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Impact of the Icelandic ITQ system on outsiders

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Abstract – Icelanders gradually adopted an Individual Transferable Quota (ITQ) in their waters. This property-rights based system yielded benefits to the economy but was not applied to all fishermen. Some fishermen remained outside of the ITQ system and were subject to other management measures. In this paper we investigate the effects of various effort restrictions on the behaviour of fishermen outside of the ITQ system. Empirical estimates from duration model analysis are presented which measure the effects of various management measures aimed at affecting the behaviour of those "outsiders" as well as the indirect effect of the ITQ system on the behaviour of those who stayed outside of it. The results show that outsiders had incentives to stay outside of the ITQ system and free-ride on the behaviour of the ITQ fleet. Management measures aimed at restricting their effort proved to be ineffective. The conclusions can be generalized to other situations where property rights based management systems are used and economic agents harvest a common resource pool.

Key words: Fisheries management / Effort restrictions / Property rights

1 Introduction

The purpose of this paper is to study the effect of regulation and spillover effects on the exit of boats from one fisheries management system to another. Using data on the Icelandic fisheries management system we estimate a Cox proportional hazard model of exit from a days-at-sea regime and incorporate both regulatory measures and the behaviour of firms in a contemporaneous ITQ system (Lancaster 1990).

An ITQ system was introduced in stages in the Icelandic fisheries, starting in 1979. First in the pelagic fisheries, but later in demersal fisheries. The system is based on sound economic principles and a well established theory (Arnason 1990; Grafton 1996; Hannesson 2004). From an economic viewpoint its stated aim is to maximize the profitability of the resource extraction activity, with the probable side-effect of conserving the fish stocks. Although the design of the system is based on economic and scientific principles its implementation has somewhat deviated from the theoretical ideal. Its implementation was marked by political and socio-economic factors. As pointed out by Eggertsson (2005) such major institutional reforms as introducing property rights in fisheries constitute a subtle art. In the period 1984 to 1990 an ITQ system had been implemented in almost all fisheries in Iceland with the notable exception of small scale fishermen. This is not the only deviation from an ideal ITQ system. A large part of the fishing industry is located in rural areas and the legislator has been reluctant to introduce measures which might have resulted in excessive imbalances among regions. This is one of the reasons that small boat operators where exempt from the ITQ system in the beginning and where left to operate under an effort-restriction regime. It soon became clear that effort restrictions proved of little effect so the legislator found it almost impossible to leave it at a *status quo*.

We argue that not only were the management measures inefficient but also we test the theory that small boats free-rided on the ITQ system, or more specifically, that all the conservation efforts, i.e. reduction of effort, was borne by the ITQ fleet but not the small boat fleet. The latter benefitted from the responsible behaviour of the former. In this study we focus solely on the cod fishery, it being the most important demersal fishery in Iceland.

Fishermen do not differ from other economic agents in the fact that they behave rationally. They maximize their utility given the numerous constraints they face. Those constraints are both due to natural circumstances such as weather conditions, non-observability of the prey and limited knowledge about the nature of the resource that they harvest, but other constraints are due to man-made measures such as the general regulatory framework in which they operate.

The literature on entry and exit of firms is large (Caves 1998; Hopenhayn 1992; Geroski 1995). This paper aims to contribute to the literature by measuring those two effects by using a Cox proportional hazard model on data on the Icelandic fisheries management system. Such models have been widely used both in economics but also engineering and medical studies (D'Agostino et al. 1990). Such models make the timing of entry and exit decisions explicit and take into account

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the length of stay on exit and entry behaviour. In economics the focus has mainly been on exit and entry in various industries for example Görg and Strobl (2003) study the effects of multinational companies on the survival of companies in Ireland and others (Disney et al. 2003) that study entry, exit and survival of firms in UK manufacturing. In a survey on the theoretical and empirical aspects of entry, the effect of institutional frameworks is almost totally absent from the stylized facts which can be learned from the literature (Geroski 1995).

