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Key Economic Characteristics of Italian Trawl Fisheries and Management Challenges

Evelina C. Sabatella[1], Francesco Colloca[2,3], Gianluigi Coppola[4], Fabio Fiorentino[2], Monica Gambino[1], Loretta Malvarosa[1] and Rosaria Sabatella[1]*

[1] NISEA Fisheries and Aquaculture Economic Research, Salerno, Italy, [2] Istituto per l'Ambiente Marino Costiero (CNR IAMC), Mazara del Vallo, Italy, [3] Dipartimento di Biologia e Biotecnologie "C. Darwin," Sapienza Università di Roma, Rome, Italy, [4] Dipartimento di Scienze Economiche e Statistiche, Università degli Studi di Salerno, Fisciano, Italy

Two key measures of economic performance are calculated and analyzed for three important Italian trawl fisheries (Northern Thyrrenian Sea, South of Sicily, Northern Adriatic Sea): the Net Economic Returns (NER), which informs on the economic performance and is considered a proxy of resource rent in fisheries and the Return on Fixed Tangible Assets (ROFTA), which is used as an approximation of the Return on Investment (ROI) and is a key financial and performance indicator for a fisherman in order to take a decision to operate in a fishery. The trend of these indicators over the last decade highlights a poor economic performance that is associated with an overall poor condition of the state of resources. The trend of economic performance indicators is put in relation, on a time-based approach, with the different types of management measures applied over the last decade. We show that trends of fishing effort and economic indicators as well as statistical analysis return a coherent interpretation of the main factors affecting the profitability levels of the selected fleets. The study reveals that management measures impacted negatively on the profitability of the sector in the short run. However, economic indicators inverted the trend in the last 3 years. An increasing biomass trend as well as the improvement in fishing mortality of some few stocks, together with the reduction of input costs could be considered as positive drivers which impacted positively on economic profitability of the fisheries concerned. The study argues that even the technical and fishery management provisions in the Mediterranean Sea may have started to reverse the trend in economic profitability of the analyzed fleets. An additional management effort needs, however, to be developed on an urgent basis in order to ensure the achievement of the management goals defined by the Common Fisheries Policy (CFP).

Keywords: trawl fisheries, economic indicators, management arrangements, challenges, management plans

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Fabio Pranovi, Università Ca' Foscari, Italy

****Correspondence:***
Evelina C. Sabatella
e.sabatella@nisea.eu

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INTRODUCTION

The fishery sector plays an important role in the Mediterranean. The officially reported fishing fleet operating in the Mediterranean comprises some 81,600 vessels, with total landings of 787,000 tons (FAO, 2016). The total value of fish landings across the Mediterranean is estimated to be about 3 billion USD; around 300 thousand fishermen are employed on fishing vessels in the Mediterranean and the Black Sea (Mitolidis and Ziegler, 2017).

The marine resources and ecosystems of this region have come under increasing pressure in recent decades, driven by demographic and economic growth as well as by diversification and intensification of marine and maritime activities. The ongoing fishing pressure is determining a general overexploitation status of commercial stocks with more than 90% of the stock assessed out of safe biological limits (Colloca et al., 2017). In addition, environmental factors play an increasing role in disrupting the productivity of stocks and fisheries as recently observed in the North Adriatic where a reduction in nutrient loading (phosphate) during early 1980s seems to have contributed to a major decline in fisheries landings (Fortibuoni et al., 2017).

Deterioration in the status and prolonged overexploitation of some fish stocks are undermining the economic performance of EU Mediterranean fleets (DGMARE, 2017) that decreased in the last decade (STECF, 2015b). The decline in economic profitability was also driven by other factors in combination with the effects of overfishing: poor marketing and market saturation; increased competition with imported products; increasing costs (e.g., fuel costs) and a shortage of local crews (DGMARE, 2017).

Within this context, the sustainable utilization of living marine resources and the implementation of rational management in the Mediterranean are of paramount importance to achieve a long-term sustainability of fisheries. Over the years, various measures have been adopted by the European Commission and the General Fisheries Commission for the Mediterranean (GFCM), with the aim of achieving sustainable levels of fishing pressure and safeguarding habitats. The Common Fisheries Policy [CFP, Regulation (EU) 1380/2013, (EU, 2013)] requires to restore and maintain populations of harvested stocks above levels that can produce the maximum sustainable yield (MSY). Even without identifying specific economic and social objectives, the CFP calls for both economic and social sustainability by specifying that management measures should "contribute to a fair standard of living for those who depend on fishing activities, bearing in mind coastal fisheries and socio-economic aspects" (art. 2 of EU Reg. 1380/2013, EU, 2013). Indeed, environmental and economic sustainability are not contradictory goals; several studies confirm that achieving MSY will result in economic gains because fishing at MSY or lower will lead to higher incomes and lower operational costs (Beddington et al., 2007; Guillen et al., 2016).

