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RESEARCH PAPER

Increasing Fuel Prices, Decreasing Fish Prices and Low Productivity Lead to Poor Economic Performance and Capacity Reduction in The Fishing Sector: Evidence from The Spanish Mediterranean

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Abstract

Fuel price increases have been identified as a major factor explaining the low economic performance of fishing fleets. Fishers have reacted by reducing costs and increasing fuel efficiency of their vessels when possible, and by reducing the days spent at sea or ceasing activity. However, fuel prices explain only part of the story. We analyzed the evolution of fuel prices, fish prices, fishing activity and productivity over a 14 year period (2000-13) for the Catalan fleet (Spanish Mediterranean). Most fish prices have increased but below inflation, or even decreased, in recent years. These low fish prices, together with low vessel productivity, mainly due to the poor status of the stocks, have worsened the already poor profitability of the sector and led to a decrease in the activity (in terms of total effort and capacity).

Keywords: Fuel efficiency, overexploitation, fish prices, economic performance, Mediterranean fisheries.

Introduction

A significant part of worldwide fishing fleets are suffering from low economic performance (STECF, 2010, 2015; Sumaila *et al*., 2010; Cheilari *et al*., 2013). In a European context, between 30 and 40% of the EU fishing fleets made losses on average for the period 2002-2008, while between 10 to 20% of the EU fleets generated negative cash flows (not generating on average enough income to cover operational costs) (STECF, 2010).

Some fleets reacted to the deteriorating economic performance due to the 2007-8 fuel prices increase, by reducing the days spent at sea and the fuel consumption, whenever possible. In 2008, a EU fishing vessel was spending on average 40 days less at sea than in 2002 (Cheilari *et al*., 2013). Indeed, modern fishing fleets suffer from high operational costs when oil prices are high, such as the prices observed over the last decade (Csirke, 2005; Abernethy *et al*., 2010; Cheilari *et al*., 2013; Parker and Tyedmers, 2015).

Fuel costs, along with labor costs, are the main costs that fishing fleets have to bear (Daurès *et al*., 2013; Guillen *et al*., 2015). The importance of fuel in the total costs has been stressed in several studies (Sumaila *et al*., 2010). On average, the share of the fuel cost over the total costs reached 27% for the EU fishing fleets in 2013 (STECF, 2015). However, the importance of fuel costs varies significantly among fleet segments, reaching 50% for large demersal trawlers and beam trawlers (Cheilari *et al*., 2013). Increases in the fuel price lead to significant increases in the fleet's operational costs, raising the share of the fuel costs in the total costs. Despite the recent oil price drop to an historical low (December 2014), future expectations are not very encouraging because oil prices are expected to rebound in the next two years, rising to near $100 a barrel (IEA, 2014).

In addition to this input cost increase, revenues have not increased significantly. Guillen and Maynou (2014, 2015) showed that the price of most fish species decreased in the Spanish Mediterranean during the 2000 – 2013 period. Likewise, global Mediterranean landings have not increased, and stagnated at around 1 million tonnes annually (FAO, 2014). World capture landings have been relatively stable since the 90's between 80 and 90 million tonnes (FAO, 2014).

This study characterizes the evolution of main economic indicators of the fishing fleets to understand recent trends in Mediterranean fisheries, using the Catalan fleets as case study, which have a long (2000-2013) series of detailed data on fisheries production and prices.

Materials and Methods

Data Collection and Data Preparation

More than 1.5 million daily sales notes of the Catalan fishing fleets for the period January 2000 – December 2013 have been used to obtain the fishing effort deployed by the fleets, as well as the daily catch of each species per vessel (vessel productivity – catch per unit of effort) and the average price per species. The daily sale notes of each local fish auction market are organized in a central database maintained by the Fisheries Directorate of Catalonia. Data were aggregated to weekly level for comparison with the minimum time resolution of fuel price data and "unit effort" is defined as number of fishing days per boat per week, for each fleet segment. Oil prices at weekly scale have been obtained from the European Commission's Weekly Oil Bulletin (European Commission, 2015) (Figure 1).

