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Rodriguez, Gonzalo and Bande, Roberto

University of Santiago de Compostela, University of Santiago de Compostela

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Market differences in wild and farmed marine fish in the Spanish seafood market.

Gonzalo Rodríguez Rodríguez*[1], Roberto Bande Ramudo[2]

[1]Department of Applied Economics, Faculty of Economics and Business Administration, University of Santiago de Compostela, Av. Burgo das Nacións s/n, 15782, Santiago de Compostela, Spain.

[2]GAME-IDEGA and Department of Economics, University of Santiago de Compostela, Av. Burgo das Nacións s/n, 15782, Santiago de Compostela, Spain.

*Corresponding author: Gonzalo Rodríguez Rodríguez, Faculty of Economics and Business Administration, University of Santiago de Compostela (Spain), Av. Burgo das Nacións s/n, 15782 A Coruña, Spain. Tel: +34 981563100, extension 11576. Fax: +34 981559965. E-mail: gonzalo.rodriguez@usc.es

Abstract

It has long been generally accepted that substitution between wild and farmed fish exists when they are of the same species. While this is true for some species and markets, the relation does not hold for all of them. In fact, using cointegration methodology, this paper proves that farmed and wild gilthead sea bream, sea bass and turbot (90% of Spanish marine fish production) are not substitutives in the Spanish seafood market. Those results have implications for policy makers, fishers and fish farmers, stemming from ecological, economical and social sustainability.

Keywords: Aquaculture, seabream; Seabass; turbot, market analysis, cointegration.

1. Introduction

It has long been generally accepted that substitution between wild and farmed fish exists when they are of the same species (Béné et al., 2000; Asche et al., 2005; Norman-López, 2009). While this is true for many species and many markets, the relation does not hold for all of them. Recent work by Rodriguez *et al* (2013) has shown that this identity does not always occur. Namely, they show that wild and farmed gilthead sea bream form two heterogeneous products in the Spanish market.

The economic literature revision on this topic reveals that most of the research supporting the above statement is based on a reduced number of species, as salmon, shrimp and tilapia. Thus, Asche *et al*., 2005 examine the Japanese market, concluding that wild salmon (sockeye and coho) and farmed salmon (coho and salmon trout) compete in the same market. Similar results have been also found in the U.S. salmon market (Clyton & Gordon, 1999) and in the Finnish market, where farmed salmon trout and farmed and wild salmon are close substitutes, while the price of imported farmed salmon affects the salmon trout prices (Asche *et al*., 2001; Setälä *et al*., 2002). As regards to shrimp Béné *et al*. (2000) have addressed this question in the case of the wild shrimp *Penaeus subtilis* exploited by the French Guyana fishery (South America) and competing on the French market with the cultured Thai shrimp 'Back Tiger' finding that the two series were cointegrated, and therefore should be regarded as substitutes. More recently, Asche *et al*. (2011) concluded that there was market integration between wild-caught shrimp and imports of farmed shrimp in the U.S. market. The results from Park *et al*. (2012) for Korean fish market go in the same direction, being their findings based on qualitative research.

All of this research may be considered still insufficient if we considerthe diversity of farmed species, the different type of products commercialized and the different characteristics of the markets. Factors like the volume of retail distribution for fish (Jaffry *et al*., 2000; Nielsen *et al*., 2007), consumers preferences or market segmentation could lead to very different results.

On the other hand, over the last three decades (1980–2010), world food fish production of aquaculture has expanded by almost 12 times, at an average annual rate of 8.8 percent, being nowadays fully comparable with capture production in terms of feeding people in the world (FAO, 2012). So interactions between wild and farmed fishes is a major issue, not only because of market concerns but also due to its implications for fishers decisions as regards investment and production (Anderson, 1985) and, therefore, sustainability.

Ultimately, three main reasons justify the present study: i) the insufficient number of studies conducted up to now; ii) the growing variety and volume of world aquaculture production; and iii) the evidence of no market integration between wild and farmed seabram in the Spanish market. In that sense, the next natural step is to question if previous results shown a feature unique to sea bream or can be verified in other species. So the main objective of this paper is to check out if sea bream, sea bass and turbot markets are integrated in Spain or not.

Results are highly relevant, as these are the most representative species in the Spanish marine fish aquaculture (90% of total production in 2011) and also are in the top ten aquaculture species in the EU by volume and value in 2011 (European Commission, 2014).

The paper is organized as follows. Section 2 analyzes the main characteristics of the Spanish seabream, seabass and turbot markets. Section 3 describes the data used in this analysis as well as the econometric methododology used. Section 4 presents the results, discussions are presented in Section 5, and Section 6 concludes.