In this context, management strategies have been implemented in the Mediterranean with the general aim to ensure biological, environmental, and economical sustainability, even if most of these measures do not adequately specific targets in terms of biomass (B_{MSY}) or fishing mortality (F_{MSY}) at MSY. The assessment of both the biological and economic impacts generated by the management measures included in regulatory framework is a difficult task, also considering the high number of derogations asked by EU Mediterranean Member States in the implementation phase of several measures.

In the present study, we aimed at addressing the effects of prices dynamics (e.g., fuel costs, average prices of landings) and enforced management measures on EU Mediterranean trawl fisheries by focusing on three important Italian fleets (Northern Tyrrhenian Sea, South of Sicily, and Northern Adriatic Sea). To this aim we reviewed in a diachronic way all available economic data and model economic indicators to investigate the main factors that affected the trend in economic profitability of the selected fleets. The relationships between observed pattern of economic indicators with the management measures enforced in the last 10 years were analyzed to evaluate their impacts on the fisheries profitability.

MATERIALS AND METHODS

Area of Study and Selected Fleet Segments

The study was focused on three trawl fleets representing 56% of Italian bottom trawlers and operating in important fishing areas (FAO Geographical Sub Areas: GSA) namely Northern Tyrrhenian Sea (GSA 9), South of Sicily (GSA 16) and Northern Adriatic Sea (GSA 17), (see **Figure 1**).

GSA 9 extends over 42,410 km^2 and includes the Ligurian Sea and the central Tyrrhenian Sea. The fishing fleet operating in the upper and middle Tyrrhenian Sea is marked by a high proportion of small-scale fishing, although trawlers provide the highest levels of actual and economic output. In 2015, around 300 trawlers employing 800 persons on board operated in GSA 9. Almost 50% of total landings are represented by five species: red mullet (*Mullus barbatus*), European hake (*Merluccius merluccius*), horned octopus (*Eledone cirrhosa*), deep-water rose shrimp (*Parapenaeus longirostris*) and spottail mantis squalid (*Squilla mantis*). According to the most recent stocks assessments carried out by GFCM/SAC (2016) and STECF (2015a), European hake and red mullet are exploited unsustainable and only deep-water rose shrimp shows sustainable exploitation rates in recent years.

GSA 16 represents the northern part of the Strait of Sicily. It is considered an area with a high productivity of fish resources, covering about 34,000 km^2. The production structure of the area is characterized by a strong presence of bottom trawling boats that give the sector an industrial connotation. The productive structure engaged in GSA 16 trawl fishery in 2015 consisted of 413 trawlers, 27% of which are bigger than 24 m. Around 1,800 persons worked on board of these vessels. Differently from other areas bottom trawling is targeted mainly to crustaceans, deep-water rose shrimp (*P. longirostris)*, giant red shrimp (*Aristaeomorpha foliacea*) and European hake (*M. merluccius*) representing almost 60% of total landings. All these three species show a general overfishing condition (STECF, 2015a).

GSA 17 covers the entire northern and central Adriatic with a total area of some 92,660 km^2. Most of the sea floor is on the continental shelf and is covered with muddy and sandy sediment of varying granulometry and composition. The trawl fleet operating in GSA 17 consisted, in 2015, of 578 vessels with an on-board employment of about 1,700 units. The main commercial species are spottail mantis shrimp (*S. mantis)*, European hake (*M. merluccius)*, red mullet (*M. barbatus*), common cuttlefish (*Sepia officinalis*), musky octopus (*Eledone moschata*), representing 40% of total production. Red mullet, European hake and the spottail mantis shrimp have been overexploited in recent years (STECF, 2015a).

