture and wild fish is based on a small number of species and markets. Studies have mostly focused on salmon, shrimp, tilapia, and seabass and seabream, which are the most traded species, and the US and EU markets, the two main consumer markets (Bjørndal and Guillen, 2016). In particular, when it comes to Southern Europe, existing knowledge on competition interactions between wild and farmed species in the area is more limited, and it is based solely on a few studies investigating gilthead seabream, European seabass, Atlantic salmon (*Salmo salar*) and shrimps (*Penaeus spp.*) in Spain, France and Italy.

For Spain, Alfranca et al. (2004) found that wild gilthead seabream prices are affected by farmed gilthead seabream prices in the Barcelona wholesale market. However, Rodríguez et al. (2013) showed that wild and farmed gilthead seabream are considered two heterogeneous products and consequently they are not substitutes in the Madrid wholesale market.

In French households, Regnier and Bayramoglu (2016) found that farmed seabream prices partly affect wild seabream species[1] prices; while, farmed European seabass does not compete with wild seabass species[2]. On the other hand, Brigante and Lem (2001) concluded that wild and farmed conspecifics are not substitutes for gilthead seabream and European seabass in Italy.

[1] Consisting of the following species: *Sparus aurata*, *Spondyliosoma cantharus*, *Pagellus bogaraveo*, *Coryphaena hippurus*, *Sebastes mentella*, *Sebastes marinus*, and *Lithognathus mormyrus.*
[2] Consisting of the following species: *Dicentrarchus labrax* and *Anarhichas lupus.*

In addition, Alfranca et al. (2004) found that wild sole, farmed Atlantic salmon, farmed European seabass, and wild European seabass prices have a weak and not very significant influence on farmed and wild gilthead seabream prices in the Barcelona wholesale market. Similarly, Jaffry et al. (2000), using quarterly import prices for the period 1984-1996, examined the extent to which farmed Atlantic salmon competes with the main traditional wild-caught fish species in the Spanish market. They found that farmed Atlantic salmon was only a weak substitute for wild-caught tuna, hake and whiting, but no significant interaction could be found.

Likewise, Gordon, Salvanes and Atkins (1993) found that farmed Atlantic salmon prices were not affected by wild turbot (*Psetta maxima*) and Atlantic cod (*Gadus morhua*) in Rungis, the Paris wholesale market, during the period 1981-1990. However, Béné et al. (2000) found that imports of wild brown shrimp (*Penaeus subtilis*) from the French Guyana were substitutes for the imports of farmed Thai black tiger shrimp (*Penaeus monodon*) in the French market for the period 1986-1993[3]. More recent studies are not available.

Therefore, available studies on competition interactions between wild and farmed species in Southern European countries are based on a limited number of cases, sometimes using old data sets, and some of their results may appear to be contradictory (especially for gilthead seabream and European seabass). The differences in the outcomes obtained could be, at least in part, due to the different data sources employed and the time periods analysed. Markets are dynamic and may be different today from the situation 10 or 20 years ago. Therefore, in this study we investigate in more detail and in a more comprehensive approach the existence of market interactions between wild and farmed gilthead seabream and European seabass in the area using recent data sets.

This paper is organised as follows. Section two describes the Spanish market chain for gilthead seabream and European seabass in Spain. Section three introduces the methodology to estimate the existence of market integration: the Johansen cointegration test. Data used for the analysis is presented in section four. Section five presents the results obtained, while section six provides a discussion and interpretation of the results. The paper is summarised in the final section.

2. Spanish market chain for seabream and seabass

Gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) are the most produced species in the Mediterranean and Black Sea, at 299 thousand tonnes and €1.39 billion in

[3] Shrimp farmed production in Europe is almost negligible, so all domestic production comes from capture fisheries.

2014 (FAO, 2016). Gilthead seabream and European seabass represent 63% in quantity and 80% in value of all the aquaculture production in the Mediterranean basin. Ninety-five percent of the world gilthead seabream and European seabass production comes from aquaculture, and 96% of the world gilthead seabream and European seabass production comes from Mediterranean countries.

Similarly, most Spanish production of gilthead seabream and European seabass comes from aquaculture. Spanish aquaculture produced 16.92 thousand tonnes of gilthead seabream and 16.72 thousand tonnes of European seabass in 2014; while, wild catches amounted to 0.82 thousand tonnes of gilthead seabream and 0.57 thousand tonnes of European seabass (FAO, 2016). The main producer countries of gilthead seabream and European seabass are Turkey and Greece, followed by Spain, Egypt, Italy and France. While, the main consumer countries are Spain, France, Italy, Greece and Turkey.

Spain is one of the largest fish producer and consumer countries in Europe. The EU is a major market of seafood products, with 12.3 million tonnes consumed in 2011, worth a total € 52.2 billion. Spain is the largest seafood market in the EU, with an apparent consumption of € 11.3 billion, followed by France and Italy with € 10 and € 9.7 billion, respectively (DG MARE, 2015). The Spanish fish market is characterized by the high diversity of species, a wide range of prices, and the importance of whole fresh fish in terms of market share (see for instance FAO, 2016).

In Spain, an important part of the fisheries production, especially landings, is directed from the first sale auctions to the wholesale markets (mercas) by intermediaries. Wholesale markets are the main commercialization centers; they work as spot markets, distributing landings from the auctions, landings from other areas, aquaculture products, as well as imports, aimed to supply the main cities. This wholesale network covers all Spain and consists of 23 markets, hosting more than 2000 wholesale firms. Of these 23 wholesale markets, just 17 of them contain a seafood market.

Mercamadrid and Mercabarna (Madrid and Barcelona wholesale markets) are the main wholesale markets in Spain. Between both of them, cover almost the 50% of the total seafood commercialized in the Spanish wholesale markets network. In 2014, they commercialized 7.60 thousand tonnes of farmed gilthead seabream, 0.32 thousand tonnes of wild-caught gilthead seabream, 4.87 thousand tonnes of farmed European seabass and 0.36 thousand tonnes of wild-caught European seabass. This amounts are equivalent to almost 45% of the total Spanish production of gilthead seabream and more than 30% of the European seabass one.