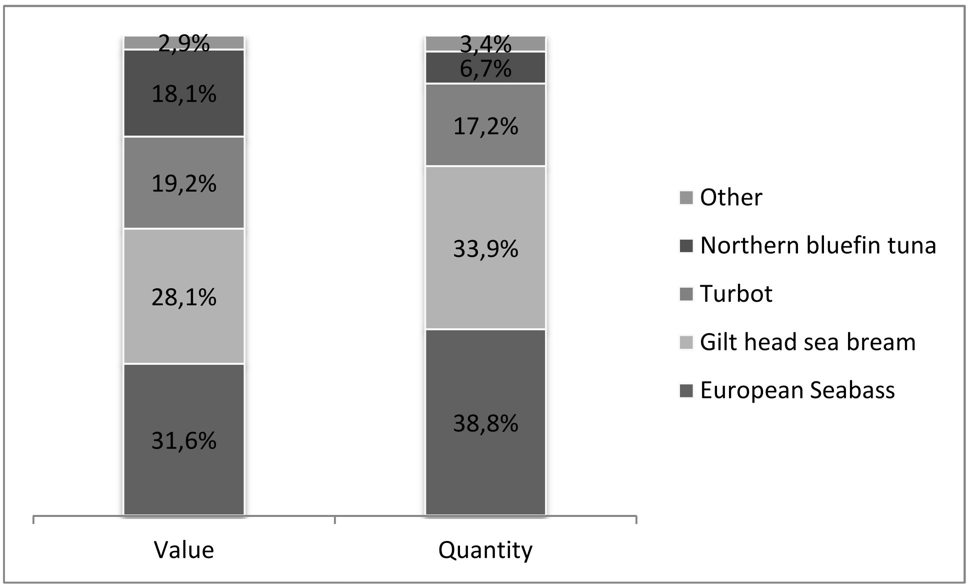
2. Background.

Spain has historically been one of the major producer, trader and consumer of fish in Europe. As a result of that productive path, a complex value chain has been set up, whose understanding, at least in some essential characteristics, must be known for proper contextualization of the results of this research.

Denmark and Spain are the two leading fishing countries in the EU, accounting for about one third of the total catches. As regards farmed seafood Spain, France, the UK and Italy are the major contributors. Spain also remains a key exporter and importer of seafood products to third countries (Glitnir Seafood Research, 2008). Finally, the Spanish market is the first European market for fish products, at more or less the same level as the French market, with a consumption of more than 2 million tons per year in live weight equivalent, being one of the countries in the world with the highest consumption of seafood per inhabitant, with more than 50 kg/year in live weight equivalent. (Paquotte and Lem, 2008). Naturally, in this picture Norway should be included , as the world leader in salmon production and high consumption fish market.

One relevant feature of the fish distribution in Spain is the role played by central wholesale markets network (“mercas”), whose market share was about 41% in 2006 (Marcos and Sansa, 2007). Of particular importance is Mercamadrid, who commercialised 118.864 tons of fish in 2011, being the biggest wholesale market in Spain (Mercasa, 2011).

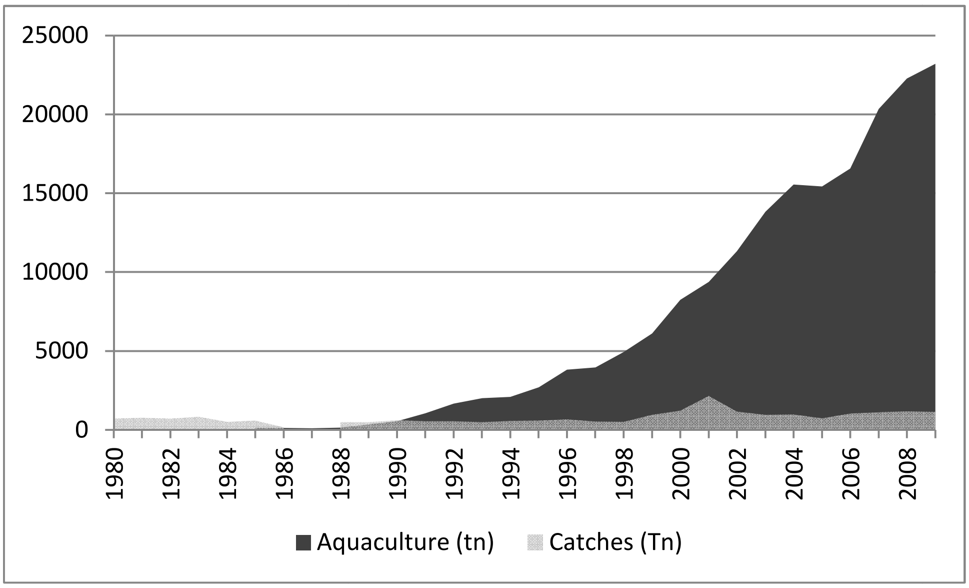
Figure 1. Spanish aquaculture production. 2011.



Source: Ministry of Agriculture, Food and Environment, 2013.