The Catalan fishing fleets comprised of 1314 active fishing vessels during the 2000-2013 period. In 2000 there were 1066 active vessels, but the numbers have been decreasing and only 646 remained in operation in 2013 (tables in the annex for details of the evolution by fleet). These vessels are divided into 6 fleet segments depending on the fishing licenses they are holding: small (6-12 m) bottom trawlers; large (12-24 m) bottom trawlers (Maravelias and Tsitsika (2014) show that it is important to distinguish by vessel length size because there can be important differences in fleet segments in terms of fishing effort and vessel characteristics); purse seiners; bottom longliners; surface longliners and a group of vessels using an all purpose "minor gear" license that use mainly set nets. Longliners and minor gear vessels are generally 6-15 m of length over all (LOA) while purse seiners are 12-24 m LOA. Table 1 shows the number of effectives in each fleet together with the value and weight of landings and total fishing days (fishing effort).

The activity of the fleets in Catalonia is regulated by input control (i.e., technical measures) and effort is controlled by limiting the time at sea: fishing is permitted for 12 h / day from Monday to Friday (Maynou *et al*., 2006); no fishing activity is allowed during weekends. No significant regulatory changes have affected the region during the period

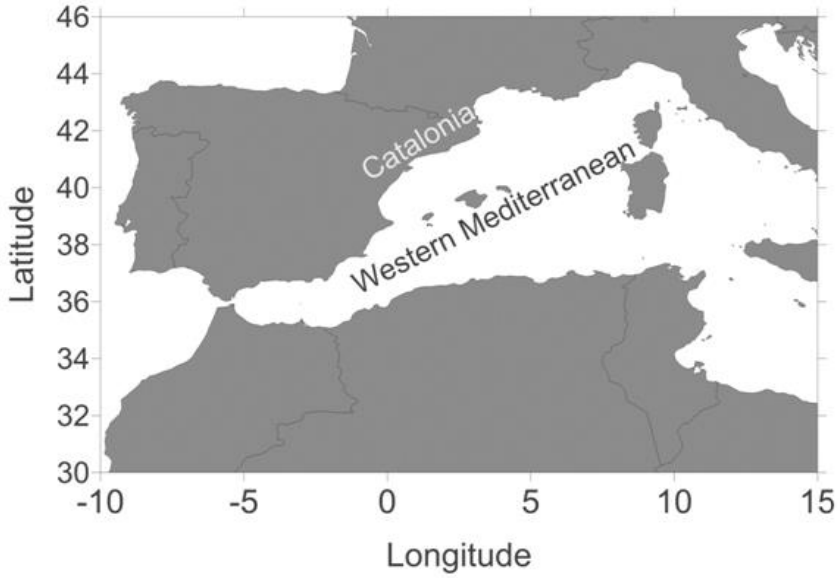


Figure 1. Map of the study area.

Table 1. Table 1: Main data of the fleets analyzed for 2013

Fleet	Number of vessels (total in the period)	Value Landings ('000 €)	Weight Landings (tonnes)	Fishing days
Small bottom trawlers	28 (62)	3059	699	4999
Large bottom trawlers	188 (356)	42882	8266	35010
Small scale (minor gears)	324 (680)	13516	2356	36259
Purse seiners	69 (138)	23444	13820	9094
Bottom long-line	31 (64)	1726	231	3659
Surface long-line	6 (14)	727	146	386
Total	646 (1314)	85354	25519	89407

Total number of vessels refers to the vessels having been active in the period 2000 – 2013 is reported inside the parenthesis

analyzed, as no proactive management is really in place (Lleonart and Maynou 2003), excepting the introduction of the regulation square 40 mm-mesh replacing the diamond 50-mm mesh in trawl codends (EU Reg 1967/2006). None of the species captured by these fleets is managed with TAC/quota regulations (with the exception of bluefin tuna caught by the surface long-line fleet), and this is the case for all Mediterranean fisheries (Lleonart and Maynou, 2003).

Weekly data are presented in the figures of the Annex together with tables reporting data aggregated at annual level (nominal values-not adjusted by the inflation). While figures in the results section report data aggregated at annual level using the year 2000 as a reference year (at percentage scale, based on year 2000 = 100).

Results

Fuel prices have more than doubled between 2000 and 2013, increasing more than the average landing fish price considering all fleets (Figure 2). In fact, fuel prices have increased more than the fish prices of any fishing fleet, as during the same period landing fish prices for most fleets have increased below inflation (i.e., the consumer price index [CPI] which measures changes in the price level of a market basket of consumer goods and services purchased by households) (Figures 3a to 3f and Table 2).

For the same time period, the total number of fishing days has decreased between 29 and 41%, depending on the fleet, while landings by fleet have mostly decreased or remained stable (Tables A.2 and A.3).