Spain is a net importer of seafood products, and in 2013 net imported (imports minus exports) 4.05 thousand tonnes of gilthead seabream and 2.65 thousand tonnes of European seabass (FAO, 2016). Unfortunately, trade data does not differentiate between the farmed and wild product. Same drawback happens to consumption data, and in addition, consumption data are often less precise. Spanish consumption at home of more generic bream and bass were estimated to be 27.0 thousand tonnes of gilthead seabream and 18.1 thousand tonnes of European seabass, worth €202 million and €151 million, respectively, in 2014 (MAPAMA, 2016).

Fresh wild fish products often go through these traditional supply chain levels of first-sale (auction), wholesale and retail markets (Guillen and Franquesa, 2015). However, some high value fresh wild fish products, especially the largest and most expensive individuals of certain species (e.g. shrimp, Norway lobster, grouper, hake), do not go to the retail market, but are destined for restaurants (Guillen and Maynou, 2015). Indeed, often white tablecloth restaurants only serve wild fish products. Thus, a part of the high valued wild products does reach the retail market level, which explains that wholesale prices can sometimes be higher than retail prices (mostly for consumption at home). On the other hand, the first sale of farmed fish often happens at the wholesale level or at least with fewer middlemen between the first sale and the wholesale market.

In the last decades, the main changes that have affected the Spanish market chain of fish products have been a concentration in the supply of fish products at the retail level by large supermarket chains that has lead to a reduction of the mercas market share and an increase in the value and volume of fish traded internationally, particularly for aquaculture products (Guillen and Franquesa, 2015).

3. Methodology

The development of prices over time provides important information on the relationship between products, as has been widely recognised by economists such as Cournot (1838), Marshall (1947) and Stigler (1969). Market integration analysis using time series data for prices has been used for a number of seafood products. It is particularly useful when there is a need to analyse a large number of products, as demand analysis in such cases is not feasible (Asche, Gordon and Hannesson, 2004).

Following Ravallion (1986), market integration is analysed by looking at whether prices of products are related over time, which allows price adjustment between markets to take time. We investigate if the price of a product (dependent variable P_1) can be explained by the price evolution of another product (explanatory variable P_2), as well as its own previous price evolution. We use the following model specification:

$$P_{1,t} = \alpha + \sum_{j=1}^{m} \beta_j P_{1,t-j} + \sum_{i=0}^{n} \delta_i P_{2,t-i} + e_t \qquad \text{(Eq. 1)}$$

Here α is a constant term and e is a white noise error term. Hence, if δ_i is equal to 0, there is no relation between the prices of both products, so there is no market integration, while if δ_i is different from 0, there is a relation between the prices of both products, and consequently there is market integration.

The relationships between variables have traditionally been studied with ordinary regression analysis. Such methodology can only be used when variables (i.e., prices) are stationary (Squires, Herrick Jr., and Hastie, 1989; Asche, Gordon and Hannesson, 2004), but many economic variables show trends, and so they are non-stationary. When non-stationary time series (e.g. prices) are used in a regression model, relationships that appear to be significant may emerge from unrelated variables (spurious regression). Therefore, the use of cointegration methodology is required to estimate real long-run relationships between non-stationary variables (Ardeni, 1989; Whalen, 1990; Goodwin and Schroeder, 1991). Since most seafood prices have been found to be non-stationary, cointegration is currently the most commonly used empirical tool to test for market integration (e.g. Nielsen et al., 2007; Norman-López and Asche, 2008; Nielsen, Smit and Guillen, 2009).

The idea of cointegration is that even if two or more variables are non-stationary in their levels, linear combinations (so-called cointegration vectors) which are stationary may exist (Engle and Granger, 1987). When cointegration is verified, the variables exhibit (one or more) long run relationships. Variables may drift apart due to random shocks, sticky prices, contracts, etc. in the short run, but in the long run, the economic processes force the variables back to their long run equilibrium path (Engle and Ganger, 1987). Hence, the economic interpretation of cointegration is that "if two (or more) series are linked to form an equilibrium relationship spanning the long-run, then even though the series themselves may contain stochastic trends (that makes them to be non-stationary) they will nevertheless move closely together over time and the difference between them will be stable (so stationary)" (Harris, 1995, p22). Therefore, prices for products in the same market are part of a long-run equilibrium system, although significant short-run deviations from equilibrium conditions may still be observed due to stochastic supply and demand shocks. So, if the products are substitutive, there will be market forces working to re-equilibrate the price ratio after a shock occurs in the market. Thus, when cointegration is verified, it implies the existence of a stable long-run relationship between the prices, from which it can be assumed that a price parity equilibrium condition exists, and consequently the variables form part of the same market (Asche and Steen, 1998). So, cointegration theory is consistent with Stigler and Sherwin's market's definition[4] and the stochastic behaviour of prices.

Most recent market integration studies have used the multivariate Johansen cointegration test (Johansen 1988, 1991; Johansen and Juselius, 1990), solving the problems faced in bivariate methods by providing a matrix with all possible distinct cointegration vectors based on all the variables. Thus, the Johansen test enables testing for both cointegration and hypothesis testing on the parameters in the cointegration vector.

Under the Johansen approach the data is divided into two groupings, the variables in their levels and their first differences. Using the technique of canonical correlation, the linear combinations of the data (in their levels) that are highly correlated with the differences are found. If the correlation is sufficiently high, then it follows that these linear combinations are stationary, and so are the cointegration vectors.

The multivariate approach developed by Johansen starts by defining a vector Z_t, containing *n* potentially endogenous variables, where it is possible to specify a data generating process and model Z_t as an unrestricted vector autoregression (VAR) with up to k-lags of Z_t:

$$Z_t = A_1 Z_{t-1} + \ldots + A_k Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \qquad \text{(Eq. 2)}$$

where Z_t is (n×1), each of the A_i is an (n×n) matrix of the coefficients, D_t are seasonal dummies orthogonal to the constant term μ and $\varepsilon_t \sim$ niid $(0,\Omega)$, so it is assumed to be an independent and identically distributed Gaussian process. Equation 2 can be reformulated in vector error-correction (VECM) form by subtracting Z_{t-1} from both sides:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \ldots + \Gamma_{k-1} \Delta Z_{t-k+1} + \Pi Z_{t-k} + \Phi D_t + \mu + \varepsilon_t \qquad \text{(Eq. 3)}$$

where, $\Gamma_i = -(I - A_1 - \ldots - A_i)$, $(i = 1, \ldots, k-1)$, and $\Pi = -(I - A_1 - \ldots - A_k)$. (Eq. 4)

The system of equations 2 and 3, contains information on both the short- and the long-run adjustment to changes in Z_t. The rank of Π, denoted as r, determines how many linear combinations of Z_t are stationary.

