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MARKET INTEGRATION BETWEEN WILD AND FARMED FISH IN MEDITERRANEAN COUNTRIES

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PREPARATION OF THIS DOCUMENT

This publication contributes to FAO's ongoing activities and examines market competition between farmed and wild fish, its consequences and policy implications, in particular for the future development of aquaculture. It was initiated as part of a larger technical study by Trond Bjørndal, Audun Lem and Alena Lappo that analysed future demand and supply of food to 2030 from an economic point of view (Lem, Bjørndal and Lappo, 2014). This report found that, in the future, aquaculture development is likely to drive fish markets. In FAO Fisheries and Aquaculture Circular No. 1114, Bjørndal and Guillen (2016), analysed different studies on market integration betweeen wild and farmed fish products. Outcomes of the study usually verify the presence of market integration between conspecifics, and so interactions between wild and farmed product prices are confirmed. However, one of the areas where results are more uncertain and do not fully confirm market integration is the Mediterranean basin, in particular regarding to seabream and seabass. Hence, the current study investigates the presence of market integration for a large variety of wild and farmed fish products in the Mediterranean area, offering further insights in this regard.

FAO. 2018.
Market competition between farmed and wild fish: a literature survey, by Trond Bjørndal and Jordi Guillen.
Fisheries and Aquaculture Circular No. 1131. Rome, Italy.

ABSTRACT

Market integration occurs when prices among different locations or related goods follow similar patterns over time. Current knowledge on market integration between aquaculture and wild-caught fish is based on a small number of species and markets. Most studies show the existence of market integration between wild and farmed conspecifics. However, there are some ambiguous results for European seabass and gilthead seabream in southern European countries in the literature. In this study, we investigate the existence of market integration between wild and farmed conspecifics for European seabass and gilthead seabream as well as several other key species in southern European countries.

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ABBREVIATIONS AND ACRONYMS

ADF	Augmented Dickey-Fuller
e.g.	from the Latin *exempli gratia*, meaning "for the sake of example"
et al.	from the Latin *et alii*, meaning "and others"
CEs	cointegration equations
EU	European Union (Member Organization)
EUMOFA	European Market Observatory for Fisheries and Aquaculture
EUR	Euro
FAO	Food and Agriculture Organization of the United Nations
i.e.	from the Latin *id est*, meaning "that is" or "in other words"
g	gram
kg	kilogram
km	kilometre
nei	not elsewhere included
no.	number
Prob	probability
S.D.	standard deviation
S.E.	standard error
spp.	several species
Std.	standard
USD	United States dollar

EXECUTIVE SUMMARY

The aim of this report is to provide an overview of the market interactions (competition) between wild and farmed species in Mediterranean fish markets. 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 existing literature on market interactions between wild and farmed fish.

The existence of market competition between wild fisheries and aquaculture implies that there is substitutability between wild and farmed species. Therefore, market competition between wild fisheries and aquaculture can be observed mostly when increased aquaculture supply leads to decreases in wild-caught seafood prices (Anderson, 1985). If two products (wild and farmed) are close substitutes, and considering that aquaculture is probably the world's fastest growing food-producing sector, farmed produce will win the market share from wild produce. If demand is not perfectly elastic, the price of both products will decline, as will the income of fishers. In an extreme case, buyers would make no distinction between both products, considering that they are the same product. However, if the two produces are not substitutes, so that there are no market effects, the increase in the supply of farmed produce will only lead to a price decrease for farmed produce, and will not affect the price of wild-caught produce (Asche *et al.*, 2001).

Previously available studies on competition interactions between wild and farmed species in the Mediterranean are based on a rather limited number of cases with no general trends detected. The differences in the outcomes obtained could be based, at least in part, in the different data sources employed and time periods analysed. In fact, market integration results can be sensitive to the period investigated because fish markets are dynamic and continuously evolving.

Therefore, this study is a detailed and wide-ranging investigation on the existence of market interactions between wild and farmed species in different Mediterranean countries. Unfortunately, only data from southern European markets and Turkish exports are available. Our results show that there is no, or low, market integration between wild and farmed products in Mediterranean countries for gilthead seabream, European seabass, or for the other species analysed (turbot, sole, meagre and clams). This general lack of integration between farmed and wild products has been explained in the literature by the traditional consumption (knowledge) of fish in the area, a preference for local products, the use of different market chains (e.g. fine restaurants normally only serve wild products), and a persisting negative perception of farmed finfish in the area. However, market integration has been found for blackspot red seabream and Atlantic cod. The existence of market integration between wild and farmed conspecifics for Atlantic cod can be explained because both products are imported and the low volumes of farmed cod sold. Market integration between wild and farmed conspecifics for blackspot (red) seabream could be due to the low volume of farmed individuals sold (i.e. only 2 percent of all fresh blackspot [red] seabream), which makes it possible that the prices of farmed products follow similar trends as the prices of their wild conspecifics.

The results show that there is no market integration between gilthead seabream and European seabass in French, Italian and Portuguese markets, and only partly in the Spanish market. There are few cases where prices of farmed gilthead seabream and European seabass are related (i.e. prices move together over time). This happens between farmed gilthead seabream and European seabass in the Madrid wholesale market, and between wild gilthead seabream and European seabass in the Barcelona wholesale market.

Finally, the results show that in general there is no market integration between wild species from different markets; only market integration for wild European seabass has been found between the Barcelona and Madrid wholesale markets. A higher degree of integration between markets for farmed species was expected, as aquaculture products are more subject to competition; however, our results show that market integration for farmed species is also quite limited. Prices of farmed turbot (*Scophthalmus maximus*) in Barcelona and Madrid wholesale markets are integrated. While market integration between farmed European seabass in Barcelona and Madrid and farmed European seabass

in Paris wholesale markets is uncertain in the best of cases, the perception is that they are not integrated. The same applies to farmed European seabass imported from Turkey into the European Union (EU) and farmed European seabass into the Madrid wholesale market. In fact, the results for market integration are not conclusive because market integration is denied or accepted depending on the number of lags chosen and the methodology applied.

1. INTRODUCTION

The aim of this report is to provide an overview of the market interactions (competition) between wild and farmed species in Mediterranean fish markets. 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 between wild and farmed fish.

The existence of market competition between wild fisheries and aquaculture means that there is substitutability between wild and farmed species. Market competition between wild fisheries and aquaculture can be observed, for the most part, when increased aquaculture supply leads to decreases in wild-caught seafood prices (Anderson, 1985).

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

Price interactions operate at a global level and can have serious consequences for wild fisheries and aquaculture producers when the imported produce price is lower than the domestic price (e.g. produce comes from countries with significantly lower production costs). Less efficient domestic aquaculture firms and wild fisheries may experience decreases in profits, thus compromising their future. In some instances, this has given rise to "dumping" complaints and the introduction of anti-dumping measures (Asche and Bjørndal, 2011).[1]

Therefore, 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). Through this contribution to the decrease in seafood prices and the increase in 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, thereby 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).

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 markets of the United States of America (USA) and the EU being the two main consumer markets (Bjørndal and Guillen, 2016). In particular, when it comes to the Mediterranean area, existing knowledge on competition interactions between wild and farmed species in the Mediterranean is more limited, and is based solely on studies investigating gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) in Spain, France and Italy. As we shall discuss later, some of the results may appear to be contradictory.

For Spain, Alfranca *et al.* (2004) found that farmed gilthead seabream (*Sparus aurata*) prices determined the evolution of wild gilthead seabream (*Sparus aurata*) prices more directly than the wild gilthead

[1] The term "dumping" is defined in the Agreement on Implementation of Article VI of the GATT 1994 (The Anti-Dumping Agreement) as the introduction of a product into the commerce of another country at less than its normal value, if the export price of the product exported from one country to another is less than the comparable price, in the ordinary course of trade, for the like product when destined for consumption in the exporting country (WTO, 2017).

seabream prices in the Barcelona wholesale market. However, Rodríguez *et al.* (2013) have shown that wild and farmed gilthead seabream (*Sparus aurata*) are two heterogeneous products and, consequently, are not substitutes in the Madrid wholesale market.

In French households, Regnier and Bayramoglu (2014) have found that fresh whole wild seabream (consisting of *Sparus aurata*, *Spondyliosoma cantharus*, *Pagellus bogaraveo*, *Coryphaena hippurus*, *Sebastes mentella*, *Sebastes marinus*, and *Lithognathus mormyrus*) and farmed gilthead seabream (*Sparus aurata*) are partially integrated and that their price relationship is led by farmed seabream; while those for whole wild seabass (*Dicentrarchus labrax* and *Anarhichas lupus*) and farmed European seabass (*Dicentrarchus labrax*) are not integrated. On the other hand, Brigante and Lem (2001), using a much older dataset, concluded that wild and farmed conspecifics are not substitutes for gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) in Italy.

In addition, Alfranca *et al.* (2004) found that the influence on farmed and wild gilthead seabream (*Sparus aurata*) prices of wild sole, farmed Atlantic salmon (*Salmo salar*), farmed European seabass (*Dicentrarchus labrax*), and wild European seabass (*Dicentrarchus labrax*) prices are rather weak and not very significant in the Barcelona wholesale market.

Therefore, available studies on competition interactions between wild and farmed species in the Mediterranean are based on a limited number of cases with no general trends observed. The differences in the outcomes obtained could be, at least in part, due to the different data sources employed and the time periods analysed. Therefore, in this study we investigate in more detail and take a more homogeneous approach to the existence of market interactions in the area using recent datasets spanning more or less the same period.

This study is organised as follows. In section one, we provide an overview of aquaculture and capture fisheries in the Mediterranean with a characterisation of the main producing and consuming countries. Section two introduces the methodology to estimate the existence of market competition interactions: the Johansen cointegration test (Johansen, 1988, 1991; Johansen and Juselius, 1990). Data used for the analysis is presented in section three. Section four shows the results obtained, while section five provides a discussion and interpretation of the results.

2. CAPTURE FISHERIES AND AQUACULTURE IN THE MEDITERRANEAN

In the Mediterranean and Black seas[2], capture fisheries production in 2013 was 1.3 million tonnes, of which, 1 113 thousand tonnes were fish, 138 thousand tonnes were molluscs and 61 thousand tonnes were crustaceans (FAO, 2017). The main capture species in 2015 (see Table 1) are European anchovy, which represents 26 percent of the total production, European pilchard (14 percent), European sprat (8 percent) and striped venus (4 percent). While quantity data are available for both aquaculture and capture fisheries, value data are only available for aquaculture.

Marine aquaculture production in the Mediterranean and Black seas reached 457 thousand tonnes in 2015, with 305 thousand tonnes coming from fish and 152 from molluscs (FAO, 2017). Marine aquaculture production in the Mediterranean and Black seas is concentrated on gilthead seabream and European seabass, and the two species combined represent 62 percent in weight and 79 percent in value of the total Mediterranean and Black seas aquaculture production. Other farmed species in terms of quantity are Mediterranean mussel (22 percent) and Japanese carpet shell (7 percent), both of which represent 5 percent in terms of value (see Table 1).

The main fishing nations in the Mediterranean and Black seas are Turkey, accounting for 30 percent of the total catches, followed by Italy (14 percent), Tunisia (9 percent), Algeria (7 percent) and the Russian Federation (7 percent) (see Table 2). Marine aquaculture production is more concentrated, with Turkey responsible for 30 percent of the total quantity produced followed by Italy (25 percent), Greece (23 percent) and Spain (8 percent) (see Table 2).

[2] The Mediterranean Sea is located between Europe and Africa, as well as Asia in the East. It is connected to the Atlantic Ocean through the 14-km-wide Gibraltar Strait and is almost completely enclosed by land: on the north by southern Europe and Anatolia, on the south by North Africa, and on the east by the Levant. The Mediterranean Sea covers an area of over 2.5 million square km (950 000 square miles).
The Black Sea is a sea between southeastern Europe and western Asia. It is bounded by Europe, Anatolia and the Caucasus. The Black Sea is an inland sea connected to the Marmara Sea by the narrow and shallow Bosporus Strait, while the Strait of Dardanelles further connects the Marmara Sea to the Aegean Sea region of the Mediterranean Sea. The Black Sea is also connected to the Sea of Azov by the Strait of Kerch. The Black Sea (not including the Sea of Azov) covers an area of 436 400 square km (168 500 square miles).
Marine biodiversity differs significantly between the Mediterranean Sea and the Black Sea, in great part due to the Black Sea's reduced salinity. In the Mediterranean Sea there are two to five times more species in various benthic taxa than in the Black Sea. There are twice as many macroalgal varieties in the Medierranean as in the Black Sea, and planktonic biodiversity is about 1.5 times higher. In the Black Sea there are no corals, no octopuses or squids, no seastars or sea urchins (of all the echinoderms, only several small ophiuran and holothurian species are adapted to the Black Sea's habitat).

Table 1. Top ten finfish special and total production from aquaculture and wild fisheries in weight (tonnes) and aquaculture value ('000 USD) in the Mediterranean and Black seas in 2015

Capture fisheries production volume	Tonnes	Aquaculture production volume	Tonnes	Aquaculture production value	'000 USD
European anchovy	345 840	Gilthead seabream	142 480	Gilthead seabream	796 908
European pilchard (= sardine)	184 758	European seabass	139 424	European seabass	793 423
European sprat	109 179	Mediterranean mussel	101 252	Japanese carpet shell	105 552
Striped venus	52 173	Japanese carpet shell	33 622	Atlantic bluefin tuna	92 585
Sardinellas nei	41 512	Sea mussels nei	7 408	Mediterranean mussel	92 256
Gobies nei	28 409	Rainbow trout	6 187	Meagre	30 659
Bogue	20 024	Atlantic bluefin tuna	5 854	Pacific cupped oyster	24 675
European hake	19 648	Pacific cupped oyster	5 603	Rainbow trout	22 707
Jack and horse mackerels nei	19 510	Meagre	5 435	Grooved carpet shell	13 651
Mediterranean horse mackerel	19 245	Grooved carpet shell	3 014	Sea mussels nei	9 317
Total general	**1 314 257**	**Total general**	**457 267**	**Total general**	**2 018 976**

Source: FAO (2017).

Table 2. Top ten countries and total production from aquaculture and wild fisheries in weight (tonnes) and value ('000 USD) in the Mediterranean and Black seas in 2015

Capture fisheries production volume	Tonnes	Aquaculture production volume	Tonnes	Aquaculture production value	'000 USD
Turkey	397 733	Turkey	137 509	Turkey	670 752
Italy	190 136	Italy	113 894	Greece	503 783
Tunisia	117 600	Greece	103 851	Italy	284 479
Algeria	96 405	Spain	34 793	Spain	188 629
Russian Federation	95 692	France	22 180	Croatia	83 737
Spain	77 356	Tunisia	13 220	Tunisia	78 540
Croatia	72 258	Croatia	10 740	France	68 101
Greece	63 527	Malta	5 913	Malta	67 121
Egypt	57 603	Cyprus	5 415	Cyprus	35 458
Ukraine	34 731	Bulgaria	3 373	Israel	18 417
Total general	**1 314 257**	**Total general**	**457 267**	**Total general**	**2 018 976**

Source: FAO (2017).

Production from capture fisheries and aquaculture in the Mediterranean and Black seas do not match with the production from Mediterranean countries[3] because in the latter we do not include production from countries with a coastline only in the Black Sea[4], or production from third countries (e.g. Japan and Korea), which have historically been fished in Mediterranean waters. In addition, Mediterranean countries also fish in other waters, especially those countries that also have coastlines in different water basins (e.g. France, Morocco, Spain), the existence of long-distance fishing fleets (e.g. fishing in the Pacific and Indian oceans), and freshwater and inland water fisheries. The Mediterranean coast is about 46 000 km long, with 15 000 km suitable for aquaculture production on the northern shore (from Spain to Turkey) and 4 000 km on the southern shore (Lacroix, 1995).

Table 3. Total production from aquaculture and wild fisheries in weight (tonnes) and value

Fishing area	Capture fisheries production volume	Aquaculture production volume	Aquaculture production value
Africa - inland waters	257 377	1 177 586	1 838 445
Asia - inland waters	37 100	123 765	338 156
Europe - inland waters	14 294	110 915	393 658
Mediterranean and Black seas	1 157 275	452 719	2 012 774
Atlantic Ocean	2 453 210	377 295	841 442
Indian Ocean	243 626		
Pacific Ocean	65 112		
Total	**4 227 994**	**2 242 280**	**5 424 475**

Source: FAO (2017).

Capture fisheries production represents two-thirds of the total seafood production, including capture and aquaculture production, in Mediterranean countries. Capture fisheries catches in the Mediterranean and Black seas by Mediterranean countries represent 27 percent of all their catches, while most catches come from the Atlantic Ocean, mainly Morocco, Spain and France, which account for 58 percent of all catches. Other capture fisheries areas are inland waters,[5] the Indian Ocean and Pacific Ocean.

Marine aquaculture production represents 37 percent in quantity and 53 percent in value of all aquaculture production by Mediterranean countries. In contrast, 20 percent in quantity and 37 percent in value of all aquaculture production come from the Mediterranean and Black seas, while the other 17 percent in quantity and 16 percent in value comes from the Atlantic Ocean. Inland aquaculture (freshwater and brackishwater) represents 63 percent in quantity and 47 percent in value for Mediterranean countries, mostly from Africa, which represents 53 percent in quantity and 34 percent in value of all aquaculture production.

The main Mediterranean fishing nations are Morocco with 32 percent of the total catch, followed by Spain (23 percent), France (12 percent), Turkey (10 percent) and Egypt (8 percent) (Table 4). Marine aquaculture production is more concentrated, with Egypt accounting for 52 percent of the total quantity produced, followed by Spain (13 percent), Turkey (11 percent), France (9 percent), Italy (7 percent), and Greece (5 percent) (Table 4).

Despite the predominance of capture fisheries as the main production source, aquaculture production in Mediterranean countries plays an increasing role in seafood supply and is very significant for some countries (see Figure 1).

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[3] Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Gibraltar (a self-governing British Overseas Territory), Greece, Israel, Italy, Lebanon, Libya, Malta, Monaco, Montenegro, Morocco, Occupied Palestinian Territory, Slovenia, Spain, the Syrian Arab Republic, Tunisia, and Turkey.
[4] Bulgaria, Georgia, Romania, the Russian Federation, and Ukraine. Turkey is considered in this study as a Mediterranean country because part of its coastline is in the Mediterranean Sea.
[5] Asia – inland waters refers to inland production in Turkey.

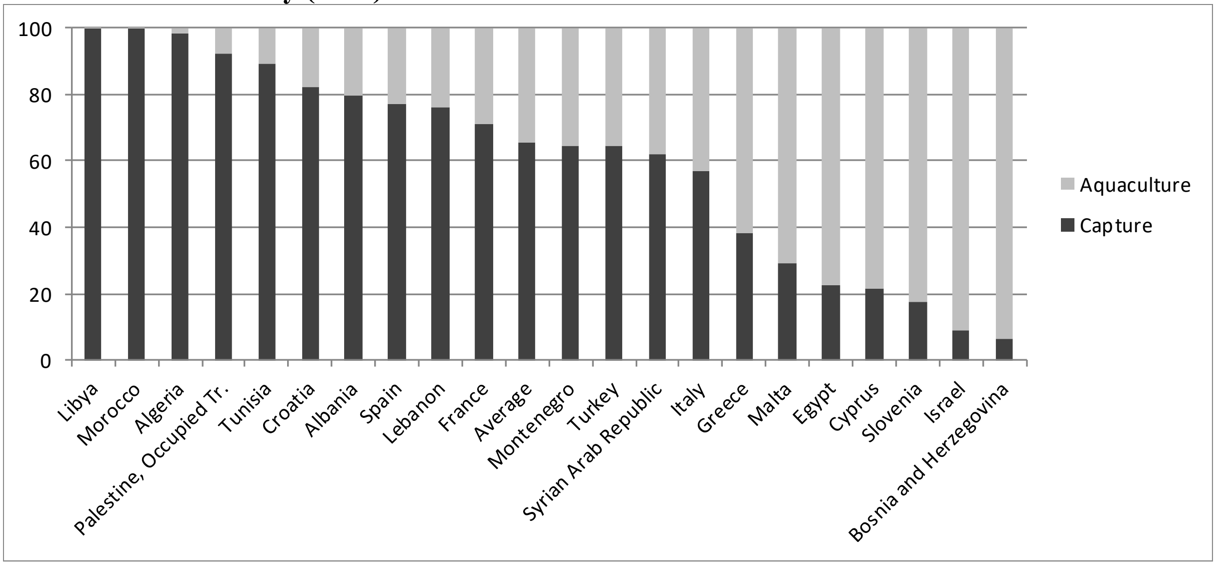
Gibraltar and Monaco are not further included in the analysis due to their low total production and consumption, which is the result of their small populations of almost 29 000 and 38 000, respectively.

Table 4. Top ten countries and total production from aquaculture and wild fisheries in weight (tonnes) and value ('000 USD) in the Mediterranean and Black seas in 2015

Country	Total seafood production	Capture fisheries production volume	Aquaculture production volume	Aquaculture production value
Albania	7 875	6 280	1 595	8 723
Algeria	97 738	96 405	1 333	4 398
Bosnia and Herzegovina	4 756	305	4 451	13 929
Croatia	88 274	72 702	15 572	92 980
Cyprus	6 954	1 495	5 459	35 844
Egypt	1 518 944	344 113	1 174 831	1 831 035
France	712 013	505 213	206 800	817 037
Gibraltar	1	1	0	0
Greece	171 310	65 192	106 118	513 903
Israel	22 933	2 078	20 855	87 593
Italy	346 961	198 198	148 763	406 423
Lebanon	4 763	3 638	1 125	3 465
Libya	26 012	26 002	10	20
Malta	8 351	2 438	5 913	67 121
Monaco	1	1	0	0
Montenegro	2 300	1 487	813	3 178
Morocco	1 370 981	1 369 931	1 050	6 129
Occupied Palestinian Territory	3 503	3 227	276	2 590
Slovenia	1 951	343	1 607	4 729
Spain	1 265 453	975 632	289 821	509 014
Syrian Arab Republic	6 600	4 100	2 500	8 196
Tunisia	133 217	118 792	14 425	80 622
Turkey	670 873	431 909	238 964	927 546
Totals	**6 471 760**	**4 229 481**	**2 242 280**	**5 424 475**

Source: FAO (2017).

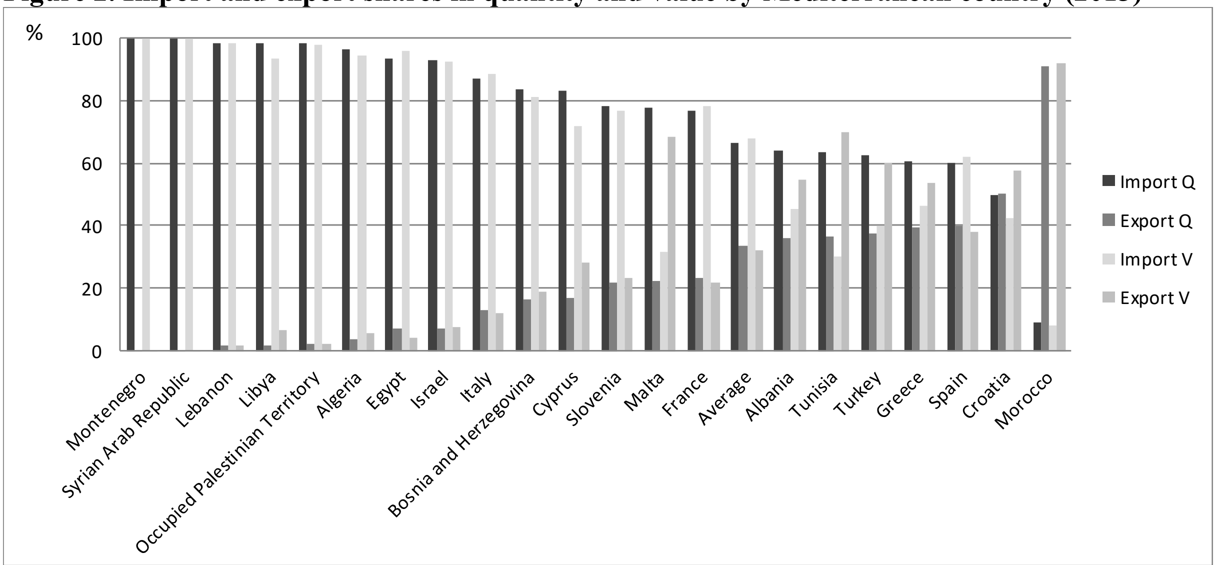
Figure 1. Capture and aquaculture production shares of the total seafood production by Mediterranean country (2015)



Source: authors' elaboration of FAO data (2017).

Mediterranean countries are net importers of seafood products, with imports being more than double that of exports. Indeed, in 2013, Mediterranean countries imported almost 4.8 million tonnes of seafood products (corresponding to about 6.8 million tonnes in live weight) valued at USD 22.0 billion, compared with the 2.4 million tonnes (equivalent to more than 2.5 million tonnes in live weight) exported valued at USD 10.5 billion (FAO, 2017). Only Morocco exported more in quantity than it imported; while in monetary terms, exports from Morocco, Croatia, Tunisia, Greece, the Turkey, Albania and Malta were more valuable than imports in 2013 (see Figure 2) (FAO, 2017). There has been a significant increase in external trade (imports and exports) during recent years. Countries such as Egypt, Croatia, Lebanon or the Syrian Arab Republic have experienced an important increase (Franquesa, Oliver and Basurco, 2008).

