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Recent trends in the productivity of the Italian trawl fishery: The importance of the socio-economic context and overexploitation

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ABSTRACT

The aim of this paper is to highlight the productivity of Italian trawl fishery, one of the most important sector in the Italian fishing fleet. As shown in this study, three variables play a significant effect on Total Factor Productivity (TFP) in a given year: the actual number of fishing days, the average market prices of commercial species and the stock of physical capital. While the number of fishing days can have a negative impact on the TFP, a positive correlation occurs instead with the other two variables. It is also possible to observe a high variability in TFP among different regions of Italy, a finding that is to be expected given the dual nature of the Italian economy, characterized by a high level of discrepancy in prosperity between the North and the South. This lends support to the hypothesis that significant positive externalities may occur in a more dynamic business environment, one which is both open to innovation and increased international and social relations.

1. Introduction

The new Common Fisheries Policy (CFP, EU Reg. 1388/2013) explicitly calls for long term sustainable and economically viable fisheries in Europe with strategic objectives to be achieved by 2020. The CFP is part of the Europe 2020 Strategy, which aims to delivering growth through more effective investment in education, research and innovation. In the next decade, economic growth in European countries will have to prove its capability to rest itself on the two main pillars of sustainability, in terms of low impact on the environment, and inclusivity, i.e. increased capacity to produce new jobs and reduce poverty.

In this context, the CFP is supposed to contribute to increase the productivity of fishing enterprises, stabilizing the market and ensuring the availability of food supplies and the long-term environmental, economic, and social sustainability of fishing activities. These ought to be managed in order to achieve a balance between fishing capacity/effort and fishing opportunities and in turn sustain economically viable fleets without overexploiting marine biological resources.

While the economic performance of North European fishing fleets has been improving in the period 2008–2015 due to an increased number of sustainable fish stocks leading to increased productivity, the economy of European fleets in the Mediterranean and Black Sea remains stagnant [1,2]. In these latter regions, the economic trends of several fleets has been negative in the period 2008–2013 [2] as a likely effect of generalized overexploitation of commercial stocks and poor management [3,4]. A particularly worrying situation for Italian fisheries was brought to light when, in 2013, a fleet of 12.635 vessels, corresponding to 164.000 GT and about 1.019.000 kW, produced about 173.000 t [5]. In the same year, the value of annual landings totalled about 834 million euro. Both the quantity and value of the annual landings had decreased respectively by 24% and 32% respectively since 2008 without a corresponding contraction of the fleet (−8%). The number of employees also declined (−10% since 2008). The poor performance in the Italian fishing sector during the period 2008–2013 was highlighted by the decrease of the Gross Value Added (GVA, −32%), the gross profit (−44%) and the net profit (−77%). The general crisis in the sector was also confirmed by the trend observed in profitability indicators, such as net profit margin and the RoFTA (Return on Fixed Tangible Assets) indicators, which have decreased respectively by 67.3% and 54% in the same period [2]. Although the status of the main commercial stocks is well known [6], there is still a poor understanding of the economic variables that, combined with a reduced biomass stocks, are affecting the profitability of Italian fishing enterprises.

Since productivity is an important driver of firm profitability, the aim of this paper is to highlight the productivity of Italian trawl fisheries, one of the most important entities in the Italian fishing fleet.

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Comprising some 2.400 vessels and 8.000 fishers, located in several ports along the Italian coast, Italian trawlers' annual production was about 30% of the total national fishing production, equal to 61.700 t in 2012, for a value of 433 million euro [7]. Despite their presumable importance for the Italian fishing sectors, there have been no studies of productivity levels and determinants, although in other countries an extensive international literature on the productive capacity of commercial fisheries is growing [8].

In this study, a two-stage productivity analysis of the Italian trawl fisheries was carried out in order to clarify the main circumstances affecting the Total Factor Productivity (TFP) and its breakdown (efficiency, technological change, pure technical efficiency and economies of scale). The Italian trawl fishery TFP was measured using the Malmquist index [9,10], estimating the production frontier by Data Envelopment Analysis [11,12]. In a second stage, we analyzed the relationship between TFP, its breakdown, and a set of explanatory variables to approximate the intensity of fish exploitation, the operational capacity of trawlers, and the intensity of accumulation processes of physical and social capital in each region.

In order to do so, it was necessary to use the fishing economic dataset for the Italian regions [13] provided as part of the National Statistical System (Sistan) and the physical and social capital dataset provided by the Italian National Institute of Statistics (Indicators for the territorial development policies). According to the available economic data on bottom trawling of Italian regions, the study focused on the period 2008–2012.