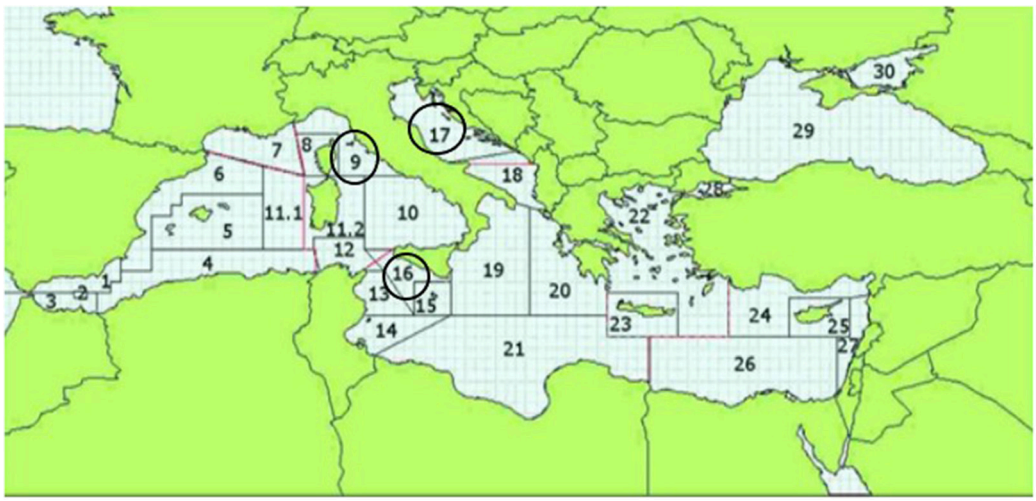

FIGURE 1 | FAO Geographical Sub Areas.

Management Measures

In line with the advice of most international fisheries management bodies, particularly the GFCM, for a long time a management regime based on effort has been considered the most appropriate management strategy for the Mediterranean (Caddy, 2009). The management scheme includes effort control tools (permanent and temporary withdrawal) combined with technical measures, such as closure of areas and seasons, restrictions concerning fishing gears and minimum landing sizes of main commercial species. The main management measures implemented in the selected area are summarized in **Table 1**.

Reg. (CE) 1967/2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea (hereafter referred to as "the MEDREG") introduced several technical measures and promoted "a different approach to fisheries management based on a decentralized decision-making process and on setting up multi-annual management plans both at national and community level" (EC, 2006; Marchal et al., 2016). In the selected GSAs, four national management plans for trawlers were adopted in 2011. The management plans were based on permanent withdrawal of an agreed number of trawlers to decrease the fishing effort and some additional measures (see **Table 1**), as temporary withdrawals and restrictions to trawling of nurseries to improve the exploitation pattern of catch.

In this study, we associated the timing when the different management measures were implemented with the timing when they started to impact on the fishing activities. In particular, we considered the following turning points:

MEDREG: Implementation of MEDREG. It was approved in 2006 but the innovations with the greatest impact became effective as from 2010.

NMFPs: Adoption of National Management Fishery Plans (NMFPs), May 2011.

FishBan6m: Fishing ban within the 6 miles. Since 2012, trawling is prohibited within a distance from the coast of 6 miles or with a depth of <60 m after the seasonal closure in North Adriatic Sea. Before 2012, the same ban applied only within 4 miles. A similar measure was introduced in 2013 through the local management plans in GSA 16, in the area out of Mazara del Vallo and Lampedusa.

EFF b-b p: EFF buy back program. In 2013, around 13% in GT of the Italian Mediterranean fleet was withdrawn (MRAG, 2013).

These turning points have been introduced in the statistical analysis to assess their eventual impact on the profitability of the selected fishing fleets.

Fisheries Data and Economic Indicators

Time series for the period 2004-2015 on capacity, effort, production, and economic information for the selected fleet segments were obtained from relevant STECF reports and electronic data annex tables (https://stecf.jrc.ec.europa.eu/reports/economic). These datasets were complemented with economic data from the Italian National Program under the European Data Collection Framework (DCR, Reg. CE 1543/00 until 2008 and DCF, Reg. EU 199/08 DCF, thereafter), as well as data included in Mannini and Sabatella (2015). Economic data collected under DCR/DCF include several variables such as income, personnel costs, energy costs, repair and maintenance costs, other operational costs and capital costs (depreciation and opportunity cost of the capital). Definition of variables and methodologies for estimation are prescribed in the DCF through coordination activities carried out by European expert groups (Sabatella, 2016).

A wide range of economic indicators exists for analyzing the economic sustainability of fisheries (Ceriola et al., 2008). Among these indicators, we selected the Net Economic Returns (NER)

TABLE 1 | Management measures for demersal trawlers in GSA9, GSA17, and GSA16 from 2002.