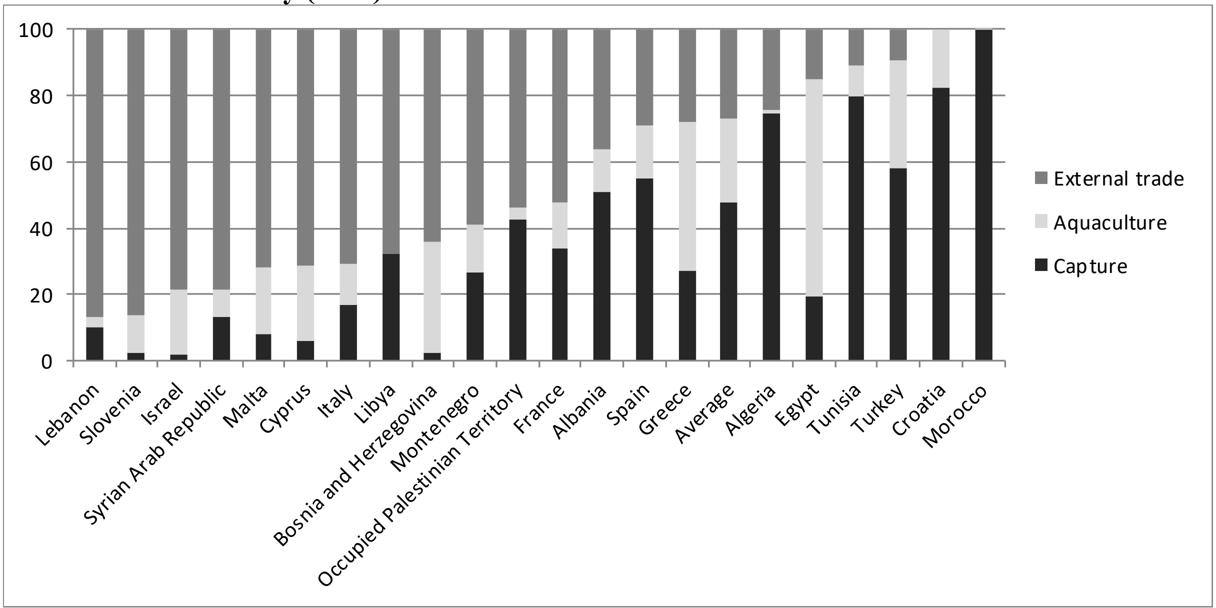
Figure 2. Import and export shares in quantity and value by Mediterranean country (2013)



Source: authors' elaboration of FAO data (2017).

In fact, external trade is the main seafood supply for most Mediterranean countries. External trade (imports and exports) represents 50 percent or more of the total seafood supply for Bosnia and Herzegovina, Cyprus, France, Israel, Italy, Lebanon, Libya, Malta, Montenegro, Occupied Palestinian Territory, Slovenia, Spain and the Syrian Arab Republic in 2013 (see Figure 3).

Figure 3. Capture, aquaculture and external trade shares of the total seafood supply by Mediterranean country (2013)



Source: authors' elaboration of FAO data (2017).

Total seafood supply, or apparent consumption[6], in Mediterranean countries was almost 9.7 million tonnes in live weight in 2013 (see Table 5) (FAO, 2017). The countries with the largest seafood consumption are France, Spain, the Egypt and Italy; these four countries consume 78 percent of all seafood in Mediterranean countries. While seafood consumed per capita (apparent consumption per capita[7]) is led by Spain, followed by France, Malta, Italy, Israel, Egypt and Cyprus (see Table 5). Average seafood consumption per capita varies from the 42.4 kg per person (kg/person) in Spain to the 1.7 kg/person in the Occupied Palestinian Territory. The total population of Mediterranean countries was 484 million people in 2013 (FAO, 2017).

[6] Apparent consumption is defined as the sum of capture fisheries production, aquaculture production and imports volume minus the exports volume.

[7] Apparent consumption divided by the population.

Table 5. Total seafood supply, apparent consumption per capita, price of aquaculture, imported and exported products (2013)

Country	Total seafood supply (tonnes)	Apparent consumption per capita (kg)	Price aquaculture products (USD/kg)	Price imported products (USD/kg)	Price exported products (USD/kg)
Albania	15 458	4.9	5.5	3.3	7.0
Algeria	158 775	4.0	3.3	2.8	4.4
Bosnia and Herzegovina	22 841	6.0	3.1	3.4	4.0
Croatia	81 795	19.1	6.0	3.3	4.4
Cyprus	24 868	21.8	6.6	3.9	7.4
Egypt	1 814 763	22.1	1.6	2.1	1.2
France	2 156 637	33.5	4.0	5.9	5.4
Greece	214 709	19.3	4.8	3.3	5.8
Israel	179 790	23.2	4.2	5.0	5.2
Italy	1 555 983	25.5	2.7	5.8	5.3
Lebanon	51 157	10.6	3.1	4.4	5.1
Libya	106 409	17.2	2.0	2.8	10.5
Malta	12 982	30.3	11.4	2.1	16.4
Montenegro	7 101	11.4	3.9	5.2	4.7
Morocco	596 618	18.1	5.8	3.0	3.4
Occupied Palestinian Territory	7 293	1.7	9.4	3.7	4.4
Slovenia	21 864	10.6	2.9	5.3	5.7
Spain	1 991 842	42.4	1.8	4.2	4.0
Syrian Arab Republic	53 546	2.4	3.3	2.2	5.3
Tunisia	149 735	13.6	5.6	2.0	7.9
Turkey	455 376	6.1	3.9	2.1	5.4
Totals	**9 679 544**	**20.0**	**2.4**	**4.6**	**4.4**

Source: authors' elaboration of FAO data (2017).

2.1. Country analysis

The countries analysed can be divided into three groups: (i) EU Member countries; (ii) North African countries; and (iii) other Mediterranean countries.

The countries included in each group are:

- **EU Member countries**: Croatia, Cyprus, France, Greece, Italy, Malta, Slovenia and Spain.
- **North African countries**: Algeria, Egypt, Libya, Morocco and Tunisia.
- **Other Mediterranean countries**: Albania, Bosnia and Herzegovina, Israel, Lebanon, Occupied Palestinian Territory, Montenegro, the Syrian Arab Republic and Turkey.

European Union countries

Seafood consumption in Mediterranean EU countries has traditionally been high. Most of the countries have consumption levels of 20 kg per capita (kg/capita) or higher (see Table 5). Only the Slovenia has a significantly lower seafood consumption (10.6 kg/capita). This is, in great part, due to Slovenia's short coastline (46 km), a population of two million people, and total area of more than 20 000 km^2. Most of Slovenia's seafood supply comes from imports.

France, Greece, Italy and Spain are important fishing nations with high levels of seafood consumption. Italy complements its Mediterranean catches mainly with high levels of imports. France and Spain, together with high levels of imports, have their most important fishery grounds in the Atlantic Ocean, while Greece also has a significant part of its seafood supply coming from aquaculture. French, Italian and Spanish import prices are higher than those for exports, while Greek export prices are higher, in great part because of exporting high-value aquaculture products (gilthead seabream and European seabass). Greece and Turkey, are the main producers of gilthead seabream and European seabass. Greek production of gilthead seabream and European seabass in 2015 is estimated to be 47 000 tonnes and 35 000 tonnes, respectively. Other significant productions are Mediterranean mussel with almost 19 000 tonnes and rainbow trout at almost 2 000 tonnes.

Low average aquaculture prices in Spain can be explained because the country produces a large volume of mussels (225 000 tonnes in 2015) that are relatively cheap (USD 0.57/kg). Other important aquaculture products in Spain are gilthead seabream and European seabass at 19 000 tonnes and 16 000 tonnes, rainbow trout also at 16 000 tonnes and turbot at more than 7 000 tonnes. It should be noted that almost three-quarters of the gilthead seabream and European seabass production takes place in the Mediterranean, while the majority of mussel and turbot production takes place in Atlantic waters.

Similarly, most aquaculture production in France comes from Atlantic waters. Main species farmed in France are Pacific cupped oyster with an estimated production in 2015 of 75 000 tonnes, blue mussel at 61 000 tonnes, rainbow trout at more than 36 000 tonnes, and Mediterranean mussel at 14 000 tonnes. In the Mediterranean Sea, the main species produced are Mediterranean mussel at almost 14 000 tonnes and Pacific cupped oyster at 5 000 tonnes. Gilthead seabream and European seabass production is relatively small compared with other countries in the Mediterranean, at about 2 000 tonnes each.

Italian marine aquaculture takes place in the Mediterranean Sea. The main aquaculture species are Mediterranean mussel at 64 000 tonnes, Japanese carpet shell at almost 34 000 tonnes, rainbow trout at more than 31 000 tonnes, gilthead seabream at almost 7 000 tonnes and European seabass at almost 6 000 tonnes.

In Cyprus and Malta, the main seafood supply consists of imports; while for Croatia imports play a tiny role and its main seafood supply is from capture fisheries. Malta's aquaculture and export prices are the highest in the Mediterranean (see Table 5), which can be explained by the cultivation and its later export of Atlantic bluefin tuna (*Thunnus thynnus*). Farmed Atlantic bluefin tuna production in Malta was more than 3 000 tonnes in 2015, while gilthead seabream production was almost 2 500 tonnes. In Cyprus, gilthead seabream and European seabass productions were almost 4 000 tonnes and almost 2 000 tonnes, respectively. In Croatia, the main species produced in 2015 were European seabass and gilthead seabream at more than 4 000 tonnes each, common carp at more than 3 000 tonnes, and Atlantic bluefin tuna at more than 1 000 tonnes (capture catches of Atlantic bluefin tuna were 500 tonnes).

North African countries

Seafood consumption varies largely by country. For example, Egypt has a high consumption at more than 22 kg/capita, while Libya, Morocco and Tunisia have consumption rates above 10 kg/capita, and Algeria below 5 kg/capita. For the Syrian Arab Republic and Libya, imports are the main source of seafood. For Algeria and Morocco capture fisheries are the main source, while Egypt, aquaculture is the main source of seafood.

The main seafood production in most North African countries (Algeria, Libya, Morocco and Tunisia) comes from capture fisheries. Indeed, these four countries have the largest share of capture fisheries in terms of total seafood production. In 2015, Tunisia produced 10 000 tonnes of gilthead seabream and almost 3 000 tonnes of European seabass; the Syrian Arab Republic produced more than 1 000 tonnes of common carp and almost 1 000 tonnes of blue tilapia; Algeria produced almost 1 000 tonnes of cyprinids, while the production of other species was very limited.

Egypt is an exception, and inland aquaculture plays a main role in seafood production. Most of Egypt's aquaculture production is from the brackishwater areas of its delta lakes and lagoons in the north of the country (Monfort, 2007). Egypt is the largest producer of tilapia in the Mediterranean; in fact, the main species produced is Nile tilapia (*Oreochromis niloticus*) at 876 000 tonnes, followed by mullet (157 000 tonnes), other cyprinids (65 000 tonnes), common carp (*Cyprinus carpio*) at 30 000 tonnes, gilthead seabream (16 000 tonnes) and European seabass (14 000 tonnes). The Egyptian volume of exports represents only 7 percent of the imports in volume and 4 percent in value. Tilapia sales, as well as most of the Egyptian production, have been traditionally mostly restricted to local markets due to its high production costs relative to other producer countries as well as food safety concerns from the EU and the USA (Feidi, 2004; Macfadyen, Nasr-Allah and Dickson, 2012; Goulding and Kamel, 2013). In addition, Norman-López and Bjørndal (2009) found that prices of frozen tilapia fillets in the Egypt are not related to other tilapia prices in international markets.

On the other hand, Morocco's seafood production comes mostly from capture fisheries (aquaculture represented less than the 0.1 percent of the total seafood production in 2015). Most of the landings of capture fisheries come from Atlantic waters (98 percent), while landings from the Mediterranean Sea account for less than 2 percent. Moreover, Morocco is the only net exporter (by volume) country in the whole region. The main products exported are European sardines and anchovies (prepared or preserved), octopus, frozen cuttlefish, frozen shrimps and prawns, and fresh, chilled or boiled common crangon shrimps (FAO, 2017).

Libya's high export prices (see Table 5) are because most exports from Libya are of fresh and frozen wild-caught Atlantic bluefin tuna.

Other Mediterranean countries

The "other" group of Mediterranean countries (i.e., Albania, Bosnia and Herzegovina, Israel, Lebanon, Montenegro, the Occupied Palestinian Territory, the Syrian Arab Republic and Turkey) represent a very heterogeneous set of countries. This group of countries is characterised by low to medium seafood consumption per capita: 1.7 kg/capita in the Occupied Palestinian Territory, 2.4 kg/capita in the Syrian Arab Republic, 11.4 kg/capita in Montenegro and 23.2 kg/capita in Israel.

In Lebanon, Israel, the Occupied Palestinian Territory, the Syrian Arab Republic, Bosnia and Herzegovina, and Montenegro, more than 50 percent of the seafood supply comes from imports. In Albania, both imports and capture fisheries play a key role in the supply of seafood. While capture fisheries are the main source of seafood in Turkey, aquaculture production is also important, especially as a key source of exports.

The main species cultured in Turkey are rainbow trout at almost 107 000 tonnes, European seabass at 75 000 tonnes, and gilthead seabream at almost 52 000 tonnes in 2015, with all these species showing an increasing production trend. The main species cultured in other Mediterranean countries are: 1) in Israel, 8 000 tonnes of tilapias, 4 000 tonnes of common carp, more than 3 000 tonnes of flathead grey mullet, and almost 2 000 tonnes of gilthead seabream; in Bosnia and Herzegovina, more than 3 000 tonnes of rainbow trout; in the Syrian Arab Republic, more than 1 000 tonnes of common carp and almost 1 000 tonnes of blue tilapia; and in Lebanon, 1 000 tonnes of rainbow trout.

2.2. Gilthead seabream and European seabass

Gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*)[8] are the most commonly produced species in the Mediterranean and Black seas, at 282 000 tonnes and USD 1.59 billion in 2015 (FAO, 2017).[9] Gilthead seabream and European seabass represent 62 percent in quantity and 79 percent in value of all aquaculture production in the Mediterranean basin.

Wild gilthead seabream and European seabass at the ex-vessel market

© FAO/J. Guillen at the Palermo fish market.

More than 95 percent of the world gilthead seabream and European seabass production comes from aquaculture, and 97 percent of the world gilthead seabream and European seabass production comes from Mediterranean countries, and includes inland production. The main producers are Turkey and Greece, while the main consumers are Spain, France, Italy, Greece and Turkey (see Tables 6 and 7).

The evolution of the gilthead seabream aquaculture production and European seabass aquaculture production presents many similarities (see Figure 4). Significant levels of European seabass and gilthead seabream production did not start until the second half of the 1980s and early 1990s even though the first efforts to breed European seabass and gilthead seabream took place in France and Italy in the late 1970s and early 1980s, initially in government research laboratories and increasingly in the private sector (University of Stirling, 2004). The principal reason for the slow initial development of the industry was the difficulty in producing large quantities of good quality fry, and the complexity in obtaining licences (University of Stirling, 2004). The production increase from the late 1980s onwards was the result of improvements at hatcheries that led to an increase in the supply of juveniles.

[8] The gilthead seabream (*Sparus aurata*) is a fish of the Sparidae family (bream) commonly found throughout the Mediterranean and along the northeastern Atlantic coasts from the United Kingdom to the Canary Islands. It can live in marine waters as well as in the brackishwaters of coastal lagoons. It has an oval-shaped body that is rather deep and compressed. It is silvery grey with a golden frontal band between the eyes and edged by two dark areas. It commonly reaches about 35 centimetres in length, but may reach up to 70 cm and weigh up to about 17 kg. It is the only species of sea bream that is currently farmed on a large scale. Farmed seabream can reach the first commercial size of 350–400 g in about one to one and a half years.
European seabass (*Dicentrarchus labrax*) is common throughout the Mediterranean, the Black Sea and the northeastern Atlantic from Norway to Senegal. It inhabits coastal waters as well as brackishwaters to a depth of 100 metres. It has a rather elongated body, and is a silvery grey colour that turns bluish on the back. It commonly reaches about 50 cm in length, but may reach up to 100 cm and weigh up to about 12 kg. Farmed seabass are generally harvested when they weigh 300–500 g, which takes from a year and a half to two years, depending on water temperature.
Both, European seabass and gilthead seabream are mostly cultivated in floating cages, and are almost always sold as fresh or chilled as a whole-portion-sized fish.
[9] Not considering inland productions.

Table 6. Production evolution of farmed gilthead seabream (*Sparus aurata*) by main producer countries in 2015

	Year										
Country	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Turkey			1 031	4 847	15 460	28 334	28 157	32 187	30 743	35 701	41 873	51 844
Greece		7	1 598	9 387	38 587	43 829	57 204	51 308	53 459	55 751	50 688	47 008
Egypt				1 062	8 862	4 398	15 065	14 155	14 806	14 537	16 967	16 092
Spain		127	565	2 706	8 242	15 433	20 358	15 118	16 607	18 897	16 915	16 005
Tunisia		5	85	160	409	576	2 296	4 184	5 273	8 475	8 124	10 216
Italy	250	360	850	3 200	6 000	6 914	6 260	5 508	5 400	5 400	6 830	6 800
Croatia				90	800	1 000	2 400	1 719	2 173	2 978	3 655	4 075
Cyprus			37	223	1 384	1 465	2 807	3 056	3 126	3 795	2 919	3 656
Saudi Arabia							1 300	1 453	1 648	1 825	1 685	3 057
Malta				550	1 512	540	1 755	1 082	2 604	2 550	2 704	2 337
Overall total	**257**	**564**	**4 570**	**24 481**	**87 303**	**110 755**	**142 306**	**134 337**	**141 999**	**157 775**	**159 819**	**166 794**

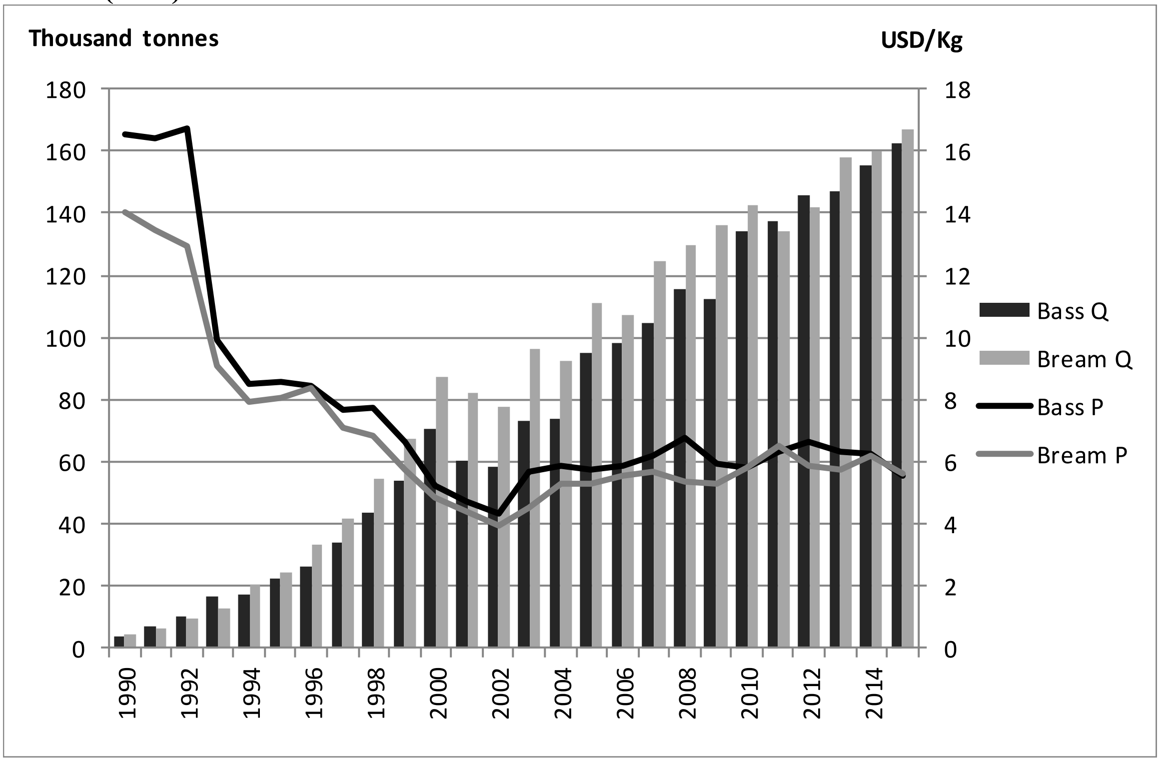
Source: FAO (2017).

Table 7. Production evolution of farmed European seabass (*Dicentrarchus labrax*) by main producer countries in 2015

	Year										
Country	**1980**	**1985**	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Turkey			102	2 773	17 877	37 490	50 796	47 013	65 512	67 913	74 653	75 164
Greece	5	60	1 952	9 539	26 653	30 959	39 884	37 089	35 805	34 920	32 142	35 382
Spain		29	31	461	1 837	5 713	11 491	17 548	14 455	14 945	16 722	18 600
Egypt				755	10 031	4 192	16 306	17 714	13 798	12 328	15 167	14 343
Italy	120	340	1 050	3 600	8 100	6 262	6 457	6 672	6 896	6 330	5 724	5 800
Croatia				247	1 300	2 000	2 800	2 775	2 453	2 826	3 215	4 488
Tunisia		15	283	230	202	633	1 466	2 832	1 999	1 968	1 869	2 802
France		70	300	2 656	3 020	3 913	2 337	2 452	2 321	2 428	2 400	2 400
Cyprus		1	15	99	299	583	1 198	1 495	1 100	1 422	1 817	1 726
Albania							135	170	170	170	129	392
Overall total	**130**	**581**	**3 921**	**22 263**	**70 694**	**95 044**	**134 328**	**137 276**	**146 022**	**146 771**	**155 509**	**162 399**

Source: FAO (2017).

Figure 4. Total aquaculture production and price of gilthead seabream and European seabass (2015)



Source: authors' elaboration of FAO data (2017).

Prices of farmed gilthead seabream and European seabass achieved their minimum level in 2001 and 2002 (ex-farm prices for gilthead seabream and European seabass in 2002 reached EUR 3.9/kg and EUR 4.3/kg, respectively), due to major production increases from 2000. Prices often fell below the cost of production, resulting in a major crisis in the industry (Rad and Köksal, 2000; University of Stirling, 2004; Rad, 2007; Wagner and Young, 2009; STECF, 2014). This brought a rationalization of the industry and stabilization of prices at around EUR 5.5/kg.

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 the need to analyse a large number of products because 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 the price adjustment between markets to occur over time. So, we investigated whether 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.

The relationships between variables have typically been studied with ordinary least squares regression analysis. Such analysis can be used when variables (i.e. prices) are stationary[10] (Squires, Herrick Jr. and Hastie, 1989; Asche, Gordon and Hannesson, 2004). However, many economic variables show trends, and so these are non-stationary. When non-stationary time series such as prices are used in a regression model, relationships that appear to be significant may emerge from unrelated variables. These are called spurious regressions. 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 the most commonly used empirical tool to test for market integration.[11]

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, and contracts 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).

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, 1995:22).

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 substitutes, 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 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, Steen and Salvanes, 1997). So, cointegration theory is consistent with Stigler and Sherwin's (1985) market definition[12] and the stochastic behaviour of prices.

We, therefore, investigated the existence of relationships between price series using the Johansen cointegration test (Johansen, 1988, 1991; Johansen and Juselius, 1990). Determining the lag order, in order to take this 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. In other words, test results on

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[10] A stationary time series is a sequence of measurements of the same variable collected over time whose statistical properties such as mean, variance, autocorrelation, etc. are all constant over time.
[11] For recent examples see Nielsen *et al.*, 2007; Norman-López and Asche, 2008; Nielsen, Smit and Guillen, 2009.
[12] Stigler and Sherwin (1985) define substitute products as those which are "in the same market" and whose relative prices "maintain a stable ratio".

whether a series is stationary changes 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.

Moreover, 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 determined the number of lags using three different criteria:

- log likelihood
- Akaike information criteria
- Schwarz criteria

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

- All tests show two cointegration equations. In this case, prices are stationary and cointegration methodology cannot be applied.
- All tests show zero cointegration equations. Here, prices are not cointegrated, and consequently products are not in the same market.
- All tests show one cointegration equation. There is a need to investigate the stationarity properties of the series, and there are two options to do so. 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. However, it is also 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 a need to investigate the stationarity properties of the series, and the results should be considered with caution.

When cointegration methodology cannot be applied (no cointegration equations are found), regressions and Granger causality tests (Granger, 1969) are used to investigate the relations between variables.

4. DATA

In this section, the data used for the realization of this study are described. Wild and farmed seabream and seabass price data from Spain, France, Italy, Greece, Portugal and Turkey have been used for different levels in the market chain. The market stages analysed include wholesale, retail, together with the imports and exports. Other species with available price data for wild and farmed varieties, such as turbot, blackspot seabream, Atlantic cod, meagre, clams and mussels have been also analysed.

Weekly data have been used when possible; if weekly data were not available, then monthly data were used. The most recent data available have been used, with price series starting no earlier than 2009 or 2010 and ending at the end of 2014 or in 2015. Longer price series are available for Spain's Madrid and Barcelona wholesale markets, with series starting in 2003 and 2006, respectively. Unfortunately, all of the required price series to complete the market integration analysis for all Mediterranean countries are not available or do not cover a long enough time period.

