

**EMPIRICAL ANALYSIS OF FISHING FLEET DYNAMICS:
ENTRY, STAY AND EXIT CHOICES IN SELECTED EU FISHERIES**

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ABSTRACT

The decision to enter or exit a fishery can be expected to depend on the anticipated profitability of operating in this fishery, as a function of observed vessel performances in previous years. For a vessel exiting a fishery, there may be several reasons including decommissioning, selling or operating elsewhere. Entry may be related to new vessels, or to vessels transferring from other fisheries. Modelling the behaviour of fishers with respect to their entering and exiting strategy can inform as to the impact of a proposed management policy and other external factors (e.g. changes in market, fuel costs and stock size), which can have major impact on the structure of fishing fleets. Three European cases studies are considered to understand the determinants of the observed changes in fleet size relating to such factors. In each case, a multinomial (unordered) logit model is used as the basis for analysis. Case studies considered include the Basque trawl fleet operating in the Bay of Biscay, the French 16-20m trawler fleet based in ports of Southern Brittany, and the English beam trawl fleet operating in the North Sea. Results confirm that in addition to individual vessel characteristics, both expected revenues and the additional incentives provided by decommissioning schemes have a bearing on a vessels' participation in a fishery.

Keywords: entry-exit, decommissioning, fisher behaviour, random utility models, logistic regression

INTRODUCTION

Early models of fishing fleet dynamics assumed an open-access system where, for the most part, changes in the numbers of vessels followed the profitability of the fishery (Gordon, 1954; Scott, 1955). Following this, dynamic models of entry and exit have been developed that directly link the entry and exit of vessels in a given fishery to the economic incentives associated to such choices (e.g. Smith, 1968; Mackinson et al., 1997; Pascoe and Revill, 2004). In these models, economic incentives are defined in terms of the anticipated levels of returns associated to the prosecution of a given fishery, net of the opportunity costs. Further developments focused on the fact that the exit of vessels from a fishery can be difficult as there may be few alternative opportunities. This issue of "non-malleability" of capital was first raised by Clark, Clarke and Munro (1979), and models of irreversible investment further developed by McKelvey (1985) and Boyce (1995). These models demonstrated how unregulated fisheries become overcapitalized and overexploited. However, they were largely theoretic, and could not be applied in practice.

Attempts at developing empirical models for particular fisheries have been limited. Early work in this area (Wilén, 1976; Bjørndal and Conrad, 1987) centred on the estimation of parameters measuring the speed at which fleets respond to changes in the average profitability of fisheries in terms of vessel entries and exits. More recent empirical studies have used a discrete choice modelling (or random utility modelling) framework. This was initiated by Bockstael and Opaluch (1983, 1984) who investigated the transfer of vessels from one fishery to another, reasoning about the choice of a particular fishery. Ward and Sutinen (1994) developed a model of entry and exit that they incorporated into a dynamic bioeconomic model of the Gulf of Mexico shrimp fishery. Guyader, Daurès et al. (2004) developed a similar model applied to a French coastal fishery. In a more recent study, Pradhan and Leung (2004) use revenue by gross tonnage in a multinomial logit framework to consider exit and entry strategies versus staying in the fisheries for Hawaiian longliners.

With ever-increasing pressure being placed on fish stocks around the world, fisheries management has increasingly constrained the movement of vessels in and out of fisheries. In many contemporary fisheries, regulations can thus have considerable impacts on the dynamics of fishing fleets. In particular, entry of new

vessels is determined not only by the incentives which fishers face, but also by the constraints imposed on the possibilities for new vessels to enter a given fishery. While there is generally some scope for changes, movement from one fishery to another can also be constrained to some extent, e.g. by issues of licensing and quota allocations.

A growing number of regulatory schemes also include payments offered to vessel owner to decommission their fishing unit, as part of programmes designed to rationalize fishing fleets. Such payments modify the incentives for fishing vessels to exit a given fishery. For example, in order to attain a sustainable balance between the capacity of the European Union (EU) fishing fleet and the available resources, a structural policy was established in 1983 within the Common Fishery Policy. The so-called Multi-Annual Guidance Programs (MAGP) especially set out a series of multi-annual capacity targets for all EU member states and their fleets (European Commission 2001). In order to remove excess capacity, the EU established a system of economic incentives co-funded by Member States for vessel decommissioning and effort reduction. During the period 1991 to 30 June 2002, the EU fleet realised reductions of approximately 20%, both in terms of vessel tonnage and engine power, although to varying degrees across member states and fleet segments (Lindebo 2005). The existence of decommissioning program is assumed to affect the decision to exit (as it overcomes, at least in part, the capital non-malleability problem). However, it may also affect the decision to enter, as the existence of decommissioning programs (and the anticipation of future similar programs) reduce the cost of capital by ensuring a higher minimum “scrap” value on exit (Clark et al, 2005). While several recent studies have stressed the limitations of such buyback schemes in terms of addressing the long-term excess capacity problems in fisheries (Munro, 1998; Weninger and McConnell, 2000; Hannesson, 2004), few empirical studies of their impacts on the reduction of capacity in specific fleets are available (see e.g. Guyader, et al., 2004).