It is fairly easy to show that when there are two fleets which operate under different management systems but harvest a common resource they inflict spillover effects on one another (Bowles 2000). Although those effects have been known to exist very few studies have attempted to measure this effect in fisheries. Few papers (Bhattacharjee et al. 2004) have tried to incorporate the institutional framework and changes in regulation into empirical analysis. In this paper we incorporate both regulatory measures and effects of externalities as covariates with exit behaviour in an industry.

What we are especially interested in is whether and how regulation measures affect the hazard rate and to explore the possibility that behaviour of firms outside the system influence the exit rate. The data is firm (boat) level data from 1992 to 2004.

The structure of the paper is as follows. First, we provide a short overview of the management measures which have been taken since 1980. Secondly we discuss some issues regarding the industry and the resource and finally we estimate a Cox-proportional hazard rate of exit for the boats. The final section concludes.

2 The Icelandic fisheries management system

Beginning in 1979 an Individual Transferable Quota (ITQ) system was gradually introduced in the Icelandic fisheries. The fishing industry plays a key role in the country's economy and signs of overfishing convinced the government to introduce the new system (Arnason 1991).

From the beginning of the ITQ system small boats were exempt from the program. It soon became evident that the small boat fleet was freeriding on the ITQ system. Their share of the total catch increased and the burden of working in a responsible fisheries management system was borne by boats operating under the quota system.

Those small boats outside the ITQ system were subject to days-at-sea restrictions and other technical constraints, described below.

The fleet consisted initially of vessels measuring less than 10 GRT, most of them around 10 GRT. They are rather homogeneous with regards to construction, made of fiberglass with powerful engines (max. speed ca. 30 knots) and with a holding capacity of up to 3 metric tons of fish. The crew is usually two persons although they can be operated by a single fisherman. The boats are designed to operate hand-lines but may also use long-line or gillnets. They fish almost exclusively demersal species, mostly cod, but also haddock, saith and other species.

The government tried to induce the small boat owners to exit the days-at-sea regime and join an IQ system for small boats. The difference between the IQ system for small boats and the ITQ system for others is the lack of transferability of quotas. Although the restrictions became more and more stringent over time there was an inherent resistance among those small boat owners to exit the days-at-sea regime and join the IQ system. It is important to note that once a boat has left the days-at-sea regime it is impossible to return to that system at a later date. We will argue that the reason for the resistance to exit is partly that small boat owners profited from the reduced effort of the ITQ fleet which again resulted in healthier stocks. At the same time the small boat fleet did not have to bear the burden of building up the stocks.

Finally, in late 2005, the Ministry of Fisheries abolished the days-at-sea regime and all vessels were incorporated into a quota system.

2.1 Chronology of management measures

As mentioned above the small boat fleet has been operating under many types of fisheries management systems the landmarks being the following:

- 1980–1985: Free fishing. Prior to the introduction of the ITQ system, vessels under 10 GRT were not under fisheries management. When the ITQ system was introduced these boats were outside of the system. Entry was easy. According to law the operations of those boats could be stopped, however, if the total catch of the fleet exceeded a pre-determined amount. This clause has never been implemented.
- 1986–1990: Effort-restricting regime. In an effort to try to limit the cod catch of the small vessel fleet, a system of limited fishing days was introduced in 1986. That same year the boats were banned from fishing for 49 days. A year later the number of banned days was increased to 64 days and in 1988 to 1990 the number of banned days was 69 days. In addition, legislators imposed a maximum allowable catch on vessels using gillnets to harvest cod.
- 1991–1995: Effort restrictions and ITQs. In 1991 it was decided that boats measuring 6-10 GRT should be incorporated into the ITQ system. Boats measuring less than 6 GRT where offered to choose between IQs and a specially designed hook and line limited effort management system. Only a small number of vessels opted for the ITQ system. The remaining boats were obliged to use either hooks or long-line but were banned from using gillnets. In addition they only had a limited number of fishing days which were reduced in number from year to year.
- 1996–2001: Special small boats ITQs and more restrictions. Still, in order to constrain the catches of the small boats, those outside of the ITQ system were given the option to enter a specially designed small-boats ITQ system for cod which had the special feature that the quotas were not transferable to other than small boats. Those who decided not to take this option where banned from fishing for a total of 176 days.