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

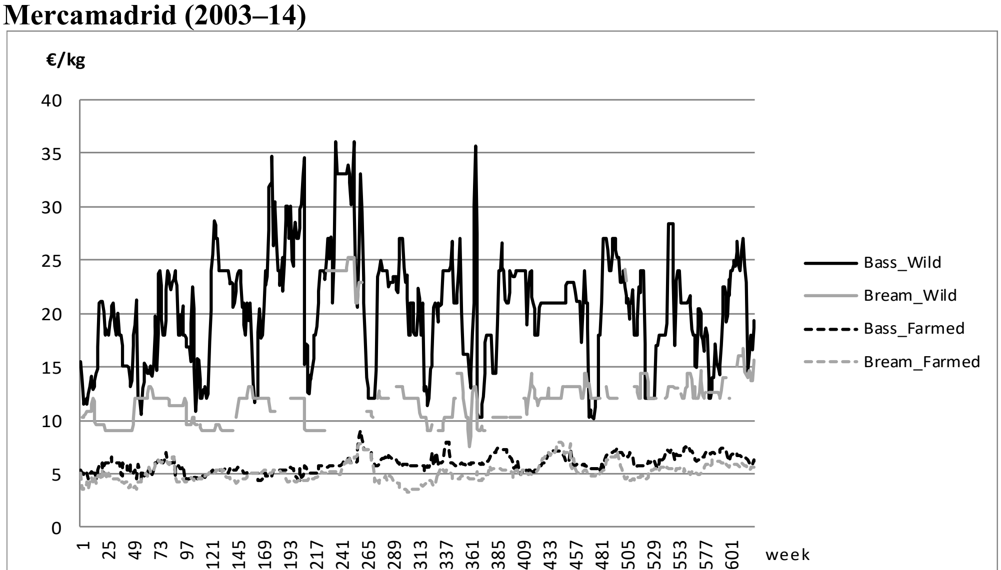
The price data used in this analysis are detailed by country.

4.1. Spain

Weekly data for Madrid's wholesale market (Mercamadrid) for the period 2003–14 (623 observations) for the species:

- gilthead seabream (*Sparus aurata*), fresh whole, wild and farmed;
- European seabass (*Dicentrarchus labrax*), fresh whole, wild and farmed;
- turbot (*Scophthalmus maximus*), fresh whole, wild and farmed; and
- sole (*Solea* spp.), fresh whole, wild and farmed, 2012–14 (141 observations).

Figure 5. Weekly prices of wild and farmed gilthead seabream and European seabass in Mercamadrid (2003–14)

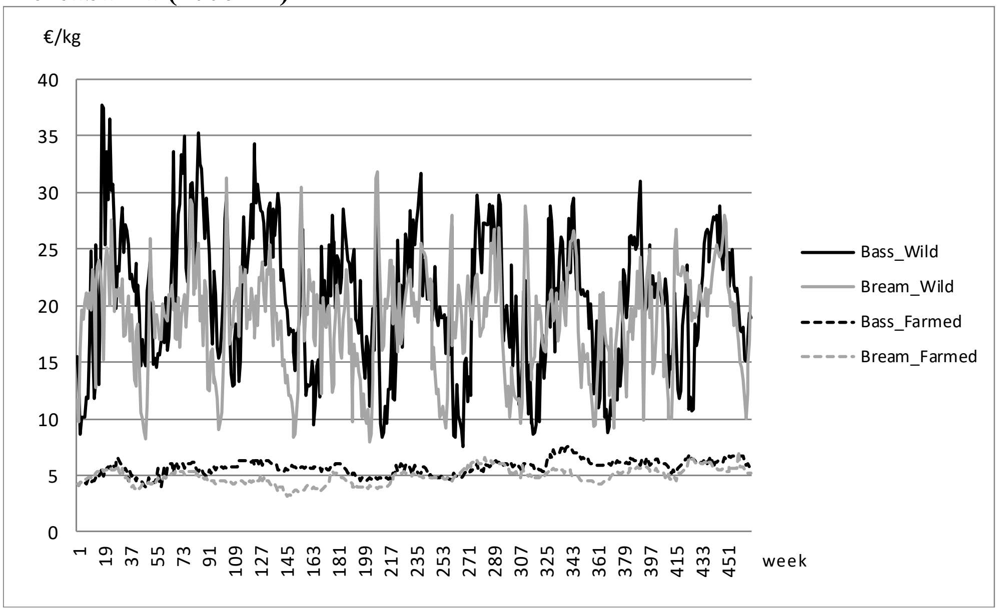


Source: Mercamadrid (2015).

Weekly data for Barcelona's wholesale market (Mercabarna) for the period 2006–14 (468 observations) for the species:

- gilthead seabream (*Sparus aurata*), fresh whole, wild and farmed;
- European seabass (*Dicentrarchus labrax*), fresh whole, wild and farmed;
- turbot (*Scophthalmus maximus*), fresh whole, wild and farmed;
- blackspot (red) seabream (*Pagellus bogaraveo*), fresh whole, wild and farmed;
- Atlantic cod (*Gadus morhua*), fresh whole, wild and farmed;
- clams (*Venerupis* spp.), fresh whole, wild and farmed; and
- meagre (*Argyrosomus regius*), fresh whole, wild and farmed.

Figure 6. Weekly prices of wild and farmed gilthead seabream and European seabass in Mercabarna (2006–14)



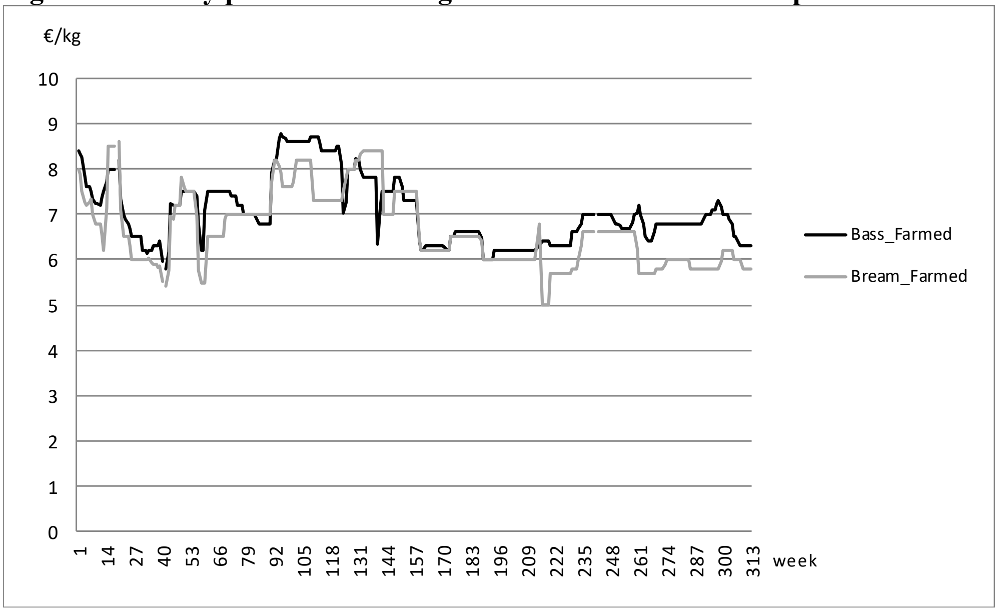
Source: Mercabarna (2015).

4.2. France

Weekly data for the Paris wholesale market (Rungis) for the period 2009–14 (313 observations):

- gilthead seabream (*Sparus aurata*), fresh whole 400–600 g, farmed; and
- European seabass (*Dicentrarchus labrax*), fresh whole 400–600 g, farmed.

Figure 7. Weekly prices of farmed gilthead seabream and European seabass in Rungis (2009–14)

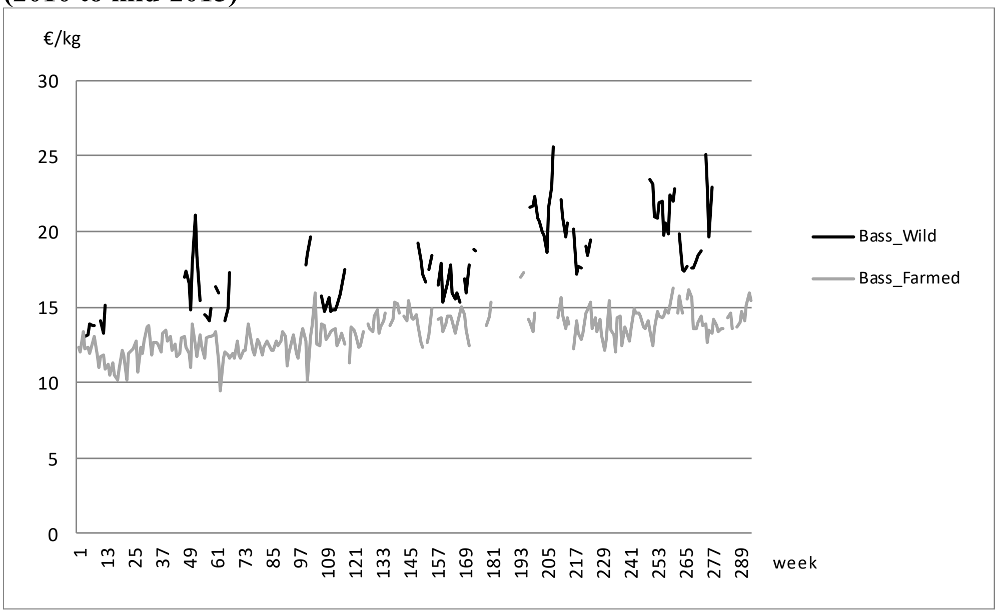


Source: EUMOFA (2015).

Retail, weekly data for the period 2010 to mid-2015:

- European seabass (*Dicentrarchus labrax*), fresh whole, wild and farmed (114 and 257 observations, respectively).

Figure 8. Weekly prices of wild and farmed European seabass at the French retail level (2010 to mid-2015)



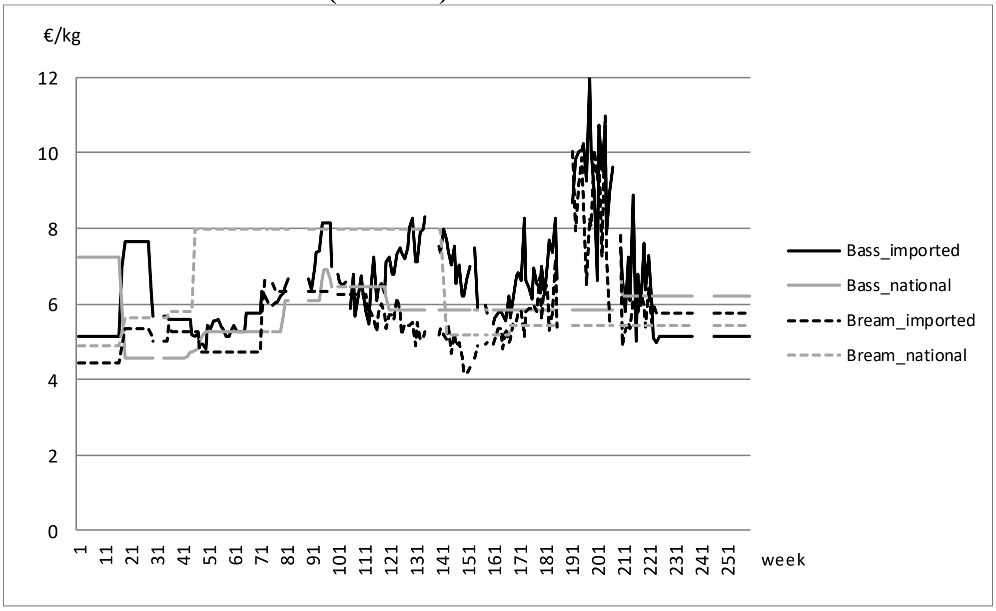
Source: EUMOFA (2015).

4.3. Italy

Weekly data for Milano's wholesale market for the period 2010–14 (225 observations) for the species:

- gilthead seabream (*Sparus aurata*), fresh whole, national and imported; and
- European seabass (*Dicentrarchus labrax*), fresh whole, national and imported.

Figure 9. Weekly prices of national and imported gilthead seabream and European seabass in Milano wholesale market (2010–14)

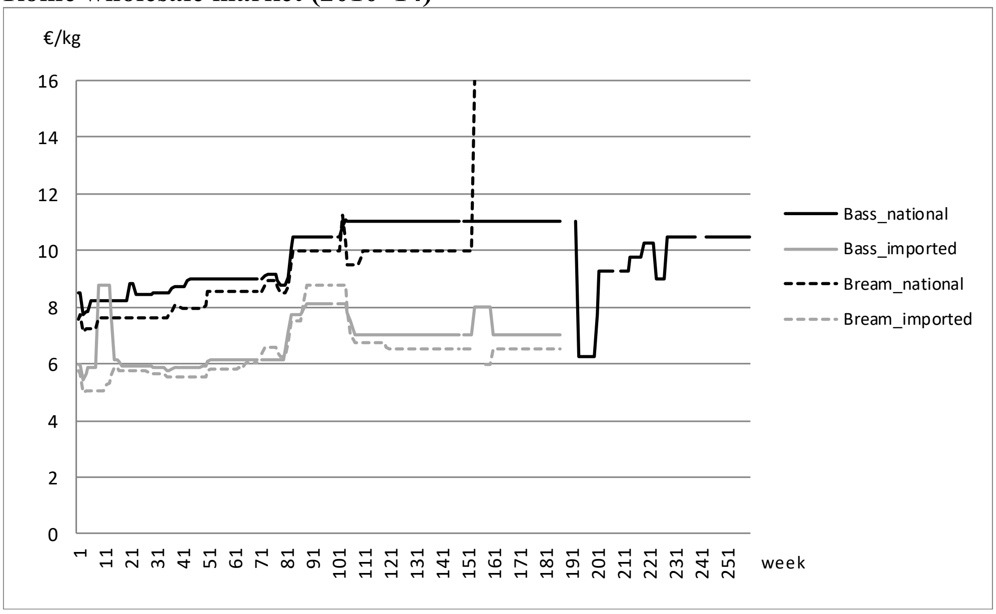


Source: EUMOFA (2015).

Weekly data for Rome's wholesale market for the period 2010–14 for the species:

- gilthead seabream (*Sparus aurata*), fresh whole, national and imported (247 and 185 observations, respectively); and
- European seabass (*Dicentrarchus labrax*), fresh whole, national and imported (151 and 182 observations, respectively).

Figure 10. Weekly prices of national and imported gilthead seabream and European seabass in Rome wholesale market (2010–14)

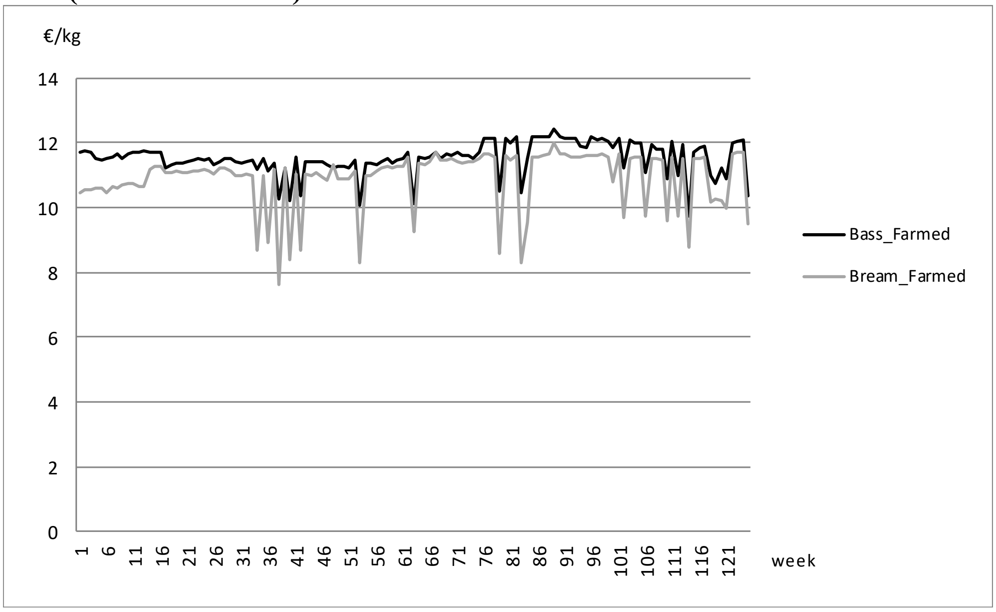


Source: EUMOFA (2015).

Retail, weekly data for the period from January 2013 to mid-2015 (125 observations):

- European seabass (*Dicentrarchus labrax*), fresh whole, farmed;
- gilthead seabream (*Sparus aurata*), fresh whole, farmed.

Figure 11. Weekly prices of farmed European seabass and gilthead seabream at the Italian retail level (2013 to mid-2015)



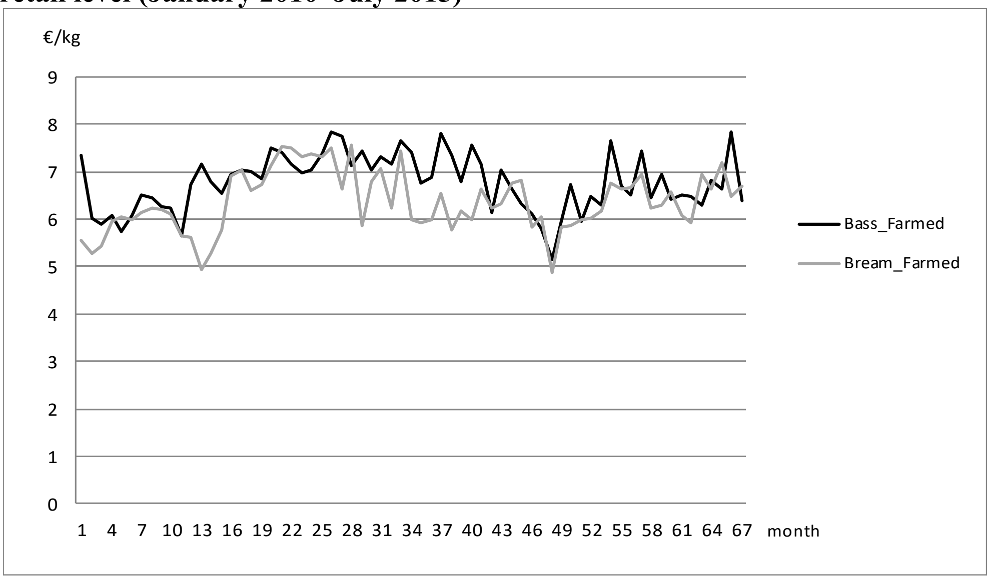
Source: EUMOFA (2015).

4.4. Portugal

Retail, monthly data for the period from January 2010 to July 2015 (67 observations):

- European seabass (*Dicentrarchus labrax*), fresh whole, farmed; and
- gilthead seabream (*Sparus aurata*), fresh whole, farmed.

Figure 12. Monthly prices of farmed European seabass and gilthead seabream at the Portuguese retail level (January 2010–July 2015)



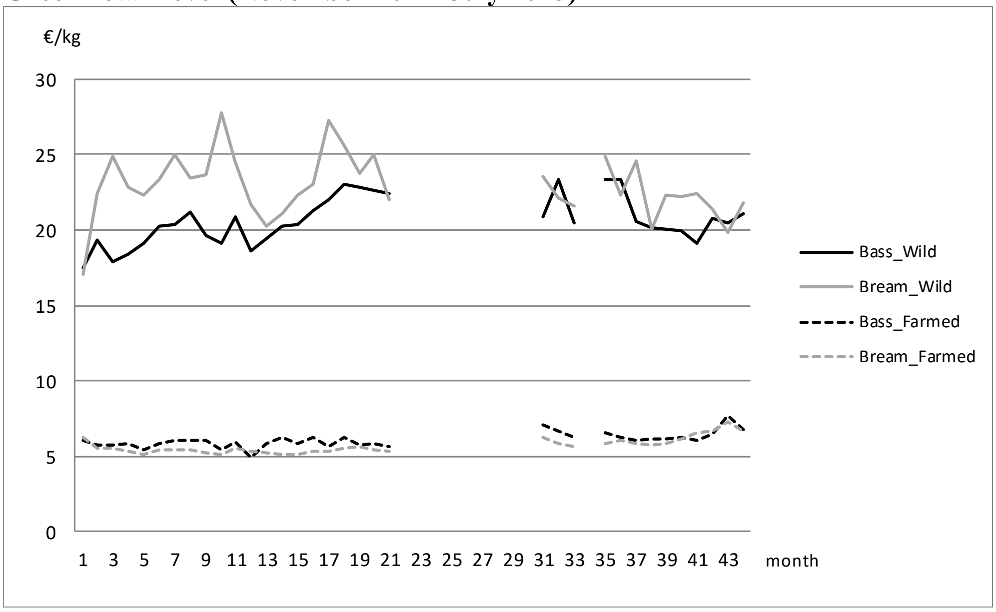
Source: EUMOFA (2015).

4.5. Greece

Retail, monthly data for the period from November 2011 to July 2015 (34 observations):

- European seabass (*Dicentrarchus labrax*), fresh whole, wild and farmed; and
- gilthead seabream (*Sparus aurata*), fresh whole, wild and farmed.

Figure 13. Monthly prices of wild and farmed European seabass and gilthead seabream at the Greek retail level (November 2011–July 2015)



Source: EUMOFA (2015).

4.6. Turkey

Weekly prices of seabass imported into the EU from Turkey for the period January 2011 to April 2015 (225 observations):

- European seabass (*Dicentrarchus labrax*), fresh whole, farmed.

Figure 14. Weekly prices of farmed European seabass imports from Turkey to the European Union (January 2011–April 2015)

Source: EUMOFA (2015).

5. RESULTS

In this section, we report on the market integration results obtained in this study. Full results are fully reported on in the Appendix.

5.1. Wild and farmed integration: Gilthead seabream and European seabass

In this section, we summarize the market integration between wild and farmed conspecifics of gilthead seabream and European seabass. By analysing the market integration between wild and farmed gilthead seabream and European seabass it is possible to investigate whether prices are related and, consequently, to determine if wild and farmed products are considered the same product or substitutes.

Table 8. Market integration results between wild and farmed conspecifics

Species	Market	Market level	Period	Market integration
European seabass	Madrid (Spain)	Wholesale	2003–14	Potential/No
European seabass	Barcelona (Spain)	Wholesale	2006–14	Potential
European seabass	France	Retail	2009–14	Potential
Gilthead seabream	Madrid (Spain)	Wholesale	2003–14	No
Gilthead seabream	Barcelona (Spain)	wholesale	2006–14	Potential/No

The results show that there is no or limited market integration between wild and farmed conspecifics of gilthead seabream and European seabass. So, wild and farm varieties of gilthead seabream and European seabass are not (or very limited) price related.

5.2. Wild and farmed integration: Other species

In this section, we analyse the market integration between wild and farmed conspecifics of species other than European seabass and gilthead seabream. Thus, this section analyses the market integration between wild and farmed conspecifics of species other than gilthead seabream and European seabass.

Table 9. Market integration results between wild and farmed conspecifics other than seabass and seabream

Species	Market	Market level	Period	Market integration
Turbot (*Scophthalmus maximus*)	Madrid (Spain)	wholesale	2003–14	No
Sole (Solea spp.)	Madrid (Spain)	wholesale	2012–14	No
Turbot (*Scophthalmus maximus*)	Barcelona (Spain)	wholesale	2006–14	No
Blackspot (red) seabream (*Pagellus bogaraveo*)	Barcelona (Spain)	wholesale	2006–14	Yes
Atlantic cod (*Gadus morhua*)	Barcelona (Spain)	wholesale	2006–14	Yes
Clams (*Venerupis* spp.)	Barcelona (Spain)	wholesale	2006–14	No
Meagre (*Argyrosomus regius*)	Barcelona (Spain)	wholesale	2006–14	No

Therefore, the results show that there is no market integration between wild and farmed conspecifics for turbot (*Scophthalmus maximus*), sole (*Solea* spp.), and meagre (*Argyrosomus regius*), while there is market integration between wild and farmed conspecifics for blackspot (red) seabream (*Pagellus bogaraveo*) and Atlantic cod (*Gadus morhua*).

5.3. Species integration: Seabream and seabass

In this section, we explore whether gilthead seabream and European seabass are integrated into the market and this includes whether seabream and seabass can be considered substitutes.

Table 10. Species integration results

Species		Market	Market level	Period	Market integration
European seabass - gilthead seabream	Wild	Madrid (Spain)	wholesale	2003–14	No
European seabass - gilthead seabream	Wild	Barcelona (Spain)	wholesale	2006–14	Yes
European seabass - gilthead seabream	Farmed	Madrid (Spain)	wholesale	2003–14	Yes
European seabass - gilthead seabream	Farmed	Barcelona (Spain)	wholesale	2006–14	No
European seabass - gilthead seabream	Farmed	Paris (France)	wholesale	2009–14	No
European seabass - gilthead seabream	Farmed	Italy	retail	2013–15	No
European seabass - gilthead seabream	Farmed	Portugal	retail	2010–15	No

The results show that there is no market integration between gilthead seabream and European seabass in French, Italian and Portuguese markets, and only partly in the Spanish market. Market integration (i.e. prices moving together overtime) between farmed gilthead seabream and European seabass has been found at the Madrid wholesale market, and between wild gilthead seabream and European seabass at the Barcelona wholesale market.

5.4. Geographical integration

In this section, we analyse the geographical component of the market integration of different wild and farmed species. Thus, the investigation focuses on whether the price of seabream and seabass in different geographical markets move together or are independent.