In this paper, we develop an analysis of the dynamics of selected European fishing fleets. Based on a general schematic of entry-stay-exit decisions, three case studies are presented. The empirical approach is based on discrete choice models applied to movements of individual vessels to and from specific fishing fleets. The paper is structured as follows. The first section presents the case studies included in the analysis. The second section presents the modelling approach and the data used. Results of two alternative formulations of the fleet dynamic problem are presented in section 3. Section 4 discusses some of the implications and limitations of the analysis, as well as surrounding issues.

CASE STUDIES

The case studies considered in the analysis focus the three following fleets:

- the French fleet of 16-20 metre trawlers based in ports of Southern Brittany (France), and operating in the bay of Biscay (ICES areas VIIIa,b,d,e) and the Celtic sea (ICES areas VIIc,f,g,h,j,k);
- the Spanish fleet of trawlers in the Basque region composed of ‘Baka’ (otter) trawlers and pair trawlers using Very High Vertical Opening which operate in ICES areas VI, VII and VIIIa,b,d; and
- the English Beam Trawlers (over 10 metres) that operate in the North Sea (ICES areas IVa,b,c).

The key information available for the three fleets, with respect to the average physical characteristics of vessels, and their average landings in year 2003 is summarized in table 1.

Table 1 – Characteristics of the selected fleets (reference year = 2003*)

	<i>Fleet size (number of vessels)†</i>	<i>Average engine power per vessel (KW)</i>	<i>Average tonnage per vessel (GRT)</i>	<i>Average annual landings (Tons/vessel)**</i>	<i>Average annual landings (KEuro 2003/vessel)**</i>	<i>Average annual price per kg (Euro 2003)</i>
French 16-20m SB trawlers	66	295	42	119	472	4.00
Basque trawlers	42	654	242	241	618	2.56
English NS beam trawlers	23	1006	-	490	1230	1.79

† UK summary data relates to the aggregated vessel beam trawl activity during 2003. Note that in 2003, 18 of the 23 vessels identified were >221 kW. The measurement of total tonnage has been complicated by a change in methodology used to measure the tonnage of vessels that was introduced from 1996 onwards – this indicator has not been presented for the UK case.

* 2002 for Basque fleets.

** For the Basque fleets only Hake, Megrim and Anglerfish have been taken into account.



Figure 1. Map of ICES areas¹

Recent trends observed at fleet level for each of the case study fleets are presented in figure 2. These are given in terms of physical capital, apparent production per unit of physical capital and prices (left), and total fleet revenue and revenue per unit of physical capital (right). Fisher indices are used to measure changes in prices and landings. Indices are calculated using the latest year as a fixed reference.

Recent trends observed in the French trawler fleet, at both fleet and average vessel levels, are presented in figure 2(a). The size of the fleet was reduced significantly over the period 1990-2003 (i.e. a reduction of 50% in gross tonnage), while its total production decreased from 16.6 to 7.9 thousand tons and from 61.0 to 31.2 m€ (in 2003 constant euros). Average physical characteristics of the vessels in this fleet remained fairly stable throughout the period, and average landings in value varied between 10 820 € per GRT and 11 230 € per GRT. Vessels mainly target nephrops (25% of landings value in 1990, rising to 33% in 2003), anglerfish (25% of landings in value in 1990, dropping to 20% in 2003), and hake (12% of landings in value in 1990, dropping to 5% in 2003). Sole represented only 3% of gross turnover of this fleet in 1990, but rose to 6% in 2003, replacing hake as the third most important species landed.