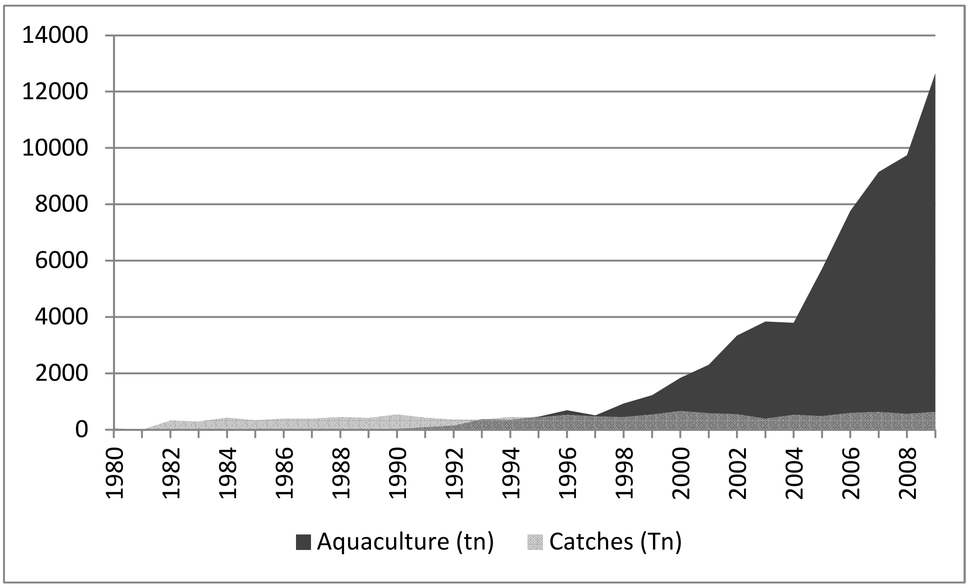
Spanish fish aquaculture is highly concentrated in three species: sea bream, sea bass and turbot, which together account for 89.9% of total volume and 78.9% in value. These three species share some similarities but also important differences that need refine. Both seabram, such as sea bass and turbot started up in Spain in the mid-80s, the first two mainly in the Mediterranean area and turbot in the North Atlantic and Cantabrian. They have been characterized by a low volume of catches, being particularly marked in the case of turbot (barely 45 tons in 2009) and with the fisheries captures greatly overtaken by aquaculture as a major source of supply

Figure 2. Spanish production of farmed and wild seabream. 1980-2009.



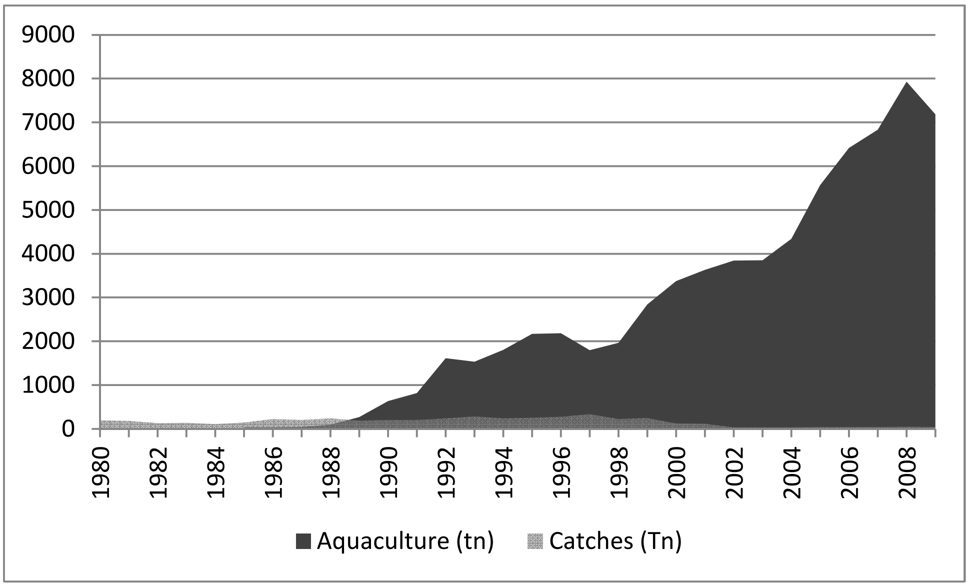
Source: FAO, FishStat, 2012.

Figure 3. Spanish production of farmed and wild seabass. 1980-2009.



Source: FAO, FishStat, 2012.

Figure 4. Spanish production of farmed and wild turbot. 1980-2009.



Source: FAO, FishStat, 2012.

Seabream and sea bass are two highly internationalized species, characterized by a high volume production, particularly in the Mediterranean area, an intense international trade and the presence of major international competitors. In 2009 production reached 136,975.6 tons of seabream and 113,653.4 tons of seabass (Fishstat, 2011), with both Greece and Turkey leading worldwide production, followed in third place, and a distance, by Spain. Exports represent about half of the whole production in both cases, being quasi-monopolistic Greece's position in the international trade of seabream and of clear dominance of this country, followed by Turkey in seabass markets.

Finally, turbot is characterized by a comparatively low production volume, a modest international trade and greater attachment to national markets. Its production volume reached 69,557.2 tons in 2009, of which 60,000 are attributed to China. If we consider only European production, this was 9238.2 tons, of which 77.8% were contributed by Spain (Fishstat, 2011). Portuguese production is expected to grow in the next years but at this time remains still low. Recorded exports[1] are reduced and consumption is concentrated on a small group of countries, such as Spain, France or the Netherlands.