Legislative references		Period of implementation	Management measures	Description
Regulation (EC) No. 2371/2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy (articles 11 to 16, Adjustment of fishing capacity) (EC, 2002)	Council Regulation (EC) No 2792/1999 Financial Instrument for Fisheries Guidance (FIFG)	2002–2006	Adjustment of fishing capacity	Objectives were established in relation to two reference parameters (fleet tonnage and engine power, as of 1 January 2003) and through continuous monitoring of the differential between new entries and exits from the fleet
	Council Regulation (EC) No 1198/2006 European fisheries fund (EFF)	2007–2013	Fleet capacity reduction	Decommissioning Plans have been drawn up in order to quantify the objectives of permanent withdrawal required by the EFF and to activate the measure of temporary withdrawal
Reg. (CE) 1967/2006 concerning management measures for the sustainable (EC, 2006) exploitation of fishery resources in the Mediterranean Sea (MEDREG)	Chapter III MEDREG Fishing Protected Areas Chapter IV MEDREG Restrictions Concerning Fishing Gears Chapter V MEDREG Minimum Sizes of Marine Organisms	Approved in 2006 but the innovations with the greatest impact became effective as from 1 June 2010	Minimum mesh sizes	For towed nets, the net shall be replaced by a square-meshed net of 40 mm at the cod-end or, at the duly justified request of the ship-owner, by a diamond meshed net of 50 mm.
			Minimum distances and depths for the use of fishing gears	The use of towed gears is prohibited within 3 nautical miles of the coast or within the 50 m isobath where that depth is reached at a shorter distance from the coast. In any case, the use of trawl nets is prohibited within 1.5 nautical miles of the coast. In GSA 9, a derogation allows to use towed gears between 0.7 and 1.5 nautical miles of the coast.
			Minimum sizes of marine organisms	A marine organism which is smaller than the minimum size specified in Annex III shall not be caught.
			Restrictions concerning fishing gears	Fishing with trawl nets, above seagrass beds of *Posidonia oceanica* or other marine phanerogams and mäerl beds is prohibited.
	Chapter VII MEDREG Management Plans	May 2011—December 2016 Ministerial Decree 20 May 2011, approval of National management fishery plans (NMFPs) Ministerial Decrees implementing the seasonal closures (one Decree is issued every year)	Seasonal closures	Each year a temporary closure is established for bottom and mid-water pair trawlers. Thirty to forty-five days of seasonal closures is set based on the recruitment season of the most significant target species.
			Other restrictions on fishing activities	Bottom and mid-water trawlers cannot operate on Saturdays, Sundays and during holidays all year round. During the 8 weeks following the seasonal closures trawlers cannot operate on Friday
			Restrictions to Essential Fish Habitat (mainly nurseries)	Biological Protection Zones (BPZ) have been established; in these areas, towed gears are not allowed to fish 2 BPZs in GSA9, 5 BPZs in GSA17, 2 BPZs in GSA16. The ZTBs in the GSA 16 have not been yet implemented.
			Restrictions to trawling areas	Since 2012, trawling is prohibited within a distance from the coast of 6 miles or with a depth of <60 m from July to October in GSA 17 (North Adriatic Sea)
Reg. (EU) No 1380/2013 on the Common Fisheries Policy (EU, 2013)	Article 22 CFP	2016	Action plan for the fleet segments with identified structural overcapacity	5.5% of reduction of fishing capacity for trawlers in 2016

(Continued)

TABLE 1 | Continued

Legislative references		Period of implementation	Management measures	Description
	Article 22, Annex II CFP	1 January 2014 - ongoing	Adjustment and management of fishing capacity	fishing capacity cannot exceed at any time the fishing capacity ceilings set out in Annex II (for Italy 173,506 GT and 1,070,028 kW)
	Article 15 CFP Commission Delegated Regulation (EU) 2017/86 establishing a discard plan for certain demersal fisheries in the Mediterranean Sea	1 January 2017 - ongoing	Landing obligation	All catches of species subject to minimum conservation reference sizes as reported in Annex III of Regulation (EC) No. 1967/2006, must be brought and retained on board fishing vessels, registered, landed and counted against the quotas, if applicable, unless they are used as live bait (EC, 2006)
REC.CM-GFCM/40/2016/4 establishing a multiannual management plan for the fisheries exploiting European hake and deep-water rose shrimp in the Strait of Sicily (GSA 12 to 16)		February 2016 – ongoing *Not yet fully implemented by EU and national legislation*	Technical measures (Fisheries Restricted Areas, temporal closure, list of operating vessels)	Three Fisheries Restricted Areas (FRA) where bottom trawling is prohibited have been established. Buffer areas have been set up around the FRA in order to avoid accidental access to the FRA. Any fishing activity with bottom trawlers in the buffer areas shall ensure their frequency of transmission of vessel monitoring system (VMS) signals.
Ministerial Decree 1 June 2017		From 1 September 2017	Marine Manag. Area in Pomo Pit (GSA 17)	Absolute ban of demersal fisheries in the larger central part of the area Two buffer areas with restricted fisheries regime

and the rate of Return on Investment (ROI) because they are two key measures of economic performance (ABARES, 2016).