[4] Stigler and Sherwin (1985) define substitute products as those which are "in the same market" and whose relative prices "maintain a stable ratio".

Determining the lag order to take into account in the model is a key issue in cointegration. This happens because in order to apply cointegration, a series should be non-stationary; but the stationarity properties of a series can change with the number of lags considered as explanatory variables. The optimal number of lags for one series (e.g. found using a unit root test) may be different from the optimal number of lags for another series we want to compare. And these lag-lengths may be different from the optimal number of lags when applying cointegration methodology. Thus, estimating the optimal number of lags for one series using a unit root test may be of little help initially. In addition, different lag length selection criteria often lead to different conclusions regarding the optimal number of lags that should be used. Meanwhile, the choice of the lag length can considerably affect the results of the cointegration analysis (Emerson, 2007). Therefore, we determine the number of lags using three different criteria:

- Log Likelihood
- Akaike Information Criteria
- Schwarz Criteria

Determining how many cointegration vectors exist is the same as testing for cointegration. If $r = N$, the variables in levels are stationary. While if $r = 0$ so that $P = 0$, none of the linear combinations are stationary. When $0 < r < N$, r cointegration vectors, or r stationary linear combinations of Z_t exist.

Therefore four different outcomes can be obtained from the cointegration tests when estimating them for the number of lags obtained using the previous criteria:

- All tests show two cointegration equations. Then prices are stationary and cointegration methodology cannot be applied.
- All tests show zero cointegration equations. Then prices are not cointegrated, and consequently products are not in the same market.
- All tests show one cointegration equation. There is then the need to investigate the stationarity properties of the series. There are two options. It could be that both series are non-stationary and they are cointegrated (i.e., are part of the same market), so there is only one cointegration equation. But it could be possible that one of the series is stationary and the other one is non-stationary, and consequently they are not cointegrated.
- Outcomes from the tests report different numbers of cointegration equations depending on the lag chosen. There is then the need to investigate the stationarity properties of the series, and results should be considered with caution.

4. Data

In order to properly analyze market integration of wild and farmed species, it is the need to compare fish prices of the same species at the same market level. However, there is an important general lack of detailed price data in many European countries. For this study, wild and farmed European seabass and gilthead seabream price data from the wholesale market level for Spain have been used. Unfortunately, no data with the required similar specifications were available for other markets and countries. Prices of these wild fish species are available at the ex-vessel market; but unfortunately, prices for these farmed species are not available at that level. While prices of these species are available at the retail level, but often prices do not differentiate between wild and farmed origin, and consequently are not suitable for the analysis.

The use of cointegration methodology is very data demanding, as it requires a large number of observations (close to 100 observations depending on the characteristics of the series) in order to obtain robust results. In addition, for our study we require price data disaggregated between farmed and wild origin. However, these data are rarely available, in part because: (i) few countries collect and report detailed price data, (ii) there are few markets where both wild and farmed conspecifics supplies are present and properly differentiated.

In order to carry out this analysis we use the following weekly price data:

- European seabass
  - Madrid's wholesale market (Mercamadrid) for the period 2003-14;
  - Barcelona's wholesale market (Mercabarna) for the period 2006-14;
- Gilthead seabream
  - Madrid's wholesale market (Mercamadrid) for the period 2003-14;
  - Barcelona's wholesale market (Mercabarna) for the period 2006-14.

The descriptive statistics (mean, standard deviation, coefficient of variation and number of observations) for the data we use are presented in Table 1. It can be seen that wild products are more expensive, but they also suffer from higher price volatility (i.e., their coefficient of variation is higher).

(Table 1 to be placed around here)

5. Results

In this section, we report the results from the market integration analysis between wild and farmed conspecifics of gilthead seabream and European seabass.

The lag length selection is done for three different criteria (Log Likelihood, Akaike Information Criteria, and Schwarz Criteria). In the appendix the different values obtained for each criterion at each lag length are presented. In table 2 we present the optimal lag length for each criterion, summarising the results in the appendix.

(Table 2 to be placed around here)

Table 3 presents the cointegration results for wild and farmed European seabass and Gilthead seabream by market place according to the lag length previously obtained.

(Table 3 to be placed around here)

For gilthead seabream in the Madrid wholesale market, both cointegration tests show the existence of one cointegration equation between wild and farmed conspecifics, so the stationarity behavior of both series needs to be analysed (see table 4).

The ADF Test statistics for wild gilthead seabream price in the Madrid wholesale market (-2.049 and -2.492) are higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level (-2.866). So, the wild gilthead seabream price in the Madrid wholesale market behaves as a non-stationary series. The farmed seabream price series on the other hand behaves as stationary. Therefore, there is no market integration between wild and farmed seabream in the Madrid wholesale market.

While for gilthead seabream in the Barcelona wholesale market, both cointegration tests, considering no lags and 5 lags, report 2 cointegration equations between wild and farmed conspecifics, showing that prices are stationary and regression methodology should be used (see table 5). But when considering 1 lag, the cointegration test shows that there is 1 cointegration equation, and consequently the stationarity behaviour of both series (for 1 lag) needs to be analysed (see table 4).

(Table 4 to be placed around here)

The ADF Test statistic for farmed gilthead seabream price in the Barcelona wholesale market (-2.649) is higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level (-2.868). Thus, the farmed seabream price series behaves as a non-stationary series. However, the wild seabream price series behaves as stationary. Therefore, there is no market integration between wild and farmed seabream in the Barcelona wholesale market when considering one lag.

For European seabass, all likelihood ratio tests of the cointegration tests show the existence of two cointegration equations between wild and farmed conspecifics, consequently, prices are stationary and regression methodology should be used (see table 5).

Therefore, regressions analysis should be used in different cases to verify the existence of market integration. It is needed to investigate whether the price of wild fish (in time t) is determined by the price of farmed fish (in time t and previous periods – lags), and vice versa. Table 5 summarises the outcomes of the regression analysis that are presented in the appendix.

(Table 5 to be placed around here)

Table 6 summarises the market integration outcomes from the cointegration and regression methodologies for wild and farmed European seabass and gilthead seabream by market place.