- 2001–2004: An extended small-boats ITQ system. In 2001, a special hook and line ITQ system was introduced for the smallest boats that was similar to the one from 1996, except that now demersal species other than cod were also introduced. The only allowable gear within this system was hook and line. Numerous boats of those still on fishing-days restrictions opted for this extended system.
- 2004: A complete small boats ITQ system. In 2004 the minister of fisheries finally decided that all boats still operating under effort restrictions should be incorporated into the small boat ITQ system. The only exception was for new boats with insufficient catch history. Those were required to enter the ITQ system in the next two years as they accumulated catch history.

It should be noted that although the law has consistently stated that small boats entering the ITQ system should not be alloted quotas based on catch history, that was nevertheless often the case. This means that instead of being penalized for excessive fishing they were rewarded with larger quotas based on their earlier catches. At the same time, the TAC has often been reduced for the whole ITQ fleet.

2.2 The industry and the resource

According to theory, an ITQ system induces a change in the behavior of fishermen.

Permanent property rights should, at least to some point, diminish the negative externality effects, which should reduce their effort, *ceteris paribus*, with a subsequent effect on the resource stock (Arnason 1990; Hannesson 2004). According to our thesis, it is this change in the ITQ-fleets behavior, which through the effect on the stock has an indirect effect on the behavior of the boats which are outside of the system. One would *a priori* assume that diminishing the number of allowable fishing days would, other things equal, limit the firms profits and therefore encourage exit. The reduction of effort by the TQ fleet counter-effects this incentive to exit the days-at-sea system for small boats. Put differently; economic theory would predict that if some inputs are constrained by regulation (days-at-sea) then the boats increase the use of other substitutable inputs. On the other hand if the stocks are getting bigger due to the constrained effort by the ITQ fleet, the outsiders have access to this bigger stock so catch per unit of effort should, *ceteris paribus* increase.

2.3 The Icelandic ITQ system and the cod stock

There is an inherent difficulty when judging whether the Icelandic ITQ system has been a success or not. The reason being that we do not know how the industry, let alone the resource, would have fared under some other management system.

The interplay between natural circumstances in the ocean, the multispecies interactions and the effect of the fishing activity is difficult to decipher. Although some scholars have criticized the system on various grounds, it is hard to find convincing evidence that points to the system being inefficient, or having totally failed its economic goals of increasing profitability and at the same time reducing effort. Most of the critique is aimed at the regional impacts of the system or the unfair grandfathering of the fishing rights when the system was being introduced (Runolfsson 1997; Gylfason 1993). It is a common claim that the ITQ system has failed to build up the stocks. Having in mind the inherent complexity of the ecosystem it is difficult to draw any clear conclusion from data on overall catches or stock measurements.

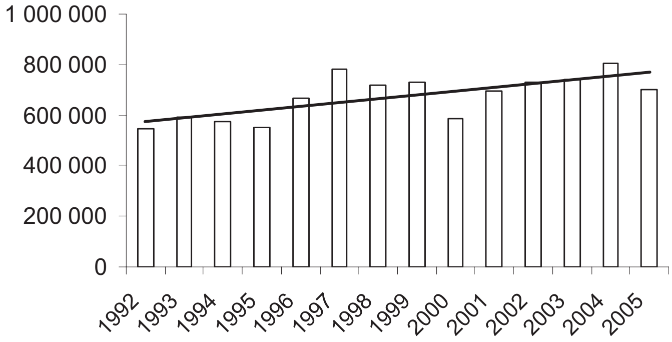

Fig. 1. Fishable cod stock 1992-2005 (>4 yrs) in tonnes.

What is of main interest to our analysis is the evolution of the cod stock over the period of observation as this is the stock that the decision makers face.

Figure 1 shows the size of the fishable stock (>4 years) from 1992 to 2005 as estimated by the Marine Research Institute. This figure shows almost a steady increase in the fishable stock size. And the increase is not negligible. The fishable stock size has grown from around 550 thousand tonnes in 1992 to around 700 thousand tonnes in 2005.