Table 11. Geographical market integration results for different wild and farmed species

Species		Market	Market level	Period	Market integration
European seabass	Wild	Madrid - Barcelona (Spain)	wholesale	2006–14	Yes
European seabass	Farmed	Madrid - Barcelona (Spain)	wholesale	2006–14	No
European seabass	Farmed	Madrid (Spain) - Paris (France)	wholesale	2009–14	Uncertain/No
European seabass	Farmed	Barcelona (Spain) - Paris (France)	wholesale	2009–14	Uncertain
European seabass	Farmed	Turkey - Madrid (Spain)	Imports - wholesale	2011–14	Uncertain
European seabass	Farmed	Turkey - Barcelona (Spain)	Imports - wholesale	2011–14	No
European seabass	Farmed	Turkey - Paris (France)	Imports - wholesale	2011–14	No
Gilthead seabream	Wild	Madrid - Barcelona (Spain)	wholesale	2006–14	No
Gilthead seabream	Farmed	Madrid - Barcelona (Spain)	wholesale	2006–14	No
Gilthead seabream	Farmed	Madrid (Spain) - Paris (France)	wholesale	2009–14	No
Gilthead seabream	Farmed	Barcelona (Spain) Paris (France)	wholesale	2009–14	No
Turbot (*Scophthalmus maximus*)	Wild	Madrid - Barcelona (Spain)	wholesale	2006–14	No
Turbot (*Scophthalmus maximus*)	Farmed	Madrid - Barcelona (Spain)	wholesale	2006–14	Yes

The results show that, in general, there is no market integration between wild species from different markets; only market integration for wild European seabass has been found between the Barcelona and Madrid wholesale markets.

Our results also show that market integration for farmed species is quite limited. Prices of farmed turbot (*Scophthalmus maximus*) in Barcelona and Madrid wholesale markets are integrated.

In addition, the price relation between farmed European seabass in Barcelona and Madrid with farmed European seabass in Paris wholesale markets is uncertain in the best of the cases, and the perception is that they are not integrated. The same applies to farmed European seabass imported from Turkey into the EU, and farmed European seabass into the Madrid wholesale market. In fact, the results for market integration are not conclusive because market integration is denied or accepted depending on the number of lags chosen and the methodology applied.

6. DISCUSSION

Bjørndal and Guillen (2016) analyse the literature on market interactions between wild and farmed fish. The literature on market competition between aquaculture and wild fish is based on a small number of species and markets. Studies concentrate on USA and EU markets, which are countries with the most traded species and the main consumer markets. Market integration studies initially focused on salmon, followed by an analysis of shrimp and tilapia, and recently of seabass and seabream (Bjørndal and Guillen, 2016). In particular, when it comes to the Mediterranean area, existing knowledge on competition interactions between wild and farmed species in the Mediterranean is limited, and based solely on studies investigating gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*).

Most of the world's production of gilthead seabream and European seabass comes from aquaculture (more than 95 percent). Gilthead seabream and European seabass are the most farmed species in the Mediterranean and Black sea. Gilthead seabream and European seabass represent 62 percent in quantity and 79 percent in value of all the marine aquaculture production in the Mediterranean and Black seas. Ninety-seven percent of the world's gilthead seabream and European seabass production comes from Mediterranean countries. The main producers are Turkey and Greece, while the main consumers are the Spain, France, Italy, Greece and Turkey. The 5–10 EUR/kg retail price for seabass and seabream is far too high for a large proportion of the population living in southern Mediterranean countries (Monfort, 2007).

The literature on market competition between farmed and wild gilthead seabream and European seabass has focused on the Spanish, French and Italian markets. These studies on competition interactions between wild and farmed species in Mediterranean countries are based on a very limited number of cases with no general trends detected. For the Spanish market, Alfranca *et al.* (2004) found that farmed gilthead seabream prices determine the evolution of wild gilthead seabream prices more directly than the wild gilthead seabream prices in the Barcelona wholesale market. However, Rodríguez *et al.* (2013) show that wild and farmed gilthead seabream are not integrated and, consequently, they are two heterogeneous products that are not substitutes in the Madrid wholesale market. More recently, Rodríguez Rodríguez and Bande Ramudo (2015) confirm that there is no integration between farmed and wild gilthead seabream, European seabass and turbot prices in the Madrid wholesale market. In French households, Regnier and Bayramoglu (2014) found that fresh, whole wild seabream and farmed gilthead seabream are partially integrated and that their price relationship is led by farmed seabream, while those for whole wild seabass and farmed European seabass are not integrated. 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.

The results from this study confirm that there is no (or limited) market integration between wild and farmed conspecifics of gilthead seabream and European seabass for all cases analysed (Barcelona and Madrid wholesale markets, and French retail market).

In addition, there is no market integration between wild and farmed turbot (*Scophthalmus maximus*) in the Barcelona and Madrid wholesale markets. There is also no market integration between wild and farmed conspecifics of sole (*Solea* spp.) in the Madrid wholesale market, clams (*Venerupis* spp.), and meagre (*Argyrosomus regius*) in the Barcelona wholesale market.

In particular, farmed turbot represents almost 90 percent of all fresh turbot sold in the wholesale markets. In fact, domestic landings are minimal and perceived as a different product compared to farmed production. It is only in spring, when significant amounts of wild turbot are imported from the Netherlands that producers believe that wild turbot may compete with farmed turbot because in some years wild turbot can be cheaper than farmed. The results from this study confirm the differentiation between both products. On the other hand, farmed production of sole is quite small (about 1 percent of the total fresh sole sold), but the product is still under development and the marketed sizes of farmed sole are very small, sometimes even smaller than the minimum landing size of wild sole. So, the two products can be easily differentiated in the market. Similarly, farmed meagre production suffers several technical issues and production is still limited. It is not a very popular species in Spain and consumption is quite concentrated in some areas in the south and east of the country. Meagre producers also failed in marketing it, by selling big fish that were 2–3 kg, which is not very convenient for household consumption. So, there is still work to do in technology and product development for farmed meagre. In the case of clam species, there is no market integration because wild and farmed species are different species and have different food uses.

However, there is market integration between wild and farmed conspecifics for blackspot (red) seabream (*Pagellus bogaraveo*) and Atlantic cod (*Gadus morhua*). The existence of market integration between wild and farmed conspecifics for Atlantic cod can be explained because both products are imported and low volumes of farmed cod are sold. The supply of wild cod was expected to prevent opening an opportunity for aquaculture, but landings of wild cod recovered and marketing of fresh wild Norwegian cod improved, leading to renewed popularity of this species among Spanish consumers. This has led to the near collapse of the farmed cod industry. Only small-size farmed cod is sold and is less frequent than wild (farmed cod represented 22 percent of all fresh cod sold at the wholesale level). On the other hand, the existence of market integration between wild and farmed conspecifics for blackspot (red) seabream is a bit more unexpected. There is a very small number of farms producing blackspot (red) seabream and consequently its commercialization has been very reduced (representing only 2 percent of all fresh blackspot [red] seabream sold). Some retailers may even reject selling this product due to deformities in the black spot, which is not always as visible as it is in wild conspecifics. Thus, it could be possible to consider that because of the low volumes sold, the prices of farmed products follow similar trends as those of their wild conspecifics.

This differentiation between farmed and wild-captured 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; Claret *et al.*, 2012). Wild fish is always preferred to farmed fish among southern European consumers (Claret et al., 2012). Southern European consumers 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). 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 their menus. Consequently, a share of the wild production will not enter into the more traditional market chains. This differentiation in favour of wild products occurs even if the aquaculture sector has the competitive advantage of having a higher degree of control over the production process and being able to deliver when requested, in the requested amount and at the requested quality (Asche, Guttormsen and Nielsen, 2013).

The fact that most seabass and seabream are sold as fresh whole with head on, can help the market to differentiate between products. Consumers in southern European countries prefer whole fish. In contrast, Northern European consumers prefer filleted fish products. Despite this potential demand, the industrial production of fillets is minor. High production costs for large individual fish does 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.

The results show that there is no market integration between gilthead seabream and European seabass in French, Italian and Portuguese markets, and only partly in the Spanish market. Market integration between farmed gilthead seabream and European seabass has been found at the Madrid wholesale market, and between wild gilthead seabream and European seabass at the Barcelona wholesale market. While for the Spanish market, Alfranca *et al.* (2004) found that the influence on farmed and wild gilthead seabream (*Sparus aurata*) prices of wild sole, farmed Atlantic salmon (*Salmo salar*), farmed European seabass (*Dicentrarchus labrax*), and wild European seabass (*Dicentrarchus labrax*) prices is rather weak, with a low level of significance in the Barcelona wholesale market.

The evolution of gilthead seabream and European seabass aquaculture production presents many similarities. In fact, both species' main production areas and techniques are the same, with many companies producing both species. So, it is not surprising that the price evolution for both products is similar (see Figure 4). Indeed, market integration (i.e. prices moving together over time) between farmed gilthead seabream and European seabass has been found at the Madrid wholesale market, and between wild gilthead seabream and European seabass at the Barcelona wholesale market. However, outcomes from this study also show that there is no market integration between gilthead seabream and European seabass in France, Italy and Portugal, and only partly in the Spanish market.

These differences in the outcomes obtained could be based, at least in part, due to the different data sources employed, markets, and the time periods analysed. Fish markets are dynamic and are continuously changing, so results can be sensitive to the period investigated (Setälä *et al*., 2003). This made us work with the latest data available and with relatively similar time periods for all cases.

Actually, Emerson (2007) demonstrated that the choice of lag length can drastically affect the results of the cointegration analysis. Moreover, different lag-length selection criteria often lead to a different conclusion regarding the optimal lag order that should be used. Therefore, in this study, we determined the number of lags using three different criteria: log likelihood, Akaike information criteria, and Schwarz criteria. This has led several times to contradictory results, depending on the number of lags chosen (i.e. depending on the criteria used). We have marked these cases as not conclusive or uncertain.

In addition, regression methodology tends to be more accepting toward the relationship between variables than cointegration methodology, and regression methodology was fully applied in cases where market integration was found. This is extremely evident in those cases where the initial cointegration analysis showed that 0 lags was the preferred model. So, for example, the existence of market integration between gilthead seabream and European seabass in Spain cannot be fully assured.

Finally, we have analysed the spatial or geographical market integration. The results show that, in general, there is no market integration between wild species from different markets; only market integration for wild European seabass has been found between the Barcelona and Madrid wholesale markets. This could be because the main supply in both markets comes from the same source: the Northeast Atlantic (FAO area 27).

A higher degree of integration between markets for farmed species was expected because aquaculture products are more subject to competition; however, our results show that market integration for farmed species is also quite limited. Prices of farmed turbot (*Scophthalmus maximus*) in Barcelona and Madrid wholesale markets are integrated. Unfortunately, turbot price data are not available from other Mediterranean markets.

The price relation between farmed European seabass in Barcelona and Madrid with the farmed European seabass Paris wholesale markets is uncertain in the best of cases, and the perception is that they are not integrated. The same applies to farmed European seabass imported from Turkey into the EU and farmed European seabass in the Madrid wholesale market. In fact, the results for market integration are not conclusive because market integration is denied or accepted, depending on the number of lags chosen and the methodology applied.

These latter results are a bit surprising because we were expecting to find a higher level of market integration between markets for farmed seabream and seabass due to the high volumes of imports coming from Greece and Turkey arriving at the Spanish, French and Italian markets. These imports would lead the long-term price evolution of these products in the more local markets. However, we have only found partial evidence for European seabass.

This outcome is difficult to explain and would require larger and better datasets before we could draw more irrefutable conclusions. For example, data are currently unavailable, or at least to the extent necessary to do this kind of analysis, for southern Mediterranean countries. In addition, some data for northern Mediterranean countries suffer from data quality and missing observations.

We expect that in the near future, more data will be available in the Mediterranean region, part of these data will also be disaggregated by size of the product[13], as well as considering the presence of ecolabels or the case of biological production.

[13] Mercamadrid has already started to differentiate the farmed gilthead seabream sold into seabream from 300 to 400 g, from 400 to 600 g and larger than 600 g.

7. CONCLUSIONS

Previously available studies on competition interactions between wild and farmed species in the Mediterranean are based on a rather limited number of cases, with no general trends detected. The differences in the outcomes obtained could be based, at least in part, in the different data sources employed and time periods analysed. In fact, market integration results can be sensitive to the period investigated. This is because fish markets are dynamic and are continuously changing.

Therefore, in this study, we investigated in more detail the existence of market interactions between wild and farmed species in different Mediterranean countries. Our results show that there is no, or low, market integration between wild and farmed products in Mediterranean countries for gilthead seabream, European seabass, and other species (turbot, meagre and clams). This lack of integration between farmed and wild products has been explained in the literature by the traditional consumption (knowledge) of fish, a preference for local products, the use of different market chains, and a persisting negative perception of farmed products in the area. There is, however, market integration for blackspot (red) seabream and Atlantic cod, which can be attributable to the low volumes of farmed products sold.

The results also show that there is no market integration between gilthead seabream and European seabass in the French, Italian and Portuguese markets, and only partly in the Spanish market. Market integration has been detected between farmed gilthead seabream and European seabass in the Madrid wholesale market, and between wild gilthead seabream and European seabass in the Barcelona wholesale market.

Moreover, the results show that, in general, there is no market integration between wild species from different markets; only market integration for wild European seabass has been found between the Barcelona and Madrid wholesale markets. A higher degree of integration between markets for farmed species was expected because aquaculture products are more subject to competition; however, our results show that market integration for farmed species is also quite limited. Prices of farmed turbot (*Scophthalmus maximus*) in the Barcelona and Madrid wholesale markets are integrated. While market integration between farmed European seabass in Barcelona and Madrid with the farmed European seabass Paris wholesale markets is uncertain in the best of cases, and the perception is that they are not integrated. The same applies to farmed European seabass imported from Turkey into the EU and farmed European seabass into the Madrid wholesale market. In fact, the results for market integration are not conclusive because market integration is denied or accepted, depending on the number of lags chosen and the methodology applied.

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9. APPENDIX

9.1. Wild and farmed integration: Gilthead seabream and European seabass

In this section, we analyse the market integration between wild and farmed conspecifics of gilthead seabream and European seabass.

9.1.1. European seabass (Madrid wholesale market)

Table 1. 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
Lags interval: No lags	0	1394.767	-4.484781	-4.484781
	1	1413.231	-4.528073	-4.492438
	2	1424.602	-4.548560	-4.477291
Lags interval: 1 to 1	0	1413.699	-4.540094	-4.511551
	1	1440.151	-4.609183	**-4.544961**
	2	1450.347	-4.625917	-4.526016
Lags interval: 1 to 2	0	1422.471	-4.562810	-4.505653
	1	1443.842	-4.615620	-4.522739
	2	**1452.482**	**-4.627362**	-4.498757
Lags interval: 1 to 3	0	1421.987	-4.555691	-4.469848
	1	1444.250	-4.611470	-4.489858
	2	1451.866	-4.619921	-4.462541
Lags interval: 1 to 4	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.

Table 2. Cointegration test considering 1 lag for wild and farmed seabass in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.081664	73.29605	19.96	24.60	None **
0.032304	20.39179	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 3. Cointegration test considering 2 lags for wild and farmed seabass in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.066617	60.02186	19.96	24.60	None **
0.027485	17.27954	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering 1 and 2 lags, show 2 cointegration equations between wild and farmed seabass in the Madrid wholesale market, consequently, prices are stationary and regression methodology should be used.

Table 4. Regression analysis for farmed and wild seabass in the Madrid wholesale market considering 1 lag

Dependent Variable: Bass Farmed				
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
Bass Wild	-0.013795	0.017448	-0.790627	0.4295
Bass Wild (-1)	0.024946	0.017439	1.430441	0.1531
Bass Farmed (-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 5. Regression analysis for wild and farmed seabass in the Madrid wholesale market considering 1 lag

Dependent Variable: Bass Wild				
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
Bass Farmed	-0.073249	0.092647	-0.790627	0.4295
Bass Farmed (-1)	0.096431	0.092367	1.043994	0.2969
Bass Wild (-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

The results from the regression analysis show the lack of integration between wild and farmed seabass in the Madrid wholesale market when considering 1 lag.

Table 6. Regression analysis for farmed and wild seabass in the Madrid wholesale market considering 2 lags

Dependent Variable: Bass Farmed				
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
Bass Wild	-0.021820	0.018044	-1.209223	0.2270
Bass Wild (-1)	0.064863	0.026831	2.417509	0.0159
Bass Wild (-2)	-0.037078	0.018006	-2.059242	0.0399
Bass Farmed (-1)	0.838343	0.040128	20.89160	0.0000
Bass Farmed (-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 7. Regression analysis for wild and farmed seabass in the Madrid wholesale market considering 2 lags

Dependent Variable: Bass Wild				
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
Bass Farmed	-0.108708	0.089899	-1.209223	0.2270
Bass Farmed (-1)	0.254772	0.116664	2.183799	0.0294
Bass Farmed (-2)	-0.119962	0.089484	-1.340608	0.1805
Bass Wild (-1)	1.137918	0.038925	29.23332	0.0000
Bass Wild (-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

The results from the regression analysis show the potential or limited integration between wild and farmed seabass in the Madrid wholesale market when considering 3 lags.

9.1.2. European seabass (Barcelona wholesale market)

Table 8. Lag interval selection for wild and farmed seabass in the Barcelona wholesale market

Lags	Rank or No. of CE(s)	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	823.3444	-3.526100	-3.526100
	1	854.3822	-3.637611	-3.593218
	2	864.1426	-3.657998	-3.569212
Lags interval: 1 to 1	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
Lags interval: 1 to 3	0	871.2587	-3.703701	-3.596635
	1	885.3029	-3.742685	-3.591008
	2	**890.7209**	-3.744486	-3.548199
Lags interval: 1 to 4	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.

Table 9. Cointegration test considering 2 lags for wild and farmed seabass in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.068550	44.34091	19.96	24.60	None **
0.024050	11.31994	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 10. Cointegration test considering 3 lags for wild and farmed seabass in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.058739	38.92429	19.96	24.60	None **
0.023083	10.83602	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering 2 and 3 lags, show 2 cointegration equations between wild and farmed seabass in Barcelona wholesale market, consequently, prices are stationary and regression methodology should be used.

Table 11. Regression analysis for farmed and wild seabass in the Barcelona wholesale market considering 2 lags

Dependent Variable: Bass Farmed				
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 Farmed (-1)	0.742875	0.046037	16.13657	0.0000
Bass Farmed (-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 12. 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 Farmed	-0.300990	0.198797	-1.514060	0.1307
Bass Farmed (-1)	0.691223	0.244132	2.831350	0.0048
Bass Farmed (-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

The results from the regression analysis show the potential (or limited) integration between wild and farmed seabass in the Barcelona wholesale market when considering 2 lags.

Table 13. Regression analysis for farmed and wild seabass in the Barcelona wholesale market considering 3 lags

Dependent Variable: Bass Farmed				
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 Farmed (-1)	0.713746	0.046531	15.33926	0.0000
Bass Farmed (-2)	0.055961	0.057010	0.981604	0.3268
Bass Farmed (-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 14. 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 Farmed	-0.280128	0.197806	-1.416176	0.1574
Bass Farmed (-1)	0.686618	0.240568	2.854154	0.0045
Bass Farmed (-2)	-0.317358	0.241401	-1.314652	0.1893
Bass Farmed (-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

The results from the regression analysis show the potential (or limited) integration between wild and farmed seabass in the Barcelona wholesale market when considering 3 lags.

9.1.3. European seabass (French retail)

Table 15. 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
Lags interval: No lags	74	0	168.4447	-4.55256	-4.55256
		1	178.2926	-4.68358	-4.52790
		2	**183.3416**	-4.68491	-4.37355
Lags interval: 1 to 1	55	0	136.6785	-4.82467	-4.67869
		1	143.3004	-4.88365	-4.55518
		2	146.0930	-4.80338	-4.29242
Lags interval: 1 to 2	38	0	109.2939	-5.33126	-4.98650
		1	111.1186	-5.16414	-4.60391
		2	112.5361	-4.97559	-4.19989
Lags interval: 1 to 3	28	0	87.80238	-5.414455	-4.843511
		1	95.49704	-5.606932	-4.798093
		2	97.19978	-5.371413	-4.324681
Lags interval: 1 to 4	22	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 because the results are not robust. So, cointegration tests are only run for 0 lags.

Table 16. Cointegration test considering 0 lags for wild and farmed seabass in the French retail market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Included observations: 74				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.233682	29.79371	19.96	24.60	None **
0.127558	10.09801	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering no lags, shows 2 cointegration equations between wild and farmed seabass in the French retail market, consequently, prices are stationary and regression methodology should be used.

Table 17. Regression analysis for wild and farmed seabass in the Paris wholesale market considering 0 lags

Dependent Variable: Bass Farmed				
Method: Least Squares				
Sample(adjusted): 4 278				
Included observations: 102				
Excluded observations: 173 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.004472	0.144560	13.86603	0.0000
Bass Wild	0.203525	0.050137	4.059372	0.0001
R-squared	0.141472	Mean dependent var		2.590364
Adjusted R-squared	0.132887	S.D. dependent var		0.088273
S.E. of regression	0.082199	Akaike info criterion		-2.139942
Sum squared resid	0.675663	Schwarz criterion		-2.088471
Log likelihood	111.1370	F-statistic		16.47850
Durbin-Watson stat	0.911260	Prob(F-statistic)		0.000098

Table 18. Regression analysis for wild and farmed seabass in the Paris wholesale market considering 0 lags

Dependent Variable: Bass Wild				
Method: Least Squares				
Sample(adjusted): 4 278				
Included observations: 102				
Excluded observations: 173 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.078131	0.443819	2.429212	0.0169
Bass Farmed	0.695112	0.171236	4.059372	0.0001
R-squared	0.141472	Mean dependent var		2.878724
Adjusted R-squared	0.132887	S.D. dependent var		0.163135
S.E. of regression	0.151909	Akaike info criterion		-0.911656
Sum squared resid	2.307636	Schwarz criterion		-0.860186
Log likelihood	48.49447	F-statistic		16.47850
Durbin-Watson stat	0.363789	Prob(F-statistic)		0.000098

The results from the regression analysis show the integration between wild and farmed seabass in the Paris wholesale market when considering 0 lags.

Table 19. Regression analysis for wild and farmed seabass in the Paris wholesale market considering 1 lag

Dependent Variable: Bass Farmed				
Method: Least Squares				
Sample(adjusted): 5 274				
Included observations: 74				
Excluded observations: 196 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.927575	0.263054	3.526173	0.0007
Bass Wild	0.092037	0.112468	0.818338	0.4159
Bass Wild (-1)	0.031120	0.108013	0.288109	0.7741
Bass Farmed (-1)	0.505015	0.108633	4.648823	0.0000
R-squared	0.368379	Mean dependent var		2.588838
Adjusted R-squared	0.341310	S.D. dependent var		0.086154
S.E. of regression	0.069922	Akaike info criterion		-2.430321
Sum squared resid	0.342241	Schwarz criterion		-2.305777
Log likelihood	93.92189	F-statistic		13.60868
Durbin-Watson stat	1.785820	Prob(F-statistic)		0.000000

Table 20. Regression analysis for wild and farmed seabass in the Paris wholesale market considering 1 lag

Dependent Variable: Bass Wild				
Method: Least Squares				
Sample(adjusted): 5 274				
Included observations: 74				
Excluded observations: 196 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.346378	0.299077	1.158155	0.2507
Bass Farmed	0.102961	0.125817	0.818338	0.4159
Bass Farmed (-1)	-0.023846	0.131414	-0.181456	0.8565
Bass Wild (-1)	0.806641	0.061414	13.13443	0.0000
R-squared	0.767941	Mean dependent var		2.857838
Adjusted R-squared	0.757995	S.D. dependent var		0.150335
S.E. of regression	0.073956	Akaike info criterion		-2.318161
Sum squared resid	0.382862	Schwarz criterion		-2.193617
Log likelihood	89.77196	F-statistic		77.21559
Durbin-Watson stat	2.185101	Prob(F-statistic)		0.000000

The results from the regression analysis show the lack of integration between wild and farmed seabass in the Paris wholesale market when considering 1 lag.

9.1.4. Gilthead seabream (Madrid wholesale market)

Table 21. 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**
Lags interval: No lags	0	1773.149	-6.846134	**-6.846134**
	1	1783.263	-6.865879	-6.824856
	2	**1784.296**	-6.850564	-6.768518
Lags interval: 1 to 1	0	1700.650	-6.841332	-6.807408
	1	1711.851	**-6.866335**	-6.790006
	2	1712.716	-6.84966	-6.730926
Lags interval: 1 to 2	0	1624.991	-6.794082	-6.724075
	1	1635.792	-6.818454	-6.704692
	2	1636.208	-6.799193	-6.641678
Lags interval: 1 to 3	0	1558.401	-6.782463	-6.673976
	1	1570.021	-6.811498	-6.657808
	2	1570.609	-6.792144	-6.593252
Lags interval: 1 to 4	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.

Table 22. Cointegration test considering no lags for wild and farmed seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.038297	22.29477	19.96	24.60	None *
0.003983	2.067092	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 23. Cointegration test considering 1 lag for wild and farmed seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.044160	24.13078	19.96	24.60	None *
0.003480	1.729244	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering no lags and 1 lag, show 1 cointegration equation between wild and farmed seabream in the Madrid wholesale market. So the stationarity behavior of the series is analysed.