Fuel price has increased in nominal terms by 128% from 2000 to 2013, a 6.5% annually, well above inflation (i.e., the consumer price index), which increased by 42% (2.7% annually). Overall, average landings price has decreased in real terms (i.e., not increased above inflation). Average landings prices for small trawlers increased in nominal terms by 7%, for large trawlers by 25%, for purse seiners by 20%, for bottom long-liners by 26%, for minor gears by 46%, and for surface long-liners just by 1% (Table 2).

Overall landings in volume have decreased by

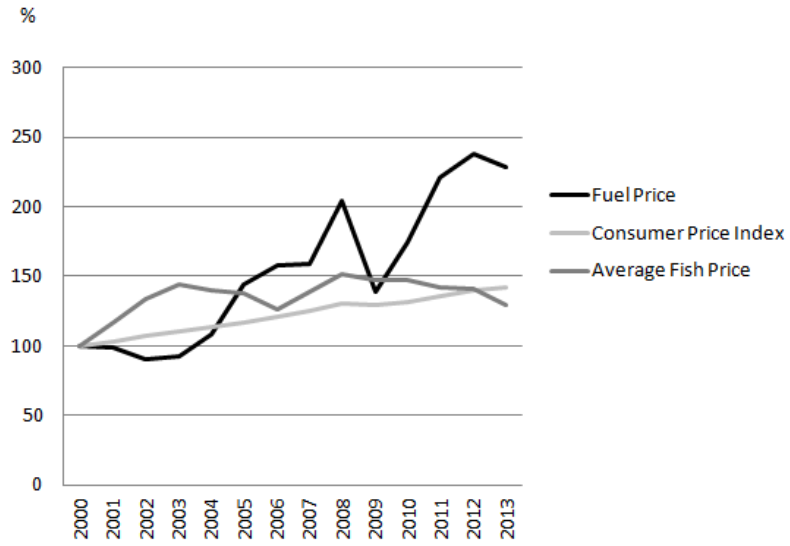
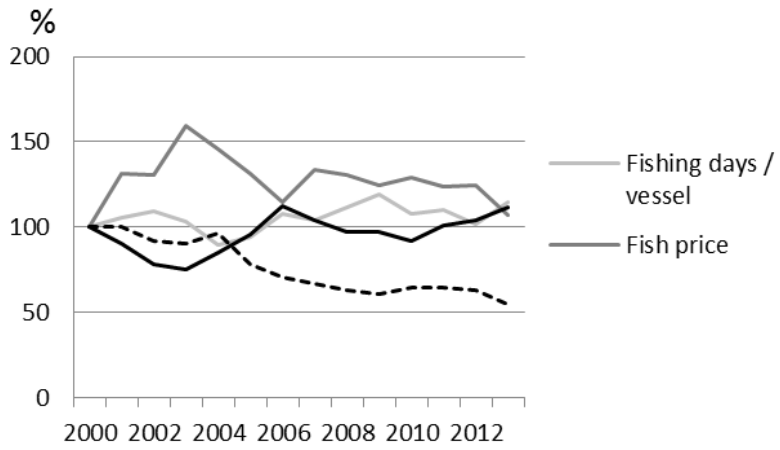
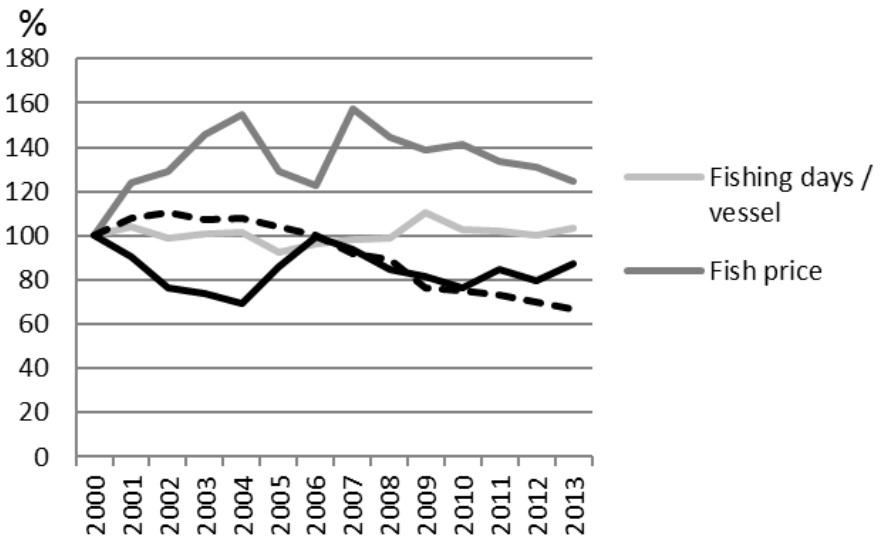