NER, also known as Earning Before Interests and Taxes (EBIT), informs on the economic performance and is considered a proxy of resource rent in fisheries. ROI is a financial performance measure and it affects the fisher's decision to operate in a fishery. The definitions of these indicators are as follows:

$$NER = revenues - (explicit\ costs + capital\ costs)^1$$

$$ROI = (NER/total\ investment)*100^2$$

NER measures the returns earned from a fishery's operation across a financial year. It is an indicator of the efficiency by evaluating the total costs of inputs (excluding natural resource costs) in comparison to outputs or revenue (STECF, 2015b). The concept and economic interpretation of NER differ from the "gross profit" which is the normal profit after accounting for operating costs, excluding capital costs, giving an indication of the commercial profitability of an industry. This means that negative gross profit is tolerable only for a very short period (depending on the availability to access to credit), while a negative NER for a short period does not imply the financial unsustainability of the fishing activity but it indicates a non-efficient use of resources in a macroeconomic concept. NER has been calculated for the selected fleets for the period 2004-2015. Economic values have been adjusted to 2015 level using the Italian index of inflation rate (ISTAT, 2016).

ROI measures the profitability of a sector in relation to its total assets. The purpose of ROI indicator is to measure, per period, rates of return on money invested in an economic entity to decide whether to undertake an investment. It measures the financial profit at full equity as a percentage of total capital for the average vessel in a fishery. ROI compares the long-term profitability of the fishing fleet segment to other available investments. A value less than zero or smaller than the low-risk long term interest rates available elsewhere, is an indication of long-term economic inefficiency and overcapitalization. The capital invested in the sector should include both tangible and intangible assets. In the fishing sector, vessels, fishing gears, and other equipment can be considered as tangible assets; while intangible assets are generally referred to the fishing rights. When data on intangible assets (fishing rights) is not included in the calculation of this indicator, the name "Return on Fixed Tangible Assets (ROFTA)" is preferred to ROI. As data on intangible assets (e.g., fishing rights, natural resource) are not always available in fisheries, ROFTA is used as an approximation of ROI (STECF, 2012).

Statistical Modeling

A random effect model using the Generalized Least Square (GLS, Green, 2012) estimator was applied to estimate the effects of input and output prices, as well as selected management measures on

[1]Where:
Revenues = value of landings + other income (income from vessel activities other than fishing)
Explicit costs = all operational costs (such as wages, energy, repair and other variable and non-variable costs)
Capital cost = depreciation + opportunity cost of capital
[2]Where:
Total investment = tangible and intangible asset value

NER. Annual data 2004-2015 have been organized by GSA, NER, Revenues, Costs, Fuel prices and average landing prices.

An "indirect NER function" was estimated assuming as dependent variable the ratio between revenues and total costs and independent variables the average price of landing and the average cost of the fuel. All the variables are in logarithms. In the loglinear equation, the coefficient are elasticities. β_x measure the percentage change in NER associated with a one percent change in each explanatory variable.

$$\log \mathrm{NER_t} = \beta_1 \log(\text{price of landings})_t + \beta_2 \log(\text{fuel cost})_t + \beta_3 \,\text{dummy} + \mathrm{cons_t}$$

The management measures identified as "turning points" were introduced as dummy variables. We considered four dummies, each one for a single measure. They have been introduced in the model considering the year from when they started to likely impact the fishing sector (**Table 2**). When a new measure is introduced, its impact is added to the impact of measures already in place.

RESULTS

Over the period 2004-2015, in line with the fishing effort adjustment process stimulated by public funding, negative changes have been recorded for all physical capacity indicators. The trawl fleets decreased in number by 36% in GSA 17, 15% in GSA 09 and 20% in GSA 16. Gross Tonnage (GT) showed a similar decrease (**Figure 2**). The reduction in fleet capacity highly affected the activity levels. Days at sea in GSA 17 decreased by more than 50% from 2004 to 2015 (**Figure 3**). As a consequence of the adjustment of the effort levels, the volume of fish production of the trawler fleets in the selected GSAs, decreased in the last decade by 48% in GSA 17, 31% in GSA 16 and 8% in GSA 9.

Regarding the economic indicators, trawlers in the three selected GSAs showed a decreasing trend of ROFTA until 2012-2013 followed by an increase in the last 2–3 years, with the lowest performance observed in GSA 16 (**Figure 4**). The NER trends across the fisheries showed a similar pattern for the three fleets, with a constant decrease in the period analyzed (**Figure 5**). All the fisheries have experienced a negative NER at some point since 2008 achieving a minimum in 2012-2013. An increase in NER was observed in the last 3 years of the period under analysis.

The trend in NER was a likely effect of a combination of various factors. Five different estimates of the Indirect NER function were produced (**Table 3**) to statistically assess the impact on profitability of input costs (namely fuel cost), average landing prices and the introduction of management measures. The results, despite the limited number of observations, highlighted that the variable related to landing prices is not significant, meaning that trend in real landing prices did not explain the trend in NER, while the fuel price is always significant with the (expected) negative sign (**Table 3**).