(Table 6 to be placed around here)

6. Discussion and Conclusions

The introduction of aquaculture has led to a higher total seafood supply, lower seafood prices and lower price volatility (Dahl and Oglend, 2014; Asche, Dahl and Steen, 2015). Aquaculture has become one of the fastest growing food production sectors in the world (Asche, 2008). Through this contribution to the decrease in the prices of seafood and the increase of total supply, aquaculture has accelerated the globalisation of trade and increased the concentration and integration of the seafood industry worldwide (Schmidt, 2003; Guillotreau, 2004). Quality improvements and new product developments have been boosted and logistics improved so that international airfreight is commonplace, changing the way of doing business with a stronger market orientation and risk reduction due to decreased price volatility. Aquaculture also has a positive influence on the development of new markets and the promotion of seafood consumption in general (Valderrama and Anderson, 2008). Indeed, fish has become one of the most traded food commodities worldwide (FAO, 2014).

This rapid growth of aquaculture has affected capture fisheries. The interactions between wild fisheries and aquaculture have been widely detailed by Soto et al. (2012) and Knapp (2015), whereas Bjørndal and Guillen (2016) analysed the literature on market interactions (i.e., market integration or competition) between wild and farmed fish. Market integration between capture fisheries and aquaculture is often perceived when increased aquaculture supply leads to decreases in wild-caught fish prices (Anderson, 1985). The literature on market integration between aquaculture and wild fish is still based on a small number of species and markets. In particular, previous studies on market integration between wild and farmed gilthead seabream and European seabass have focused on the Spanish, French and Italian markets. These studies are based on a very limited number of cases, sometimes using old data sets, and some of their results may appear to be contradictory. These diverse results could be, at least in part, due to the different data sources employed, markets and the time periods analysed. Fish markets are dynamic and are continuously evolving, so results can be sensitive to the period investigated (Setälä et al., 2003). This made us use the most recent data available.

Gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) production from aquaculture has been increasing since the 1990s. Rapid growth in the aquaculture production of both species has led to significant declines in the prices of farmed varieties of both species. First sale prices of farmed gilthead seabream and European seabass have recently stabilised at around €4.5/kg. Farmed gilthead seabream and European seabass prices achieved their minimum historical level in 2001 and 2002 due to investments in production that resulted in an increased supply that the demand could not absorb at profitable prices and led to a rationalisation of the industry.

Results from this study confirm that there is no or limited market integration between wild and farmed conspecifics of gilthead seabream and European seabass at the Madrid and Barcelona wholesale markets in Spain[5]. This helps to explain the existence of important price crises for farmed gilthead seabream and European seabass, while wild products were almost not affected.

[5] It should be noted that the regression methodology tends to accept more often the presence of market integration. Moreover, regression results for one species are not always consistent across the different estimations using different

This differentiation or the lack of market integration between farmed and aquaculture products can be explained, at least in part, by the negative perception aquaculture products have in comparison to wild fish in Spain, and Southern Europe in general (Fernández-Polanco and Luna, 2010, 2012; Claret et al., 2012; Fernández-Polanco et al., 2013). Wild fish is always preferred by Southern European consumers when compared to farmed fish (Claret et al., 2012). Southern European consumers often perceive farmed fish as being of lower quality and affected by more health and safety issues than wild fish (Kole, 2003; Verbeke et al., 2007; Fernández-Polanco and Luna, 2010, 2012). Farmed fish is also perceived as more processed or manipulated than those from the wild (Claret et al., 2012). This is translated into lower prices for farmed fish than for wild (capture) fish and some fine restaurants only serve wild fish products, specifying this on the menu. Consequently, a share of the wild production will not enter into the more traditional market chains. In the case of gilthead seabream and European seabass, the capture quantity is small and is largely destined for niche markets. This differentiation in favour of wild products happens even if the aquaculture sector has the competitive advantage that the sector has a higher degree of control over the production process and can deliver at the right time, in the right amount and at the right quality (Asche, Guttormsen and Nielsen, 2013). On the other hand, products only available in a season may command a price premium (Aviv and Pazgal, 2008).

The fact that most seabass and seabream are marketed as fresh whole and head-on, can help the market to differentiate between products, as well as between wild and farmed varieties. Consumers in Southern European/Mediterranean countries prefer whole fish. In contrast, Northern European consumers prefer filleted fish products. Despite this potential demand, industrial production of seabass and seabream fillets is minor. High production costs for large individual fish do not allow for competitive prices for seabass and seabream fillets and other value added presentations (Monfort, 2007). Hence, the expansion of seabass and seabream in non-Mediterranean markets has been limited so far.

These difficulties to develop added value presentations and reach new markets for European seabass and gilthead seabream at the current level of cost of production, together with the lack of integration between wild and farmed conspecifics, led to aquaculture producers to face a "reduced potential demand". If seabass and seabream production costs, especially for larger individuals,

time lags. In addition, when market cointegration is confirmed (e.g. a relation between wild and farmed prices is obtained), it only happens for one lag period of the explanatory variable, not for all.

could decline further, seabass and seabream fillet prices could be competitive with other white flesh fish fillets in Northern European markets. This could allow further expansion of the industry without rapid price declines, sometimes below cost of production.

Because there is no or limited market integration (limited substitutability) between wild and farmed European seabass and gilthead seabream, prices of wild-caught European seabass and gilthead seabream do not decrease significantly when aquaculture production of both species increases. Therefore, the capture fisheries sector is not significantly affected by the aquaculture production evolution of European seabass and gilthead seabream. Moreover, this is not likely to change in the future, as capture production is expected to remain stagnant, which may allow capture production to keep its market niche.