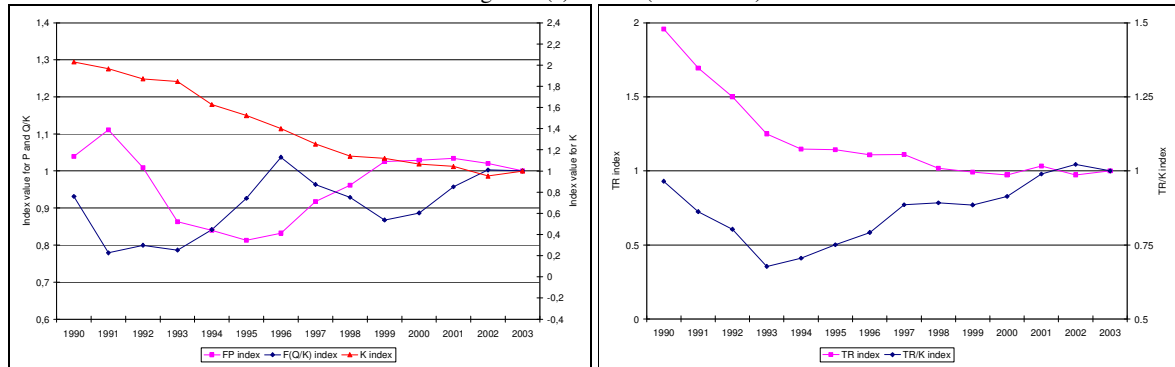
A negatively correlated oscillatory pattern of prices and apparent productivity of physical capital is apparent in this fleet, throughout the period. In the first 2-3 years, production per unit of capital tends to decrease, while prices increase to reach a maximum in 1991. The negative correlation between price and productivity indices is likely due to the strategic response of vessel owners to more or less favourable conditions on the market for their production. It is also due to the fact that the strong reduction in fleet was mainly achieved via the exiting of less efficient vessels, making the average productivity of the remaining vessels higher.

Figure 2(b) presents recent trends observed in the English beam trawler fleet. Based on physical characteristics, the fleet has reduced in size significantly over the period 1990-2003. After an influx of vessels to the larger North Sea beam trawl fleet in the early 1990s, there has been a steady decrease in the number of vessels operating in the fleet. Total number of vessel capacity units (VCUs), which are an indication of vessel quota allocations, have followed the same trend as number of vessels. However as with engine power, average numbers of VCUs per vessel have increased very slightly: the vessels that remain are on average catching more per vessel (and per kW) at the end of the period than at the beginning. This is attributed to both increasing

¹ Source : http://www.ices.dk/aboutus/icesareas/ICES_areas_Arc9_Weuro_300.pdf, downloaded June 2006

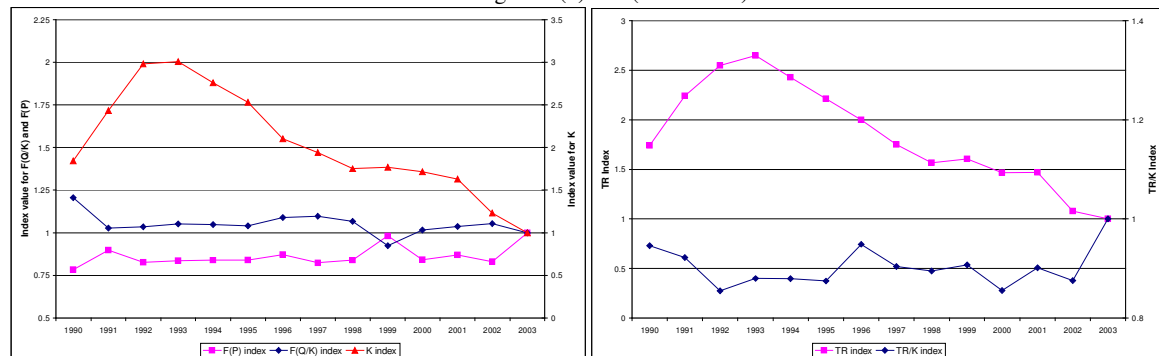
prices and a shift in species composition of the catch, while average annual landings by weight have remained stable over the period. Beam trawlers by their design predominantly target flatfish: historically plaice has comprised the largest component of the catch. In the early part of the 1990s, sole and cod were more important to the volume of catch. In the later period, this has been replaced by turbot, brill and dab.