2. Materials and methods

2.1. Productivity estimation

In order to measure the productivity of the bottom trawl fishery in the Italian regions, a non-parametric technique known as Data Envelopment Analysis (DEA) was adopted. Within the DEA approach, the production-possibility frontier of the bottom trawling industry can be obtained by solving a system of linear equations based on data at a regional level. Unlike the stochastic approach, DEA can determine the production frontier without resorting to a previously defined production function, thus avoiding the errors of measurement and the assumptions associated with the latter procedure. Moreover, DEA allows preservation of the symmetry in the output mix, which is important when studying multi-species fisheries [14], such as the Italian trawl fisheries. Once the production frontier has been estimated, DEA compares the outcomes of each region with the frontier, thus obtaining an indicator of relative performance [15,16].

According to the DEA estimation, total revenue was used as a measure of output, while using fixed costs, variable costs and labor costs to represent inputs. No measure of biomass was used. Although international literature suggests normalizing productivity estimates by biomass [8,17], it was considered that this approach is not applicable to our case study. Italian trawl fisheries work in a large multi-species context and the catch is characterized by a mix of fish and shellfish species mostly lacking in biomass estimates. Accordingly, it would be arbitrary to use any biomass indicators, because it might lead to misleading productivity measures [18,19]. Since the Mediterranean Sea is overexploited [3], it can moreover be assumed that there is a reduced biomass annual variability.

In our application, the Malmquist total factors productivity index (m_0) was used as indicator of relative performance. In formal terms:

$$m_0 = \left(\frac{d_0^{t+1}(x^{t+1}, y^{t+1})}{d_0^{t}(x^{t}, y^{t})}\right) \times \left[\frac{d_0^{t}(x^{t+1}, y^{t+1})}{d_0^{t+1}(x^{t+1}, y^{t+1})} \times \frac{d_0^{t}(x^{t}, y^{t})}{d_0^{t+1}(x^{t}, y^{t})}\right]^{1/2} \quad (1)$$

where d_0 and d_0^{t+1} represent the distances between regional annual data and the national production frontier at the time t and $t+1$, and where (x^t, y^t) and (x^{t+1}, y^{t+1}) represent the Cartesian coordinates associated with inputs and output at time t and $t+1$.

The relationships in parenthesis measure the relative "technical efficiency". These capture the spread of technology, the ability to use it and, more generally, the structural differences in economies. The relationships within the square brackets measure the geometric mean of production frontier shift between the time t and t +1 according to inputs used in the two different times (x^t and x^{t+1}). In this way, this provides information on new production techniques, innovations and, technological change.

Both the first part of the index (the measure of efficiency) and the second part (the measurement of "technical change") can assume values greater, less than, or equal to one. The value one indicates the absence of any temporal change, while values greater or smaller than one are correlated respectively to the presence of progress or deterioration in the indexes. Since the TFP is the product of these two components, it can assume values in the neighborhood of one, with the same meanings previously described.

The productivity index of Malmquist, as described, refers to an assumption of constant returns to scale. Färe et al. [20] propose a further decomposition of the index, dropping the assumption of constant returns in favor of variable returns to scale. Under this new condition, the "technical efficiency" is divided into two sub-components: "pure technical efficiency" and "scale variations". The first one measures the ratio of distances between observed points from production frontiers at variable returns of scale (homogeneous functions of second order), whilst the second one has a residual nature and captures the efficiency differences between constant and variable returns to scale.

In this form, the index of Malmquist was used to consider the TFP as a product of "technical efficiency" and "technological change", $TFP = EFF \times TECH$, and then to measure "technical efficiency" as the product of "economies of scale" (SE) and "pure technical efficiency" (PE): $EFF = SE \times PE$.

2.2. Determinants of productivity

In order to understand the role of the economic and social context for bottom trawling productivity of Italian regions, regression models for panel data were estimated. The dependent variables are the TFP and its breakdowns (i.e.: efficiency, technological change, pure technical efficiency and economies of scale), which are measured in terms of annual changes. To take into account both the intensity of fish resource exploitation and key aspects related to the socio-economic context, the following predictors were selected: fleet capacity measured as total kW, total annual number of fishing days, fish prices, the stock of physical capital accumulated in each region and the percentage of cooperative societies.

Total kW and total annual number of fishing days aim to capture the effect of the specific industry on productivity. In particular, engine power summarizes the investment intensity, while fishing days measure the fishing pressure on fish stocks. In the presence of collective resources, as reported in a pioneering article by Gordon [21], firms tend to invest in excess and over-exploit resources. At a constant catch rate, fishing overexploitation increases production costs and progressively reduces return on investment. This specific condition also reduces individual motivation to innovate, with direct negative effects on the overall productivity of industry.

To offset the higher production costs due to over-exploitation of fish stocks, companies and producer organizations can act on prices, implementing specific marketing policies and differential pricing strategies. Such policies and strategies, increasing revenues, can stimulate motivation to innovation and in this way generate improvements in productivity. In this sense, the average price of fish and shellfish (considered as a predictor) may capture the specific effect of these policies and strategies on productivity.

Propagation of knowledge, dissemination of new technologies and sharing of best production practices are not the result of isolated