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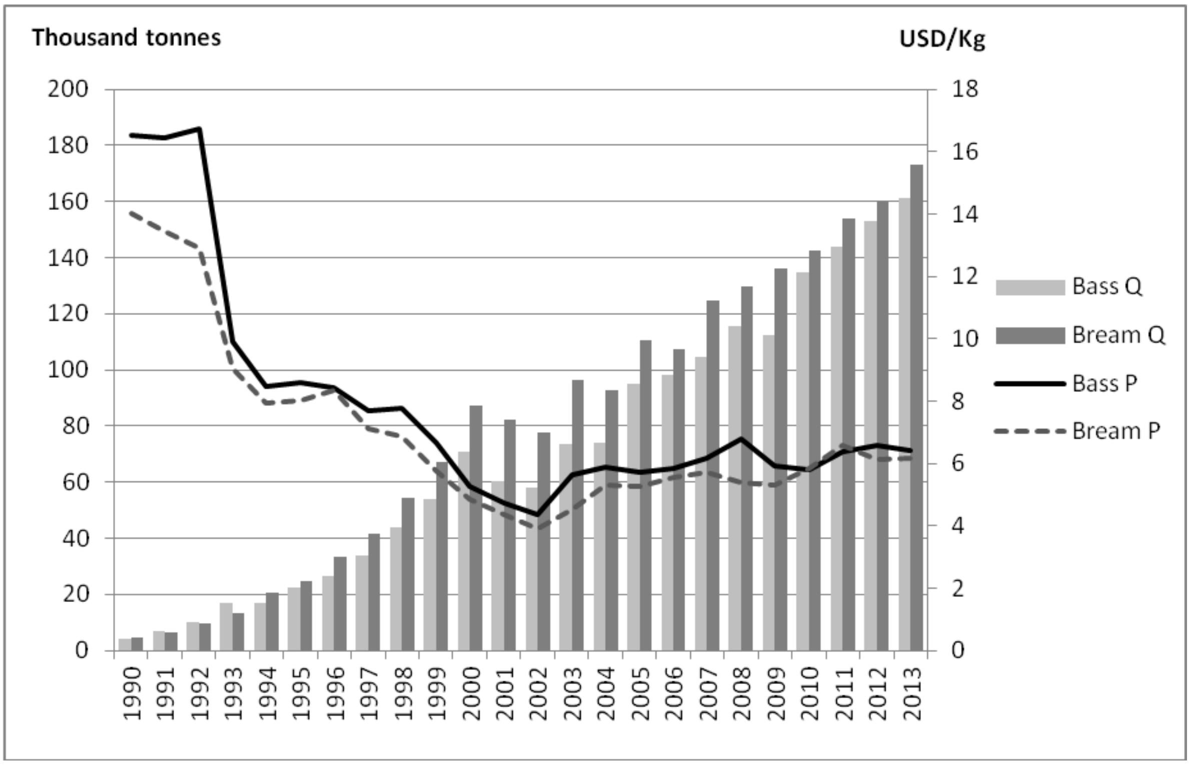
Fig. 1. Total aquaculture production and price of gilthead seabream and European seabass



Source: authors' elaboration of FAO data (2015).

Table 1. Descriptive statistics of the wild and farmed gilthead seabream and European seabass price series data

Species	Market	Origin	Mean	Std. Dev.	C.Var.	N. Observations
		Wild	12.31	3.50	28.47	540
		Farmed	5.14	0.88	17.10	623
		Wild	18.39	4.65	25.27	416
		Farmed	4.82	0.65	13.55	416
		Wild	20.58	5.35	26.02	623
		Farmed	5.97	0.79	13.31	623
		Wild	20.64	6.24	30.21	416
		Farmed	5.64	0.67	11.94	416

Table 2. Optimal lag length for wild and farmed gilthead seabream and European seabass at different market places by criteria

Species	Market	Likelihood Ratio	Akaike Information Criteria	Schwarz Criteria
	Madrid wholesale	0	1	0
	Barcelona wholesale	5	1	0
	Madrid wholesale	2	2	1
	Barcelona wholesale	3	2	2

Table 3. Cointegration test for wild and farmed gilthead seabream and European seabass by market place

Species	Market	Lags	Eigenvalue	Likelihood Ratio	5% Critical Value	No. of CE(s)
			0.038297	22.29477	19.96	None *
			0.003983	2.067092	9.24	At most 1
			0.04416	24.13078	19.96	None *
			0.00348	1.729244	9.24	At most 1
			0.136734	78.25155	19.96	None *
			0.020321	9.587526	9.24	At most 1 *
			0.14262	78.97628	19.96	None *
			0.015482	7.270892	9.24	At most 1
			0.090243	54.30291	19.96	None *
			0.0227	10.60822	9.24	At most 1 *
			0.081664	73.29605	19.96	None *
			0.032304	20.39179	9.24	At most 1 *
			0.066617	60.02186	19.96	None *
			0.027485	17.27954	9.24	At most 1 *
			0.06855	44.34091	19.96	None *
			0.02405	11.31994	9.24	At most 1 *
			0.058739	38.92429	19.96	None *
			0.023083	10.83602	9.24	At most 1 *
			0.127558	10.09801	9.24	At most 1 *

* denotes rejection of the hypothesis at 5% significance level

Table 4. Unit root test considering intercept for wild and farmed gilthead seabream by market place

Market	Lags	Series	ADF test Statistic
		Farmed	-3.725 *
		Wild	-2.049
		Farmed	-3.630 *
		Wild	-2.492
		Farmed	-2.649
		Wild	-8.219 *

* denotes rejection of the hypothesis at 5% significance level. Critical values at 1%: -3.45, 5%: -2.87, 10%: -2.57.

Table 5: Regression test results for wild and farmed gilthead seabream and European seabass by market place

	Market	Lags	Number of significant relations (Total relations)	Market integration
		2	1 (3)	Potential
		3	1 (4)	Potential
		1	0 (2)	No
		2	1 (3)	Potential
		0	1 (1)	Yes
		5	0 (6)	No

Table 6. Summary of the market integration outcomes for wild and farmed gilthead seabream and European seabass by market place

	Market	Lags	Market integration	Methodology	Market integration
		0	No	Cointegration	
		1	No	Cointegration	
		0	Yes	Regression	
		1	No	Cointegration	
		5	No	Regression	
		1	No	Regression	
		2	Potential	Regression	
		2	Potential	Regression	
		3	Potential	Regression	

APPENDIX.

APPENDIX 1: LAG SELECTION RESULTS

Wild and farmed seabass in the Madrid wholesale market

Table A1: Lag interval selection for wild and farmed seabass in Madrid wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
	0	1394.767	-4.484781	-4.484781
	1	1413.231	-4.528073	-4.492438
	2	1424.602	-4.548560	-4.477291
	0	1413.699	-4.540094	-4.511551
	1	1440.151	-4.609183	**-4.544961**
	2	1450.347	-4.625917	-4.526016
	0	1422.471	-4.562810	-4.505653
	1	1443.842	-4.615620	-4.522739
	2	**1452.482**	**-4.627362**	-4.498757
	0	1421.987	-4.555691	-4.469848
	1	1444.250	-4.611470	-4.489858
	2	1451.866	-4.619921	-4.462541
	0	1421.967	-4.550054	-4.435452
	1	1441.786	-4.598014	-4.447600
	2	1449.678	-4.607372	-4.421145

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 2, while under the Schwarz Information Criteria the optimal lags is 1. So, cointegration tests are run for 1 and 2 lags.

