Marine Policy 33 (2009) 860–867

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Capacity and economic efficiency in small-scale fisheries: Evidence from the Mediterranean Sea

Fabio A. Madau [a,*], Lorenzo Idda [b], Pietro Pulina [a]

[a] University of Sassari, Via E. De Nicola 1, 07100 Sassari, Italy
[b] National Institute of Agricultural Economics (INEA), Via E. De Nicola 1, 07100 Sassari, Italy

ARTICLE INFO

Article history:
Received 30 April 2008
Accepted 30 March 2009

Keywords:
Small-scale fleet
Fishing capacity
Technical efficiency
Common fisheries policy
Data envelopment analysis

ABSTRACT

To design an effective capacity management plan for small-scale fisheries one must understand what one is measuring and define its capacity. As recognized by some authors, overcapacity is a problem that generally affects small-scale fisheries just as much as it does other types of fishing. This study aims to estimate fishing capacity, technical efficiency, scale efficiency and capacity utilization in a particular small-scale fishery in the Mediterranean, i.e., the Northwest Sardinian fleet in Italy. A non-parametric approach using a data envelopment analysis (DEA) model was applied to a sample of trawls in order to estimate their economic capacity, and related measurements were taken. The capacity and efficiency with reference to two different alternative scenarios were also calculated.

1. Introduction

It is well known that the fishery resources of the world are currently overexploited and excess harvesting capacity is universally recognized as a major problem for fisheries throughout the world. Since the late 1990s—when the Food and Agriculture Organization (FAO) of the United Nations started treating the problem of capacity as a political priority—several institutional agreements and policies have been aimed at reducing overall fleet capacity.

In order to manage fishing capacity and to reduce excess capacity, policy makers first need to evaluate the level of overcapacity in a fleet [1–4]. This means that information about the current and desired levels of capacity is of strategic relevance when designing rational management regulations.

In the European Union (EU), a sustainable balance between resources and fishing capacity is today one of the main objectives of the common fisheries policy (CFP). In order to promote this, the EU introduced the multi-annual guidance programmes (MAGPs). In these capacity reduction goals are long-term and measured in terms of fishing-effort; i.e., the gross tonnage (GT) and engine kilowatt (kW) power of the vessels. In January 2005, the CFP removed subsidies for modernization and renewal of the fleet in order to discourage an increase in overcapacity. The newly established European Fisheries Fund (EFF) also grants more attractive premiums for the fishing vessel decommissioning scheme and provides financial assistance for new equipment and the modernization of vessels on condition that there is an overall reduction in capacity.[1]

Lindebo [5,6] and Frost and Andersen [7] provide more details about capacity policies in the CFP and their inefficiencies, but it is widely accepted that historically CFP measures designed to reduce or eliminate overcapacity have not achieve their goals because they are not precisely targeted. According to Vestergaard [8] and Lindebo [6], one important reason for this inefficiency is that since its establishment the CFP has focused its policies on *capacity base* reduction. In other words, capacity targets have been estimated by measuring certain relatively straightforward physical characteristics of a fleet (GT and kW). The rationale behind this is the supposed linear relationship between fish mortality and the size of different fleets. In reality in most fisheries this relationship is not linear due to presence of non-constant returns of scale [2].

In substance, the CFP does not make any distinction between *capacity base*—that is a physical measurement of capacity—and *capacity output*, i.e., the maximum potential harvest of a fully used fleet. *Capacity output* is a technical and economic concept that reflects the ability of vessels to catch fish. Not recognizing capacity output and capacity utilization as parameters for calibrating reduction capacity policies meant that programmed reductions in capacity (base) could not be targeted at those segments of the fishing fleet with the highest overcapacity.

*Corresponding author. Tel.: +39 079 229259; fax: +39 079 229356.
E-mail address: famadau@uniss.it (F.A. Madau).

0308-597X/$ - see front matter © 2009 Elsevier Ltd. All rights reserved.
doi:10.1016/j.marpol.2009.03.006

[1] These supports serve to improve gear selectivity, fish quality, safety for employers, etc.

Given this, Vestergaard affirms that "… understanding the measurement and definitions of capacity are necessary conditions for designing an effective capacity management plan" [8; p. 323]. This means that more research in the field of capacity estimation would be useful in the CFP decision making process.

On the other hand, assessment of capacity is not, of itself, an adequate policy guide when monitoring excess capacity. Other measurements can be also be useful when deciding on policy. In recent years, estimations of capacity utilization [9–12], technical efficiency [10,13–15], scale efficiency (SE) [16], productivity [17] and variable input utilization rates [18] have been becoming topics of research among fishery economists. For example, joint estimation of capacity utilization and technical efficiency enables one to separate two different effects that may contribute to not achieving the potential output: the presence of not fully used capacity and the ability of individual fishermen to use their available resources, respectively.

An important research issue is capacity and efficiency estimation when dealing with multi-species and small-scale fisheries [9,10,12,19–21]. Since there are already many capacity analyses on multi-output fisheries in fisheries economics literature, we shall not discuss in-depth the management of multi-product situations. Our attention is specifically focused on the economic modelling of small-scale fishing capacity and efficiency.