This data makes it clear that the resource which is being faced by the fishermen has been increasing over the period of observation. Our claim is that this increase, induced by a more responsible fishing management system, has affected the behavior of those outside of the system.

2.4 The data

We have data on the number of fishing boats under each management system and also aggregated catches for each fleet provided by the Directorate of Fisheries. Also we have more microeconomic data on the characteristics of each boat, i.e. size of the boat (GRT), home-port location, engine size and catches for each boat. The catch data are very detailed, e.g. on a monthly-basis.

Such a data set makes it possible to estimate a hazard rate function that explains the flow of boats from one system to the other (i.e. in and out of the effort-limitation system). When we look at the data, we see that the number of outsiders, i.e. those boats operating outside of the ITQ system, has been decreasing over the period from 1992 to 2004 (Table 1).

An interesting thing to notice is that although the number of vessels outside of the ITQ system decreases drastically over the period the catch per boat does not. If we group the vessels according to their timing of exit, we get some interesting phenomena.

Table 1. Number of "outsider"s' and their average catches (in kg) and outsider's share of total catch.

Season	No. of Boats	Avg. catch/boat	"Outsider"s' share of total catch
1992/'93	987	22 256	14%
1993/'94	1002	31 231	30%
1994/'95	1022	33 402	35%
1995/'96	592	27 575	14%
1996/'97	422	49 249	15%
1997/'98	363	36 192	7%
1998/'99	304	25 481	4%
1999/'00	299	30 304	5%
2000/'01	301	32 245	6%
2001/'02	288	43 119	8%
2002/'03	296	37 243	
2003/'04	293	32 668	

Table 2. Number of boats existing and entering.

Season	No of "exits"	No of "entries"
1992/'93	32	
1993/'94	49	72
1994/'95	409	72
1995/'96	193	10
1996/'97	75	12
1997/'98	57	6
1998/'99	34	6
1999/'00	23	13
2000/'01	24	10
2001/'02	28	9
2002/'03	23	28
2003/'04	293	14

Those that exited after 1997 had a peak in catches that year, although no such peak can be detected in the total catch of cod that year when looking at the whole fleet. This can also be detected by looking at the percentage of the catch of the outsider's fleet over the years, shown in Table 1.

Those are very crude results from crude data. Nevertheless they suggest that a more detailed analysis could disentangle common effects from individual effects.

2.4.1 Who exits and when?

It is not easy to draw clear conclusions about the exit decision of the fishermen by simply looking at the data. However, some descriptive statistics are in order.

Table 2 shows the number of boats for which the stated year was the last one inside the effort management system, i.e. the number of boats exiting the days-at-sea regime each year.

It is clear that there was a boom in exits in 1995 until 1998 but since then the number of exits was much lower. The great number of exits in 2004 signifies the closing of the old system so those exits are almost all the remaining boats. Their exits do not affect the general results for the previous years. According to information provided by the Fisheries Directorate almost all those boats entered into a quota-based system.

Table 3. Average catches (in kg).

Season	Exits	Enters	Active
1992/'93	22 256	6004	21 725
1993/'94	31 231	5244	14 574
1994/'95	33 402	42 298	32 242
1995/'96	27 575	22 723	53 040
1996/'97	49 249	36 575	69 861
1997/'98	36 192	34 302	51 390
1998/'99	25 481	11 684	35 317
1999/'00	30 304	23 518	45 697
2000/'01	32 245	28 597	44 960
2001/'02	43 119	20 107	74 205
2002/'03	37 243	26 827	34 911
2003/'04	37 243	32 668	37 853

2.4.2 Entries

One of the main criticism concerning the "outsider"s' of the ITQ system was that although the legislator tried to induce the vessels to join the ITQ system, there were still possibilities for certain vessels to enter the small-vessel system. By looking at our data set, we can see how many boats entered in the period under scrutiny (Table 2).