The impact on profitability of the introduction of management measures has also been simulated in the model through the introduction of four dummies. The management measures considered in the model are those with the supposed higher impact on fishing activities. They are reported in **Figure 5** together with the trend of NER from 2004 to 2015, adjusted to 2015 level. The results of the models confirm that all dummies are significant with a probability lower than 10% and negative as well. In the fifth output of the model, the logarithm of fuel cost and the dummy assuming 0 for the years 2004 and 2012 and 1 for the year 2013 report p(value) lower than 0.01. These results seem to confirm that the introduction of management measures impacted on profitability. Indeed, the parameters of the statistical analysis are negative, confirming that in the short run the economic impact of the measures was negative in terms of profitability because they imposed additional costs to adapt fisheries to the new rules.

In synthesis, over the last decade, the trawling fleets in GSA 9, GSA 16, and GSA 17 followed similar trends, summarized in a reduction of the production structure, decline in capacity and activity, and decrease in physical and economic returns. However, economic indicators (NER and ROFTA) inverted the trend in the last 3 years (2013-2015). These improvements are linked to reductions in fishing capacity associated with fishery level cost decreases. Stock variation and management changes are additional factors that could eventually have positively impacted on economic indicators. Considering the availability of data and the short time series, it is not possible to assess if the inverted trend of the last 3 years is a structural one, or just a fluctuation due to market conditions and oscillation of input prices.

TABLE 2 | Selected management instruments introduced in the statistical modeling.

Management instruments/measures	Dummy code	Starting year
MEDREG	du10	2010
MEDREG + NMFPs	du11	2011
MEDREG + NMFPs + FishBan6m	du12	2012
MEDREG + NMFPs + FishBan6m+EFF b-b p	du13	2013

DISCUSSION

We showed that the nominal fishing effort has decreased remarkably in the last 10 years. This reduction was accompanied by a structural resizing of the productive structure even in terms of total landings. The capacity reduction was stimulated by public funding but also by a voluntary departure from the sector due to the general obsolescence of the fishing fleets and to economic factors, such us the low physical productivity and the increasing operating costs. Despite the reduction in the number of vessels and gross tonnage of the fleet, the results of stock assessments demonstrate that stocks are still largely overfished and/or in a bad state (European Commission, 2016). However, the ratio F/FMSY for some important target stocks of demersal fleets like red mullet and giant red shrimp has significantly declined over time, even if the value is still above 1 (2.5 and 1.1, for red mullet and giant red shrimp, respectively), as shown by Cardinale and Scarcella (2017).

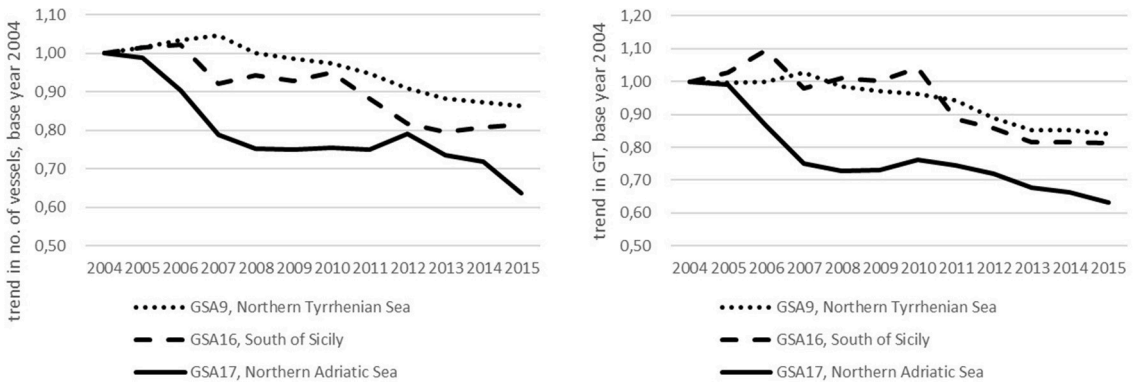

FIGURE 2 | Trend in capacity of the trawling fleet in selected GSAs.

