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Review

The determinants that cause small-scale vessels to exit fishing: The case of the Spanish small-scale purse seine fishery

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ABSTRACT

In this paper, we explore the determinants that affect the exit decisions of vessels in the Spanish small-scale purse seine fishery. Obviously, some of the technical characteristics of the vessels, such as vessel length, engine power, gross registered tonnage and age, can have a significant influence on the decision to leave the fishery.

Using survival analysis techniques, we analyse the vessels' exit decisions from the fishery. Specifically, the Cox proportional hazard model can help identify the factors that influence these decisions. One of these factors is the granting of aid by national and community fishery administrations. Thus, we find that the hazard rate to exit from fishing activity remained more or less constant in the case of vessels that did not receive assistance to exit from fishing activity. Our results also show that fishing vessels operating with a single fishing gear (purse seiner) are more likely to exit than are those that operate using different main fishing gears. Furthermore, we find that vessels with lower incomes are more likely to seek other opportunities in alternative fisheries or industries. The paper concludes that vessels whose overall length is less than 12 m are more likely to exit the fleet than are those with a length between 12 and 15 m. These results indicate the importance of the protection of small-scale fishery and are of concern to its long-term sustainability.

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1. Introduction

Small-scale fisheries (SSF) have traditionally received less research effort than large-scale and industrialised fisheries and are generally under-studied in Europe (Alfaro-Shigueto et al., 2010; Guyader et al., 2013). Nevertheless, SSF play an important role in the economy of the sector and in the socioeconomic fabric of coastal regions in the European Union (EU) because they frequently operate in areas with low employment opportunities, such as rural areas and isolated islands. In fact, it has been estimated that SSF generate approximately 50% of the direct employment in the EU extractive fishing sector and represent approximately 83% of the fishing vessels (Guyader et al., 2013).

Despite the importance of SSF, there are no uniform standards for defining SSF because their characteristics differ among countries. Thus, the definition of SSF is not necessarily closed and a useful definition will depend on the purpose of the study and the scale of the study.

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In the geographic context of this study which focuses in the Spanish small-scale purse seine fishery, we have considered fishing vessels with an overall length of less than 15 m as SSF.

To improve the knowledge on SSF, this study aims to examine the factors that influence the vessels' exit decisions from the Spanish small-scale purse seine fishery, such as the vessel's length, fishing area, engine power, income, gross registered tonnage and age. Furthermore, we also identify whether vessels under 12 m in length are more vulnerable to leaving the fishery than those with a length between 12 and 15 m.

To determine what causes small-scale vessels to exit fishing, we select the Spanish small-scale purse seine fishery for two main reasons: (i) 80% of all fishing in Spain is carried out by vessels of length under 15 m and (ii) small-scale fishing has specific problems that differentiate it from large-scale fishing. Thus, this manuscript analyses the exit dynamics of these vessels through the cessation of a vessel's fishing activities. Among the works reviewed, Gordon (1954); Scott (1955) stated that early bioeconomic research about fishing fleet dynamics assumed an open-access system, where changes in the number of vessels followed the profitability of the fishery. Thus, they argued that fishing effort would increase with the entry of new vessels as long as the fishery remained profitable. In contrast, as profits declined, vessels were assumed to exit the fishery if they could achieve greater returns on their capital investment elsewhere.

Later, the dynamic models of entry and exit that were developed linked the entry and exit of vessels in a given fishery to the economic incentives associated with such choices, which are defined in terms of the anticipated levels of returns from a fishery (Mackinson et al., 1997; Pascoe and Revill, 2004; Smith, 1968). Following this, more recently, Prellezo et al. (2012) assessed recent advances in the domain of applied bioeconomic modelling.

Moreover, Van Putten et al. (2012) focused on the empirical applications of the behavioural models that have been put forward to explain and predict fleet dynamics. They highlight the conceptual models that have largely dominated the literature on the modelling of fishing behaviour, distinguishing between models that focus on individual behaviour (profit and utility maximization, foraging theory, and rule-based models of behaviour) and others that explain the behaviour of individuals in groups (game theory and network theory).