It is important to notice how we define "entries" and "exits". "Entries" are those that start fishing in a certain season within the period under observation. "Exits" are those which stop fishing in a certain season and do not resume their activity within the data period.

It is not uncommon in the literature to emphazise the role that size of firm plays in entry and exit (Geroski 1995). The data at hand show that due to formal restrictions on size it is hard to see any clear trend in boat sizes over the period. Most measures, such as GRT, show that the boats characteristics are quite homogeneous. The hp (horsepower) of the engines has however increased considerably over the period. However, looking at the average catches for each group of boats, i.e. "entrants", "exits" and all "active" vessels, clearly shows that they differ with regards to catches.

In Table 3 we compare each group for each year, which means that e.g. in the season 1992-'93 those who exited that year harvested on average 22 t, those who entered that year harvested on average 6 t and the average catch for all active boats (including those who exited and entered) was on average a little less than 22 t that season.

It is clear from this that those who exit used to catch more than those who did not. In the last seasons those average catch rates converged.

3 An extended Cox hazard rate model of exit

In order to gain further insights into the exit behaviour of boats from the days at sea regime into the quota system we estimated a Cox proportional hazard model. The main difference between hazard regression models and discrete outcome models (such a probit, logit, etc.) is that the former take the timing of alternative outcomes explicitly into account and make it possible to segregate the age aspect of the propensity to exit or entry from the effect of other covariates. It is therefore possible to disentangle the general effects of rules and regulation (incentive structure) from those that can be considered to be firm- or industry specific.

If we denote the hazard rate of boat i by λ_i i.e. the probability that this boat exits in the interval from t to $t + 1$, (given that he did not exit before) then

$$\lambda_{it} = \lambda_0(t)\exp^{\beta X_t}$$

and λ_0 is the baseline hazard function whose parametric form we do not specify, when all covariates are set to zero. X is a vector of explanatory variables, or covariates, which influence the hazard rate.

The covariates used in the estimation are: gross registered tons of the vessel (GRT), maximum days-at-sea allowed (maxdays), catch of boats (catch), the number of trawlers in the ITQ system (notrawl), the catch per GRT of the trawler fleet (catchpgrt), the size of the fishable stock (fishstock) and finally the price of quota in the ITQ system (quotaprice). We assume that those covariates are exogenous to the model. All but GRT are time-variant covariates. Since the fishery is an efficient market each actor takes the quota price as given and is hence exogeneous to the model.

Using some indicator of size are standard in this kind of analysis but due to the homogeneity of the small boat fleet we believe it is more appropriate to look at the catch of the boat as it indicates not only its capacity but also the intensity of its fishing activity. The size of the fishing stock is an appropriate measure of the quantity of fish that each vessel (or rather manager) faces and the quota price is theoretically an indicator of the success of the fishing management system (Arnason 1990).

The robustness of the model estimates is tested by omitting weak but non-trivial covariates. Consistent results of all model estimations of the significant variables imply the robustness of the estimates.

A positive coefficient implies a postive effect of exiting from the days-at-sea regime to the quota system. As survival analysis has its origins in medical science it is often easier to think in terms of patients and treatments rather than in economic terms. Seen in this light we may think of the firms/boats as agents where the probability of exiting is influenced by their respective characteristics and the "treatment" they receive. In our case the main characteristics are their size (GRT), how much they catch (catch) and how efficient they are (catch/grt) and catch/day. The "treatment" they receive is of two types. Firstly, there is the direct management measure, i.e. the maximum fishing days allowed (maxdays) and secondly there are derived effects of other management measures, such as the size of the fishable cod stock (fishstock) and the price of the quota.

The Cox proportional hazard rate model approach does not allow a quantitive interpretation of the estimated parameters. However, it gives qualitative information on whether specific covariates incite or dissuade exit.

In order to facilitate the interpretation of the estimation results, the variables have been scaled by factors of 10, 100 or 1000 to obtain similarities in magnitutes. This does not affect the statistical outcomes otherwise.

Table 4. Estimation results A.