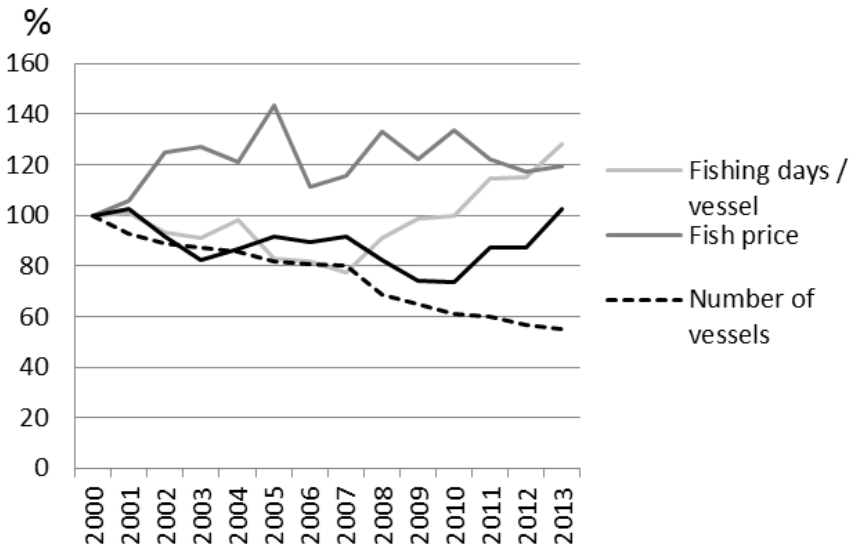
Figure 2. Fuel price, fish price and consumer price index (year 2000 as base 100).



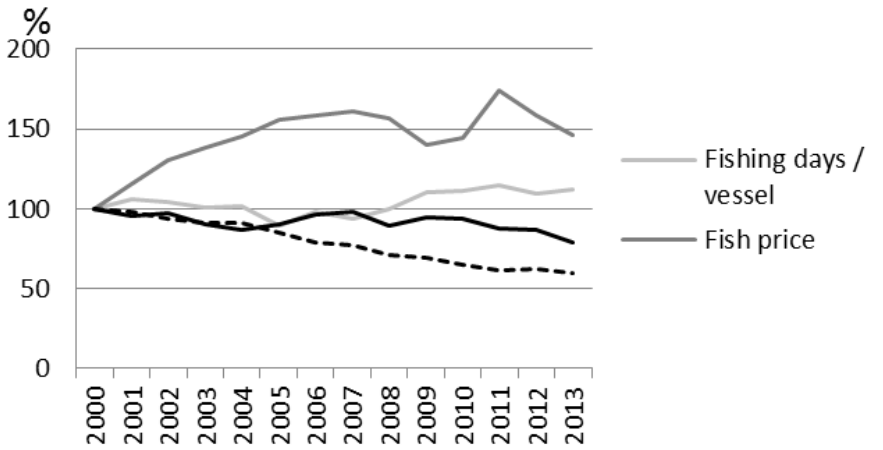
Figures 3a. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the small trawler fleet (year 2000 as base 100).



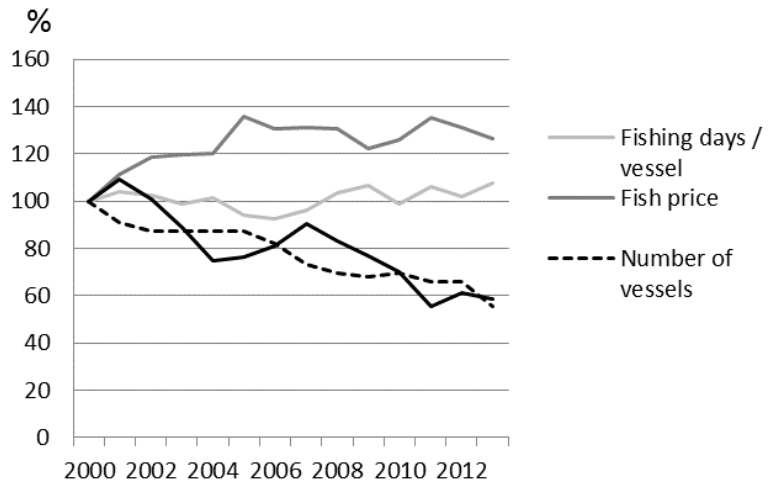
Figures 3b. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the trawler fleet (year 2000 as base 100).