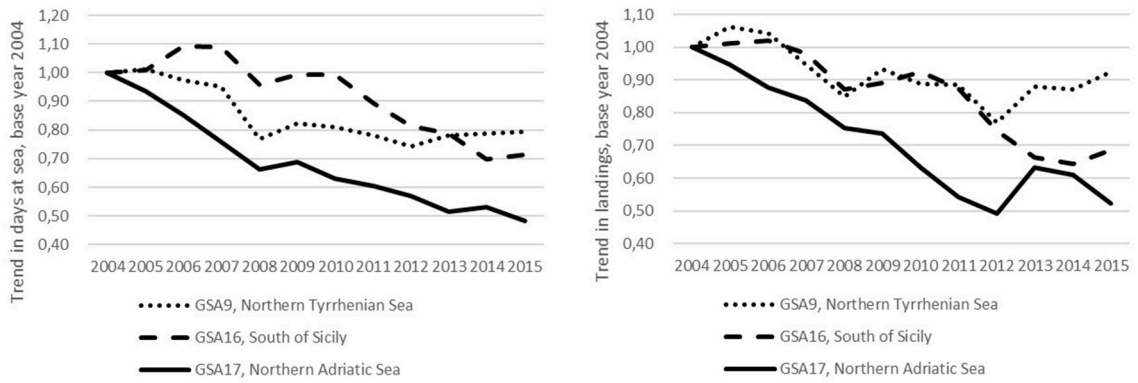

FIGURE 3 | Trend in activity and production of the trawling fleets in selected GSAs.

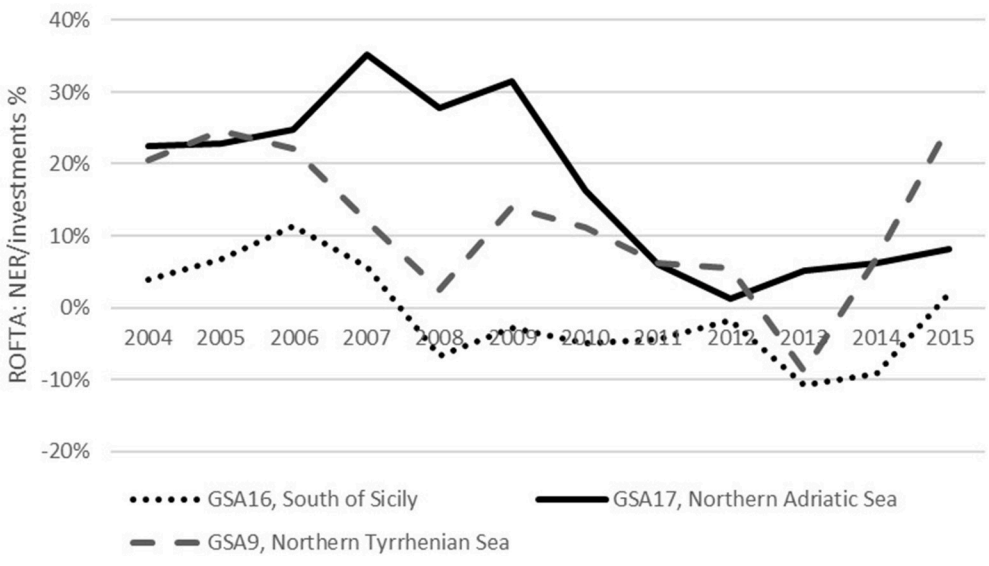

FIGURE 4 | Rate of return for selected European fishing segments operating in the Mediterranean.

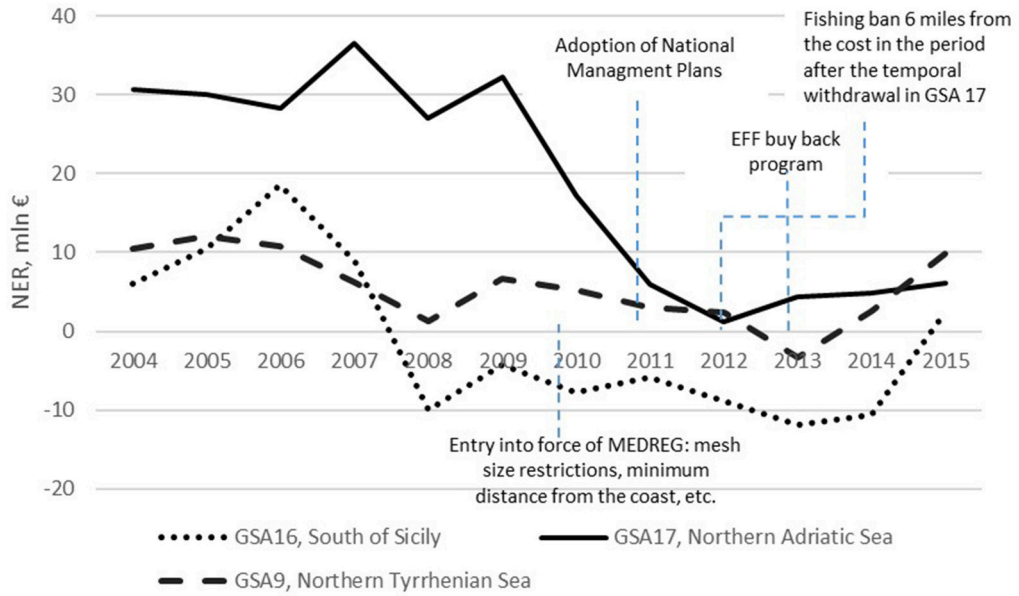

FIGURE 5 | Net Economic Return for selected European fishing segments operating in the Mediterranean.