More recent empirical behavioural studies on the entry and exit activities of fishing vessels have used multinomial (unordered) logit models. Mardle et al. (2006) compared models of the entry, stay, and exit of vessels in three European fisheries; Pradhan and Leung (2004) analysed the entry, stay and exit decisions of fishers in Hawaii's longline fishery; and Tidd et al. (2011) analysed the strategic decision-making behaviour of fishers in entering or exiting the English North Sea beam trawl fishery. Furthermore, Ward and Sutinen (1994) applied the multinomial (unordered) logit model in a study on the entry-stay-exit analysis in the Gulf of Mexico shrimp fishery. Finally, referring to the entry/exit dynamics of SSF, Cinner et al. (2009); Muallil et al. (2011) determined the influence of different socio-economic factors in the exit-behaviour of the fishers using a binary logistic-regression model.

In this paper, we demonstrate the usefulness of duration analysis in understanding fleet dynamics, specifically for forecasting vessels' exit decisions and investigating the role of fishing vessel characteristics in modelling their exit from SSF.

This analysis is relevant for several reasons. There is little information on the factors that affect the exit decisions of vessels in the Spanish SSF. It is innovative because it uses the methodology of survival analysis that, although it is well known in health sciences and industrial organisation, has rarely been applied in fisheries economics. Further, it is the first study to address the survival analysis applied in SSF.

Table 1
SSF fleet by main gear.

Gear	No. vessels	1000 GT	1000 kW
Set gillnets (anchored)	6656	18.74	165.04
Set longlines	833	2.97	25.11
Purse seines	153	1.85	11.77
Bottom otter trawls	89	1.30	5.54
Drifting longlines	33	0.39	2.20
Total	7764	25.26	209.66

Source: Prepared by the authors based on the Community fishing Fleet Register, 31.12.2014.

The paper is organised as follows. In Section 2, we describe Spanish SSF. In Section 3, we analyse the dataset. In Section 4, we discuss the methodology of survival analysis. In Section 5, we present the results and, finally, summarise our findings and their implications.

2. Materials and methods

2.1. Description of small-scale fisheries in EU and Spain

Taking an overall vessel length of 15 m as a practical delimitation between small-scale and large-scale fisheries in Europe, SSF are strongly represented in all EU Member States. In fact, 90.37% (77,626 active vessels) of the EU's 25 entire fleets is composed of vessels shorter than 15 m, based on the Community fishing Fleet Register at 31 December 2014 (http://ec.europa.eu/fisheries/fleet/index.cfm). In the specific case of Spain, small-scale fleet shorter than 15 m account for 80.61% of EU vessels (7764 active vessels).

Although there has been a slight decrease in the number of small-scale vessels in the EU during the period 1990–2014, the reduction was greater in the case of Spain (Fig. 1).[1] This declining trend was motivated by the structural adjustment of the Spanish fleet, mainly the SSF. Thus, the Spanish SSF declined by 51.47%, and the Spanish small-scale purse seine fleet decreased by 75.07%.

Moreover, Fig. 1c and d show a decrease in the EU fleet and its subsets, SSF and purse seine fleet. Thus, the European SSF declined by 13.84% and the European small-scale purse seine fleet decreased by 37.29%.

The overall average age of the Spanish fleet is 30.2 years old and 33.5 years old in the case of SSF fleet. The SSF represent approximately 7.06% of the total gross tonnage of the Spanish fishing fleet and approximately 25.48% of its engine power.

Purse seine is a method of fishing, which aggregates species near the surface. Spanish purse seine fisheries focus on large pelagic species, such as the bluefin tuna (*Thunnus thynnus*), or middle and small pelagic species, such as the sardine (*Sardina pilchardus*), mackerel (*Scomber* spp.), horse mackerel (*Trachurus trachurus*) and anchovy (*Engraulis encrasicolus*), among others.

88.66% and 97.21% of the SSF fleet have declared passive gear as their main gear in the EU and Spain, respectively (Community fishing Fleet Register, December 2014). The primary form of passive gear is set gillnets (anchored), which are used by 85.73% of Spanish SSF fleet (Table 1). In contrast, active gears are used by the biggest and more powerful SSF fleet. Although the average GT and average kW is 11.43 GT and 73.18 kW for the SSF fleet (186 vessels) using active or mobile gears, for SSF fleet (7547 vessels) that use passive or static gears, these numbers drop to 2.97 GT and 25.71 kW, respectively.

Most Spanish SSF fleet are made of fibreglass (51.44%) and wood (46.42%), and only 1.74% are built of metal. Furthermore, there is a clear relationship between the age and material of a

[1] Considering that the EU fleet register started in 1989, it is likely that the data for year 1990 is erroneous and can be disregarded.