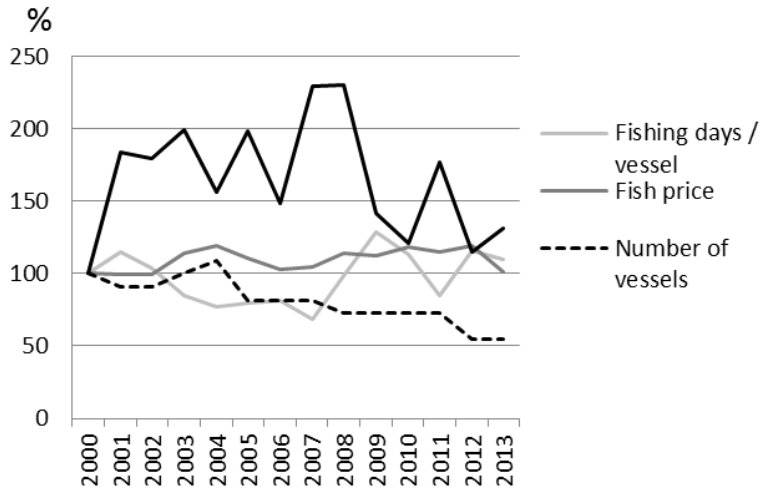
Figures 3c. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the purse seine fleet (year 2000 as base 100).



Figures 3d. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the small-scale fleet (year 2000 as base 100).



Figures 3e. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the bottom long-line fleet (year 2000 as base 100).



Figures 3f. Evolution of the number of vessels, fishing days per vessel, landings volume per fishing day and fish price for the surface long-line fleet (year 2000 as base 100).

Table 2. Average nominal fish price (€ kg-1) for each fleet, nominal fuel price (€ l-1) and the 2 consumer price index (base 100).

Year	Small trawler fish price	Trawler fish price	Purse seine fish price	Small scale fisheries fish price	Bottom long-line fish price	Surface long-line fish price	Average fish price	Fuel Price	Consumer Price Index
2000	4.8	6.3	1.8	6.2	6.9	7.5	2.4	3.3	100.0
2001	6.2	7.8	1.9	7.1	7.6	7.4	2.8	3.3	103.4
2002	6.2	8.1	2.3	8.1	8.1	7.5	3.2	3.0	106.7
2003	7.6	9.1	2.3	8.5	8.2	8.6	3.4	3.1	110.0
2004	6.9	9.7	2.2	9.0	8.2	8.9	3.3	3.6	113.4
2005	6.3	8.1	2.6	9.7	9.3	8.3	3.3	4.8	117.2
2006	5.4	7.7	2.0	9.8	9.0	7.7	3.0	5.2	121.2
2007	6.4	9.8	2.1	10.0	9.0	7.8	3.3	5.3	124.6
2008	6.2	9.1	2.4	9.7	8.9	8.5	3.6	6.7	129.8
2009	5.9	8.7	2.2	8.7	8.4	8.4	3.5	4.6	129.6
2010	6.1	8.8	2.4	9.0	8.6	8.9	3.5	5.8	131.9
2011	5.9	8.4	2.2	10.8	9.3	8.6	3.4	7.3	136.1
2012	5.9	8.2	2.1	9.8	9.0	9.0	3.4	7.9	139.4
2013	5.1	7.8	2.2	9.0	8.6	7.6	3.1	7.5	141.6

34% during this period, with all fleets reporting decreases, from a 27% decrease by purse seiners to a 65% decrease by bottom long-liners. However, landings per vessel increased by 9% for the same period. This increase in the landings per vessel is due to the decrease in the number of vessels that lead to a stable or even increasing number of fishing days in the remaining vessels. By fleet, an increase in the landings per vessel by 28% for the small trawlers, by 32% for purse seiners and by 44% for surface long-liners can be observed; while landings decreased for trawlers by 10%, by 11% for small scale fisheries, and by 37% for bottom long-liners (Table 3). Similarly, overall landings per fishing day decreased by 2%, varying between -41 to 31% by fleet, with small trawlers, purse seiners and surface long-liners reporting increases during this period.

Likewise, overall landings in value have decreased by 23% during this period, with all fleets reporting decreases, ranging from a 13% decrease in purse seiners up to a 56% decrease in bottom long-liners.