3. Material and methods

3.1. Data.

The data used for the econometric analysis are monthly wholesale prices from Mercamadrid (Madrid). This is the main wholesale market in Spain, providing data on a regular basis from 2007 for both captured and farmed species. Specifically, time series covers from January 2007 to March 2012, which implies 63 observations for seabass and turbot and 62 for seabram. Unfortunately, on April 2009 no transactions with wild seabream were recorded. Following the general rule in the existing literature missing observations were droped from the sample, and no attempts to interpolate values for the missing data were made.

Early stages of development of this market have been overcome. After the price shocks of 2001 and 2002, seabream and seabass may already have passed the first part of the growth stage of the business lifecycle (Luna et al. 2004). On the other side, the strong process of concentration suffered by turbot industry in Spain suggests that the early stage was surpassed time ago. In fact, as early as 1992 the sector suffered its first crisis and the beginning of a process of restructuring and business vertical and horizontal integration (Fernandez Gonzalez, 2008). Currently, Spanish production is highly concentrated, with the market dominated by only two firms.

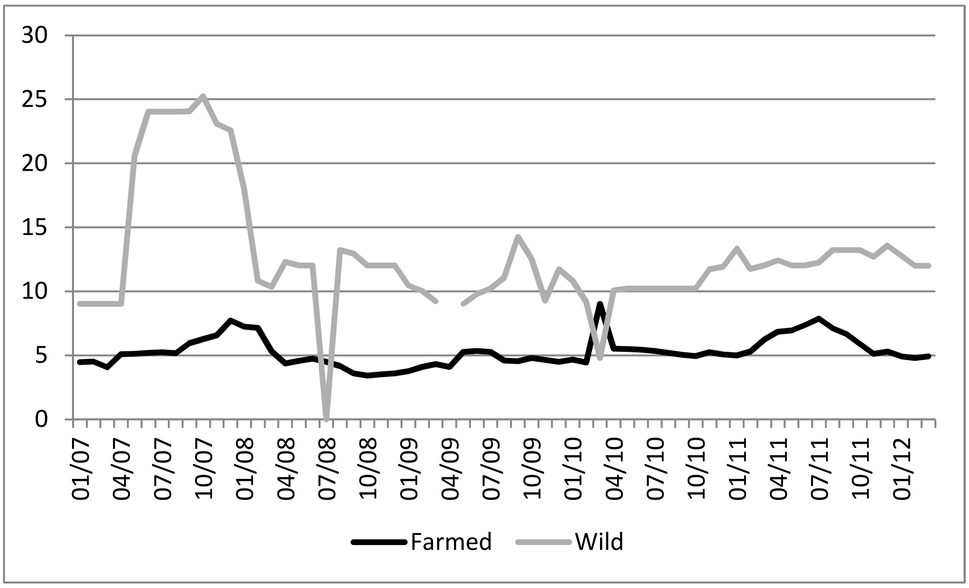
An advantage of using wholesale data is that it is the price from the wholesaler that is measured, with tariffs, transportation costs and all other transaction costs included.

[1] Turbot´s international trade statistics are likely to be underestimated.

Hence it provides a reliable image of the market, defined as "the area within which the price of a commodity tends to uniformity, allowance being made for transportation costs" (Stigler 1969; p. 85).

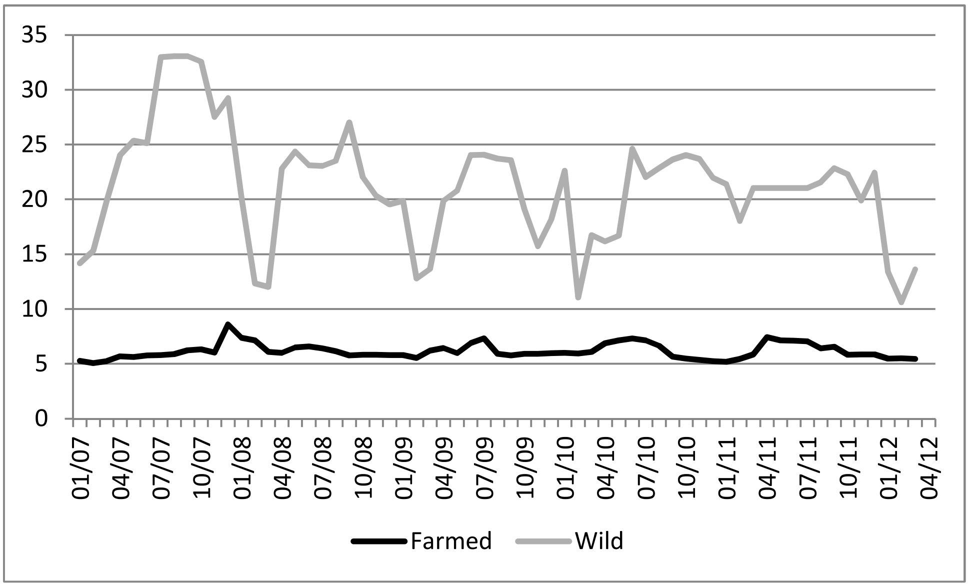
We impose a number of *a* priori requirements to our dataset, in order to make sure it correctly represents the market performance of the considered species. Thus, following Rodriguez *et* al (2013) we require that the data: i) should have a high frequency periodicity, preferably monthly or weekly, in order to isolate results from the lack of seasonality in an annual series; ii) it should be recent, in order to rule out the possibility of analyzing a market in which interactions are not present due to an immature state of development; and iii) it should provide a measure of the Spanish market as a whole Data from Mercamadrid meets all of our prior requirements, and therefore we confidently rely on this dataset to perform our empirical exercise.