Figure 2 (a) France (1990-2003):



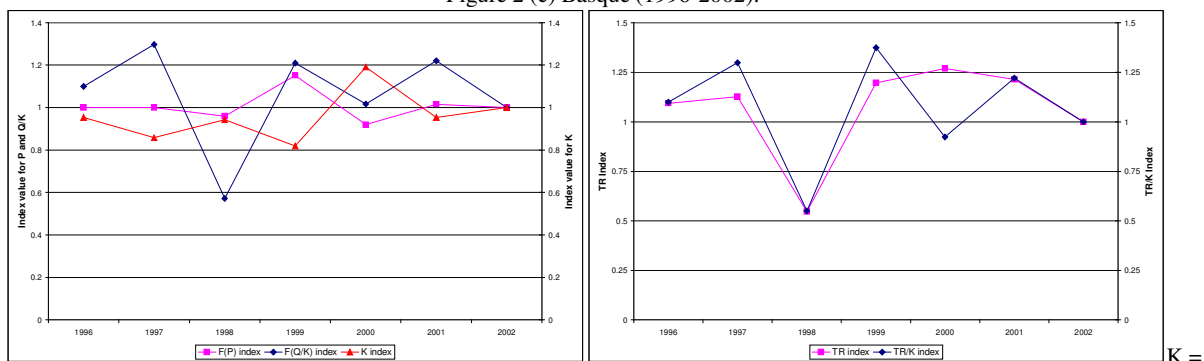
K = fleet size (GRT) index; P = Fisher price (euros 2003) index; Q/K = Fisher total landings per GRT (kg/GRT) index; TR = total fleet revenue (euros 2003) index; TR/K = total revenue per fleet size index. Source: IFREMER.

Figure 2 (b) UK (1990-2003):



K = fleet size (kW) index; P = Fisher price (£s 2003) index; Q/K = Fisher total landings per kW (kg/kW) index; TR = total fleet revenue (£s 2003) index; TR/K = total revenue per fleet size index. Source: CEFAS/CEMARE.

Figure 2 (c) Basque (1996-2002):



K = fleet size (GT) index; P = Fisher price (€ 2003) index; Q/K = Fisher total landings per GT (kg/GT) index; TR = total fleet revenue (€ 2003) index; TR/K = total revenue per fleet size index. Source: AZTI-Technalia.

Figure 2. Evolution of physical capital, production per unit of physical capital, prices, and revenue.

In the English beam trawl fleet, production per unit of capital has remained consistent. Fluctuations in prices have played a part in this trend: as landings have decreased prices have increased. Overall, the production per unit of capital index has remained similar from 1991-2003. The increase in capital in the fleets from 1990 to

1992/3 caused an increase in total revenue, but a decrease in revenue per unit of capital. Since 1993 total revenue has decreased along with the size of the fleet, but revenue per unit of capital has remained consistent. In the last year of the period studied, revenue per unit of capital increased slightly. The reason for this is likely to be a reflection of the capacity of the remaining fleet.

Figure 2(c) presents recent trends observed in the Basque trawler fleet, at both fleet and average vessel levels. The fleet is composed of two distinct vessel types: Baka trawlers and pair trawlers. The catch composition is along with harvest technology a feature that differentiates the two vessel types. Baka trawlers' catches are highly diversified and target species vary with the season of the year. Hake, megrim and anglerfish are the three key species of this fleet and their catches represent approximately 40% of the total catches. Horse mackerel, pout, whiting and rays are also important, accounting for 25% of the total catches. Pair trawlers' technology was developed to harvest hake, which contributes 73% of the total catches of these vessels.

Regarding Baka trawlers, the price of the products did not change considerably over the study period. While the index of physical capital does not show major changes overall, a reduction is observed in 1998 due to the disappearance of some Baka trawlers. Production per unit of physical capital also decreases considerably in 1998, due to a reduction in landings of hake. Indices for total revenue and revenue per unit of physical capital thus show a considerable reduction in 1998. With regard to pair trawlers, both price and capital indices show stability over the period. The determinant influence of the management context in which the fleet operates is illustrated by the evolution of the index of landings per unit of physical capital. While this index displays a regular evolution from 1996 to 2001, in 2002, it increases considerably. This is due to a fairly high increase in hake quota while physical capital remained stable. As a consequence of this increase in hake quota, total revenue of the fleet increased substantially in 2002.

MODEL SPECIFICATION AND DATA USED

The structure of a model of fleet dynamics with respect to vessels entering or exiting a given fleet will vary depending on the focus of the analysis. A general representation of the possible choices that could be included in a model is proposed in the following schematic (figure 3).