Covariate	Coefficient	p-value	Hazard ratio	95% CI
catch	−0.000447	0.003	0.999553	[0.999258;0.9999848]
GRT	0.121543	<0.0001	1.129238	[1.083375;1.177043]
maxdays	0.016671	0.2614	1.016811	[0.987656;1.046827]
sumvstac	−0.001275	0.9539	0.998726	[0.956437;1.042885]
notrawl	−0.136311	0.259	0.872571	[0.688682;1.105562]
catch/grt	0.012995	0.2885	1.013039	[0.989094;1.037564]
catch/day	0.000082	0.215	1.000082	[[0.99953;1.000211]
fishstock	0.9267222	0.003	2.526213	[1.370229;4.4657435]
quotaprice	−0.184139	0.0001	0.83182	[0.756413;0.914745]

Table 5. Estimation results B.

Covariate	Coefficient	p-value	Hazard ratio	95% CI
catch	−0.000449	0.0029	0.999552	[0.999257;0.9999847]
GRT	0.121683	<0.0001	1.129396	[1.083579;1.177149]
maxdays	0.00367	0.6717	1.003677	[0.986786;1.020856]
catch/grt	0.012919	0.2898	1.013003	[0.989059;1.037526]
catch/day	−0.000082	0.2141	1.000082	[[0.99953;1.000211]
fishstock	1.002372	<0.0001	2.724737	[1.763681;4.209486]
quotaprice	−0.17566	<0.0001	0.838903	[0.78757;0.893582]

4 Results

The results of the estimated Cox proportional hazard model, described above, when all the covariates have been incorporated into the model are shown in Table 4. The sample consists of 239 boats, with a total of 6116 observations.

The signs are as one would expect but we see that some of the parameters are not statistically different from zero. It should be kept in mind that the coefficients in a Cox regression relate to hazard so that a positive coefficient indicates a negative effect on not exiting and similarily a postive effect indicates a postive effect on "survival" of the covariate under scrutiny. A test of the overall statistical significance of the model is given by the chi-square test statistic shown in the table. It is calculated by comparing the deviance of the model, with all of the covariates specified, against the model with all covariates dropped. The individual contribution of covariates to the model can be assessed from the significance test given with each coefficient in the main output, i.e. the corresponding p-values.

If we drop the number of trawlers and the share of the "outsider" fleet of the total catch we get the results shown in Table 5.

Those results are very similar to the specification using all the covariates. There are neither changes in signs, nor considerable differences in magnitudes between these two specifications. The covariates which may be interpreted as proxies for efficiencies or intensities of effort (catch/day and catch/GRT) are still not significantly different from zero. Therefore it seems that the main factors which influence the probability of a boat exiting the days-at-sea regime are the catch volume of each boat, the size of the fish stock they exploit and the quota price. The effort restriction, maximum allowable fishing days, is also not statistically different from zero, but we nevertheless include it in the models specification to see if that changes with

Table 6. Estimation results C.

Covariate	Coefficient	p-value	Hazard ratio	95% CI
catch	−0.000335	0.0058	0.999666	[0.999428;0.999903]
GRT	0.122123	<0.0001	1.129396	[1.083579;1.177149]
maxdays	−0.004853	0.166	0.995159	[0.988348;1.002016]
fishstock	0.783392	<0.0001	2.188885	[1.866684;2.5667]
quotaprice	−0.149359	<0.0001	0.86126	[0.827194;0.896729]

Table 7. Estimation results D.

Covariate	Coefficient	p-value	Hazard ratio	95% CI
catch				
GRT	0.092052	< 0.0001	1.096422	[1.057723;1.136537]
fishstock	0.795045	<0.0001	2.21454	[1.888913;2.596303]
quotaprice	−0.150353	<0.0001	0.860405	[0.826377;0.895833]

omitting other covariates. Table 6 shows the estimation results when catch/day and catch/GRT have further been dropped out of the specification.

The result of dropping catch/day and catch/GRT seems to have the only notable effect of lowering the hazard rate for the fish stock, but this decrease does not seem to be of a great magnitude and does not alter the main results in any way.