Table 24. Unit root test considering intercept and no lags and 1 lag for wild and farmed seabream in Madrid wholesale market

Series	**Lags**	**ADF Test Statistic**	**Critical Values**		
Farmed seabream	0	-3.724575	1%: -3.4453	5%: -2.8674	10%: -2.5699
Wild seabream	0	-2.049078	1%: -3.4433	5%: -2.8665	10%: -2.5694
Farmed seabream	1	-3.630154	1%: -3.4458	5%: -2.8677	10%: -2.5700
Wild seabream	1	-2.492221	1%: -3.4433	5%: -2.8665	10%: -2.5694

The ADF Test statistics for wild seabream (-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 seabream price series behaves as a non-stationary series. While the farmed seabream price series behaves as stationary.

Therefore, there is no market integration between wild and farmed seabream in the Madrid wholesale market.

9.1.5. Gilthead seabream (Barcelona wholesale market)

Table 25. 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
Lags interval: No lags	0	952.8161	-4.080583	-4.080583
	1	987.1482	-4.206202	**-4.161809**
	2	991.9419	-4.205319	-4.116532
Lags interval: 1 to 1	0	959.9336	-4.102719	-4.067147
	1	995.7863	**-4.235134**	-4.155096
	2	999.4217	-4.229278	-4.104774
Lags interval: 1 to 2	0	963.6102	-4.110151	-4.038891
	1	997.2240	-4.233222	-4.117423
	2	1000.4150	-4.22544	-4.065103
Lags interval: 1 to 3	0	965.6643	-4.110622	-4.003556
	1	997.5639	-4.226569	-4.074892
	2	1001.1850	-4.220624	-4.024337
Lags interval: 1 to 4	0	976.7978	-4.150315	-4.007326
	1	1001.1310	-4.233829	-4.046157
	2	1005.6470	-4.231735	-3.999379
Lags interval: 1 to 5	0	979.5822	-4.154035	-3.975007
	1	1001.4300	-4.226968	-4.003182
	2	**1006.7340**	-4.228284	-3.959741
Lags interval: 1 to 6	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.

Table 26. Cointegration test considering no lags for wild and farmed seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CEs
0.136734	78.25155	19.96	24.60	None **
0.020321	9.587526	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 27. Cointegration test considering 1 lags for wild and farmed seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.142620	78.97628	19.96	24.60	None **
0.015482	7.270892	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 28. Cointegration test considering 5 lags for wild and farmed seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 5				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.090243	54.30291	19.96	24.60	None **
0.022700	10.60822	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering no lags and 5 lags, show 2 cointegration equations between seabream wild and farmed in the Barcelona wholesale market, consequently, prices are stationary and regression methodology should be used. When considering 1 lag, the cointegration test shows that there is 1 cointegration equation

Table 29. Unit root test considering intercept and 1 lag for wild and farmed seabream in the Barcelona wholesale market

Series	Lags	ADF Test Statistic	Critical Values		
Farmed seabream	1	-2.648794	1%: -3.4466	5%: -2.8680	10%: -2.5702
Wild seabream	1	-8.219314	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test statistic for farmed seabream (-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). So, the farmed seabream price series behaves as a non-stationary series. While the wild seabream price series behaves as stationary. Therefore, there is no market integration between wild and farmed seabream in the Barcelona wholesale market considering 1 lag.

Table 30. Regression analysis for farmed and wild seabream in the Barcelona wholesale market considering no lags

Dependent Variable: Bream Farmed				
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 31. 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 Farmed	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

The results from the regression analysis show the presence of integration between wild and farmed seabream in the Barcelona wholesale market when considering 0 lags.

Table 32. 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 Farmed	0.166352	0.212712	0.782052	0.4346
Bream Farmed (-1)	0.095465	0.267441	0.356957	0.7213
Bream Farmed (-2)	-0.084711	0.270021	-0.313719	0.7539
Bream Farmed (-3)	0.334772	0.269798	1.240824	0.2153
Bream Farmed (-4)	-0.137733	0.266700	-0.516434	0.6058
Bream Farmed (-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

Table 33. Regression analysis for farmed and wild seabream in the Barcelona wholesale market considering 5 lags

Dependent Variable: Bream Farmed				
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 Farmed (-1)	0.775694	0.046553	16.66266	0.0000
Bream Farmed (-2)	0.180237	0.059135	3.047899	0.0024
Bream Farmed (-3)	0.109156	0.059565	1.832541	0.0675
Bream Farmed (-4)	0.028451	0.059002	0.482204	0.6299
Bream Farmed (-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

The results from the regression analysis show the lack of integration between wild and farmed seabream in the Barcelona wholesale market when considering 5 lags.

9.2. Wild and farmed integration: Other species

In this section, we analyse the market integration between wild and farmed conspecifics of species other than seabream and seabass.

9.2.1. Turbot (Scophthalmus maximus) (Madrid wholesale market)

Table 34. Lag interval selection for wild and farmed turbot in the Madrid wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	2117.713	-6.809368	-6.809368
	1	2132.299	-6.840189	-6.804554
	2	2137.272	-6.840102	-6.768833
Lags interval: 1 to 1	0	2126.261	-6.834979	-6.806435
	1	2144.122	-6.876400	**-6.812177**
	2	2149.937	-6.879024	-6.779123
Lags interval: 1 to 2	0	2124.908	-6.828736	-6.771578
	1	2142.786	-6.870277	-6.777396
	2	2149.206	-6.874859	-6.746255
Lags interval: 1 to 3	0	2142.476	-6.883606	-6.797762
	1	2156.505	-6.912777	-6.791165
	2	**2163.117**	**-6.917986**	-6.760606
Lags interval: 1 to 4	0	2141.242	-6.877804	-6.763203
	1	2154.501	-6.904535	-6.754121
	2	2162.481	-6.914180	-6.727952

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 3 lags and 1 lag under the Schwarz Information Criteria. So, cointegration tests are run for 1 and 3 lags.

Table 35. Cointegration test considering 1 lags for wild and farmed turbot in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.055901	47.35251	19.96	24.60	None **
0.018554	11.63008	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 36. Cointegration test considering 3 lags for wild and farmed turbot in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.044314	41.28150	19.96	24.60	None **
0.021138	13.22458	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 1 and 3 lags, shows 2 cointegration equations between wild and farmed turbot in Madrid wholesale market. Therefore, prices are stationary and regression methodology should be used.

Table 37. Regression considering 3 lags for farmed and wild turbot in the Madrid wholesale market

Dependent Variable: Turbot farmed Madrid				
Method: Least Squares				
Sample(adjusted): 4 623				
Included observations: 620 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.083066	0.024163	3.437689	0.0006
Turbot farmed Madrid (-1)	1.125581	0.040279	27.94474	0.0000
Turbot farmed Madrid (-2)	-0.113931	0.063231	-1.801833	0.0721
Turbot farmed Madrid (-3)	-0.038059	0.045636	-0.833968	0.4046
Turbot wild Madrid	0.008451	0.019989	0.422773	0.6726
Turbot wild Madrid (-1)	-0.023344	0.029341	-0.795607	0.4266
Turbot wild Madrid (-2)	0.032841	0.029340	1.119329	0.2634
Turbot wild Madrid (-3)	-0.026144	0.019745	-1.324103	0.1860
R-squared	0.952517	Mean dependent var		2.181020
Adjusted R-squared	0.951974	S.D. dependent var		0.138100
S.E. of regression	0.030264	Akaike info criterion		-4.144866
Sum squared resid	0.560554	Schwarz criterion		-4.087708
Log likelihood	1292.908	F-statistic		1753.817
Durbin-Watson stat	2.004249	Prob(F-statistic)		0.000000

Table 38. Regression considering 3 lags for wild and farmed turbot in the Madrid wholesale market

Dependent Variable: Turbot wild Madrid				
Method: Least Squares				
Sample(adjusted): 4 623				
Included observations: 620 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.110714	0.049123	2.253797	0.0246
Turbot farmed Madrid	0.034549	0.081721	0.422773	0.6726
Turbot farmed Madrid (-1)	-0.012055	0.122865	-0.098119	0.9219
Turbot farmed Madrid (-2)	0.073429	0.128154	0.572972	0.5669
Turbot farmed Madrid (-3)	-0.027418	0.092320	-0.296985	0.7666
Turbot wild Madrid (-1)	1.076284	0.040379	26.65465	0.0000
Turbot wild Madrid (-2)	-0.136410	0.059129	-2.307012	0.0214
Turbot wild Madrid (-3)	-0.022892	0.039969	-0.572735	0.5670
R-squared	0.901127	Mean dependent var		3.124293
Adjusted R-squared	0.899996	S.D. dependent var		0.193506
S.E. of regression	0.061193	Akaike info criterion		-2.736737
Sum squared resid	2.291711	Schwarz criterion		-2.679580
Log likelihood	856.3886	F-statistic		796.8207
Durbin-Watson stat	1.923573	Prob(F-statistic)		0.000000

The results from the regression analysis show the lack of integration between wild and farmed turbot in the Madrid wholesale market when considering 3 lags.

Table 39. Regression considering 2 lags for wild and farmed turbot in the Madrid wholesale market

Dependent Variable: Turbot wild Madrid				
Method: Least Squares				
Sample(adjusted): 3 623				
Included observations: 621 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.103335	0.048377	2.136022	0.0331
Turbot wild Madrid (-1)	1.082801	0.039705	27.27145	0.0000
Turbot wild Madrid (-2)	-0.163416	0.039324	-4.155643	0.0000
Turbot farmed Madrid	0.044728	0.081276	0.550322	0.5823
Turbot farmed Madrid (-1)	-0.020657	0.122298	-0.168906	0.8659
Turbot farmed Madrid (-2)	0.044336	0.082389	0.538130	0.5907
R-squared	0.901550	Mean dependent var		3.123630
Adjusted R-squared	0.900749	S.D. dependent var		0.194056
S.E. of regression	0.061136	Akaike info criterion		-2.741831
Sum squared resid	2.298598	Schwarz criterion		-2.699016
Log likelihood	857.3385	F-statistic		1126.363
Durbin-Watson stat	2.010463	Prob(F-statistic)		0.000000

Table 40. Regression considering 2 lags for farmed and wild turbot in the Madrid wholesale market

Dependent Variable: Turbot farmed Madrid				
Method: Least Squares				
Sample(adjusted): 3 623				
Included observations: 621 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.075831	0.023890	3.174190	0.0016
Turbot wild Madrid	0.011004	0.019996	0.550322	0.5823
Turbot wild Madrid (-1)	-0.020000	0.029262	-0.683476	0.4946
Turbot wild Madrid (-2)	0.002926	0.019777	0.147934	0.8824
Turbot farmed Madrid (-1)	1.129508	0.040069	28.18900	0.0000
Turbot farmed Madrid (-2)	-0.155667	0.040391	-3.853990	0.0001
R-squared	0.952099	Mean dependent var		2.181070
Adjusted R-squared	0.951710	S.D. dependent var		0.137994
S.E. of regression	0.030324	Akaike info criterion		-4.144127
Sum squared resid	0.565527	Schwarz criterion		-4.101312
Log likelihood	1292.751	F-statistic		2444.811
Durbin-Watson stat	2.003391	Prob(F-statistic)		0.000000

The results from the regression analysis show the lack of integration between wild and farmed turbot in the Madrid wholesale market when considering 2 lags.

9.2.2. Sole (Solea spp.) (Madrid wholesale market)

Table 41. Lag interval selection for wild and farmed sole in the Madrid wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	571.4617	-8.163738	**-8.163738**
	1	574.0108	-8.128726	-8.023668
	2	575.2968	-8.075669	-7.865552
Lags interval: 1 to 1	0	571.2381	-8.161699	-8.077253
	1	574.6160	-8.138360	-7.948358
	2	576.2593	-8.090062	-7.794504
Lags interval: 1 to 2	0	574.5791	**-8.211292**	-8.041596
	1	577.8710	-8.186536	-7.910780
	2	**578.9017**	-8.129010	-7.747194
Lags interval: 1 to 3	0	570.0202	-8.146280	-7.890515
	1	573.4847	-8.123865	-7.761531
	2	574.7470	-8.069299	-7.600397
Lags interval: 1 to 4	0	572.7825	-8.187979	-7.845313
	1	576.2887	-8.166010	-7.716262
	2	578.5713	-8.126048	-7.569217

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 2 lags, while under the Schwarz Information Criteria the optimal lags are no lags, consequently, cointegration tests are run only for 0 and 2 lags.

Table 42. Cointegration test considering no lags for wild and farmed sole in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.035762	7.670350	19.96	24.60	None
0.018204	2.572004	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 43. Cointegration test considering 2 lags for wild and farmed sole in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.046588	8.645063	19.96	24.60	None
0.014826	2.061366	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 0 and 2 lags, show 0 cointegration equations between wild and farmed turbot in the Madrid wholesale market. Therefore, there is no market integration between wild and farmed sole in the Madrid wholesale market.

9.2.3. Turbot (Scophthalmus maximus) (Barcelona wholesale market)

Table 44. Lag interval selection for wild and farmed turbot in the Barcelona wholesale market

Lags	**Rank or No. of Ces**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	941.6926	-4.032945	-4.032945
	1	980.8899	**-4.179400**	**-4.135007**
	2	**983.5505**	-4.169381	-4.080595
Lags interval: 1 to 1	0	945.2929	-4.039884	-4.004311
	1	979.0243	-4.163195	-4.083157
	2	981.7117	-4.153269	-4.028766
Lags interval: 1 to 2	0	950.6946	-4.054600	-3.983340
	1	978.2768	-4.151728	-4.035929
	2	980.7318	-4.140782	-3.980445
Lags interval: 1 to 3	0	955.0115	-4.064705	-3.957639
	1	978.2162	-4.143173	-3.991497
	2	980.4546	-4.131270	-3.934982
Lags interval: 1 to 4	0	955.3436	-4.057640	-3.914651
	1	976.9710	-4.129464	-3.941792
	2	979.0335	-4.116775	-3.884419

From the lag selection table, we can see that under the Log Likelihood, the Akaike and Schwarz Information Criteria the optimal lags are no lags, consequently, cointegration tests are run only for no lags.

Table 45. Cointegration test considering no lags for wild and farmed turbot in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.154535	83.71565	19.96	24.60	None **
0.011329	5.321044	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

The cointegration test, considering no lags, shows 1 cointegration equation between wild and farmed turbot in Barcelona wholesale market. So the stationarity behavior of the series is analysed.

Table 46. Unit root test considering intercept and no lags for wild and farmed turbot in the Barcelona wholesale market

Series	**Lags**	**ADF Test Statistic**	**Critical Values**		
Farmed turbot	0	-2.272751	1%: -3.4466	5%: -2.8680	10%: -2.5702
Wild turbot	0	-8.619563	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test statistic for farmed turbot is higher than for the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the farmed turbot price series behaves as a non-stationary series. While the wild turbot price series behaves as stationary.

Therefore, there is no market integration between wild and farmed turbot in the Barcelona wholesale market.

9.2.4. Blackspot (red) seabream (Pagellus bogaraveo) (Barcelona wholesale market)

Table 47. Lag interval selection for wild and farmed blackspot 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
Lags interval: No lags	0	128.1625	-0.985866	-0.985866
	1	146.0919	-1.085323	**-1.016848**
	2	**156.3623**	**-1.125864**	-0.988914
Lags interval: 1 to 1	0	101.2478	-0.88007	-0.818565
	1	119.6521	-1.001376	-0.86299
	2	127.5447	-1.027554	-0.812286
Lags interval: 1 to 2	0	92.75395	-0.882854	-0.747125
	1	109.9868	-1.010279	-0.789719
	2	115.7323	-1.018044	-0.712654
Lags interval: 1 to 3	0	82.54147	-0.844808	-0.620761
	1	106.7777	-1.075182	-0.757782
	2	110.8441	-1.064001	-0.653248
Lags interval: 1 to 4	0	85.97225	-0.952003	-0.626514
	1	101.4360	-1.094367	-0.667163
	2	103.972	-1.060844	-0.531924

From the lag selection table, we can see that under the Log Likelihood, the Akaike and Schwarz Information Criteria the optimal lags are no lags, consequently, cointegration tests are run only for no lags.

Table 48. Cointegration test considering no lags for wild and farmed blackspot seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.128830	56.39953	19.96	24.60	None **
0.075962	20.54067	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test considering no lags, shows 2 cointegration equations between blackspot seabream wild and farmed in Barcelona wholesale market, consequently, prices are stationary and regression methodology should be used.

Table 49. Regression considering 1 lag for farmed and wild blackspot seabream in the Barcelona wholesale market

Dependent Variable: Blackspot seabream farmed				
Method: Least Squares				
Sample(adjusted): 2 462				
Included observations: 260				
Excluded observations: 201 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.118046	0.186558	-0.632758	0.5275
Blackspot seabream farmed (-1)	0.881265	0.028292	31.14905	0.0000
Blackspot seabream wild	0.153931	0.071492	2.153129	0.0322
Blackspot seabream wild (-1)	-0.036651	0.076784	-0.477322	0.6335
R-squared	0.792277	Mean dependent var		1.943651
Adjusted R-squared	0.789843	S.D. dependent var		0.421168
S.E. of regression	0.193075	Akaike info criterion		-0.436207
Sum squared resid	9.543192	Schwarz criterion		-0.381428
Log likelihood	60.70695	F-statistic		325.4708
Durbin-Watson stat	2.421581	Prob(F-statistic)		0.000000

Table 50. Regression considering 1 lag for wild and farmed blackspot seabream in the Barcelona wholesale market

Dependent Variable: Blackspot seabream wild				
Method: Least Squares				
Sample(adjusted): 2 462				
Included observations: 260				
Excluded observations: 201 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.919224	0.151217	6.078825	0.0000
Blackspot seabream farmed	0.115552	0.053667	2.153129	0.0322
Blackspot seabream farmed (-1)	-0.140834	0.052922	-2.661183	0.0083
Blackspot seabream wild (-1)	0.699739	0.050171	13.94713	0.0000
R-squared	0.446349	Mean dependent var		2.892864
Adjusted R-squared	0.439861	S.D. dependent var		0.223514
S.E. of regression	0.167284	Akaike info criterion		-0.722988
Sum squared resid	7.163847	Schwarz criterion		-0.668208
Log likelihood	97.98847	F-statistic		68.79512
Durbin-Watson stat	1.771851	Prob(F-statistic)		0.000000

The results from the regression analysis show the integration between wild and farmed blackspot seabream in the Barcelona wholesale market when considering 1 lag.

Table 51. Regression considering 5 lags for wild and farmed blackspot seabream in the Barcelona wholesale market

Dependent Variable: Blackspot seabream wild				
Method: Least Squares				
Sample(adjusted): 55 412				
Included observations: 147				
Excluded observations: 211 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1.623646	0.302727	5.363398	0.0000
Blackspot seabream farmed	0.165703	0.066761	2.482043	0.0143
Blackspot seabream farmed (-1)	-0.220419	0.084205	-2.617666	0.0099
Blackspot seabream farmed (-2)	0.155832	0.088490	1.761006	0.0805
Blackspot seabream farmed (-3)	-0.069374	0.089288	-0.776963	0.4385
Blackspot seabream farmed (-4)	-0.054242	0.086766	-0.625157	0.5329
Blackspot seabream farmed (-5)	-0.022267	0.067387	-0.330433	0.7416
Blackspot seabream wild (-1)	0.772977	0.085571	9.033116	0.0000
Blackspot seabream wild (-2)	-0.169049	0.101957	-1.658049	0.0996
Blackspot seabream wild (-3)	0.029991	0.102485	0.292643	0.7702
Blackspot seabream wild (-4)	-0.118069	0.100221	-1.178079	0.2408
Blackspot seabream wild (-5)	-0.053471	0.092120	-0.580444	0.5626
R-squared	0.521328	Mean dependent var		2.867458
Adjusted R-squared	0.482325	S.D. dependent var		0.217011
S.E. of regression	0.156139	Akaike info criterion		-0.798033
Sum squared resid	3.291217	Schwarz criterion		-0.553916
Log likelihood	70.65542	F-statistic		13.36638
Durbin-Watson stat	1.995746	Prob(F-statistic)		0.000000

Table 52. Regression considering 5 lags for wild and farmed blackspot seabream in the Barcelona wholesale market

Dependent Variable: Blackspot seabream farmed				
Method: Least Squares				
Sample(adjusted): 55 412				
Included observations: 147				
Excluded observations: 211 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-0.039830	0.420344	-0.094757	0.9246
Blackspot seabream wild	0.263376	0.106113	2.482043	0.0143
Blackspot seabream wild (-1)	-0.153432	0.136011	-1.128082	0.2613
Blackspot seabream wild (-2)	0.004411	0.129842	0.033972	0.9729
Blackspot seabream wild (-3)	-0.176283	0.128353	-1.373424	0.1719
Blackspot seabream wild (-4)	0.202698	0.125796	1.611319	0.1094
Blackspot seabream wild (-5)	-0.071590	0.116120	-0.616512	0.5386
Blackspot seabream farmed (-1)	0.819221	0.082889	9.883339	0.0000
Blackspot seabream farmed (-2)	0.022262	0.112821	0.197324	0.8439
Blackspot seabream farmed (-3)	-0.041035	0.112765	-0.363902	0.7165
Blackspot seabream farmed (-4)	0.182321	0.108417	1.681661	0.0949
Blackspot seabream farmed (-5)	-0.070729	0.084774	-0.834324	0.4056
R-squared	0.794633	Mean dependent var		1.891964
Adjusted R-squared	0.777899	S.D. dependent var		0.417695
S.E. of regression	0.196850	Akaike info criterion		-0.334645
Sum squared resid	5.231226	Schwarz criterion		-0.090528
Log likelihood	36.59638	F-statistic		47.48718
Durbin-Watson stat	2.146539	Prob(F-statistic)		0.000000

The results from the regression analysis show the integration between wild and farmed blackspot seabream in the Barcelona wholesale market when considering 5 lags.

9.2.5. Atlantic cod (Gadus morhua) (Barcelona wholesale market)

Table 53. Lag interval selection for wild and farmed cod in the Barcelona wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	471.1776	-2.127213	-2.127213
	1	530.1068	-2.370685	-2.324482
	2	561.1630	-2.488321	-2.395915
Lags interval: 1 to 1	0	518.2373	-2.369757	-2.332218
	1	553.8724	-2.510933	-2.426469
	2	574.7387	-2.584049	**-2.452661**
Lags interval: 1 to 2	0	539.4415	-2.483371	-2.407500
	1	561.3505	-2.562385	-2.439094
	2	**575.7537**	-2.606326	-2.435615
Lags interval: 1 to 3	0	545.8391	-2.530043	-2.415019
	1	560.8047	-2.577273	-2.414323
	2	572.3742	**-2.608409**	-2.397531
Lags interval: 1 to 4	0	546.6693	-2.551295	-2.396268
	1	557.8781	-2.581145	-2.377673
	2	567.8461	-2.605029	-2.353111

From the lag selection table, we can see that under the Schwarz Information Criteria the optimal lags are 1, under the Akaike Information Criteria the optimal are 3 lags, while under the Log Likelihood the optimal lag is 2. So, cointegration tests are run for 1, 2 and 3 lags.

Table 54. Cointegration test considering 1 lag for wild and farmed cod in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.151442	113.0028	19.96	24.60	None **
0.091680	41.73264	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 55. Cointegration test considering 2 lags for wild and farmed cod in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.097312	72.62441	19.96	24.60	None **
0.065090	28.80643	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 56. Cointegration test considering 3 lags for wild and farmed cod in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.068470	53.07017	19.96	24.60	None **
0.053356	23.13902	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration tests, considering 1, 2 and 3 lags, show 2 cointegration equations between wild and farmed cod in the Barcelona wholesale market; consequently, prices are stationary and regression methodology should be used.

Table 57. Regression considering 3 lags for farmed and wild Atlantic cod in the Barcelona wholesale market

Dependent Variable: Atlantic cod farmed				
Method: Least Squares				
Sample(adjusted): 4 467				
Included observations: 428				
Excluded observations: 36 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.174044	0.106883	1.628361	0.1042
Atlantic cod farmed (-1)	0.652379	0.048468	13.45998	0.0000
Atlantic cod farmed (-2)	0.077248	0.056575	1.365414	0.1729
Atlantic cod farmed (-3)	0.074783	0.046570	1.605820	0.1091
Atlantic cod wild	0.217223	0.059297	3.663312	0.0003
Atlantic cod wild (-1)	0.089681	0.066082	1.357126	0.1755
Atlantic cod wild (-2)	-0.122449	0.065597	-1.866696	0.0626
Atlantic cod wild (-3)	-0.122959	0.060841	-2.020974	0.0439
R-squared	0.599476	Mean dependent var		1.371293
Adjusted R-squared	0.592800	S.D. dependent var		0.215364
S.E. of regression	0.137429	Akaike info criterion		-1.112907
Sum squared resid	7.932406	Schwarz criterion		-1.037035
Log likelihood	246.1620	F-statistic		89.80362
Durbin-Watson stat	2.022227	Prob(F-statistic)		0.000000

Table 58. Regression considering 3 lags for wild and farmed Atlantic cod in the Barcelona wholesale market

Dependent Variable: Atlantic cod wild				
Method: Least Squares				
Sample(adjusted): 4 467				
Included observations: 428				
Excluded observations: 36 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.502646	0.083319	6.032822	0.0000
Atlantic cod farmed	0.142539	0.038910	3.663312	0.0003
Atlantic cod farmed (-1)	-0.057590	0.046888	-1.228242	0.2200
Atlantic cod farmed (-2)	-0.123135	0.045536	-2.704151	0.0071
Atlantic cod farmed (-3)	0.038742	0.037793	1.025119	0.3059
Atlantic cod wild (-1)	0.416456	0.049649	8.387957	0.0000
Atlantic cod wild (-2)	0.093252	0.053162	1.754110	0.0801
Atlantic cod wild (-3)	0.166362	0.048854	3.405282	0.0007
R-squared	0.337185	Mean dependent var		1.549957
Adjusted R-squared	0.326138	S.D. dependent var		0.135614
S.E. of regression	0.111325	Akaike info criterion		-1.534217
Sum squared resid	5.205136	Schwarz criterion		-1.458346
Log likelihood	336.3225	F-statistic		30.52296
Durbin-Watson stat	1.989059	Prob(F-statistic)		0.000000

Results from the regression analysis show the integration between wild and farmed Atlantic cod in the Barcelona wholesale market when considering 3 lags.