Wild and farmed seabass in the Barcelona wholesale market

Table A2: Lag interval selection for wild and farmed seabass in the Barcelona wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
	0	823.3444	-3.526100	-3.526100
	1	854.3822	-3.637611	-3.593218
	2	864.1426	-3.657998	-3.569212
	0	838.7091	-3.582442	-3.54687
	1	864.6355	-3.672255	-3.592217
	2	872.6763	-3.685306	-3.560803

Lags interval: 1 to 2	0	866.8185	-3.693843	-3.622582
	1	883.3289	-3.743350	**-3.627551**
	2	888.9889	**-3.746189**	-3.585852
	0	871.2587	-3.703701	-3.596635
	1	885.3029	-3.742685	-3.591008
	2	**890.7209**	-3.744486	-3.548199
	0	869.7366	-3.687847	-3.544859
	1	883.7652	-3.726848	-3.539175
	2	889.4483	-3.729798	-3.497442

From the lag selection table, we can see that under the Akaike and Schwarz Information Criteria the optimal lags are 2, while under the Log Likelihood the optimal lag is 3. So, cointegration tests are run for 2 and 3 lags.

<u>Wild and farmed seabass in the French retail market</u>

Table A3: Lag interval selection for wild and farmed seabass in the French retail market

Lags	Included observations	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
		0	168.4447	-4.55256	-4.55256
		1	178.2926	-4.68358	-4.52790
		2	**183.3416**	-4.68491	-4.37355
		0	136.6785	-4.82467	-4.67869
		1	143.3004	-4.88365	-4.55518
		2	146.0930	-4.80338	-4.29242
		0	109.2939	-5.33126	-4.98650
		1	111.1186	-5.16414	-4.60391
		2	112.5361	-4.97559	-4.19989
		0	87.80238	-5.414455	-4.843511
		1	95.49704	-5.606932	-4.798093
		2	97.19978	-5.371413	-4.324681
		0	80.45692	-5.85972	-5.066235
		1	88.70897	**-6.155361**	**-5.113912**
		2	89.44081	-5.767346	-4.477933

From the lag selection table, we can see that under the Akaike and Schwarz Information Criteria the optimal lags are 4 (or more), while under the Log Likelihood Criteria the optimal lag is 0. However, the number of observations included in the analysis decreases significantly when the number of lags considered in the model increases. This is because of the existence of gaps in the price series. The Cointegration test cannot be run with few observations since results are not robust. So, cointegration tests are only run for 0 lags.

Wild and farmed seabream in the Madrid wholesale market

Table A4: Lag interval selection for wild and farmed seabream in the Madrid wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
	0	1773.149	-6.846134	**-6.846134**
	1	1783.263	-6.865879	-6.824856
	2	**1784.296**	-6.850564	-6.768518
	0	1700.650	-6.841332	-6.807408
	1	1711.851	**-6.866335**	-6.790006
	2	1712.716	-6.84966	-6.730926
	0	1624.991	-6.794082	-6.724075
	1	1635.792	-6.818454	-6.704692
	2	1636.208	-6.799193	-6.641678
	0	1558.401	-6.782463	-6.673976
	1	1570.021	-6.811498	-6.657808
	2	1570.609	-6.792144	-6.593252
	0	1500.959	-6.811737	-6.662099
	1	1511.731	-6.838214	-6.641814
	2	1512.154	-6.817222	-6.574060

From the lag selection table, we can see that under the Log Likelihood and the Schwarz Information Criteria the optimal is no lags, while under the Akaike Information Criteria the optimal lags is 1. So, cointegration tests are run for 0 and 1 lag.

Wild and farmed seabream in the Barcelona wholesale market

Table A5: Lag interval selection for wild and farmed seabream in the Barcelona wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
	0	952.8161	-4.080583	-4.080583
	1	987.1482	-4.206202	**-4.161809**
	2	991.9419	-4.205319	-4.116532
	0	959.9336	-4.102719	-4.067147
	1	995.7863	**-4.235134**	-4.155096
	2	999.4217	-4.229278	-4.104774
	0	963.6102	-4.110151	-4.038891
	1	997.2240	-4.233222	-4.117423
	2	1000.4150	-4.22544	-4.065103
	0	965.6643	-4.110622	-4.003556
	1	997.5639	-4.226569	-4.074892
	2	1001.1850	-4.220624	-4.024337
	0	976.7978	-4.150315	-4.007326

	1	1001.1310	-4.233829	-4.046157
	2	1005.6470	-4.231735	-3.999379
	0	979.5822	-4.154035	-3.975007
	1	1001.4300	-4.226968	-4.003182
	2	**1006.7340**	-4.228284	-3.959741
	0	978.8902	-4.142691	-3.927503
	1	998.6663	-4.206795	-3.946777
	2	1004.1440	-4.208868	-3.904019

From the lag selection table, we can see that under the Akaike Information Criteria the optimal lags is 1, under the Schwarz Information Criteria the optimal lags is 0, while under the Log Likelihood the optimal lag is 5. So, cointegration tests are run for 0, 1 and 5 lags.