TABLE 3 | The Indirect NER function.

Variable |	I	II	III	IV	V
llandprice |	0.0209				
lfuelprice |	−0.0911	−0.0837*	−0.0834*	−0.1119**	−0.1367***
du10|	−0.0532*	−0.0564***			
du11|			−0.0556***		
du12|				−0.0486***	
du13|					−0.0549***
constant |	0.0080	0.0544	0.0522	0.0323	0.0187
N |	36	36	36	36	36
sigma |	0.0470	0.0965	0.0967	0.0974	0.0969
r2_o |	0.2485	0.2461	0.2384	0.2198	0.2347

*The Econometric Results. Years 2004-2015. legend: *p < 0.1; **p < 0.05; ***p < 0.01.*

Data analysis also presented the critical economic status of the trawling fleets. The negative trend in the NER highlighted the inefficiency of the sectors that is not able to cover the total costs of inputs (excluding natural resource costs) with the revenues obtained by output values. Even the profitability of the sector in relation to its total assets, presented in terms of ROFTA, showed very low if not negative values, thus indicating a situation of long-term economic inefficiency and overcapitalization.

We showed that analysis of trends (effort, production, and economic indicators) and statistical analysis return a coherent interpretation of the main factors affecting the profitability levels. Input prices (and in particular fuel price) in the model were significant and negative, while average landing prices were not explaining the trend in NER. The results of the analysis reinforced the expectation that management measures impacted negatively on the profitability of the sector in the short run. Indeed, once a measure is introduced, the sector should adapt the fishing modalities to the new rules and this process requires new investments and/or increased costs. However, in the medium to long-term period, the introduction of management measures, if effective and if well implemented, should lead to an improvement in the overall state of resources. This fact, together with the overcoming of the adaptive period, should increase the profitability of the concerned fleet. Actually, the data reported in this study, showed a trend change of the economic indicators (NER and ROFTA) in the last 3 years which started to increase. An increasing biomass trend of red mullet and striped red mullet in GSA 15-16 as well as the improvement in fishing mortality level of deep sea pink shrimp in GSA 9 (STECF, 2015a) could be considered as positive drivers which impacted positively on economic profitability of the fisheries concerned. Even the technical and fishery management provisions in the Mediterranean Sea, especially those managed through national management plans, could be considered as drivers producing positive effects in the long term. However, it has to be noticed that the evaluation of the impact of all these drivers is not sufficiently robust from a statistical view because available time series are still too short and because the management measures introduced by the CFP are not yet fully implemented.

The present scenario of EU Mediterranean fisheries is driven by the political concerns with respects to the achievement of the CFP goals. Considering that the exploitation of Mediterranean shared stocks implies a multiple management levels, where the management of resources is outside the responsibility of the individual states, GFCM and European Commission

are undertaken several common actions to enforce a rational management and best utilization of living marine resources. GFCM recently implemented the multiannual management plan (MAP) for the demersal fisheries exploiting hake and deep-water rose shrimp in the Strait of Sicily (GSAs 12-16). This MAP represented a clear attempt in the development of a science-based management (Vielmini et al., 2017).

All these recent actions will impact on the biological aspects of the demersal resources as well as on the economic viability of the concerned fisheries. It is premature to forecast the potential impact of these new measures still under implementation. Economic theory suggests that the introduction of new management measures leads to economic losses in the short terms because fisheries need time to adapt to regulation adjustments (Sutinen and Peder, 1985). As shown before, the profitability of the selected trawling fleets is improving, but it is not certain that this improvement is robust enough to internalize the possible shocks coming from the introduction of the new proposed management measures. However, new and more effective management instruments, like Long Term Management Plans, updated National Management Plans based on MSY target and Harvest Control Rules, are needed to face the critical state of Mediterranean resources and ensure a long term economic sustainability of fisheries.

AUTHOR CONTRIBUTIONS

ES: substantial contributions to the conception or design of the work; the acquisition, analysis, and interpretation of data for the work; and drafting the work; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. FC: substantial contributions; revising it critically for important intellectual content; and final approval of the version to be published. GC: data analysis and statistical modeling and final approval of the version to be published. FF, MG, LM, and RS: substantial contributions; revising it critically for important intellectual content; and final approval of the version to be published.

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