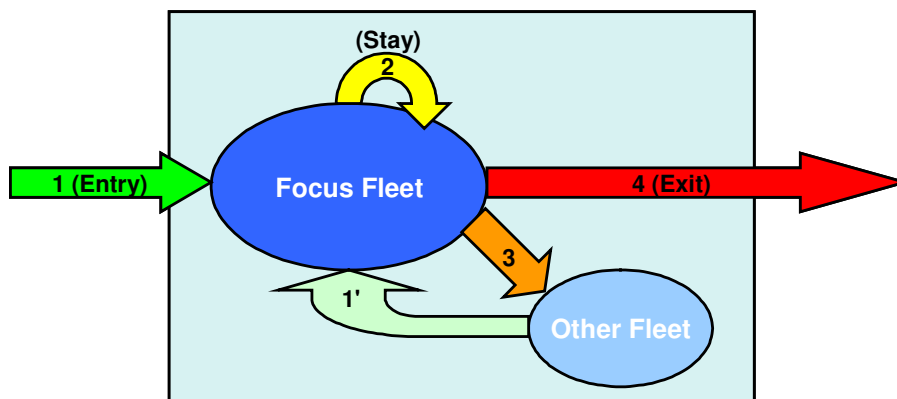


Figure 3. Schematic of the decisions to enter, stay or exit a fleet in a National fleet setting.

The representation includes decisions made by vessel owners to enter, stay or exit a given fishing fleet in a National fleet setting, within the boundaries of a given fisheries system (which in this case is in the European context). Decisions made by vessel owners can be assimilated to the movements of fishing vessels in and out of a the fleet, defined as a group of vessels having similar physical characteristics and fishing activity. There are four basic decisions that can be made by a vessel during a given year in the fleet being focused on: (1) to enter the fleet as a new vessel in the fisheries system; (1') to enter the fleet from another fleet; (2) to remain in the fleet; (3) to move to another fleet; or (4) to exit the fisheries system. From this, different hierarchies of decisions can be identified and detailed, that may include the decision 'to fish' or 'not to fish'.

In this paper, we consider two alternative model specifications: one that focuses on the contribution of vessel decommissioning to exiting behaviour; and one that focuses on explanatory factors of vessels entering or exiting a given fleet in relation to staying in that fleet. The former specification is undertaken for the French

[16-20m] trawl fleet in South Brittany, and compares the decision to exit from fishing #4 (i.e. via decommissioning) with the alternative decision to remain in fishing #1,1',2,3 (i.e. enter, stay or change fleets). The latter specification is undertaken for the English beam trawl fleet and the Basque 'Baka' and pair trawl fleets, and compares the decisions to enter a given fleet #1,1', to stay in a given fleet #2, and to exit a given fleet #3,4. Detailed presentations of each of the case studies are available in Thébaud et al. (2006), Mardle et al. (2005) and Prellezo et al. (2006).

The data in each case study was compiled from logbooks which form the official landings declaration system in each country. All active vessels in a given year are present in the landings databases. Information on the annual landings per species in volume and value of vessels is collected as well as physical vessel details regarding length, gross tonnage, engine power, age of the vessel and home port of the vessel. Spawning stock biomasses were identified for the main target species for fleets based on published stock assessments (e.g. ICES, 2005). Other data collated by case study that is not consistently available includes fishing rights (measured by so-called vessel capacity units in the UK), crew size, vessel value on the second-hand market, and market share and turnover of the fishing firm to which the vessel belongs. In the French case study, economic data relating to decommissioning premiums and interest rates were also collected.

The period that data were available for varied across case studies. The French case study data was available for the period 1991-2003, for the UK 1989-2003 and for the Basque country 1994-2002. This is for the most part due to issues of database consistency and natural lags in the national data collection programmes.

In the following analyses, a multinomial logit formulation was designed to evaluate the decisions of vessels. In each case study, several variables were analysed in the model, but not all of them were found to be individually significant. Hence, the variables presented in the model specification and results are those that are significant.

RESULTS

Actively fish Vs Decommission vessel

A multinomial (binary) logit was implemented to consider the decisions for choosing to fish in a given year versus choosing to stop fishing via decommissioning with focus on the South Brittany [16-20m] trawl fleet. The model formulated for the decision (Z_{ijt}) to fish or to decommission by vessel, i , choice, j , and time period, t , can be written as,

$$Z_{ijt} = \beta_0 + \beta_1 RELPROD_{it} + \beta_2 DECPREM_{it} + \beta_3 IRATE_t + \beta_4 VVAL_{it} + \beta_5 CREW_{it} + \varepsilon_t \quad (1)$$

where the key independent variables identified in the model include an index of the relative productivity of individual vessels, measured by vessel to fleet gross turnover per vessel length (RELPROD), the decommissioning premium of a vessel standardised by length (DECPREM), the average interest rate (IRATE), the second-hand market value of a vessel standardised by length (VVAL), and the crew size of a vessel (CREW). The model was estimated with logged values of non-indexed independent variables, for years 1991 to 1998 included, as these were the years during which the main decommissioning schemes were implemented.