During this period, the Catalan fleet has suffered an important decrease in the fishing capacity. The overall number of vessels has decreased by 39%, ranging between a 33% decrease of the trawlers and a 45% decrease of the purse seiners. Similarly, the Catalan fleet has reduced significantly the fishing effort. The overall number of fishing days per year has decreased by 32%, ranging between a 29% decrease by purse seiners and a 41% decrease by bottom long-liners (Table 4).

Discussion

Fuel costs represent a significant part of the operational costs (30% or more, depending on the fleet segment: STECF, 2015); consequently, fuel price changes have a relevant impact in the fleets' economic performance. Because fuel prices have been significantly increasing over time up to recent years (e.g., more than doubled in the 14 years' period analyzed) and exhibit large short-time variation, they are often perceived by fishers, governments and researchers as the most important factor driving the fishing sector's profitability (Csirke, 2005; Abernethy *et al*., 2010; Cheilari *et al*., 2013; Parker and Tyedmers, 2015). Fuel prices increased significantly in 2004 and 2008, suffered a relative decline at the end of 2008 and beginning of 2009, and then continued to increase (Figure 2). However, since the end of 2014, fuel prices have started to decrease. This is because the decrease in crude oil prices due to, at least in part, the increased crude oil production from the United States, Canada, Iraq, Russia and Iran's return to the international market, together with a lower international demand of oil by the United States and economies in Europe and developing countries are still weak and doing efforts to more energy-efficient process (New York Times, 2016). This decline in fuel prices implies a decrease in fuel costs, and consequently increased pressure to the fish stocks as fishers will find less encumbrance to increase fishing effort.

However, decreasing fish prices and low stock productivity are also important factors to determine the sector's economic performance, even if they show narrower oscillations. Fishers are suffering from low product prices despite increasing fishing costs. This decrease in fish prices has been more accentuated since 2008, as a result of the current economic crisis and the loss of purchasing power by consumers (Guillen and Maynou, 2014, 2015). Fishers have not succeeded into passing the cost increases on to consumers by increasing the price of fish (Guillen and Franquesa, 2015). This is in part because local fish production in Catalonia comprises only 17% of total fish domestic consumption in the area (MAGRAMA, 2015), and combined with the use of auctions at first sale and the increase of aquaculture production, fishers cannot be price-setters and suffer a loss of income. However, prices for Mediterranean, and in particular local, fish products are higher (receive a price-premium) than fish products coming from other areas (e.g., North Atlantic) (Asche and Guillen, 2012). Similarly, fish prices remained relatively stable in Southern England between 1998 and 2008, even if fuel prices increased by 359% (Abernethy *et al*., 2010): average hake prices increased by 15%, monkfish prices by 19%, sole prices by 48%, and megrim by 130%.

The outcomes of this study suggest that the economic performances of most fleet segments have deteriorated during the period analyzed. The only fleet segment whose economic performance may have not worsened is the purse seine. Purse seiners catch relatively low valued fish species (e.g., sardine and anchovy), and prices for such 'cheap' species have increased during this period, probably linked to the diminishing purchasing power of consumers in recent years (Guillen and Maynou, 2015).

This low economic efficiency together with the low productivity and the general state of overexploitation of Mediterranean fish stocks can elucidate the large reduction of effort (i.e., total number of fishing days) and capacity (i.e., total number of vessels) observed, where the number of fishing vessels has decreased by more than 40% in most fleet segments of the Catalan fleet (and the number of fishing days has decreased more than 30% in most fleets), resulting in an increase in the average number fishing days per vessel for most of the fleets in the period analyzed. However, it can be seen that in 2004 and 2008-9 there was a general decrease in the number of fishing days per vessel due to fuel price increases, as already reported in Cheilari *et al*., (2013) and Parker and Tyedmers (2015).

Additionally, most vessels currently continuing their operation have undergone modernization or have

Table 3. Overall landings volume (kg), landings by vessel (kg vessel^{-1}) and landings by fishing day (kg day^{-1}) for each fleet.