Figure 5. Price evolution of farmed and wild seabram in Mercamadrid. Jan. 2007-Mar. 2012.



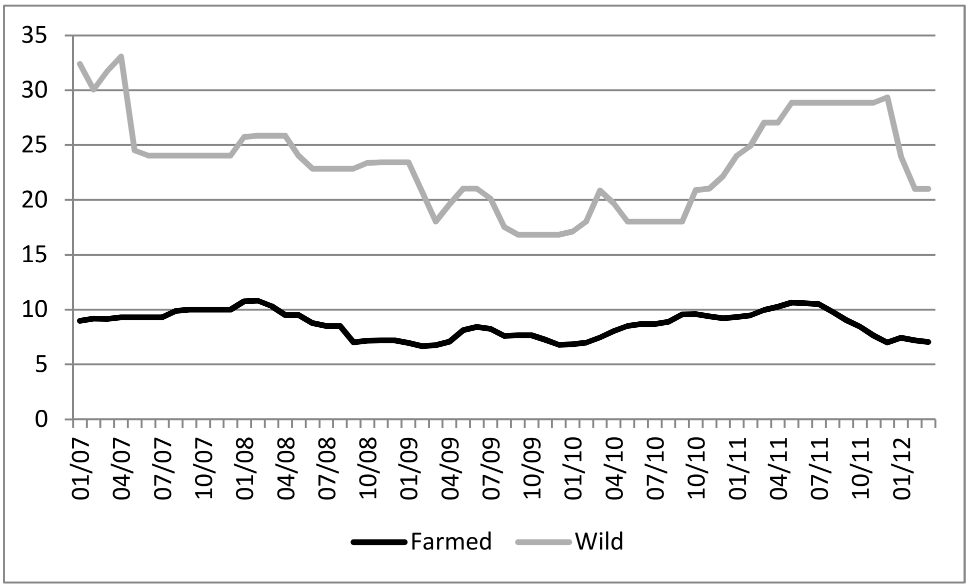
Source: Mercamadrid, 2012.

Figure 6. Price evolution of farmed and wild seabass in Mercamadrid. Jan. 2007-Mar. 2012.



Source: Mercamadrid, 2012.

Figure 7. Price evolution of farmed and wild turbot in Mercamadrid. Jan. 2007-Mar. 2012.



Source: Mercamadrid, 2012.

Figure 5, 6 and 7 show the prices of captured and farmed seabram, seabass and turbot respectively in euros/kg. Generally speaking, a higher fluctuation in prices for wild species can be observed. This may be due the strong seasonal fluctuations of catches compared with the more regular production of fish farms. These seasonal variations are particularly appreciable in the case of seabass, whose prices tend to fall in the months of February or March. Secondly, prices for wild species are markedly higher than those for the farmed ones, especially for turbot. If we take into account the prices for the latter species during the last 12 months of the series, the average price for the catch is 27.02 Euros/kg (23.30 for the whole period of analysis), while the price for the farmed one is 8.80 Euros/kg (8.65 for the whole period). Even though differences are not so broad for the other two species, prices for captured seabream are double than those for the farmed and in the case of captured seabass are slightly more than three times higher.

Ultimately, descriptive data show differences in prices high enough to support the assumption of no substitution between wild and farmed species. However we must carry out robust test to corroborate this hypothesis.

3.1. Methodology.

In this section we summarize our econometric methodology. Our main task is to ascertain whether capture and aquaculture species belong to the same market (and therefore should be regarded as substitutes) or not (in which case they should be treated as complementary). The literature has solved the problem of defining a market for a commodity or a group of commodities in terms of prices. Therefore, if the prices of two commodities tend to uniformity (Stigler, 1969), they should be ascribed to the same market. Empirically the general procedure has consisted in using times series econometrics to check if prices move together in the long run, i.e., if they are cointegrated or not. Following Asche *et al*. (2005), evidence of price changes in one market generating price changes in another market reflect a long-run relationship, which may be represented as follows:

$$p_t^1 - \beta_0 - \beta_1 p_t^2 = \varepsilon_t \tag{1}$$

where p_t^j represents the log of the price observed in market j at time t (j=1,2), β_0 is a constant term reflecting the transportation or transaction costs and quality differences, while β_1 is the relationship between the prices. If $\beta_1=0$, then there is no relationship between these prices. This would indicate that these markets are not integrated. However, if β_1=1, then the law of one price holds and the relative price between both species is constant. Therefore, the main econometric task is to identify the existence of a non spurious long run relationship between the prices of two commodities.