Two alternative versions of the model were implemented, where the choice set for vessel owners differed:

- Model 1 included all vessel-years for which information was available in the analysis. In this case, a fairly small vessel exit ratio over the study period can be seen (i.e. 3.2% of total decisions – see table 2);
- Model 2 included only vessel-years where the final decision to stay or exit was made, which amounted to considering the 1991-1998 years as a single period with respect to the decision to decommission a vessel. The vessel exit ratio in this case was 15.1%.

Table 2. Number of vessels and decommissions each year, French [16-20m] South Brittany trawl fleet

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Fish	134	133	126	113	106	100	90	78	75	72	70	66	65
Dec.	4	0	1	4	5	3	7	5	1	1	0	3	0

Estimation results for Model 1 and Model 2 are presented in table 3.

Table 3. French case study estimation results (versus “stay in fishing”)

Variable	Model 1 Coefficient		Standard Error		Model 2 Coefficient		Standard Error
Constant	13.234		12.789		15.248		21.123
RELPROD	-5.116	***	1.153		-4.713	***	1.676
DECPREM	5.317	***	1.683		6.467	***	2.631
IRATE	-7.810	***	2.285		-4.933	*	2.767
VVAL	-5.078	***	1.113		-6.178	***	1.585
CREW	3.026	*	1.792		-0.705		2.293
MacFadden coefficient	0.506				0.593		

*** significant at the 1% level, ** significant at the 5% level, * significant at the 10% level

The model is globally significant, and the coefficients are denoted to a 1%, 5% or 10% level of significance. In both models, the performance of individual vessels as compared to the average performance of vessels in the fleet (RELPROD), the value of a vessel on the second-hand market (VVAL), and the interest rate (IRATE) impact negatively on the probability for a vessel to be decommissioned. The incentives provided by the Administration in terms of decommissioning premiums (DECPREM) have a positive influence on this probability. In Model 1, the crew size indicator (CREW) implies larger vessels have a higher chance of exiting the fleet, which could be interpreted as the consequence of higher costs/earnings ratios for vessels of a given size class. In model 2 however, this variable is not significant implying that size of vessel does not have an effect.

The fact that the interest rate has a negative influence on the decommissioning probability contradicts with the expected sign of this variable. This could be due to the fact that, while it is not a good measure of the discount rates used by vessel owners in their evaluation of future returns from fishing with their vessel, it provides a measure of the cost of investment in the fishery. In this fleet, as in the other French fleets affected by decommissioning programs (Guyader et al., 2004), a significant proportion of the vessel owners who decommissioned their vessels did so to invest in another vessel. It can then be expected that the cost of (re)investment in the fishery impacts negatively on the probability for vessels to be decommissioned.

While model 1 is valid, its overall explanatory power is not very high (the value of the MacFadden coefficient calculated in Limdep is 0.506), and its predictive capacity remains limited (39% of correctly predicted exit choices). This is probably due to the relatively small number of decommissioning choices, relative to the total number of choices included in the analysis, already discussed. The explanatory power of Model 2 is improved in comparison to model 1 (the value of the MacFadden coefficient calculated in Limdep is 0.593), as well as its predictive capacity (72% of correctly predicted exit choices).

In both versions of the estimated model, the constant term is not significant. This could be due to the fact that an important explanatory variable has been omitted from the analysis. Different variables summarizing the information available on fishing vessels, their economic performance in terms of profit, as well as the economic context in which they operate, and the biological status of stocks were tested as extra explanatory variables. None of the variables used allowed an improvement in the significance and/or the predictive capacity of the model. It is possible that some key variables for which no information is available to the authors also influenced the probability for vessels to be decommissioned. More probably, the data used to measure the incentives provided by decommissioning premiums may be incomplete due to the existence of buyback subsidies paid by local authorities on top of national and European premiums, hence only part of the influence of this variable is effectively captured in the estimation.

Entry Vs Stay and Exit Vs Stay

A multinomial logit was implemented to consider the decisions for choosing to stay in a given fleet versus entering or exiting that fleet. Two case studies, Basque trawlers and English beam trawlers, have been implemented to consider this question:

The response variable includes the three possible decisions, j, (enter/stay/exit) of vessel i. A vessel is defined as an ENTRY if it starts fishing for the first time in the trawl fleet. If a vessel retires, it is defined as an EXIT. Finally, if a vessel was active in the previous year and is active in the following year, then it is defined as a STAY vessel.