Table 59. Regression considering 5 lags for wild and farmed Atlantic cod in the Barcelona wholesale market

Dependent Variable: Atlantic cod wild				
Method: Least Squares				
Sample(adjusted): 6 467				
Included observations: 416				
Excluded observations: 46 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.409548	0.090624	4.519178	0.0000
Atlantic cod wild (-1)	0.387678	0.050823	7.627969	0.0000
Atlantic cod wild (-2)	0.057666	0.054472	1.058645	0.2904
Atlantic cod wild (-3)	0.115342	0.054559	2.114080	0.0351
Atlantic cod wild (-4)	0.045902	0.054397	0.843839	0.3993
Atlantic cod wild (-5)	0.137477	0.050367	2.729492	0.0066
Atlantic cod farmed	0.131681	0.039378	3.344056	0.0009
Atlantic cod farmed (-1)	-0.045211	0.047168	-0.958526	0.3384
Atlantic cod farmed (-2)	-0.116941	0.047263	-2.474266	0.0138
Atlantic cod farmed (-3)	0.051717	0.047188	1.095989	0.2737
Atlantic cod farmed (-4)	-0.013826	0.045881	-0.301355	0.7633
Atlantic cod farmed (-5)	-0.016017	0.038123	-0.420135	0.6746
R-squared	0.355302	Mean dependent var		1.549504
Adjusted R-squared	0.337749	S.D. dependent var		0.135649
S.E. of regression	0.110390	Akaike info criterion		-1.541175
Sum squared resid	4.923113	Schwarz criterion		-1.424905
Log likelihood	332.5644	F-statistic		20.24094
Durbin-Watson stat	1.984237	Prob(F-statistic)		0.000000

Table 60. Regression considering 5 lags for farmed and wild Atlantic cod in the Barcelona wholesale market

Dependent Variable: Atlantic cod farmed				
Method: Least Squares				
Date: 05/10/17 Time: 01:28				
Sample(adjusted): 6 467				
Included observations: 416				
Excluded observations: 46 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.065360	0.115722	0.564801	0.5725
Atlantic cod wild	0.204544	0.061166	3.344056	0.0009
Atlantic cod wild (-1)	0.068975	0.067663	1.019376	0.3086
Atlantic cod wild (-2)	-0.114505	0.067745	-1.690235	0.0918
Atlantic cod wild (-3)	-0.141073	0.068012	-2.074227	0.0387
Atlantic cod wild (-4)	0.066942	0.067774	0.987719	0.3239
Atlantic cod wild (-5)	0.020072	0.063342	0.316878	0.7515
Atlantic cod farmed (-1)	0.630371	0.049801	12.65788	0.0000
Atlantic cod farmed (-2)	0.078399	0.059222	1.323825	0.1863
Atlantic cod farmed (-3)	-0.027338	0.058883	-0.464283	0.6427
Atlantic cod farmed (-4)	0.076459	0.057062	1.339925	0.1810
Atlantic cod farmed (-5)	0.077803	0.047366	1.642575	0.1012
R-squared	0.605071	Mean dependent var		1.374315
Adjusted R-squared	0.594318	S.D. dependent var		0.216007
S.E. of regression	0.137582	Akaike info criterion		-1.100773
Sum squared resid	7.647222	Schwarz criterion		-0.984504
Log likelihood	240.9609	F-statistic		56.26980
Durbin-Watson stat	2.024452	Prob(F-statistic)		0.000000

The results from the regression analysis show the integration between wild and farmed Atlantic cod in the Barcelona wholesale market when considering 5 lags.

9.2.6. Clams (Venerupis spp.) (Barcelona wholesale market)

Table 61. Lag interval selection for wild and farmed clams in the Barcelona wholesale market

Lags	**Rank or No. of Ces**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	1362.077	-5.833305	-5.833305
	1	1382.666	-5.90007	**-5.855676**
	2	1385.882	-5.892429	-5.803642
Lags interval: 1 to 1	0	1365.531	-5.843479	-5.807907
	1	1390.297	**-5.928312**	-5.848274
	2	1393.924	-5.922421	-5.797918
Lags interval: 1 to 2	0	1364.998	-5.836551	-5.765291
	1	1387.381	-5.911318	-5.795519
	2	1390.861	-5.904778	-5.744441
Lags interval: 1 to 3	0	1372.993	-5.866348	-5.759282
	1	1391.308	-5.92374	-5.772063
	2	**1394.204**	-5.914674	-5.718386
Lags interval: 1 to 4	0	1372.477	-5.85951	-5.716521
	1	1388.807	-5.908456	-5.720783
	2	1391.885	-5.900152	-5.667796

From the lag selection table, we can see that under the Akaike Information Criteria the optimal lags are 1, under the Schwarz Information Criteria the optimal is no lags, while under the Log Likelihood the optimal lag is 3. So, cointegration tests are run for 0, 1 and 3 lags.

Table 62. Cointegration test considering no lags for wild and farmed clams in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.084402	47.61054	19.96	24.60	None **
0.013678	6.431685	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 63. Cointegration test considering 1 lag for wild and farmed clams in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.100838	56.78671	19.96	24.60	None **
0.015447	7.254587	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 64. Cointegration test considering 3 lags for wild and farmed clams in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.075908	42.42308	19.96	24.60	None **
0.012408	5.793400	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

All cointegration tests show that there is 1 cointegration equation. Therefore, we analysed the stationary properties of the series.

Table 65. Unit root test considering intercept and 0, 1 and 3 lags for wild and farmed clams in the Barcelona wholesale market

Series	Lags	ADF Test Statistic	Critical Values		
Farmed clams	0	-2.514807	1%: -3.4467	5%: -2.8680	10%: -2.5702
Wild clams	0	-6.070624	1%: -3.4467	5%: -2.8680	10%: -2.5702
Farmed clams	1	-2.689492	1%: -3.4466	5%: -2.8680	10%: -2.5702
Wild clams	1	-6.842604	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed clams	3	-2.372153	1%: -3.4466	5%: -2.8680	10%: -2.5702
Wild clams	3	-5.685445	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test statistics for farmed clams are higher than for the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level (-2.868). So, farmed clams series behaves as non-stationary, while wild clams price series behaves as stationary. Therefore, there is no market integration between wild and farmed clams in the Barcelona wholesale market.

9.2.7. Meagre (Argyrosomus regius) (Barcelona wholesale market)

Table 66. Lag interval selection for wild and farmed meagre in the Barcelona wholesale market

Lags	**Rank or No. of Ces**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	31.40852	-0.135968	-0.135968
	1	89.21035	-0.364547	-0.31979
	2	114.3514	-0.451737	-0.362223
Lags interval: 1 to 1	0	127.7939	-0.539407	-0.503424
	1	159.9796	-0.657863	-0.576901
	2	174.5773	-0.699683	-0.573743
Lags interval: 1 to 2	0	153.5512	-0.638382	-0.566058
	1	177.7931	-0.722777	-0.60525
	2	186.6859	-0.739851	-0.577121
Lags interval: 1 to 3	0	167.1812	-0.685127	-0.576097
	1	183.8603	-0.73669	-0.582231
	2	191.416	-0.747974	-0.548085
Lags interval: 1 to 4	0	188.6898	-0.76751	-0.621404
	1	198.9739	-0.790995	-0.59923
	2	204.1866	-0.791941	-0.554517
Lags interval: 1 to 5	0	204.9168	-0.827368	**-0.643809**
	1	211.9695	-0.836552	-0.607103
	2	214.8216	-0.826942	-0.551603
Lags interval: 1 to 6	0	211.0501	-0.842568	-0.621172
	1	217.2988	-0.848193	-0.580673
	2	220.4005	-0.839642	-0.525998
Lags interval: 1 to 7	0	213.243	-0.840104	-0.580482
	1	219.2137	-0.844506	-0.538524
	2	221.6879	-0.833052	-0.480708
Lags interval: 1 to 8	0	224.8005	-0.880368	-0.582123
	1	230.9516	-0.885624	-0.540779
	2	235.0911	-0.881695	-0.490249
Lags interval: 1 to 9	0	243.8583	-0.95567	-0.61840
	1	249.2874	-0.957643	-0.57353
	2	251.557	-0.94509	-0.514134
Lags interval: 1 to 10	0	247.6691	-0.961431	-0.584725
	1	253.2295	-0.964025	-0.540231
	2	255.3112	-0.950515	-0.479632
Lags interval: 1 to 11	0	260.0142	-1.007059	-0.5905
	1	263.2549	-0.998858	-0.534962
	2	265.0365	-0.983853	-0.472621
Lags interval: 1 to 12	0	264.4287	**-1.016097**	-0.559259
	1	268.1803	-1.010236	-0.50581
	2	**269.5635**	-0.993256	-0.441243
Lags interval: 1 to 13	0	262.4651	-0.995107	-0.497558
	1	266.0772	-0.988545	-0.443154
	2	267.3252	-0.970805	-0.377573

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 12, while under the Schwarz Information Criteria the optimal is 5 lags. So, cointegration tests are run for 5 and 12 lags.

Table 67. Cointegration test considering 5 lags for wild and farmed meagre in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 5				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.031063	19.80968	19.96	24.60	None
0.012680	5.704323	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 68. Cointegration test considering 12 lags for wild and farmed meagre in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 12				
	Likelihood	**5 percent**	**1 percent**	**Hypothesized**
Eigenvalue	**Ratio**	**Critical Value**	**Critical Value**	**No. of CEs**
0.017459	10.26959	19.96	24.60	None
0.006473	2.766468	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Both cointegration tests show that there are no cointegration equations. So, both price series are non-stationary, consequently, there is no market interation between both products.

9.3. Species integration: Seabream and seabass

In this section, we report the analysis done to investigate the market integration between different species, wild and farmed.

9.3.1. Wild European seabass and gilthead seabream (Madrid wholesale market)

Table 69. Lag interval selection for wild European seabass and gilthead 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
Lags interval: No lags	0	1275.855	-4.926082	-4.926082
	1	1290.783	-4.964415	-4.923392
	2	**1293.353**	-4.955032	-4.872986
Lags interval: 1 to 1	0	1229.176	-4.940227	-4.906303
	1	1251.867	**-5.011562**	**-4.935233**
	2	1254.960	-5.003873	-4.885139
Lags interval: 1 to 2	0	1175.206	-4.904229	-4.834222
	1	1192.534	-4.956027	-4.842266
	2	1195.150	-4.946010	-4.788494
Lags interval: 1 to 3	0	1120.702	-4.862727	-4.754240
	1	1138.409	-4.918460	-4.764770
	2	1140.749	-4.906795	-4.707903
Lags interval: 1 to 4	0	1066.264	-4.817723	-4.668085
	1	1081.126	-4.862961	-4.666561
	2	1083.362	-4.850284	-4.607122

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

Table 70. Cointegration test considering 0 lags for wild European seabass and gilthead seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.056008	34.99588	19.96	24.60	None **
0.009873	5.139618	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 71. Cointegration test considering 1 lags for wild European seabass and gilthead seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.087435	51.56834	19.96	24.60	None **
0.012395	6.186219	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 0 and 1 lags, shows 1 cointegration equation between wild European seabass and gilthead seabream in the Madrid wholesale market. So the stationary behavior of the series is analysed.

Table 72. Unit root test considering intercept and 0 and 1 lags for wild European seabass and gilthead seabream in the Madrid wholesale market

Series	Lags	ADF Test Statistic	Critical Values		
wild European seabass	0	-5.700563	1%: -3.4433	5%: -2.8665	10%: -2.5694
wild European seabass	1	-7.280558	1%: -3.4433	5%: -2.8665	10%: -2.5694
wild gilthead seabream	0	-2.049078	1%: -3.4453	5%: -2.8674	10%: -2.5699
wild gilthead seabream	1	-2.492221	1%: -3.4458	5%: -2.8677	10%: -2.5700

The ADF Test statistics for wild gilthead seabream in the Madrid wholesale market are higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the wild gilthead seabream price series behaves as a non-stationary series, while wild European seabass in Mercamadrid price series behaves as stationary.

Therefore, there is no market integration between wild European seabass and gilthead seabream in the Madrid wholesale market.

9.3.2. Wild European seabass and gilthead seabream (Barcelona wholesale market)

Table 73. Lag interval selection for wild European seabass and gilthead 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
Lags interval: No lags	0	189.3669	-0.810993	-0.810993
	1	223.6375	-0.936349	-0.891956
	2	248.2795	-1.020469	-0.931682
Lags interval: 1 to 1	0	200.6597	-0.844033	-0.808461
	1	233.2593	-0.962486	-0.882448
	2	255.3302	-1.035752	-0.911248
Lags interval: 1 to 2	0	229.5644	-0.952965	-0.881704
	1	258.5390	-1.056082	**-0.940283**
	2	272.7792	**-1.095824**	-0.935487
Lags interval: 1 to 3	0	235.3435	-0.962688	-0.855622
	1	262.8858	-1.059852	-0.908176
	2	274.4972	-1.088350	-0.892062
Lags interval: 1 to 4	0	244.5080	-0.987076	-0.844087
	1	266.5612	-1.060740	-0.873067
	2	279.5134	-1.095090	-0.862734
Lags interval: 1 to 5	0	246.4144	-0.980149	-0.801120
	1	269.0180	-1.056355	-0.832569
	2	**282.2627**	-1.092046	-0.823503

From the lag selection table, we can see that under the Akaike and the Schwarz Information Criteria the optimal lags are 2, while under the Log Likelihood the optimal lags are 5. So, cointegration tests are run for 2 and 5 lags.

Table 74. Cointegration test considering 2 lags for wild European seabass and gilthead seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.117169	86.42944	19.96	24.60	None **
0.059410	28.48038	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 75. Cointegration test considering 5 lags for wild European seabass and gilthead seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 5				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.093216	71.69660	19.96	24.60	None **
0.055724	26.48943	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 2 and 5 lags, shows 2 cointegration equations between wild European seabass and gilthead seabream in the Barcelona wholesale market. Therefore, wild European seabass and gilthead seabream price series in the Barcelona wholesale market are stationary and regression methodology needs to be applied.

Table 76. Regression considering 2 lags for wild European seabass and gilthead seabream in the Barcelona wholesale market

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	0.661187	0.122373	5.403066	0.0000
BASS_WILD	0.210854	0.041871	5.035804	0.0000
BASS_WILD(-1)	-0.007946	0.052622	-0.150991	0.8801
BASS_WILD(-2)	-0.097220	0.052488	-1.852233	0.0646
BASS_WILD(-3)	-0.040992	0.052341	-0.783183	0.4339
BASS_WILD(-4)	-0.026778	0.052202	-0.512970	0.6082
BASS_WILD(-5)	-0.006137	0.042484	-0.144447	0.8852
BREAM_WILD(-1)	0.744751	0.047434	15.70091	0.0000
BREAM_WILD(-2)	0.003214	0.058916	0.054545	0.9565
BREAM_WILD(-3)	0.012069	0.058733	0.205479	0.8373
BREAM_WILD(-4)	-0.073853	0.058370	-1.265249	0.2064
BREAM_WILD(-5)	0.052344	0.046521	1.125162	0.2611
R-squared	0.614729	Mean dependent var		2.892563
Adjusted R-squared	0.605332	S.D. dependent var		0.272118
S.E. of regression	0.170952	Akaike info criterion		-0.669294
Sum squared resid	13.18026	Schwarz criterion		-0.562053
Log likelihood	166.9416	F-statistic		65.41869
Durbin-Watson stat	1.991841	Prob(F-statistic)		0.000000

Table 77. Regression considering 2 lags for wild gilthead seabream and European seabass in the Barcelona wholesale market

Dependent Variable: BASS_WILD				
Method: Least Squares				
Sample(adjusted): 6 468				
Included observations: 463 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.183203	0.137904	1.328483	0.1847
BREAM_WILD	0.252477	0.050136	5.035804	0.0000
BREAM_WILD(-1)	-0.065628	0.064476	-1.017864	0.3093
BREAM_WILD(-2)	-0.095083	0.064314	-1.478420	0.1400
BREAM_WILD(-3)	-0.003310	0.064272	-0.051499	0.9590
BREAM_WILD(-4)	-0.116742	0.063749	-1.831274	0.0677
BREAM_WILD(-5)	0.142377	0.050535	2.817402	0.0051
BASS_WILD(-1)	0.700791	0.047191	14.85018	0.0000
BASS_WILD(-2)	-0.099423	0.057463	-1.730211	0.0843
BASS_WILD(-3)	0.158181	0.056827	2.783552	0.0056
BASS_WILD(-4)	0.117295	0.056871	2.062467	0.0397
BASS_WILD(-5)	-0.048336	0.046434	-1.040962	0.2985
R-squared	0.670908	Mean dependent var		2.983489
Adjusted R-squared	0.662881	S.D. dependent var		0.322183
S.E. of regression	0.187065	Akaike info criterion		-0.489141
Sum squared resid	15.78205	Schwarz criterion		-0.381900
Log likelihood	125.2361	F-statistic		83.58521
Durbin-Watson stat	2.036984	Prob(F-statistic)		0.000000

Table 78. Regression considering 5 lags for wild European seabass and gilthead seabream in the Barcelona wholesale market

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	0.406368	0.123040	3.302730	0.0010
BREAM_WILD	0.238884	0.051612	4.628434	0.0000
BREAM_WILD(-1)	-0.103433	0.065763	-1.572817	0.1164
BREAM_WILD(-2)	-0.059776	0.052071	-1.147971	0.2516
BASS_WILD(-1)	0.737717	0.047016	15.69089	0.0000
BASS_WILD(-2)	0.052467	0.046973	1.116949	0.2646
R-squared	0.647461	Mean dependent var		2.978836
Adjusted R-squared	0.643629	S.D. dependent var		0.326372
S.E. of regression	0.194834	Akaike info criterion		-0.420549
Sum squared resid	17.46168	Schwarz criterion		-0.367190
Log likelihood	103.9878	F-statistic		168.9639
Durbin-Watson stat	2.003582	Prob(F-statistic)		0.000000

Table 79. Regression considering 5 lags for wild gilthead seabream and European seabass in the Barcelona wholesale market

Dependent Variable: BREAM_WILD				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.652634	0.105635	6.178186	0.0000
BASS_WILD	0.186275	0.040246	4.628434	0.0000
BASS_WILD(-1)	-0.010366	0.051439	-0.201529	0.8404
BASS_WILD(-2)	-0.134391	0.041060	-3.273028	0.0011
BREAM_WILD(-1)	0.761516	0.046150	16.50103	0.0000
BREAM_WILD(-2)	-0.029507	0.046027	-0.641095	0.5218
R-squared	0.602213	Mean dependent var		2.892592
Adjusted R-squared	0.597889	S.D. dependent var		0.271315
S.E. of regression	0.172047	Akaike info criterion		-0.669305
Sum squared resid	13.61609	Schwarz criterion		-0.615947
Log likelihood	161.9482	F-statistic		139.2793
Durbin-Watson stat	1.987822	Prob(F-statistic)		0.000000

The results from the regression methodology show that considering 2 and 5 lags, there is market integration between wild European seabass and gilthead seabream in the Barcelona wholesale market.

9.3.3. Farmed European seabass and gilthead seabream (Madrid wholesale market)

Table 80. Lag interval selection for farmed European seabass and gilthead 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**
Lags interval: No lags	0	2057.000	-6.614148	-6.614148
	1	2073.283	-6.650427	**-6.614792**
	2	2080.895	-6.658828	-6.587558
Lags interval: 1 to 1	0	2058.206	-6.615800	-6.587257
	1	2072.227	-6.644855	-6.580632
	2	2079.700	-6.652819	-6.552917
Lags interval: 1 to 2	0	2064.395	-6.633533	-6.576375
	1	2075.980	-6.654773	-6.561892
	2	2082.605	-6.660016	-6.531412
Lags interval: 1 to 3	0	2066.245	-6.637302	-6.551458
	1	2075.684	-6.651644	-6.530032
	2	**2083.363**	**-6.660299**	-6.502919
Lags interval: 1 to 4	0	2063.706	-6.626880	-6.512279
	1	2073.900	-6.643689	-6.493274
	2	2082.663	-6.655866	-6.469639

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 3, while under the Schwarz Information Criteria the optimal lags are 0. So, cointegration tests are run for 0 and 3 lags.

Table 81. Cointegration test considering 0 lags for farmed European seabass and gilthead seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.051009	47.79052	19.96	24.60	None **
0.024181	15.22528	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 82. Cointegration test considering 3 lags for farmed European seabass and gilthead seabream in the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.030037	34.23513	19.96	24.60	None **
0.024505	15.35731	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 0 and 3 lags, shows 2 cointegration equations between farmed European seabass and gilthead seabream in the Madrid wholesale market. Therefore, farmed European seabass and gilthead seabream price series in the Madrid wholesale market are stationary and regression methodology needs to be applied.

Table 83. Regression considering 0 lags for farmed European seabass and gilthead seabream in the Madrid wholesale market

Dependent Variable: BASS_FARMED				
Method: Least Squares				
Sample: 1 623				
Included observations: 623				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.072304	0.043645	24.56867	0.0000
BREAM_FARMED	0.434862	0.026758	16.25137	0.0000
R-squared	0.298390	Mean dependent var		1.777913
Adjusted R-squared	0.297260	S.D. dependent var		0.132307
S.E. of regression	0.110913	Akaike info criterion		-1.556945
Sum squared resid	7.639283	Schwarz criterion		-1.542709
Log likelihood	486.9884	F-statistic		264.1071
Durbin-Watson stat	0.181868	Prob(F-statistic)		0.000000

Table 84. Regression considering 0 lags for farmed gilthead seabream and European seabass in the Madrid wholesale market

Dependent Variable: BREAM_FARMED				
Method: Least Squares				
Sample: 1 623				
Included observations: 623				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.402650	0.075275	5.349057	0.0000
BASS_FARMED	0.686172	0.042222	16.25137	0.0000
R-squared	0.298390	Mean dependent var		1.622604
Adjusted R-squared	0.297260	S.D. dependent var		0.166197
S.E. of regression	0.139323	Akaike info criterion		-1.100845
Sum squared resid	12.05409	Schwarz criterion		-1.086609
Log likelihood	344.9133	F-statistic		264.1071
Durbin-Watson stat	0.102779	Prob(F-statistic)		0.000000

Table 85. Regression considering 3 lags for farmed European seabass and gilthead seabream in the Madrid wholesale market

Dependent Variable: BASS_FARMED				
Method: Least Squares				
Sample(adjusted): 4 623				
Included observations: 620 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.056167	0.026635	2.108794	0.0354
BREAM_FARMED	0.465834	0.041258	11.29063	0.0000
BREAM_FARMED(-1)	-0.441542	0.059954	-7.364636	0.0000
BREAM_FARMED(-2)	0.073376	0.062357	1.176718	0.2398
BREAM_FARMED(-3)	-0.048693	0.045295	-1.075018	0.2828
BASS_FARMED(-1)	0.838918	0.040141	20.89930	0.0000
BASS_FARMED(-2)	-0.021800	0.052536	-0.414961	0.6783
BASS_FARMED(-3)	0.106672	0.040157	2.656409	0.0081
R-squared	0.880740	Mean dependent var		1.778721
Adjusted R-squared	0.879376	S.D. dependent var		0.132100
S.E. of regression	0.045880	Akaike info criterion		-3.312767
Sum squared resid	1.288230	Schwarz criterion		-3.255609
Log likelihood	1034.958	F-statistic		645.6611
Durbin-Watson stat	2.002727	Prob(F-statistic)		0.000000

Table 86. Regression considering 3 lags for farmed gilthead seabream and European seabass in the Madrid wholesale market

Dependent Variable: BREAM_FARMED				
Method: Least Squares				
Sample(adjusted): 4 623				
Included observations: 620 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.060458	0.023700	2.550998	0.0110
BASS_FARMED	0.370066	0.032776	11.29063	0.0000
BASS_FARMED(-1)	-0.358396	0.044539	-8.046792	0.0000
BASS_FARMED(-2)	0.047509	0.046792	1.015308	0.3104
BASS_FARMED(-3)	-0.059550	0.035917	-1.658013	0.0978
BREAM_FARMED(-1)	0.956660	0.040165	23.81846	0.0000
BREAM_FARMED(-2)	-0.044643	0.055612	-0.802756	0.4224
BREAM_FARMED(-3)	0.051436	0.040356	1.274553	0.2030
R-squared	0.939367	Mean dependent var		1.624124
Adjusted R-squared	0.938674	S.D. dependent var		0.165129
S.E. of regression	0.040893	Akaike info criterion		-3.542914
Sum squared resid	1.023391	Schwarz criterion		-3.485756
Log likelihood	1106.303	F-statistic		1354.513
Durbin-Watson stat	1.989262	Prob(F-statistic)		0.000000

The results from the regression methodology show that considering 0 and 3 lags, there is market integration between farmed European seabass and gilthead seabream in the Madrid wholesale market.