In this context the general procedure is first to check the dynamic properties of the time series involved in the analysis, i.e., whether they are stationary or not, by running unit root tests. If the series are $I(1)$ the next step is to check if some linear combination of these series is stationary. If some parameters β_0 and β_1 can be identified, then equation (1) holds and both series would be regarded as cointegrated. If we fail to find such linear combination, then we can statistically reject the existence of a long run relationship between these variables. The issue here is how to obtain the values of β_0 and β_1. The standard approach (see Asche, 2005) is the Johansen methodology. Let Y_t be a 2×1 vector of prices (in logs), and assume that Y_t follows an unrestricted vector autoregression (VAR) on the levels of the variables (Lütkepohl and Krätzig, 2004), of the following type:

$$Y_t = \Pi_1 Y_{t-1} + \ldots + \Pi_k Y_{t-k} + \Gamma D_t + \mu + e_t, \tag{2}$$

where each of the Π_i matrices is a k×2 matrix of parameters, μ is a constant term, D_t is the vector of deterministic terms, and e_t is a 2×1 vector of identically and independently distributed residuals, with a zero mean and a contemporaneous covariance matrix Ω. The VAR model above may be written into its error corrected form as follows:

$$\Delta Y_t = \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{k-1} \Delta Y_{t-k+1} + \Pi Y_{t-k} + \psi D_t + e_t \, , \qquad (3)$$

With $\Gamma_i = -I + \Pi_1 + \ldots + \Pi_i, i = 1,\ldots,k-1$ and $\Pi_i = -I + \Pi_1 + \ldots + \Pi_k$. Therefore, Π is the long-run level solution to (1). If Y_t is a vector of I(1) variables, the left hand side and the first (k-1) variables in equation (2) are I(0), while the k-th element in (3) is a linear combination of I(1) variables. Given our assumptions for the error term, the k-th element in (2) must also be stationary, which implies either that Y_t contains a number of cointegrating relationships or Π is a matrix of zeros. The rank of Π, denoted by r, determines the number of linear combinations of Y_t that are stationary. If $r=n$, the variables in the levels are stationary. If $r=0$ and Π=0, none of the linear combinations are stationary. Finally, if $0<r<n$, there are r cointegrating vectors. This may be written as $\Pi = \alpha\beta'$, where α and β are $n \times r$ matrices, while β contains the cointegrated relationships and α is the adjustment parameter. Johansen (1988, 1991) provides a procedure to estimate these cointegrating vectors.

The initial stage of the Johansen procedure, therefore, is to check that the involved variables are I(1) or I(0). But classifying variables as stationary of non-stationary on the grounds of unit root tests can be sometimes difficult, given that these tests are known to have low statistical power (see *inter alia* Schwert, 1987, Lo and MacKinlay, 1989, Blough, 1988, Cochrane, 1991, Perron and Ng, 1996 or Caner and Killian, 2001). These authors show that tests for unit roots have low power in finite samples against the local alternative of a root close to but below unity (Cochrane, 1991). . Moreover, this standard methodology would prevent the possibility of a framework in which some variables are I(1) and others are I(0). In fact, previous attempts to test market integration of sea bass and sea bream markets stumbled with the stationarity of the data series (Asche *et al* 2001), limiting the systematization of the knowledge about the substituibility between wild and farmed species.

The procedure suggested by Pesaran *et al* (1996) and Pesaran and Shin (1999), based on the use of Autoregresive Distributed Lag (ARDL) models may overcome these difficulties. These authors show that the main advantage of this testing and estimation strategy is that it can be applied irrespective of whether the involved regressors are stationary or not, and therefore can avoid the pre-testing problems associated with the standard cointegration analysis just described. The procedure involves two stages in the analysis. At the first stage we test for the existence of a long run relationship, i.e., for the existence of cointegration. To do so an Error Correction (ECM) version of the underlying ARDL model involving the variables of interest is first estimated:

$$\Delta p_t^1 = \alpha_0 + \sum_{i=1}^{p} b_i \Delta p_{t-1}^1 + \sum_{j=1}^{q} d_j \Delta p_{t-j}^2 + \delta_1 p_{t-1}^1 + \delta_2 p_{t-1}^2 + u_t \qquad (4)$$

Where Δ is the difference operator, p and q are the optimal lag lengths (determined following statistical information criteria, as the AIC or the SBC), **b**, **d** and $\boldsymbol{\delta}$ are parameter vectors to be estimated, and u_t is the error term. After estimation of model (4) the joint significance of the lagged levels of the variables is tested by computing an *F*-statistic. However, the asymptotic distribution of this *F*-statistic is non-standard, irrespective of whether the regressors are I(0) or I(1). Pesaran *et al* (1996) have tabulated the appropriate critical values, and provide for each combination of number of regressors and size of the test two sets of critical values: one set assuming that all of the variables in the regression are I(1) and another computed under the assumption that all of the regressors are stationary. This provides a band covering all of the possible classifications of the variables into I(1) and I(0). If the computed F-statistic falls outside this band we may provide a decision as regards the existence of a long run relationship. If the value of the F-statistics falls within the critical values the results of the test are inconclusive and therefore further testing is needed. Should we conclude that the variables in the ARDL are cointegrated we proceed to the second stage of the modelling procedure, in which the coefficients of the long run relationship are estimated through an ARDL model, and inferences about their values may be conducted.