3 Year	Small trawler landings	Trawler landings	Purse seine landings	Small scale fisheries landings	Bottom long-line landings	Surface long-line landings	Small trawler landings per vessel	Trawler landings per vessel	Purse seine landings per vessel	Small scale fisheries landings per vessel	Bottom long-line landings per vessel	Surface long-line landings per vessel	Small trawler landings by fishing day	Trawler landings by fishing day	Purse seine landings by fishing day	Small scale fisheries landings by fishing day	Bottom long-line landings by fishing day	Surface long-line landings by fishing day
2000	991750	13811200	22625958	3777145	673843	186002	19446	48976	181008	6982	12033	16909	124.9	271.1	1735.9	69.9	109.5	288.4
2001	945686	14043161	21677880	3709522	697661	357279	18543	46195	186878	7012	13680	35728	112.7	245.7	1777.6	66.5	119.6	530.9
2002	782300	11512970	17160849	3594967	609106	315015	16645	37019	154602	7077	12431	31502	97.7	207.2	1590.3	68.1	110.3	518.1
2003	696294	11021077	14756238	3124132	515894	314189	15137	36373	135378	6311	10528	28563	93.8	199.4	1428.9	62.9	97.1	575.4
2004	721687	10470803	16480741	3044645	448187	243680	14728	34443	154026	6151	9147	20307	105.8	188.1	1506.2	60.5	82.0	451.3
2005	701331	11434911	14027879	2592061	423968	240666	17533	39027	137528	5635	8652	26741	119.6	233.1	1594.3	63.1	83.6	573.0
2006	844681	13247451	13371676	2820147	415250	184247	23463	46977	132393	6636	9027	20472	140.0	269.8	1554.1	67.4	88.6	427.5
2007	719405	11700584	12871435	2676871	428877	239290	21159	45176	128714	6435	10460	26588	130.2	254.4	1591.2	68.6	99.1	662.9
2008	673505	10361376	11672993	2384219	403055	307754	21047	41280	135732	6225	10335	38469	121.1	230.6	1431.7	62.5	91.0	663.3
2009	698144	9433267	10686583	2727404	374242	246595	22521	43876	131933	7293	9848	30824	121.5	220.4	1284.3	66.1	84.1	407.6
2010	638765	8135300	10118171	2568571	325050	185447	19357	38374	133134	7297	8335	23181	115.0	207.0	1277.5	65.7	76.6	349.9
2011	712774	8776594	13554962	2347417	262324	203734	21599	42399	180733	7028	7090	25467	125.9	229.6	1512.1	61.2	60.7	509.3
2012	655438	7772975	12940665	2241028	276974	135392	20482	39257	182263	6630	7486	22565	129.7	216.7	1515.6	60.4	66.8	331.8
2013	699095	8265765	16444742	2006747	234474	146331	24968	43967	238330	6194	7564	24389	139.8	236.1	1783.3	55.1	64.1	379.1

Table 4. Number of vessels, fishing days (day) and fishing days per vessel (day vessel^{-1}) for each fleet

Year	Small trawler number of vessels	Trawler number of vessels	Purse seine number of vessels	Small scale number of vessels	Bottom long-line number of vessels	Surface long-line number of vessels	Small trawler fishing days	Trawler fishing days	Purse seine fishing days	Small scale fishing days	Bottom long-line fishing days	Surface long-line fishing days	Small trawler fishing days per vessel	Trawler fishing days per vessel	Purse seine fishing days per vessel	Small scale fishing days per vessel	Bottom long-line fishing days per vessel	Surface long-line fishing days per vessel
2000	51	282	125	541	56	11	7943	50940	13034	54065	6156	645	155.7	180.6	104.3	99.9	109.9	58.6
2001	51	304	116	529	51	10	8391	57164	12195	55814	5831	673	164.5	188.0	105.1	105.5	114.3	67.3
2002	47	311	111	508	49	10	8008	55562	10791	52811	5523	608	170.4	178.7	97.2	104.0	112.7	60.8
2003	46	303	109	495	49	11	7420	55268	10327	49658	5313	546	161.3	182.4	94.7	100.3	108.4	49.6
2004	49	304	107	495	49	12	6823	55659	10942	50315	5465	540	139.2	183.1	102.3	101.6	111.5	45.0
2005	40	293	102	460	49	9	5866	49061	8799	41096	5070	420	146.7	167.4	86.3	89.3	103.5	46.7
2006	36	282	101	425	46	9	6034	49096	8604	41811	4685	431	167.6	174.1	85.2	98.4	101.8	47.9
2007	34	259	100	416	41	9	5524	45985	8089	39049	4328	361	162.5	177.5	80.9	93.9	105.6	40.1
2008	32	251	86	383	39	8	5561	44934	8153	38120	4430	464	173.8	179.0	94.8	99.5	113.6	58.0
2009	31	215	81	374	38	8	5745	42793	8321	41243	4449	605	185.3	199.0	102.7	110.3	117.1	75.6
2010	33	212	76	352	39	8	5553	39292	7920	39074	4245	530	168.3	185.3	104.2	111.0	108.8	66.3
2011	33	207	75	334	37	8	5662	38221	8965	38342	4319	400	171.6	184.6	119.5	114.8	116.7	50.0
2012	32	198	71	338	37	6	5053	35874	8538	37102	4147	408	157.9	181.2	120.3	109.8	112.1	68.0
2013	28	188	69	324	31	6	4999	35010	9222	36391	3659	386	178.5	186.2	133.6	112.3	118.0	64.3