APPENDIX 2: REGRESSION ANALYSIS RESULTS

Wild and farmed seabass in the Madrid wholesale market

Table A6: Regression analysis for farmed and wild seabass in the Madrid wholesale market considering 1 lag

Dependent Variable: BA_C_MAD				
Method: Least Squares				
Sample(adjusted): 2 623				
Included observations: 622 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.113367	0.032829	3.453274	0.0006
BA_W_MAD	-0.013795	0.017448	-0.790627	0.4295
BA_W_MAD(-1)	0.024946	0.017439	1.430441	0.1531
BA_C_MAD(-1)	0.917659	0.015715	58.39355	0.0000
R-squared	0.852848	Mean dependent var		1.778149
Adjusted R-squared	0.852134	S.D. dependent var		0.132282
S.E. of regression	0.050867	Akaike info criterion		-3.112791
Sum squared resid	1.599051	Schwarz criterion		-3.084283
Log likelihood	972.0780	F-statistic		1193.913
Durbin-Watson stat	2.160663	Prob(F-statistic)		0.000000

Table A7: Regression analysis for wild and farmed seabass in the Madrid wholesale market considering 1 lag

Dependent Variable: BA_W_MAD				
Method: Least Squares				
Sample(adjusted): 2 623				
Included observations: 622 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.258018	0.075666	3.409937	0.0007
BA_C_MAD	-0.073249	0.092647	-0.790627	0.4295
BA_C_MAD(-1)	0.096431	0.092367	1.043994	0.2969

BA_W_MAD(-1)	0.900062	0.017589	51.17100	0.0000
R-squared	0.816079	Mean dependent var		2.988993
Adjusted R-squared	0.815186	S.D. dependent var		0.272655
S.E. of regression	0.117215	Akaike info criterion		-1.443211
Sum squared resid	8.490860	Schwarz criterion		-1.414703
Log likelihood	452.8386	F-statistic		914.0446
Durbin-Watson stat	1.522692	Prob(F-statistic)		0.000000

Table A8: Regression analysis for farmed and wild seabass in the Madrid wholesale market considering 2 lags

Dependent Variable: BA_C_MAD				
Method: Least Squares				
Sample(adjusted): 3 623				
Included observations: 621 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.111999	0.033478	3.345497	0.0009
BA_W_MAD	-0.021820	0.018044	-1.209223	0.2270
BA_W_MAD(-1)	0.064863	0.026831	2.417509	0.0159
BA_W_MAD(-2)	-0.037078	0.018006	-2.059242	0.0399
BA_C_MAD(-1)	0.838343	0.040128	20.89160	0.0000
BA_C_MAD(-2)	0.088822	0.039988	2.221189	0.0267
R-squared	0.854833	Mean dependent var		1.778386
Adjusted R-squared	0.853653	S.D. dependent var		0.132257
S.E. of regression	0.050595	Akaike info criterion		-3.120295
Sum squared resid	1.574339	Schwarz criterion		-3.077480
Log likelihood	974.8516	F-statistic		724.3008
Durbin-Watson stat	2.016571	Prob(F-statistic)		0.000000

Table A9: Regression analysis for wild and farmed seabass in the Madrid wholesale market considering 2 lags

Dependent Variable: BA_W_MAD				
Method: Least Squares				
Sample(adjusted): 3 623				
Included observations: 621 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.333990	0.074189	4.501912	0.0000
BA_C_MAD	-0.108708	0.089899	-1.209223	0.2270
BA_C_MAD(-1)	0.254772	0.116664	2.183799	0.0294
BA_C_MAD(-2)	-0.119962	0.089484	-1.340608	0.1805
BA_W_MAD(-1)	1.137918	0.038925	29.23332	0.0000
BA_W_MAD(-2)	-0.264961	0.038887	-6.813540	0.0000
R-squared	0.829074	Mean dependent var		2.989840
Adjusted R-squared	0.827684	S.D. dependent var		0.272055
S.E. of regression	0.112933	Akaike info criterion		-1.514438
Sum squared resid	7.843556	Schwarz criterion		-1.471623
Log likelihood	476.2330	F-statistic		596.6079
Durbin-Watson stat	1.968129	Prob(F-statistic)		0.000000

Wild and farmed seabass in the Barcelona wholesale market

Table A10: Regression analysis for farmed and wild seabass in the Barcelona wholesale market considering 2 lags

Dependent Variable: BASS_CULT				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.125806	0.033386	3.768189	0.0002
BASS_WILD	-0.016475	0.010881	-1.514060	0.1307
BASS_WILD(-1)	0.027818	0.013804	2.015249	0.0445
BASS_WILD(-2)	-0.011695	0.010828	-1.080051	0.2807
BASS_CULT(-1)	0.742875	0.046037	16.13657	0.0000
BASS_CULT(-2)	0.185648	0.045785	4.054755	0.0001
R-squared	0.855275	Mean dependent var		1.736433
Adjusted R-squared	0.853702	S.D. dependent var		0.120596
S.E. of regression	0.046127	Akaike info criterion		-3.302056
Sum squared resid	0.978731	Schwarz criterion		-3.248698
Log likelihood	775.3791	F-statistic		543.6867
Durbin-Watson stat	2.045046	Prob(F-statistic)		0.000000

Table A11: Regression analysis for wild and farmed seabass in the Barcelona wholesale market considering 2 lags

Dependent Variable: BASS_WILD				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.357361	0.143928	2.482906	0.0134
BASS_CULT	-0.300990	0.198797	-1.514060	0.1307
BASS_CULT(-1)	0.691223	0.244132	2.831350	0.0048
BASS_CULT(-2)	-0.204340	0.198940	-1.027145	0.3049
BASS_WILD(-1)	0.784168	0.046639	16.81364	0.0000
BASS_WILD(-2)	-0.012264	0.046338	-0.264658	0.7914
R-squared	0.638990	Mean dependent var		2.978836
Adjusted R-squared	0.635066	S.D. dependent var		0.326372
S.E. of regression	0.197161	Akaike info criterion		-0.396805
Sum squared resid	17.88125	Schwarz criterion		-0.343446
Log likelihood	98.45550	F-statistic		162.8406
Durbin-Watson stat	1.991624	Prob(F-statistic)		0.000000

Table A12: Regression analysis for farmed and wild seabass in the Barcelona wholesale market considering 3 lags

Dependent Variable: BASS_CULT				
Method: Least Squares				
Sample(adjusted): 4 468				
Included observations: 465 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.107546	0.033612	3.199665	0.0015
BASS_WILD	-0.015598	0.011014	-1.416176	0.1574
BASS_WILD(-1)	0.029458	0.013760	2.140816	0.0328
BASS_WILD(-2)	-0.019376	0.013799	-1.404173	0.1609
BASS_WILD(-3)	0.003866	0.010915	0.354166	0.7234
BASS_CULT(-1)	0.713746	0.046531	15.33926	0.0000