English beam trawlers

The model formulated for the English beam trawl fleet with the decision (Z_{ijt}) to enter, stay or exit by vessel, i, choice, j, and time period, t, can be written as,

$$Z_{ijt} = \beta_0 + \beta_1 VAGE_{it} + \beta_2 FLEET_t + \beta_3 TOTVAL_{it} + \beta_4 SSBPLE_t + \beta_5 SSBSOL_t + \sum d_H \quad (2)$$

where the key independent variables identified in the model include vessel age in years (VAGE), the number of vessels in the fleet (FLEET) during a given year which is assumed to be a proxy for ‘congestion’, three binary variables to indicate the homeport of vessel England, Scotland and other respectively (d_H), total revenue (TOTVAL) that includes the key targeted species of this fleet species plaice and sole as well as other species, and spawning stock biomass (SSB*) for plaice and sole. Note that SSBSOL is highly correlated to FLEET.

The number of vessels in taking a decision to enter, stay or exit this fleet during the period 1989-2003 is presented in table 4.

Table 4. Number of entry, stay, exit decisions, English beam trawl fleet (1989-2003).

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Enter		17	21	18	8	1	4		3	5	4	3	1	2	
Stay	138	137	146	165	175	166	157	149	142	136	131	125	125	111	116
Exit	1	1	6	3	6	12	11	7	10	11	6	8	6	15	

The results of this analysis are given in table 5.

Table 5. English case study estimation results (versus “stay in fleet”)

Parameter	Exit Vs Stay			Entry Vs Stay		
	df	Coefficient	S.E.	df	Coefficient	S.E.
Intercept	1	26.603***	6.694	1	-37.662***	8.427
VAGE	1	0.845***	0.201	1	-0.934***	0.12
FLEET	0	-	-	1	3.752***	1.025
$d_{ENGLAND}$	1	-1.5***	0.323	1	-0.88	0.657
$d_{SCOTLAND}$	1	-0.926*	0.479	1	1.184*	0.693
d_{OTHER}	0	-	-	0	-	-
TOTVAL	1	-0.597***	0.063	1	-0.271***	0.075
SSBPLE	1	-1.889***	0.556	1	1.722***	0.464
SSBSOL	1	-0.06	0.301	0	-	-

[Notes: *** 1% significance; ** 5% significance; * 10% significance]

Many of the key parameters are shown to be significant. Vessel age shows an expected outcome, with a negative coefficient on the entry results indicating that a younger vessel would be more likely to enter than an older vessel. Contrary, a positive coefficient on the exit results indicates that an older vessel is more likely to leave. The stock status of plaice is also an expected outcome, with a reducing plaice spawning stock biomass (SSB) giving a higher probability of exit and an increasing plaice spawning stock biomass (SSB) giving a higher probability of entry. This result is particularly pertinent to this fleet as, even with reducing quotas, plaice remains the main target species. A relatively high negative coefficient on total revenue indicates that vessels with lower revenues will have a higher probability of exit from this fleet also. A negative coefficient on this variable for entry is not intuitive. In this case, it is more likely that, rather than having a higher probability of entry with lower revenues, a vessel in its first year is less productive than existing vessels. This is contrary to what could be expected given VCUs of entering vessels which are considerably higher than those either remaining in or exiting the fleet (as indicated also by the high positive coefficient on this variable). The negative total revenue coefficient is also perhaps a reflection on the declining revenues over this period for the North Sea beam trawl fleet. It is also apparent that during this period, revenues from catch of plaice are higher for both entering and exiting vessels than for those that stay. In both cases, this is perhaps a reflection of

changing strategies in the fleet that remains which is adapting more readily to the declining plaice stock and placing more importance (relatively) on other species. So-called congestion effects, estimated through a ‘fleet size’ variable are indicated to have a significant effect on the decisions of vessels to enter the beam trawl fleet. The homeport of vessels is also shown to have a significant impact of the decisions of vessels.