4. Results.

We start analyzing whether the species under scrutiny (sea bass, sea bream and turbot) are I(0) or I(1) and conduct standard unit root tests for each of the price variables, both with and without a constant term (we do not consider the inclusion of a time trend given the behavior of the series observed in graphs A1, A2 and A3 of the appendix). Table 1 summarises the results of the Augmented Dickie-Fuller (ADF) tests for each variable[2].

[2] We have run other unit root tests, as the KPSS or the Phillips-Perron test, and results are similar to those reported in Table 1. We do not report these results for brevity, but are available from authors upon request.

Table 1. Unit root tests.

a. Original variables

Variable	Levels: Constant	Levels: No constant	First Differences: Constant	First Differences: No constant
Sea Bass (aquaculture)	-3.29	-0.18	-9.53	-9.58
Sea Bass (captured)	-4.19	-0.74	-9.01	-9.06
Sea Bream (aquaculture)	-3.25	-0.41	-10.26	-10.34
Sea Bream (captured)	-2.84	-0.67	-8.87	-8.95
Turbot (aquaculture)	-1.87	-0.71	-5.27	-5.28
Turbot (captured)	-2.21	-0.93	-6.93	-6.94

b. Variables in logs

Variable	Levels: Constant	Levels: No constant	First Differences: Constant	First Differences: No constant
Sea Bass (aquaculture)	-3.13	0.05	-9.28	-9.33
Sea Bass (captured)	-4.51	-0.21	-7.3	-9.24
Sea Bream (aquaculture)	-2.86	-0.25	-9.69	-9.77
Sea Bream (captured)	-2.74	-0.18	-7.75	-7.82
Turbot (aquaculture)	-1.84	-0.60	-5.42	-5.44
Turbot (captured)	-2.17	-0.62	-6.47	-6.49

Results from Table 1 suggest that in general we may regard our price variables as non-stationary, since for the intercept version of the test, in most of the cases the test-statistic is lower (in absolute value) than the 95% critical value. However, as we already discussed, unit root tests tend to show low power, and lowering the significance of the test to, say, 10%, results in a number of price variables stationary in levels. Note that even at the 5% significance level the price of captured sea bass seems to be level-stationary, whereas the farmed price is first-difference stationary, and therefore standard cointegration tests would be precluded.

Given these problems we decided to apply the ARDL approach discussed above to each pair of price variables. Our methodology begins by estimating a first-stage ARDL model of the type

$$\Delta p_t^1 = \alpha_0 + \sum_{i=1}^{p} b_i \Delta p_{t-1}^1 + \sum_{j=1}^{q} d_j \Delta p_{t-j}^2 + \delta_1 p_{t-1}^1 + \delta_2 p_{t-1}^2 + u_t \qquad (4)$$

in which we include up to 12 lags of each differenced variable. Next we compute a standard test for the joint significance of the lagged level terms in equation (4), and compare the resulting test statistic with the critical value bounds reported in Pesaran and Pesaran (2009) and Pesaran *et al* (1996), as discussed in the previous subsection. Results are summarised in Table 2.

Table 2

		F-Statistic
Sea Bass	cap=>ac	2,093
	ac=>cap	1,154
Sea Bream	cap=>ac	2,903
	ac=>cap	4,070
Turbot	cap=>ac	4,841
	ac=>cap	2,180

Lower bound	Upper Bound
3,793	4,855

From these results we observe that in the case of two of the three species (sea bass and sea bream) the value of the F-statistic is below the 95% critical value bound, which does not allow us to reject the null of no cointegration between the prices of each species irrespective of their order of integration. In the case of the turbot, the statistic falls in the indeterminacy area, and therefore we need to explore further the relationship between the farmed and captured species. Moreover, note that we have run sensitivity tests by reversing the order of the long run forcing variables (aquaculture forcing captures) and in two of the three cases (sea bream and turbot) we cannot reject the null of no cointegration. Therefore, the ARDL approach needs to be complemented by further analysis in the cases of sea bream and turbot. The conclusion in the case of sea bass is definitive, we cannot reject the null of no cointegration between the prices in these markets, which cannot be regarded, therefore, as integrated.

Table 3 summarises the results of the Johansen procedure for the sea bream and turbot prices respectively (which the ADF tests suggested were first-difference stationary). In both cases the value of the Maximum Eigenvalue Statistic is below the 5% critical value, and therefore the null of no cointegration cannot be rejected. In sum, our empirical analysis suggests that in the case of these three species the Spanish markets for cultured and captured species are not integrated.