modified their fishing practices. Fishers may have improved the vessel operation or have invested in improvements of energy efficiency (for example, through replacement of engines or propellers). The observed reduction in daily energy consumption however could be also related to less time spent at sea on a daily basis (shorter daily fishing trips: Cheilari *et al*., 2013). Alterations in normal fishing practices have been observed by skippers in communities of southwest England as an adaptation to the situation (Abernethy *et al*., 2010). Bastardie *et al*., (2010, 2013) have analyzed the effects of changes in fishing practices on fuel consumption and profitability for the Danish fleets. Apart from the social impact (i.e., job losses) the rising fuel prices seem to cause a positive side effect on the fishing effort (almost 25% reduction). The remaining fishing effort may concentrate on traditional fishing grounds closer to the ports, creating new problems, likely increasing the pressure on specific stocks or interactions with other fisheries.

The low vessel productivity (catch per unit of effort) is related the low productivity of fish stocks due to the general state of overexploitation of Mediterranean fish stocks. Indeed, most Mediterranean fish stocks are overexploited (Colloca *et al*., 2013). In European Mediterranean fisheries, 85% of the assessed stocks are overfished compared to a maximum sustainable yield (MSY) reference value; this proportion reaches 100% in FAO/GFCM geographical subarea GSA6 (Colloca *et al*., 2013), where Catalonia is located. Mediterranean fisheries, especially European ones, have been chronically overexploited due to a combination of poor selectivity and high fishing effort and capacity (Lleonart and Maynou, 2003; Samy-Kamal *et al*., 2014; Vasilakopoulos *et al*., 2014).

This has resulted in recommendations to reduce fishing effort and capacity in most Mediterranean fleets (e.g., Ulman *et al*., 2013; Maouel *et al*., 2014; Maynou *et al*., 2014; Dereli *et al*., 2015; Merino *et al*., 2015; Samy-Kamal *et al*., 2015a,b). However, previous fishing effort and capacity reductions in the Mediterranean have proven insufficient. Even if fishing effort and capacity in EU fleets have been decreasing in the last two decades, the escalating catchability (i.e., fishing power) of the remaining fleet units has resulted in non-decreasing fishing mortality (Damalas *et al*., 2014). Selectivity improvements have also been recommended in fisheries worldwide (Broadhurst *et al.*, 1996; Vasilakopoulos *et al*., 2014; Dereli *et al*., 2015). Improving selectivity, in particular reducing catches of the smallest individuals, results in medium to long term higher yields per unit of fishing effort and in greater catch values (Broadhurst *et al.*, 1996; Fonseca *et al.*, 2005a,b). However, economic performance improvements may not be so straight forward in multi-species fisheries, such as the Mediterranean fisheries (Ordines *et al*., 2006; Tosunoğlu *et al*., 2009).

Conclusions

Fuel price increases, together with low fish prices and low productivity are the main reasons for the decrease in the economic performance and fishing activity of the Catalan fishing fleets. Fuel costs can represent up to 50% of the total fishing costs, depending on the fleet. Fishing fleets' economic performance is, therefore, very dependent on the fuel price. Moreover, the large fuel price increases, together with its high variability, have a high impact on the profitability and the fishers' behavior (e.g., reduction in fishing days and changes in fishing practices).

Likewise, decreasing real fish prices (nominal prices increasing less than inflation), together with low productivity (landings and landings per fishing day not increasing over time, despite investments in the sector) also lead to a poor economic performance. However, their trends and variations are not so pronounced as for fuel prices, and may often be not given that much attention.

Conclusively, Mediterranean fisheries, and Spanish ones in particular, may require significant further fishing effort and capacity reductions as well as selectivity improvements to recover their economic performance. Similar effort and capacity reductions, together with selectivity improvements, may also be required in most Mediterranean countries.

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