9.3.4. Farmed European seabass and gilthead seabream (Barcelona wholesale market)

Table 87. Lag interval selection for farmed European seabass and gilthead 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
Lags interval: No lags	0	1610.760	-6.898330	-6.898330
	1	1624.562	-6.936026	-6.891633
	2	1629.773	-6.936930	-6.848143
Lags interval: 1 to 1	0	1631.436	-6.984703	-6.949130
	1	1642.590	-7.011118	-6.931080
	2	1646.648	-7.007073	-6.882569
Lags interval: 1 to 2	0	1643.594	-7.034815	**-6.963554**
	1	1651.438	-7.047046	-6.931247
	2	1655.336	-7.042305	-6.881968
Lags interval: 1 to 3	0	1643.838	-7.033785	-6.926719
	1	1650.730	-7.041939	-6.890262
	2	1654.857	-7.038176	-6.841888
Lags interval: 1 to 4	0	1648.476	-7.051730	-6.908742
	1	1656.102	**-7.063077**	-6.875405
	2	**1660.324**	-7.059715	-6.827358
Lags interval: 1 to 4	0	1646.537	-7.041286	-6.862258
	1	1655.013	-7.056333	-6.832547
	2	1659.397	-7.053665	-6.785122

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 4, while under the Schwarz Information Criteria the optimal lags are 2. So, cointegration tests are run for 2 and 4 lags.

Table 88. Cointegration test considering 2 lags for farmed European seabass and gilthead seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.033174	23.48324	19.96	24.60	None *
0.016625	7.795527	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 89. Cointegration test considering 4 lags for farmed European seabass and gilthead seabream in the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 4				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.032409	23.69685	19.96	24.60	None *
0.018070	8.443070	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 2 and 4 lags, shows 1 cointegration equations between farmed European seabass and gilthead seabream in the Barcelona wholesale market. So the stationary behavior of the series is analysed.

Table 90. Unit root test considering intercept and 2 and 4 lags for farmed European seabass and gilthead seabream in the Barcelona wholesale market

Series	Lags	ADF Test Statistic	Critical Values		
Farmed European seabass	2	-3.346856	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed European seabass	4	-3.435541	1%: -3.4467	5%: -2.8681	10%: -2.5702
Farmed gilthead seabream	2	-2.504890	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed gilthead seabream	4	-2.981604	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test statistic considering 2 lags for farmed gilthead seabream in the Barcelona wholesale market is higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the wild gilthead seabream price series behaves as a non-stationary series when considering 2 lags, but stationary when considering 4 lags. While farmed European seabass in Mercabarna price series behaves as stationary for all lags analysed.

Thus, there is a contradiction between the ADF test and the cointegration test results when considering 4 lags, because according to the ADF test there should be 0 cointegration equations since both series are stationary. This could be in part explained because the ADF Test statistic value is close to the critical value. This makes us believe that according to the cointegration test results farmed gilthead seabream in the Barcelona wholesale market series behaves as non-stationary while farmed European seabass in Mercabarna behaves as stationary. Consequently, there is no market integration between farmed European seabass and gilthead seabream in the Barcelona wholesale market.

9.3.5. Farmed European seabass and gilthead seabream (Paris wholesale markets)

Table 91. Lag interval selection for farmed European seabass and gilthead seabream in the Paris wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	1231.946	-8.409189	**-8.409189**
	1	1240.043	-8.430327	-8.367525
	2	1241.750	-8.407846	-8.282243
Lags interval: 1 to 1	0	1232.218	-8.412449	-8.362083
	1	1240.427	-8.434432	-8.321107
	2	1242.918	-8.417244	-8.240961
Lags interval: 1 to 2	0	1236.708	-8.444726	-8.343741
	1	1244.488	-8.463838	-8.299737
	2	1246.464	-8.443053	-8.215837
Lags interval: 1 to 3	0	1252.124	-8.552578	-8.400721
	1	1258.775	-8.563963	-8.348832
	2	1260.205	-8.539346	-8.260942
Lags interval: 1 to 4	0	1260.051	-8.609346	-8.406361
	1	1265.853	**-8.614900**	-8.348482
	2	**1266.761**	-8.586582	-8.256731
Lags interval: 1 to 5	0	1256.024	-8.583502	-8.329130
	1	1261.221	-8.584872	-8.266906
	2	1261.989	-8.555479	-8.173920

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 4 lags, while under the Schwarz Information Criteria the optimal lags are 0. So, cointegration tests are run for 0 and 4 lags.

Table 92. Cointegration test considering 0 lags for farmed European seabass and gilthead seabream in the Paris wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.053768	19.60671	19.96	24.60	None
0.011582	3.413294	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 93. Cointegration test considering 4 lags for farmed European seabass and gilthead seabream in the Paris wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 4				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.039361	13.42126	19.96	24.60	None
0.006265	1.816143	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Cointegration tests, considering 0 and 4 lags, show 0 cointegration equations between farmed European seabass and gilthead seabream in the the Paris wholesale market. Therefore, there is no market integration between farmed European seabass and gilthead seabream in the Paris wholesale market.

9.3.6. Farmed European seabass and gilthead seabream (Italian retail market)

Table 94. Lag interval selection for farmed European seabass and gilthead seabream in the Italian retail market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	375.0385	-6.049008	-6.049008
	1	418.8116	-6.674380	-6.560659
	2	435.5466	-6.863654	-6.636212
Lags interval: 1 to 1	0	437.9626	-7.056303	-6.964850
	1	452.2454	-7.207242	-7.001472
	2	457.8651	-7.217318	-6.897232
Lags interval: 1 to 2	0	435.2570	-7.004212	-6.820342
	1	449.3723	-7.153645	-6.854856
	2	454.8716	-7.161830	-6.748122
Lags interval: 1 to 3	0	452.7021	-7.284332	**-7.007063**
	1	458.9123	**-7.304336**	-6.911539
	2	**462.1581**	-7.275341	-6.767016
Lags interval: 1 to 4	0	451.9965	-7.266608	-6.894942
	1	457.6741	-7.277902	-6.790091
	2	459.8253	-7.230422	-6.626466

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

Table 95. Cointegration test considering 3 lags for farmed European seabass and gilthead seabream in the Italian retail market

Test assumption: No deterministic trend in the data				
Series: ITBASSF ITBREAMF				
Lags interval: 1 to 3				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.097556	18.91216	19.96	24.60	None
0.052236	6.491629	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 3 lags, shows 0 cointegration equations between farmed European seabass and gilthead seabream in the Italian retail market. Therefore, there is no market integration between between farmed European seabass and gilthead seabream in the Italian retail market.

9.3.7. Farmed European seabass and gilthead seabream (Portugal retail market)

Table 96. Lag interval selection for farmed European seabass and gilthead seabream in the Portuguese retail market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	133.0615	-4.032166	-4.032166
	1	149.9292	-4.391793	-4.225910
	2	156.0810	-4.426698	-4.094932
Lags interval: 1 to 1	0	147.6430	-4.419785	**-4.285977**
	1	154.8802	**-4.488620**	-4.187551
	2	158.7756	-4.454635	-3.986305
Lags interval: 1 to 2	0	149.0370	-4.407405	-4.137545
	1	156.2160	-4.475501	-4.036978
	2	**158.9809**	-4.405653	-3.798467
Lags interval: 1 to 3	0	147.3278	-4.296122	-3.887906
	1	154.7381	-4.372639	-3.794332
	2	157.2790	-4.294571	-3.546175
Lags interval: 1 to 4	0	150.1041	-4.325938	-3.777000
	1	154.4232	-4.303973	-3.583492
	2	157.5661	-4.244069	-3.352045

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

Table 97. Cointegration test considering 1 lags for farmed European seabass and gilthead seabream in the Portuguese retail market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.199630	22.26522	19.96	24.60	None *
0.112956	7.790936	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 98. Cointegration test considering 2 lags for farmed European seabass and gilthead seabream in the Portuguese retail market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.200961	19.88782	19.96	24.60	None
0.082774	5.529688	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 1 and 2 lags, shows 1 and 0 cointegration equations respectively between farmed European seabass and gilthead seabream in the Portuguese retail market. So, when 2 lags are considered, there is no cointegration between the two species, but when 1 lag is considered the stationarity behavior of the series needs to be analysed.

Table 99. Unit root test considering intercept and 1 and 2 lags for farmed European seabass and gilthead seabream in the Portuguese retail market

Series	Lags	ADF Test Statistic	Critical Values		
farmed European seabass	1	-3.054414	1%: -3.5328	5%: -2.9062	10%: -2.5903
farmed gilthead seabream	1	-2.952411	1%: -3.5328	5%: -2.9062	10%: -2.5903

The ADF Test statistics for farmed gilthead seabream in the Portuguese retail market are lower than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the farmed European seabass and farmed gilthead seabream price series behave as stationary series, and consequently regressions methodology should be used.

Here, there is a contradiction between the ADF test and the cointegration test results. According to the ADF test there should be 0 cointegration equations when considering 1 lag since both series are stationary. However, cointegration tests show the presence of 1 cointegration equation when considering 1 lag. This could be in part explained because of the low number of observations, and because the ADF Test statistic values is close to the critical value.

In any case, regression methodology is also applied.

Table 100. Regression considering 1 lag for farmed European seabass and gilthead seabream in Portugal

Dependent Variable: Bass_Farmed				
Method: Least Squares				
Sample(adjusted): 2 67				
Included observations: 66 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.545306	0.212811	2.562391	0.0128
Bass_Farmed(-1)	0.335453	0.114746	2.923436	0.0048
Bream_Farmed	0.288252	0.111216	2.591829	0.0119
Bream_Farmed(-1)	0.102121	0.116400	0.877327	0.3837
R-squared	0.400825	Mean dependent var		1.906667
Adjusted R-squared	0.371833	S.D. dependent var		0.090356
S.E. of regression	0.071614	Akaike info criterion		-2.376369
Sum squared resid	0.317968	Schwarz criterion		-2.243663
Log likelihood	82.42019	F-statistic		13.82521
Durbin-Watson stat	1.957446	Prob(F-statistic)		0.000001

Table 101. Regression considering 1 lag for farmed gilthead seabream and European seabass in Portugal

Dependent Variable: Bream_Farmed				
Method: Least Squares				
Sample(adjusted): 2 67				
Included observations: 66 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.347928	0.238691	1.457650	0.1500
Bream_Farmed(-1)	0.433387	0.114495	3.785210	0.0003
Bass_Farmed	0.339135	0.130848	2.591829	0.0119
Bass_Farmed(-1)	0.028146	0.132716	0.212077	0.8327
R-squared	0.431843	Mean dependent var		1.847844
Adjusted R-squared	0.404351	S.D. dependent var		0.100647
S.E. of regression	0.077678	Akaike info criterion		-2.213805
Sum squared resid	0.374097	Schwarz criterion		-2.081099
Log likelihood	77.05556	F-statistic		15.70824
Durbin-Watson stat	2.295930	Prob(F-statistic)		0.000000

The results from the regression tests show that farmed gilthead seabream and European seabass in Portugal are not integrated.

9.4. Geographical integration

In this section, we report the analysis done to investigate the geographical component of the market integration of different wild and farmed species.

9.4.1. Wild European seabass (Madrid and Barcelona wholesale markets)

Table 102. Lag interval selection for wild European seabass in the Madrid and Barcelona wholesale markets

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	383.2329	-1.641254	-1.641254
	1	442.8674	-1.875235	-1.830842
	2	457.3761	-1.915958	-1.827171
Lags interval: 1 to 1	0	406.2093	-1.72622	-1.690648
	1	450.4349	-1.894571	-1.814533
	2	471.0896	-1.961758	-1.837254
Lags interval: 1 to 2	0	442.9865	-1.87091	-1.799649
	1	471.4785	-1.97195	-1.856151
	2	487.6026	-2.019796	**-1.859459**
Lags interval: 1 to 3	0	452.0389	-1.896719	-1.789653
	1	477.6854	-1.985713	-1.834036
	2	**492.5375**	**-2.028179**	-1.831891
Lags interval: 1 to 4	0	455.6157	-1.898988	-1.755999
	1	478.1127	-1.974569	-1.786897
	2	491.3834	-2.010295	-1.777939

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

Table 103. Cointegration test considering 2 lags for wild European seabass in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.115335	89.23211	19.96	24.60	None **
0.067001	32.24829	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 104. Cointegration test considering 3 lags for wild European seabass in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
Eigenvalue	Likelihood Ratio	5 percent Critical Value	1 percent Critical Value	Hypothesized No. of CEs
0.104654	80.99720	19.96	24.60	None **
0.062011	29.70414	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 2 and 3 lags, shows 2 cointegration equations between wild European seabass in the Madrid and Barcelona wholesale markets. So, wild European seabass prices in the Madrid and Barcelona wholesale markets behave as stationary and consequently regression methodology should be applied.

Table 105. Regression considering 2 lags for wild European seabass in the Barcelona and Madrid wholesale markets

Dependent Variable: BASS_BARCELONA				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.497452	0.107938	4.608676	0.0000
BASS_MADRID	0.423779	0.079819	5.309247	0.0000
BASS_MADRID(-1)	-0.184529	0.113003	-1.632957	0.1032
BASS_MADRID(-2)	-0.110911	0.076752	-1.445063	0.1491
BASS_BARCELONA(-1)	0.683473	0.048112	14.20590	0.0000
BASS_BARCELONA(-2)	0.019459	0.048836	0.398458	0.6905
R-squared	0.656853	Mean dependent var		2.978836
Adjusted R-squared	0.653123	S.D. dependent var		0.326372
S.E. of regression	0.192221	Akaike info criterion		-0.447551
Sum squared resid	16.99649	Schwarz criterion		-0.394192
Log likelihood	110.2794	F-statistic		176.1065
Durbin-Watson stat	2.000358	Prob(F-statistic)		0.000000

Table 106. Regression considering 2 lags for wild European seabass in the Madrid and Barcelona wholesale markets

Dependent Variable: BASS_MADRID				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.193794	0.061945	3.128484	0.0019
BASS_BARCELONA	0.136251	0.025663	5.309247	0.0000
BASS_BARCELONA(-1)	0.054568	0.032623	1.672704	0.0951
BASS_BARCELONA(-2)	-0.024781	0.027672	-0.895537	0.3710
BASS_MADRID(-1)	0.964867	0.045887	21.02714	0.0000
BASS_MADRID(-2)	-0.192558	0.042685	-4.511192	0.0000
R-squared	0.843188	Mean dependent var		3.023710
Adjusted R-squared	0.841483	S.D. dependent var		0.273756
S.E. of regression	0.108994	Akaike info criterion		-1.582265
Sum squared resid	5.464609	Schwarz criterion		-1.528906
Log likelihood	374.6677	F-statistic		494.6892
Durbin-Watson stat	1.979994	Prob(F-statistic)		0.000000

Table 107. Regression considering 3 lags for wild European seabass in the Barcelona and Madrid wholesale markets

Dependent Variable: BASS_BARCELONA				
Method: Least Squares				
Sample(adjusted): 4 468				
Included observations: 465 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.464722	0.108693	4.275534	0.0000
BASS_MADRID	0.412980	0.077588	5.322764	0.0000
BASS_MADRID(-1)	-0.132195	0.111896	-1.181411	0.2381
BASS_MADRID(-2)	-0.244621	0.112078	-2.182600	0.0296
BASS_MADRID(-3)	0.023116	0.074741	0.309282	0.7572
BASS_BARCELONA(-1)	0.678041	0.046771	14.49695	0.0000
BASS_BARCELONA(-2)	-0.133578	0.055894	-2.389824	0.0173
BASS_BARCELONA(-3)	0.239951	0.047299	5.073082	0.0000
R-squared	0.676048	Mean dependent var		2.980612
Adjusted R-squared	0.671086	S.D. dependent var		0.324461
S.E. of regression	0.186082	Akaike info criterion		-0.508206
Sum squared resid	15.82428	Schwarz criterion		-0.436945
Log likelihood	126.1580	F-statistic		136.2432
Durbin-Watson stat	2.054729	Prob(F-statistic)		0.000000

Table 108. Regression considering 3 lags for wild European seabass in the Madrid and Barcelona wholesale markets

Dependent Variable: BASS_MADRID				
Method: Least Squares				
Sample(adjusted): 4 468				
Included observations: 465 after adjusting endpoints				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.171075	0.064354	2.658337	0.0081
BASS_BARCELONA	0.141354	0.026556	5.322764	0.0000
BASS_BARCELONA(-1)	0.052824	0.032969	1.602221	0.1098
BASS_BARCELONA(-2)	0.001608	0.032904	0.048866	0.9610
BASS_BARCELONA(-3)	-0.043330	0.028368	-1.527429	0.1273
BASS_MADRID(-1)	0.973081	0.047188	20.62143	0.0000
BASS_MADRID(-2)	-0.241020	0.064940	-3.711427	0.0002
BASS_MADRID(-3)	0.061163	0.043638	1.401608	0.1617
R-squared	0.844446	Mean dependent var		3.024075
Adjusted R-squared	0.842063	S.D. dependent var		0.273937
S.E. of regression	0.108866	Akaike info criterion		-1.580341
Sum squared resid	5.416286	Schwarz criterion		-1.509081
Log likelihood	375.4294	F-statistic		354.4122
Durbin-Watson stat	1.995670	Prob(F-statistic)		0.000000

The results from the regressions tests show that wild European seabass in the Madrid and Barcelona wholesale markets are related, and consequently there is market integration.

9.4.2. Farmed European seabass (Madrid and Barcelona wholesale markets)

Table 109. Lag interval selection for farmed European seabass in the Madrid and Barcelona wholesale markets

Lags	**Rank or No. of Ces**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	1564.192	-6.698893	-6.698893
	1	1583.911	-6.761933	-6.717540
	2	1590.382	-6.768233	-6.679446
Lags interval: 1 to 1	0	1576.455	-6.748734	-6.713162
	1	1593.942	-6.802327	-6.722289
	2	1600.537	-6.809173	-6.684670
Lags interval: 1 to 2	0	1589.722	-6.803105	**-6.731844**
	1	1601.569	-6.832553	-6.716754
	2	**1607.204**	**-6.835285**	-6.674948
Lags interval: 1 to 3	0	1587.261	-6.789919	-6.682853
	1	1598.092	-6.815050	-6.663373
	2	1603.663	-6.817512	-6.621224
Lags interval: 1 to 4	0	1584.820	-6.776759	-6.633771
	1	1596.511	-6.805664	-6.617992
	2	1602.842	-6.811414	-6.579058

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

Table 110. Cointegration test considering no lags for farmed European seabass in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.049677	34.96351	19.96	24.60	None **
0.023946	11.27018	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 2 lags, shows 2 cointegration equations between farmed seabass in the Madrid and Barcelona wholesale markets. So, farmed European seabass prices in the Madrid and Barcelona wholesale markets behave as stationary and consequently regression methodology should be applied.

Table 111. Regression considering 2 lags for farmed European seabass in the Barcelona and Madrid wholesale markets

Dependent Variable: BASS_BARCELONA				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.096868	0.035549	2.724952	0.0067
BASS_MADRID	0.081181	0.051874	1.564959	0.1183
BASS_MADRID(-1)	-0.078390	0.074278	-1.055350	0.2918
BASS_MADRID(-2)	0.034525	0.051426	0.671358	0.5023
BASS_BARCELONA(-1)	0.717713	0.045981	15.60876	0.0000
BASS_BARCELONA(-2)	0.187920	0.046021	4.083338	0.0001
R-squared	0.855296	Mean dependent var		1.736433
Adjusted R-squared	0.853723	S.D. dependent var		0.120596
S.E. of regression	0.046123	Akaike info criterion		-3.302205
Sum squared resid	0.978586	Schwarz criterion		-3.248846
Log likelihood	775.4137	F-statistic		543.7810
Durbin-Watson stat	2.040024	Prob(F-statistic)		0.000000

Table 112. Regression considering 2 lags for farmed European seabass in the Madrid and Barcelona wholesale markets

Dependent Variable: BASS_MADRID				
Method: Least Squares				
Sample(adjusted): 3 468				
Included observations: 466 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.070784	0.031953	2.215245	0.0272
BASS_BARCELONA	0.065236	0.041686	1.564959	0.1183
BASS_BARCELONA(-1)	0.033443	0.050956	0.656322	0.5119
BASS_BARCELONA(-2)	-0.026518	0.041978	-0.631715	0.5279
BASS_MADRID(-1)	1.032020	0.046141	22.36648	0.0000
BASS_MADRID(-2)	-0.140097	0.045658	-3.068408	0.0023
R-squared	0.889590	Mean dependent var		1.812092
Adjusted R-squared	0.888390	S.D. dependent var		0.123762
S.E. of regression	0.041347	Akaike info criterion		-3.520862
Sum squared resid	0.786388	Schwarz criterion		-3.467504
Log likelihood	826.3610	F-statistic		741.2600
Durbin-Watson stat	1.987008	Prob(F-statistic)		0.000000

The results from the regressions tests show that farmed European seabass in the Madrid and Barcelona wholesale markets are not related, and consequently there is no market integration.

9.4.3. Farmed European seabass (Madrid and Paris wholesale markets)

Table 113. Lag interval selection for farmed European seabass in the Madrid and Paris wholesale markets

Lags	**Rank or No. of Ces**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	1177.185	-7.719245	-7.719245
	1	1183.558	-7.728248	-7.667259
	2	**1188.516**	-7.727976	-7.605999
Lags interval: 1 to 1	0	1173.837	-7.773000	-7.723736
	1	1182.205	-7.795382	-7.684538
	2	1186.442	-7.790311	-7.617887
Lags interval: 1 to 2	0	1177.288	-7.873992	**-7.774497**
	1	1183.925	**-7.885020**	-7.723341
	2	1186.531	-7.868898	-7.645035
Lags interval: 1 to 3	0	1159.772	-7.834623	-7.683900
	1	1165.912	-7.842406	-7.628881
	2	1168.003	-7.822546	-7.546219
Lags interval: 1 to 4	0	1143.739	-7.804422	-7.601436
	1	1151.790	-7.825536	-7.559118
	2	1153.536	-7.803020	-7.473169

From the lag selection table, we can see that under the Log Likelihood the optimal lags are 0, while under the Akaike and Schwarz Information Criteria the optimal lags are 2. So, cointegration tests are run for 0 and 2 lags.

Table 114. Cointegration test considering no lags for farmed European seabass in the Madrid and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.040929	22.66321	19.96	24.60	None *
0.031993	9.917270	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 115. Cointegration test considering 2 lags for farmed European seabass in the Madrid and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.043714	18.48710	19.96	24.60	None
0.017395	5.211805	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 0 and 2 lags, shows 2 and 0 cointegration equations respectively between farmed European seabass in the Madrid and Paris wholesale markets. So, when considering 2 lags, farmed European seabass in Madrid and Paris wholesale markets are not cointegrated. Regression methodology is needed to investigate the relationship between both price series when considering 0 lags.

Table 116. Regression considering 0 lags for farmed European seabass in the Madrid and Paris wholesale markets

Dependent Variable: BASS_MAD				
Method: Least Squares				
Date: 09/14/17 Time: 10:55				
Sample: 1 312				
Included observations: 309				
Excluded observations: 3				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.274403	0.111326	20.43006	0.0000
BASS_FRA	-0.220282	0.057083	-3.858960	0.0001
R-squared	0.046263	Mean dependent var		1.845377
Adjusted R-squared	0.043156	S.D. dependent var		0.103755
S.E. of regression	0.101492	Akaike info criterion		-1.731228
Sum squared resid	3.162274	Schwarz criterion		-1.707064
Log likelihood	269.4747	F-statistic		14.89157
Durbin-Watson stat	0.173312	Prob(F-statistic)		0.000139

Table 117. Regression considering 0 lags for farmed European seabass in the Paris and Madrid wholesale markets

Dependent Variable: BASS_FRA				
Method: Least Squares				
Sample: 1 312				
Included observations: 309				
Excluded observations: 3				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.335180	0.100589	23.21507	0.0000
BASS_MAD	-0.210016	0.054423	-3.858960	0.0001
R-squared	0.046263	Mean dependent var		1.947621
Adjusted R-squared	0.043156	S.D. dependent var		0.101309
S.E. of regression	0.099099	Akaike info criterion		-1.778952
Sum squared resid	3.014902	Schwarz criterion		-1.754788
Log likelihood	276.8481	F-statistic		14.89157
Durbin-Watson stat	0.103077	Prob(F-statistic)		0.000139

The results from the regression tests show that farmed European seabass in the Paris and Madrid wholesale markets are related when considering 0 lags; however, the explanatory potential (R-squared) is very low, so the relation seems very weak.

Consequently, the existence of market integration between farmed European seabass from the Madrid and Paris wholesale markets is uncertain as we obtain different results when considering different lags.

9.4.4. Farmed European seabass (Barcelona and Paris wholesale markets)

Table 118. Lag interval selection for farmed European seabass in the Barcelona and Paris wholesale markets

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	1204.986	-7.901546	-7.901546
	1	1216.377	-7.943457	-7.882469
	2	**1220.024**	-7.934582	-7.812604
Lags interval: 1 to 1	0	1201.884	-7.959359	-7.910095
	1	1211.515	-7.990134	-7.879291
	2	1214.684	-7.977964	-7.805540
Lags interval: 1 to 2	0	1203.474	**-8.050333**	**-7.950838**
	1	1208.181	-8.048357	-7.886678
	2	1210.967	-8.033446	-7.809583
Lags interval: 1 to 3	0	1185.134	-8.007738	-7.857014
	1	1189.977	-8.006669	-7.793143
	2	1192.632	-7.990666	-7.714339
Lags interval: 1 to 4	0	1169.092	-7.979872	-7.776887
	1	1172.734	-7.970479	-7.704061
	2	1175.198	-7.952926	-7.623075

From the lag selection table, we can see that under the Log Likelihood, the optimal number of lags is 0, while under the Akaike and Schwarz Information Criteria the optimal lags are 2. So, cointegration tests are run for 0 and 2 lags.