Table 3

	Max. Eigenvalue Statisic	0.05 critical value	p-value
Sea Bream			
r=0	9.36	14.26	0.256
r=1	5.66	3.84	0.017
Turbot			
r=0	14.09	14.26	0,053
r=1	4718	3841	0.029

5. Discussion.

Previous research (Rodriguez *et al*., 2013) on the Spanish market has shown that wild and farmed sea bream do not belong to the same market. Consumers appreciate the different characteristics of the two products and pay a different price for them. But the evidence was not wide enough to attribute this segmentation to a broader market. In other words, it was necessary to test if this was an exception or rather suggests a wider phenomenon.

Current research shows that in the Spanish seafood market, wild and farmed sea bream, sea bass, and turbot, i.e., 90% of the Spanish finfish aquaculture production, this statement remains true. Nevertheless, this is not the totality of the Spanish seafood market, which it´s also made up of other fish species not farmed in Spain (as salmon) or mollusc (as mussels, clams, etc). So a further delineation of the phenomena is needed.

The available literature had identified that the markets for the Italian and Spanish striped venus and the Japanese carpet shell are interrelated and to some extent these clams can be considered to be substitutes (Jimenez-Toribio *et al*., 2007). Not all the clam species are interrelated, as Grooved carpet shell constitutes a single market.

Jaffry *et al*. (2000) had analysed market interactions between salmon and wild caught fish (tuna, whiting and hake) in Spain, with no significant interaction being identified. And, even though it´s generally accepted that wild and farmed salmon and trout are substitutives (Nielsen *et al*., 2007; Asche *et al*., 2005), until now this relation had not been tested for the Spanish market.

Ultimately, two axes seem to be of high importance when explaining those results:

- Preferences steaming from Spanish culinary tradition.
- The belonging to intensive versus extensive cultured systems.

Generally talking, when compared with farmed fish, wild fish was always preferred among consumer (Claret *et al*., 2012). In an overall sense, European consumers perceive farmed fish as being of lower quality than wild fish (Kole, 2003; Verbeke *et al*., 2007a), in spite of having a positive overall image of both, fishery and aquaculture products (DG Mare, 2008). Regarding Spain, and according to MAPA (2009), Guerrero, Claret, *et al*. (2009) and Fernández-Polanco and Luna (2010), farmed fish species are perceived as having lower quality, as well as more health and safety issues. Normally farmed fish is also perceived as more processed or manipulated than its respective wild equivalent (Claret *et al*., 2012).

In this regard, seafood coming from extensive aquaculture (as clams, mussels, etc) may be perceived as more natural (as they involve less manipulation and use of chemical or pharmaceutical inputs) than those from intensive systems (as farmed sea bream, sea bass, turbot, etc). At the same time, for certain products historically linked to the culinary tradition (as Grooved carpet shell) the autochthonous-locally fished character seems to be important, making the difference between the premium demand for wild sea bass, sea bream or turbot, but not as much for salmon.

6. Concluding remarks.

In the Spanish seafood market wild and farmed marine fishes do not belong to the same market and this market segmentation is likely be similar in, at least, other south European countries, as Italy, Portugal, Greece or France. Nevertheless, the latter requires further research in order to be confirmed.

Those results have implications for policy makers, fishers and fish farmers. With respect to commercial fishers, the no substitution between wild and farmed marine fishes means that catches should not suffer the impact derived from the low prices of the aquaculture. On the contrary, fisheries can preserve their own markets by addressing market niches of high quality products. Therefore, *ceteris paribus*, we can expect the social and economic contribution of the fishing activity to the local economies not to be eroded by farmed fish competition.

Generally speaking fishing sector is nowadays facing serious problems (overexploitation, overcapitalisation, etc) and is particularly under a high competition pressure, but these problems, at least in the case of the species analyzed in this paper, and probably others, are not derived specifically from their farmed pairs.

On the other hand, aquaculture sector has been frequently accused of traditional fisheries displacement. Nevertheless, this charge is not true in all of the cases, and therefore the aquaculture has an opportunity to improve its public perception.

To the best of our knowledge, the most remarkable consequence is for sustainability of fish stocks and, therefore, it implies a new challenge for fisheries management. If wild and farmed fish are substitutes, the decreasing prices of the cultured ones mean that catches will suffer from a decreasing demand and prices. Consequently, fisher's income will be reduced in the short term. Fishermen response is likely to be an effort reduction (or even the abandon of those fisheries), allowing for the improving of the fish stock. But, on the contrary, if they are not substitutes, additional fisheries management measures are likely to be necessary to preserve the fish stock and guarantee the sustainability of the fishery.

Furthermore, as the number of farmed species keeps on growing worldwide this issue should be addressed in order to manage the derived problems for fishers if the new specie has wild substitutes, or either the problems for sustainability of the stocks if not.

It is worth noting, finally, that the method used (based on ARDL models) was critical to extend the findings of our research to sea bream and sea bass, while previous attempts stumbled with the limitations of the standard cointegration test when the series are stationary.

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