Finally, we represent the estimation outcome when all covariates but GRT, the fishable stock size (fish stock) and the quotaprice have been omitted from the model. The following table reports the results.

Again, the main findings are intact and it seems that those are the factors which have the greatest impact on the probability of exit from the days-at-sea regime.

The statistical properties of the estimation results reported in Table 7 seem to be satisfactory. Different specifications, where one or several covariates were dropped from the estimation do not change the main outcomes, signs of coefficients or their magnitudes significantly.

Perhaps the most striking outcome is that the chief regulatory measure, i.e. the maximum allowable days-at-sea seem to have an insignificant effect on the probability of exit. This result is however in accordance with the common belief that simple input restrictions are not an efficient way of controlling effort (FAO 1983). Fishing effort is a bundle of various input factors and there are numerous ways of subsituting one factor for another. This also is in concordance with the idea that this small-boat fleet is not the same now as it was a decade or two ago, as the fishing gear and motors have become more powerful than before. This is left for further research. Nevertheless, our analysis consistently suggests that limiting the allowable fishing days has been unsuccessful in inciting boats to exit the days-of-sea regime. The hazard ratio is under some specifications even positive which implies that limiting the allowable fishing days has even had the perverse effect of lowering the incentive of exit. This could possibly indicate model misspecification, but a more plausible reason is that the quota system has exerted a postive externality effect on the outsiders, which is the scenario of interest in our case. The model results show that the externality effect of the quota system overshadows the effect of the diminishing number of allowable days at sea.

The level of activity, measured by the catch level does not seem to be significant factor in affecting exit behavior from the system. This holds irrespectable of whether we measure efficiency by catch/GRT or catch/day. These results might also indicate a high level of heterogeneity between different boats, as reflected in relatively high standard errors.

Additionally, then it must be acknowledged that GRT is perhaps not a reliable measure of fishing power due to more powerful motors and fishing gear.

Turning to the two remaining covariates, we see that an increase in the fish stock which the boats observe induces them to exit, and vice versa, while the opposite holds for the price of quota. Here it must be kept in mind that the fish stock is the one that all fishing vessels observe, be they in the ITQ, IQ or days-at-sea regime. It is therefore difficult to estimate the overall effect of an increasing fish stock as it is faced by the outsiders and the insiders. If we adopt the previously mentioned idea that the quota price is a measure of the present and future success of the fishing management system as a whole we seem to be able to draw the conclusion that the apparement success of the system, as it manifests itself in the increasing quota prices, has an inverse effect on the decision to exit the days-at-sea regime.

5 Conclusion

We have discussed the main features of the fisheries management system in Iceland for the period 1992 to 2004. A sometimes overlooked fact is that although the mainstay of the management system has been an ITQ system then a contemporanous system of effort restrictions (mostly using restrictions on the maximum allowable days at sea) has been in effect for the small vessels. During the last decade, the authorities have been encouraging those small boat owners to enter a quota system, mostly by reducing the number of days allowed for fishing.

We argue that those measures have had little success partly owing to the fact that the small scale fishermen have reaped the benefits of the ITQ system, where vessels have

reduced effort and contributed to the well-being of the stocks and industry.

Using a Cox proportional hazard model we estimate how various covariates affect the exit from the days-at-sea system our main findings are that reducing the number of allowable fishing days has contributed little to exits while the reduction of effective effort in the ITQ system has greatly hindered the flux of the small boats from the days-at-sea regime. Additionally, we have argued that the success of the ITQ system has partially delayed the entry of those who have been operating outside. Seen in this light the Icelandic ITQ system has exerted a postive externality on those fishermen who are operating outside of the system. At the same time the fishermen working under the ITQ system have been left to the task of bearing the burden of reducing their effort and building up the fish stocks.

Our results indicate that fisheries management is a subtle art. A well designed fisheries management system must be free of loop-holes. The Icelandic experience shows that even exceptions that seemed to be minor at the time led to suboptimal behaviour by some fishermen entailing loss of efficiency. It is perhaps the success of the quota system, in reducing overall effort, which led some to benefit from staying out of it.

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