Table 119. Cointegration test considering no lags for farmed European seabass in the Barcelona and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.071977	30.07603	19.96	24.60	None **
0.023628	7.292933	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 120. Cointegration test considering 2 lags for farmed European seabass in the Barcelona and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.031197	14.98455	19.96	24.60	None
0.018584	5.571356	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 0 and 2 lags, shows 1 and 0 cointegration equations respectively between farmed European seabass in Barcelona and Paris wholesale markets. So, when considering 2 lags, farmed European seabass in Barcelona and Paris wholesale markets are not cointegrated, and so there is no market integration. The stationary behavior of the series for no lags is analysed.

Table 121. Unit root test considering intercept and no lags for farmed European seabass in the Barcelona and Paris wholesale markets

Series	Lags	ADF Test Statistic	Critical Values		
Bass at Barcelona	0	-2.894261	1%: -3.4532	5%: -2.8710	10%: -2.5718
Bass at Paris	0	-2.960999	1%: -3.4536	5%: -2.8712	10%: -2.5719

The ADF Test statistics for farmed European seabass in the Barcelona and Paris wholesale markets considering no lags are lower than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, both price series behave as a stationary series when considering no lags.

There is a contradiction between the ADF test and the cointegration test results when considering no lags, because according to the ADF test there should be 0 cointegration equations since both series are stationary. This could be in part explained because the ADF Test statistic value is close to the critical value.

Table 122. Regression considering no lags for farmed European seabass in the Barcelona and Paris wholesale markets

Dependent Variable: Bass at Barcelona				
Method: Least Squares				
Sample: 1 312				
Included observations: 309				
Excluded observations: 3				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.772808	0.111083	24.96169	0.0000
Bass at Paris	-0.521618	0.056958	-9.157914	0.0000
R-squared	0.214567	Mean dependent var		1.756892
Adjusted R-squared	0.212009	S.D. dependent var		0.114082
S.E. of regression	0.101269	Akaike info criterion		-1.735612
Sum squared resid	3.148440	Schwarz criterion		-1.711448
Log likelihood	270.1521	F-statistic		83.86739
Durbin-Watson stat	0.159656	Prob(F-statistic)		0.000000

Table 123. Regression considering no lag for farmed European seabass in the Paris and Barcelona wholesale markets

Dependent Variable: Bass at Paris				
Method: Least Squares				
Sample: 1 312				
Included observations: 309				
Excluded observations: 3				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2.670318	0.079081	33.76703	0.0000
Bass at Barcelona	-0.411349	0.044917	-9.157914	0.0000
R-squared	0.214567	Mean dependent var		1.947621
Adjusted R-squared	0.212009	S.D. dependent var		0.101309
S.E. of regression	0.089931	Akaike info criterion		-1.973106
Sum squared resid	2.482866	Schwarz criterion		-1.948942
Log likelihood	306.8448	F-statistic		83.86739
Durbin-Watson stat	0.138909	Prob(F-statistic)		0.000000

The results from the regression tests show that farmed European seabass in the Paris and Barcelona wholesale markets are related when considering no lags, and so there is market integration.

Consequently, the existence of market integration between farmed European seabass from the Barcelona and Paris wholesale markets is uncertain as we obtain different results when considering different lags.

9.4.5. Farmed European seabass (Turkish Exports and Madrid wholesale market)

Table 124. Lag interval selection for farmed European seabass imported to the EU from Turkey and the Madrid wholesale market

Lags	Rank or No. of Ces	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	829.3961	-8.013489	**-8.013489**
	1	836.0907	-8.029862	-7.949361
	2	841.2962	-8.031848	-7.870847
Lags interval: 1 to 1	0	835.7022	-8.074778	-8.010159
	1	842.6236	**-8.093433**	-7.948040
	2	**846.3126**	-8.080704	-7.854538
Lags interval: 1 to 2	0	836.5827	-8.083734	-7.954055
	1	841.9984	-8.087789	-7.877062
	2	845.0587	-8.068865	-7.777089
Lags interval: 1 to 3	0	832.5601	-8.044707	-7.849524
	1	837.8187	-8.047242	-7.770732
	2	840.8140	-8.027589	-7.669752
Lags interval: 1 to 4	0	834.4810	-8.063852	-7.802713
	1	840.0906	-8.069859	-7.727113
	2	843.1619	-8.050856	-7.626504

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

Table 125. Cointegration test considering no lags for farmed European seabass imported to the EU from Turkey and the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.062635	23.80025	19.96	24.60	None *
0.049051	10.41105	9.24	12.97	At most 1 *
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

Table 126. Cointegration test considering 1 lag for farmed European seabass imported to the EU from Turkey and the Madrid wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.064990	21.22076	19.96	24.60	None *
0.035181	7.377945	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 0 and 1 lags, shows 2 and 1 cointegration equations respectively, between farmed imported to the EU from Turkey and from the Madrid wholesale market. So, prices of farmed European seabass imported to the EU from Turkey and from the Madrid wholesale market behave as stationary series, and consequently regression methodology needs to be applied in order to assess market integrated when considering no lags.

Instead, when considering 1 lag, the stationary behavior of the series needs to be further analysed.

Table 127. Unit root test considering intercept and 1 lag for farmed European seabass imported to the EU from Turkey and from the Madrid wholesale market

Series	Lags	ADF Test Statistic	Critical Values		
Turkish exports	1	-2.600862	1%: -3.4634	5%: -2.8756	10%: -2.5742
Madrid wholesale market	1	-3.516019	1%: -3.4634	5%: -2.8756	10%: -2.5742

The ADF Test statistics for farmed European seabass imported to the EU from Turkey are higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the farmed European seabass imported to the EU from the Turkish price series behaves as a non-stationary series. While farmed European seabass from the Madrid wholesale market behaves as stationary when considering 1 lag. Consequently, there is also no market integration between farmed European seabass imported to the EU from Turkey and from the Madrid wholesale market when considering 1 lag.

Table 128. Regression considering 0 lags for farmed European seabass in the Madrid wholesale market and exports from Turkey

Dependent Variable: BASS_MADRID				
Method: Least Squares				
Sample: 1 208				
Included observations: 208				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.860285	0.101740	8.455730	0.0000
BASS_TURKEY	0.640074	0.065085	9.834475	0.0000
R-squared	0.319496	Mean dependent var		1.859320
Adjusted R-squared	0.316193	S.D. dependent var		0.097871
S.E. of regression	0.080932	Akaike info criterion		-2.180842
Sum squared resid	1.349304	Schwarz criterion		-2.148750
Log likelihood	228.8075	F-statistic		96.71690
Durbin-Watson stat	0.224902	Prob(F-statistic)		0.000000

Table 129. Regression considering 0 lags for farmed European seabass exports from Turkey and in the Madrid wholesale market

Dependent Variable: BASS_TURKEY				
Method: Least Squares				
Sample: 1 208				
Included observations: 208				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	0.632723	0.094501	6.695409	0.0000
BASS_MADRID	0.499155	0.050756	9.834475	0.0000
R-squared	0.319496	Mean dependent var		1.560813
Adjusted R-squared	0.316193	S.D. dependent var		0.086429
S.E. of regression	0.071470	Akaike info criterion		-2.429507
Sum squared resid	1.052242	Schwarz criterion		-2.397416
Log likelihood	254.6688	F-statistic		96.71690
Durbin-Watson stat	0.205592	Prob(F-statistic)		0.000000

The results from the regressions tests show that farmed European seabass imported to the EU from Turkey and from the Madrid wholesale market are related (i.e., there is market integration) when considering no lags.

Consequently, the existence of market integration between farmed European seabass imported to the EU from Turkey and from the Madrid wholesale market is uncertain as we obtain different results when considering different lags.

9.4.6. Farmed European seabass (Turkish Exports and Barcelona wholesale market)

Table 130. Lag interval selection for farmed European seabass imported to the EU from Turkey and the Barcelona wholesale market

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	827.0397	-7.990722	-7.990722
	1	838.7500	-8.055555	-7.975055
	2	843.4889	-8.053033	-7.892032
Lags interval: 1 to 1	0	839.3099	-8.109805	**-8.045186**
	1	845.9192	**-8.125429**	-7.980037
	2	**849.2732**	-8.109448	-7.883282
Lags interval: 1 to 2	0	838.5826	-8.103245	-7.973567
	1	843.8821	-8.106167	-7.895439
	2	847.0668	-8.088456	-7.796680
Lags interval: 1 to 3	0	835.2228	-8.070811	-7.875628
	1	840.5845	-8.074358	-7.797848
	2	843.6505	-8.055397	-7.697561
Lags interval: 1 to 4	0	838.1064	-8.099570	-7.838431
	1	843.5299	-8.103743	-7.760997
	2	846.5775	-8.084508	-7.660156

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

Table 131. Cointegration test considering 1 lag for farmed European seabass imported to the EU from Turkey and from the Barcelona wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.062152	19.92650	19.96	24.60	None
0.032038	6.707962	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration test, considering 1 lag, shows 0 cointegration equations between farmed European seabass imported to the EU from Turkey and from the Barcelona wholesale market. Therefore, there is no market integration between farmed European seabass imported to the EU from Turkey and from the Barcelona wholesale market.

9.4.7. Farmed European seabass (Turkish Exports and Paris wholesale market)

Table 132. Lag interval selection for farmed European seabass imported to the EU from Turkey and the Paris wholesale market

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	884.8164	-8.632355	-8.632355
	1	890.7351	-8.641318	-8.560269
	2	**894.1361**	-8.625718	**-8.463620**
Lags interval: 1 to 1	0	881.5881	-8.646188	-8.580904
	1	887.1536	**-8.651760**	-8.504869
	2	889.8492	-8.629056	-8.400559
Lags interval: 1 to 2	0	875.4429	-8.631273	-8.499798
	1	880.5987	-8.632823	-8.419176
	2	882.6282	-8.603266	-8.307447
Lags interval: 1 to 3	0	866.7394	-8.590345	-8.391754
	1	872.7517	-8.600519	-8.319182
	2	874.4803	-8.567641	-8.203557
Lags interval: 1 to 4	0	862.0817	-8.589662	-8.323006
	1	867.6539	-8.595471	-8.245484
	2	870.1564	-8.570116	-8.136799

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

Table 133. Cointegration test considering no lags for farmed European seabass imported to the EU from Turkey and from the Paris wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.056108	18.63931	19.96	24.60	None
0.032636	6.801959	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 134. Cointegration test considering 1 lag for farmed European seabass imported to the EU from Turkey and from the Paris wholesale market

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.053356	16.52213	19.96	24.60	None
0.026208	5.391114	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

The cointegration tests, considering 0 and 1 lags, shows 0 cointegration equations between farmed European seabass imported to the EU from Turkey and from the Paris wholesale market. Therefore, there is no market integration between farmed European seabass imported to the EU from Turkey and from the Paris wholesale market.

9.4.8. Wild gilthead seabream (Madrid and Barcelona wholesale markets)

Table 135. Lag interval selection for wild gilthead seabream in the Madrid and Barcelona wholesale markets

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	691.6580	-3.7387	-3.7387
	1	717.3198	**-3.8504**	**-3.7975**
	2	**719.2755**	-3.8339	-3.7282
Lags interval: 1 to 1	0	654.5822	-3.7176	-3.6735
	1	679.3939	-3.8308	-3.7316
	2	681.9001	-3.8166	-3.6623
Lags interval: 1 to 2	0	613.0281	-3.6447	-3.5531
	1	637.6333	-3.7629	-3.6139
	2	639.9293	-3.7466	-3.5403
Lags interval: 1 to 3	0	581.2535	-3.6258	-3.4825
	1	601.1125	-3.7205	-3.5175
	2	603.0785	-3.7011	-3.4384
Lags interval: 1 to 4	0	545.6293	-3.5786	-3.3791
	1	558.5662	-3.6322	-3.3704
	2	560.5839	-3.6121	-3.2879

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

Table 136. Cointegration test considering 0 lags for wild gilthead seabream in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.129522	55.23486	19.96	24.60	None **
0.010515	3.911290	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 0 lags, shows 1 cointegration equation between wild gilthead seabream in the Madrid and Barcelona wholesale markets. So the stationary behavior of the series is analysed.

Table 137 Unit root test considering intercept and 0 lags for wild gilthead seabream in the Madrid and Barcelona wholesale markets

Series	Lags	ADF Test Statistic	Critical Values		
Wild seabream Madrid	0	-1.606148	1%: -3.4500	5%: -2.8696	10%: -2.5710
Wild seabream Barcelona	0	-8.076360	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test Statistic for wild seabream in the Madrid wholesale market is higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the wild seabream in the Mercamadrid price series behaves as a non-stationary series. While wild seabream in the Mercabarna price series behaves as stationary.

Therefore, there is no market integration between wild seabream in the Madrid and Barcelona wholesale markets.

9.4.9. Farmed gilthead seabream (Madrid and Barcelona wholesale markets)

Table 138. Lag interval selection for farmed gilthead seabream in the Madrid and Barcelona wholesale markets

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	1667.538	-7.141492	-7.141492
	1	1681.957	-7.181828	-7.137435
	2	1684.546	-7.171505	-7.082719
Lags interval: 1 to 1	0	1679.810	-7.192319	**-7.156747**
	1	1690.799	-7.218022	-7.137985
	2	1693.868	-7.209732	-7.085229
Lags interval: 1 to 2	0	1687.379	-7.223135	-7.151874
	1	1695.195	-7.235247	-7.119448
	2	1698.628	-7.228508	-7.068171
Lags interval: 1 to 3	0	1689.970	-7.232631	-7.125565
	1	1696.926	**-7.241060**	-7.089383
	2	**1701.245**	-7.238123	-7.041836
Lags interval: 1 to 4	0	1687.996	-7.222443	-7.079455
	1	1695.356	-7.232638	-7.044966
	2	1700.465	-7.233109	-7.000753

From the lag selection table, we can see that under the Log Likelihood and the Akaike Information Criteria the optimal lags are 3, while under the Schwarz Information Criteria the optimal lag is 1. In this case, cointegration tests are run for 1 and 3 lags.

Table 139. Cointegration test considering 1 lag for farmed gilthead seabream in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.046067	28.11443	19.96	24.60	None **
0.013083	6.136806	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 140. Cointegration test considering 3 lags for farmed gilthead seabream in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 3				
	Likelihood	5 percent	1 percent	Hypothesized
Eigenvalue	Ratio	Critical Value	Critical Value	No. of CEs
0.029536	22.54860	19.96	24.60	None *
0.018443	8.637554	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering 1 lag and 3 lags, show 1 cointegration equations between farmed gilthead seabream in the Madrid and Barcelona wholesale markets. So the stationary behavior of the series is analysed.

Table 141. Unit root test considering intercept and 1 lag and 3 lags for farmed gilthead seabream in the Madrid and Barcelona wholesale markets

Series	Lags	ADF Test Statistic	Critical Values		
Farmed seabream Madrid	1	-2.902637	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed seabream Madrid	3	-3.013477	1%: -3.4467	5%: -2.8680	10%: -2.5702
Farmed seabream Barcelona	1	-2.648794	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed seabream Barcelona	3	-2.658592	1%: -3.4467	5%: -2.8680	10%: -2.5702

The ADF Test statistics for farmed seabream in the Barcelona wholesale market are higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5% significance level. So, the wild seabream in the Mercabarna price series behaves as a non-stationary series. While farmed seabream in the Mercamadrid price series behaves as stationary.

Therefore, there is no market integration between farmed seabream in the Madrid and Barcelona wholesale markets.

9.4.10. Farmed gilthead seabream (Madrid and Paris wholesale markets)

Table 142. Lag interval selection for farmed gilthead seabream in the Madrid and Paris wholesale markets

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	1092.863	-7.166317	-7.166317
	1	1097.758	-7.165628	-7.104639
	2	1101.558	-7.157760	-7.035782
Lags interval: 1 to 1	0	1097.116	-7.263231	-7.213967
	1	1101.574	-7.259626	-7.148782
	2	**1105.344**	-7.251457	-7.079033
Lags interval: 1 to 2	0	1097.483	**-7.336583**	**-7.237089**
	1	1100.604	-7.323935	-7.162256
	2	1103.139	-7.307336	-7.083473
Lags interval: 1 to 3	0	1080.907	-7.296294	-7.145571
	1	1083.750	-7.281569	-7.068043
	2	1086.379	-7.265384	-6.989057
Lags interval: 1 to 4	0	1071.679	-7.305737	-7.102751
	1	1075.432	-7.297107	-7.030688
	2	1077.500	-7.276815	-6.946964

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

Table 143. Cointegration test considering 1 lag for farmed gilthead seabream in the Madrid and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.029183	16.45605	19.96	24.60	None
0.024743	7.541262	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 144. Cointegration test considering 2 lags for farmed gilthead seabream in the Madrid and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.020802	11.31347	19.96	24.60	None
0.016926	5.070066	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Cointegration tests, considering 1 and 2 lags, show 0 cointegration equations between farmed gilthead seabream in the Madrid and Paris wholesale markets. Therefore, there is no market integration between farmed gilthead seabream in the Madrid and Paris wholesale markets.

9.4.11. Farmed gilthead seabream (Barcelona and Paris wholesale markets)

Table 145. Lag interval selection for farmed gilthead seabream in the Barcelona and Paris wholesale markets

Lags	**Rank or No. of CEs**	**Log Likelihood by Rank**	**Akaike Information Criteria by Rank**	**Schwarz Criteria by Rank**
Lags interval: No lags	0	1102.745	-7.231115	-7.231115
	1	1108.068	-7.233234	-7.172245
	2	1111.789	-7.224847	-7.102870
Lags interval: 1 to 1	0	1118.619	-7.406105	-7.356841
	1	1122.859	-7.401059	-7.290215
	2	**1125.665**	-7.386480	-7.214057
Lags interval: 1 to 2	0	1118.052	**-7.475098**	**-7.375604**
	1	1120.605	-7.458619	-7.296941
	2	1122.535	-7.437945	-7.214082
Lags interval: 1 to 3	0	1102.512	-7.443767	-7.293043
	1	1105.448	-7.429679	-7.216154
	2	1107.454	-7.409245	-7.132918
Lags interval: 1 to 4	0	1093.459	-7.456465	-7.253479
	1	1096.780	-7.444846	-7.178427
	2	1098.727	-7.423718	-7.093867

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

Table 146. Cointegration test considering 1 lag for farmed gilthead seabream in the Barcelona and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.027783	14.09299	19.96	24.60	None
0.018472	5.611916	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Table 147. Cointegration test considering 2 lags for farmed gilthead seabream in the Barcelona and Paris wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 2				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.017044	8.965332	19.96	24.60	None
0.012911	3.859605	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. rejects any cointegration at 5% significance level				

Cointegration tests, considering 1 and 2 lags, show 0 cointegration equations between farmed gilthead seabream in the Barcelona and Paris wholesale markets. Therefore, there is no market integration between farmed gilthead seabream in the Barcelona and Paris wholesale markets.

9.4.12. Wild turbot (Madrid and Barcelona wholesale markets)

Table 148. Lag interval selection for wild turbot in the Madrid and Barcelona wholesale markets

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	892.5112	-3.822318	-3.822318
	1	936.4712	-3.989170	-3.944777
	2	940.7889	-3.986248	-3.897461
Lags interval: 1 to 1	0	911.5230	-3.894949	-3.859376
	1	949.9413	-4.038375	**-3.958337**
	2	**957.3513**	**-4.048718**	-3.924215
Lags interval: 1 to 2	0	916.4777	-3.907431	-3.836170
	1	948.6915	-4.024480	-3.908681
	2	955.2178	-4.031044	-3.870707
Lags interval: 1 to 3	0	921.2674	-3.919256	-3.812190
	1	946.6449	-4.007090	-3.855413
	2	953.1593	-4.013618	-3.817330
Lags interval: 1 to 4	0	925.4626	-3.928564	-3.785576
	1	947.4193	-4.001811	-3.814139
	2	953.2964	-4.005600	-3.773244

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

Table 149. Cointegration test considering 1 lag for wild turbot in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.152009	91.65661	19.96	24.60	None **
0.031302	14.82002	9.24	12.97	At most 1 **
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 2 cointegrating equation(s) at 5% significance level				

The cointegration test, considering 1 lag, shows 2 cointegration equations between wild turbot in the Madrid and Barcelona wholesale markets. So, wild turbot prices in the Madrid and Barcelona wholesale markets behave as stationary and consequently regression methodology should be applied.

Table 150. Regression considering 1 lag for wild turbot in the Barcelona and Madrid wholesale markets

Dependent Variable: TURBOT_BARCELONA				
Method: Least Squares				
Sample(adjusted): 2 468				
Included observations: 467 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.565594	0.127473	4.436955	0.0000
TURBOT_MADRID	0.215311	0.140963	1.527428	0.1273
TURBOT_MADRID(-1)	-0.102346	0.139538	-0.733461	0.4636
TURBOT_BARCELONA(-1)	0.682670	0.034650	19.70190	0.0000
R-squared	0.530322	Mean dependent var		2.899354
Adjusted R-squared	0.527279	S.D. dependent var		0.224815
S.E. of regression	0.154571	Akaike info criterion		-0.887799
Sum squared resid	11.06208	Schwarz criterion		-0.852284
Log likelihood	211.3010	F-statistic		174.2607
Durbin-Watson stat	1.993341	Prob(F-statistic)		0.000000

Table 151. Regression considering 1 lag for wild turbot in the Madrid and Barcelona wholesale markets

Dependent Variable: TURBOT_MADRID				
Method: Least Squares				
Sample(adjusted): 2 468				
Included observations: 467 after adjusting endpoints				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.040595	0.042761	0.949345	0.3429
TURBOT_BARCELONA	0.023286	0.015245	1.527428	0.1273
TURBOT_BARCELONA(-1)	0.019720	0.015423	1.278612	0.2017
TURBOT_MADRID(-1)	0.947338	0.013034	72.68390	0.0000
R-squared	0.932853	Mean dependent var		3.138968
Adjusted R-squared	0.932418	S.D. dependent var		0.195535
S.E. of regression	0.050832	Akaike info criterion		-3.112041
Sum squared resid	1.196357	Schwarz criterion		-3.076526
Log likelihood	730.6615	F-statistic		2144.099
Durbin-Watson stat	1.501682	Prob(F-statistic)		0.000000

The results from the regressions tests show that wild turbot in the Madrid and Barcelona wholesale markets are not related, and consequently there is no market integration.

9.4.13. Farmed turbot (Madrid and Barcelona wholesale markets)

Table 152. Lag interval selection for farmed turbot in the Madrid and Barcelona wholesale markets

Lags	Rank or No. of CEs	Log Likelihood by Rank	Akaike Information Criteria by Rank	Schwarz Criteria by Rank
Lags interval: No lags	0	1717.521	-7.355548	**-7.355548**
	1	1727.894	-7.378561	-7.334167
	2	1730.468	-7.368172	-7.279386
Lags interval: 1 to 1	0	1723.014	-7.377742	-7.342170
	1	1733.567	**-7.401575**	-7.321537
	2	**1736.805**	-7.394012	-7.269509
Lags interval: 1 to 2	0	1720.947	-7.367514	-7.296253
	1	1732.344	-7.395026	-7.279227
	2	1735.125	-7.385486	-7.225149
Lags interval: 1 to 3	0	1720.340	-7.363536	-7.256470
	1	1731.448	-7.389861	-7.238184
	2	1734.866	-7.383045	-7.186757
Lags interval: 1 to 4	0	1716.275	-7.344598	-7.201610
	1	1727.177	-7.370095	-7.182423
	2	1730.512	-7.362904	-7.130548

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

Table 153. Cointegration test considering 0 lags for farmed turbot in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: No lags				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.043453	25.89533	19.96	24.60	None **
0.010964	5.148573	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Table 154. Cointegration test considering 1 lag for farmed turbot in the Madrid and Barcelona wholesale markets

Test assumption: No deterministic trend in the data				
Lags interval: 1 to 1				
Eigenvalue	**Likelihood Ratio**	**5 percent Critical Value**	**1 percent Critical Value**	**Hypothesized No. of CEs**
0.044282	27.58173	19.96	24.60	None **
0.013800	6.475534	9.24	12.97	At most 1
*(**) denotes rejection of the hypothesis at 5% (1%) significance level				
L.R. test indicates 1 cointegrating equation(s) at 5% significance level				

Both cointegration tests, considering 0 and 1 lag, show 1 cointegration equation between farmed turbot in the Madrid and Barcelona wholesale markets. So the stationary behavior of the series is analysed.

Table 155. Unit root test considering intercept and 0 and 1 lags for farmed turbot in the Madrid and Barcelona wholesale markets

Series	Lags	ADF Test Statistic	Critical Values		
Farmed turbot Madrid	0	-2.315818	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed turbot Madrid	1	-2.837989	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed turbot Barcelona	0	-2.272751	1%: -3.4466	5%: -2.8680	10%: -2.5702
Farmed turbot Barcelona	1	-2.329792	1%: -3.4466	5%: -2.8680	10%: -2.5702

The ADF Test statistics for farmed turbot in the Barcelona and Madrid wholesale markets are higher than the MacKinnon critical value for rejection of the hypothesis of a unit root at a 5 percent significance level. So, both price series behave as a non-stationary series according to the ADF Test.

Because the cointegration tests show the presence of 1 cointegration equation (1 non-stationary trend), this confirms the existence of market integration between farmed turbot in the Madrid and Barcelona wholesale markets.

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