BASS_CULT(-2)	0.055961	0.057010	0.981604	0.3268
BASS_CULT(-3)	0.171586	0.046080	3.723636	0.0002
R-squared	0.858646	Mean dependent var		1.736957
Adjusted R-squared	0.856481	S.D. dependent var		0.120194
S.E. of regression	0.045534	Akaike info criterion		-3.323648
Sum squared resid	0.947530	Schwarz criterion		-3.252387
Log likelihood	780.7482	F-statistic		396.5738
Durbin-Watson stat	1.999482	Prob(F-statistic)		0.000000

Table A13: Regression analysis for wild and farmed seabass in the Barcelona wholesale market considering 3 lags

Dependent Variable: BASS_WILD				
Method: Least Squares				
Sample(adjusted): 4 468				
Included observations: 465 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.313117	0.143283	2.185311	0.0294
BASS_CULT	-0.280128	0.197806	-1.416176	0.1574
BASS_CULT(-1)	0.686618	0.240568	2.854154	0.0045
BASS_CULT(-2)	-0.317358	0.241401	-1.314652	0.1893
BASS_CULT(-3)	0.051360	0.198208	0.259120	0.7957
BASS_WILD(-1)	0.782626	0.045765	17.10084	0.0000
BASS_WILD(-2)	-0.161187	0.058117	-2.773509	0.0058
BASS_WILD(-3)	0.192120	0.045383	4.233302	0.0000
R-squared	0.651625	Mean dependent var		2.980612
Adjusted R-squared	0.646289	S.D. dependent var		0.324461
S.E. of regression	0.192969	Akaike info criterion		-0.435522
Sum squared resid	17.01729	Schwarz criterion		-0.364261
Log likelihood	109.2588	F-statistic		122.1148
Durbin-Watson stat	2.025557	Prob(F-statistic)		0.000000

<u>Wild and farmed seabream in the Barcelona wholesale market</u>

Table A14: Regression analysis for farmed and wild seabream in the Barcelona wholesale market considering no lags

Dependent Variable: BREAM_CULT				
Method: Least Squares				
Sample: 1 468				
Included observations: 468				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.109549	0.067745	16.37822	0.0000
BREAM_WILD	0.164520	0.023335	7.050399	0.0000
R-squared	0.096388	Mean dependent var		1.585070
Adjusted R-squared	0.094449	S.D. dependent var		0.144641
S.E. of regression	0.137641	Akaike info criterion		-1.124076
Sum squared resid	8.828354	Schwarz criterion		-1.106347
Log likelihood	265.0337	F-statistic		49.70813
Durbin-Watson stat	0.133002	Prob(F-statistic)		0.000000

Table A15: Regression analysis for wild and farmed seabream in the Barcelona wholesale market considering no lags

Dependent Variable: BREAM_WILD				
Method: Least Squares				
Sample: 1 468				
Included observations: 468				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.961699	0.132262	14.83189	0.0000
BREAM_CULT	0.585874	0.083098	7.050399	0.0000
R-squared	0.096388	Mean dependent var		2.890350
Adjusted R-squared	0.094449	S.D. dependent var		0.272950
S.E. of regression	0.259740	Akaike info criterion		0.145996
Sum squared resid	31.43872	Schwarz criterion		0.163725
Log likelihood	-32.16310	F-statistic		49.70813
Durbin-Watson stat	0.539303	Prob(F-statistic)		0.000000

Table A16: Regression analysis for farmed and wild seabream in the Barcelona wholesale market considering 5 lags

Dependent Variable: BREAM_CULT				
Method: Least Squares				
Sample(adjusted): 6 468				
Included observations: 463 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.043442	0.028073	1.547473	0.1225
BREAM_WILD	0.008141	0.010410	0.782052	0.4346
BREAM_WILD(-1)	-0.006985	0.013255	-0.526956	0.5985
BREAM_WILD(-2)	0.004067	0.013220	0.307668	0.7585
BREAM_WILD(-3)	0.008734	0.013183	0.662526	0.5080
BREAM_WILD(-4)	0.008161	0.013134	0.621313	0.5347
BREAM_WILD(-5)	-0.013617	0.010382	-1.311537	0.1903
BREAM_CULT(-1)	0.775694	0.046553	16.66266	0.0000
BREAM_CULT(-2)	0.180237	0.059135	3.047899	0.0024
BREAM_CULT(-3)	0.109156	0.059565	1.832541	0.0675
BREAM_CULT(-4)	0.028451	0.059002	0.482204	0.6299
BREAM_CULT(-5)	-0.136285	0.046393	-2.937638	0.0035
R-squared	0.929481	Mean dependent var		1.586418
Adjusted R-squared	0.927761	S.D. dependent var		0.144776
S.E. of regression	0.038912	Akaike info criterion		-3.629459
Sum squared resid	0.682874	Schwarz criterion		-3.522218
Log likelihood	852.2198	F-statistic		540.4063
Durbin-Watson stat	2.037963	Prob(F-statistic)		0.000000

Table A17: Regression analysis for wild and farmed seabream in the Barcelona wholesale market considering 5 lags

Dependent Variable: BREAM_WILD				
Method: Least Squares				
Sample(adjusted): 6 468				
Included observations: 463 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.621727	0.123824	5.021074	0.0000
BREAM_CULT	0.166352	0.212712	0.782052	0.4346
BREAM_CULT(-1)	0.095465	0.267441	0.356957	0.7213
BREAM_CULT(-2)	-0.084711	0.270021	-0.313719	0.7539
BREAM_CULT(-3)	0.334772	0.269798	1.240824	0.2153
BREAM_CULT(-4)	-0.137733	0.266700	-0.516434	0.6058
BREAM_CULT(-5)	-0.226313	0.211441	-1.070337	0.2850

BREAM_WILD(-1)	0.789667	0.047007	16.79907	0.0000
BREAM_WILD(-2)	-0.040080	0.059734	-0.670983	0.5026
BREAM_WILD(-3)	-0.011846	0.059617	-0.198700	0.8426
BREAM_WILD(-4)	-0.102820	0.059200	-1.736828	0.0831
BREAM_WILD(-5)	0.069032	0.046908	1.471639	0.1418
R-squared	0.592121	Mean dependent var		2.892563
Adjusted R-squared	0.582173	S.D. dependent var		0.272118
S.E. of regression	0.175896	Akaike info criterion		-0.612270
Sum squared resid	13.95369	Schwarz criterion		-0.505029
Log likelihood	153.7406	F-statistic		59.52010
Durbin-Watson stat	2.000442	Prob(F-statistic)		0.000000