Basque trawlers

The multinomial model formulated for the Basque trawl fleet with the decision (Z_{ijt}) to enter, stay or exit by vessel i , choice j , and time period t , can be written as

$$Z_{ijt} = \beta_0 + \beta_1 AGE_{it} + \beta_2 GEAR_{it} + \beta_3 MS_{it} + \beta_4 GS_{it} + \beta_5 TUR_{it} + \beta_6 SIZE_{it} + \beta_7 SSB_{it} + \epsilon_t \quad (3)$$

where the key independent variables identified in the model include the age of the vessel in years (VAGE), a binary variable to indicate the gear used by a vessel either ‘Baka’ or pair trawl (GEAR=0 or 1 respectively), the market share of the firm owning the vessel as a percentage number of vessels (MS), the gross surplus of the vessel (GS), the average turnover of a vessel in a given firm (TUR), the size of the vessel measured by length (SIZE) and an index of spawning stock biomass for the key stocks targeted (SSB).

The number of vessels taking a decision to enter, stay or exit this fleet during the period 1994-2002 is presented in table 6. Table 7 presents estimation results.

Table 6. Number of vessels and entry-stay-exit decision each year, Basque trawl fleet

Year	1994	1995	1996	1997	1998	1999	2000	2001	2002
Entry	6	8	10	6	10	5	21	8	1
Stay	31	31	37	35	37	40	32	36	44
Exit	6	2	2	6	4	7	11	6	0

Table 7. Basque case study estimation results (versus “Exit”)

Variables	Log (Entry/Exit)		S.E.		Log (Stay/Exit)		S.E.
Intercept	-8.553		5.249		-8.743		4.347
Age of the vessel	-0.176	***	0.053		-0.111	***	0.049
Gear-PRS	1.316	**	0.618		0.400		0.531
Market share	0.057		0.083		0.215	***	0.078
Gross surplus	0.004	***	0.001		0.003	***	0.001
Turnover	0.002		0.017		-0.034	**	0.016
Size of the vessel	0.160	**	0.093		0.185	**	0.075
SSB	0.096	*	0.066		0.100	**	0.055
Log-likelihood=	-211.620						

* Statistical significance at 10% level
 ** Statistical significance at 5% level
 *** Statistical significance at 1% level

The odds of choosing to enter and stay, relative to exit, decrease with the vessel’s age. On the other hand, the odds increase with the vessel’s size and if the vessel is a pair trawler. Characteristics of the owner also play an important role. The odds of choosing to enter or stay, relative to exit, increase with market share and gross surplus. Turnover is also statistically significant: entry relative to exit is positively associated, while stay relative to exit is negatively associated to turnover. On the other hand, gross surplus and costs (both fixed and variable) are not statistically significant for choosing entry or stay relative to exit. The reason could be that economic performance is captured by variables describing the owner, hence economic variables do not add extra information. The only significant variable concerning characteristics of the fishery is Spawning Stock Biomass: the odds to enter and stay relative to exit from the fishery increase with SSB.

While this model is valid, its overall explanatory power is not very high (the log-likelihood coefficient calculated in Limdep is -211.62), and its predictive capacity remains limited. This is probably due to the relatively small number of vessels entering and exiting the fleet each year relative to the total number of choices included in the analysis.

CONCLUSIONS

Results of the above empirical studies of entry-stay-exit decisions in three European fishing fleets tend to confirm the assumption that decisions to operate in the fleets under consideration have been determined, more than anything else, by the anticipated profitability of doing so. Overall, less economically efficient vessels have been more likely to leave fleets than efficient vessels. The results of the different models estimated provide insight into the variables that best serve as proxies for the measurement of vessel owner anticipations as regards profitability. These include revenues being achieved by vessels and how these compare to the average performance of the fleet, as well as the physical characteristics of vessels and their value on the second-hand market for fishing vessels. A large proportion of the data needed to carry out such empirical analysis is available from the regular data collection programmes currently existing in Europe.

In the EC, the new capacity management approach no longer defines a set of specific capacity objectives for member states or fleets, as was the case under the MAGP. The adjustment of capacity will occur indirectly via limitations on fishing effort (days at sea restrictions) and new multi-annual management plans (e.g. fishing mortality reduction, stock recovery plans). For example, management plans will likely cause severe reductions in fishing opportunities in certain segments of the fleet, as currently seen with the recovery plans of the cod fisheries in the North Sea and hake fisheries in the Bay of Biscay and Western Approaches. The reduction of fishing capacity in response to the fishing effort limits will be the responsibility of member states, with the new Community fleet policy being asked to create the environment to encourage this capacity reduction. The main instrument to physically control fleet capacity is established via the reference levels of the individual member state and stringent entry-exit capacity ratios. Improving the understanding of the factors affecting entry-stay-exit of vessels in the fleets targeted by this management system will allow better forecasting of the potential impacts of these measures.

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