This study aims to estimate fishing capacity, technical efficiency, scale efficiency and capacity utilization in a particular segment of the Mediterranean small-scale fisheries, i.e., the Northwest Sardinian fleet in Italy. To be more precise, our analysis was focused on a sample of trawls that operate coastal waters of the National Park of Asinara (NPA).

A data envelopment analysis (DEA) model was used to evaluate these measures. Capacity and efficiency outputs were also calculated, using a hypothetical scenario in which vessels would be at sea for the maximum number of days allowed by Sardinian regulations and by weather and other conditions not under fishermens' control.

2. Background

Small-scale fisheries provide food, livelihoods and income for millions of people. The FAO estimates that about 35 million of the world's fishermen and fish-farmers (90% of the total fishermen) can be classified as small-scale [22].[2] However, it would be inappropriate to formulate a universally applicable definition for the small-scale fisheries due to wide range of characteristics that are likely to be found in any specific fishery [23]. Generally, terms such as "small-scale", "traditional", "subsistence" and "artisan" are used interchangeably as counterparts to large-scale and industrialized fisheries. Strictly speaking these different terms reflect the different structural, environmental and managerial characteristics of the particular "small-scale" fisheries [24–26].[3]

Small-scale fisheries can be broadly defined by their low level of capitalization their use of labour-intensive harvesting to exploit marine and inland fishery resources [23,26]. As a result, small-scale fisheries mainly use smaller vessels, have small catches per fishing unit, supply products to local and domestic markets and are less integrated into market structures [25].

Mediterranean fisheries are a typical case of small-scale fisheries in the EU. About 80% of the EU Mediterranean fleet is composed of small vessels (length of hull $\leqslant 12$ m) that practice a multi-specific fishing [28]. Although they are mainly artisan in management, in many Mediterranean areas fishing plays an important economic and social role in local communities.[4]

Despite its importance, there are few suitable strategies and policies for promoting and managing small-scale fisheries in the Mediterranean regions and in the world in general. The inherent non-homogeneity (within and across countries and regions) of small-scale systems often complicates the formulation of appropriate policy measures by national and international institutions. However—as underlined by Hauck [26]—it is a fact that policies tend to favour the interests of large-scale fisheries over small-scale ones.

Given the above, recently the literature has paid more attention to management and policies for small-scale fisheries [26,30,31]. However, the crucial issue of fishing capacity and its related problems (overcapacity, excess capacity, etc.) in small-scale fisheries has been largely ignored in the scientific debate. Studies have been carried out on capacity in small-scale fisheries by some authors, but capacity is mainly analysed in terms of capacity base or fishing effort rather than in terms of overcapacity and capacity output [32,33].

However, as Cunningham and Greboval recognized, overcapacity is an economic problem, and it affects small-scale fisheries just as much as it does other types of fishing [34]. The "artisan" (low revenue) and high labour intensive nature of this activity may generate a latent use of capacity. Indeed, when faced with very limited alternative employment, some conditions—e.g., new vessels that are able to operate in the open seas—could lead to a reduction in the number of days at sea and, thus to an under-use of capacity. Furthermore, labour as well as capital is often a non-elastic input and fishermen may find it relatively easy to begin fishing, but difficult do stop doing it. In other cases—where profitability is poor and there is some alternative employment—small-scale fishermen tend to do other activities and quickly switch to fishing if economic conditions warrant it [34]. As a result capacity tends to be only partially used.

In the Mediterranean small-scale fleet, understanding how much capacity is used would enable the authorities to improve policy measures aimed at reducing capacity. To be more precise, an economic estimation of capacity measures—rather than information about the capacity base—would guide Mediterranean policy makers to monitor and manage capacity in the small-scale fisheries rationally. On the other hand, despite the importance of EC Mediterranean fisheries, its peculiar characteristics and the presence of *ad hoc* CFP instruments for managing excess capacity and natural resources, capacity and other related measures have been little investigated in small-scale fleets [35–37].

3. Definition of capacity and related measures

On the basis of the International Plan of Action for Management of Fishing Capacity, capacity is defined as: "… the maximum amount of fish over a period of time (year, season) that can be produced by a fishing fleet if fully utilized, given the biomass and age structure of the fish stock and the present state of the technology" [38]. The FAO [38] definition is basically the same as Johansen's definition of capacity in a production system, i.e., "… the maximum amount that can be produced per unit of time with existing plant and equipment, provided the availability of variable factors of production is not restricted" [39,52].[5] According to this definition, capacity reflects fishers ability to produce the

[2] In addition more than 100 million people are employed in other occupations associated with small-scale fisheries (e.g., processing, trading).

[3] For example, the term "subsistence" would be appropriate for indicating poor fishermen that catch fish primarily for family consumption [27].

[4] Many of the regions identified by the EU as strongly dependent on fishery are sited in the Mediterranean basin [29].

[5] Kirkley and Squires provide a discussion and listing of various approaches on capacity in fisheries [40].