POSSIBLE STAKEHOLDER CONFLICTS IN QUOTA REGULATED FISHERIES

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ABSTRACT

Fisheries economists and fishery scientists have forcefully argued that access to fisheries has to be restricted so as to increase stock size, harvest and/or profitability compared to what would be the results of free access. Fisheries economists have pointed out that management by Individual Transferable Quotas (ITQs for short) fare better than other systems of management considered. It is the purpose of this paper to ask what kind of resource stewardship would best serve different stakeholders in an ITQ fishery. The stakeholders in focus are quota holders, non-quota-holding fishing firms (skippers) and processors. It is shown, utilizing a simple model, that non-quota holding fish firms would argue for smaller steady-state size of the fish stock than would quota holding firms. Fishery managers may find themselves in the line of fire between the two. The final outcome may well be decided by the political weight of either group. <P>

Keywords:

Introduction

Fishery economists and fishery scientists have forcefully argued that access to fisheries has to be restricted so as to increase stock size, harvest and/or profitability compared to what would be the results of free access. Fisheries economists have pointed out that management by Individual Transferable Quotas (ITQs for short) fare better than other systems of management considered. Qualifications apply as pointed out by several authors. (Squires, Campbell et al. 1998) review some of the relevant literature. Problems invoked or aggravated by ITQ based management are related to discarding of less valuable catch, by-catch of non-targeted species and quota-substitution (reporting cod to be haddock, for instance). Squires, Campbell et al. op. cit. point out that ITQs should improve resource stewardship as fishers may be faced with longer term interest in the fishery. A variety factors can weaken the resource stewardship effect, however. Squires, Campbell et al. point out that quota-holders may lease quota to skippers and crews with no long-term attachment to the fishery[1]. ITQs have proven hard to implement. Politicians have had to be inventive in terms of practical solution. One solution that has gradually evolved in Iceland is to split the ITQs between big vessels and hook-and-line vessels. That has eased tension in some aspects, but may increase tension in other aspects. This paper deals with some of the possible matters of debate. Furthermore, fishers and fishery scientists may disagree on the state of the stock and hence the appropriate size of total allowable catch (TAC).

It is the purpose of this paper to consider the possible conflict between quota-holders whose financial position is directly affected by the future development of the industry and non-quota holding fishers and processors whose financial position is only indirectly affected by the future of the fishing industry. Fishery managers (politicians) are caught up in the middle between the above mentioned interests as they have to fix the TAC on a year to year basis and periodically turn to the aforementioned stakeholders for renewal of their political mandate. To

[1] In the model presented below we will assume that interests of non-quota holding skippers and crews are represented by seamans unions.

complicate matters further, fishery managers may have the power to fix the structural composition of the fishing fleet as in Iceland when the quota is split between hook and line boats and big vessels.

The reminder of this paper is organized as follows: A model of the cost structure and the profit of big vessels and hook and line boats is presented in the next section, then we consider the problem of the fishery manager assuming that s/he is free to fix management strategy for the fish stock, division of quotas between big vessels and hook-and-line boats and number of big vessls. A fourth section is devoted to map out the optimal stock management as seen through the lenses of hook-and-line quota holders, a fifth section discusses the stock management wished for by the big vessel owners. A last section offers conclusions and discussion.

Model of cost structure and profit of big vessles and hook and line boats

The model presented in this paper is an adoption and simplification of (Grafton 1992). Assume that there are two types of vessel fleets operated. A big vessel fleet (B), and a hook and line fleet (H). Before operating a big vessel its operator has to invest a considerable amount of capital, *K*. Investment necessary for operation in the hook and line fleet is far less and will be assumed to be of no importance. Given investment, catch of one unit of fish requires less effort in the big vessel fleet than in the hook and line fleet. Assume further that use of effort in a typical fishing firm (e_i) depends on catch (q_i) and abundance of fish at the fishing ground as measured by the indicator, *b*, and the efficiency of the adopted techology, *s*, in the following manner:

$$e_i(s,\pi,q)=\begin{cases}\dfrac{1}{s^2 b}q_i^2 & \text{for the big vessel fleet}\\[2ex] \dfrac{1}{b}q_i \quad q_i\le\overline{q}, & \text{for the hook and line fleet}\end{cases} \qquad (1)$$

Here the parameter *s* is a productivity factor, *s*>1. Note that for given abundance of the fish stock (*b*), big vessels operate under a law of diminishing return to scale while the hook and line vessels operate under a law of constant return to scale until they reach a constraint of maximum capacity. If vessel owners were free to compete for inputs, quotas included, only the most profitable and effective vessels would prevail. Not so here as it will be assumed that the fishery manager can fix the fraction π of total catch that is caught by "efficient" vessels. This could be done indirectly by a complicated set of regulation and restrictions on gear use, area-closures, landing restrictions etc in an effort based fishery management system. In a ITQ system the fraction π can be fixed more directly when quotas are allotted and divided between vessel classes as already mentioned in the case of Iceland above. Lets assume that quotas are transferable within each class of vessels but not between categories.[2] In addition to regulation

[2] This assumption is very much in line with how the system is organized in Iceland. A holder of big vessel quota can (almost) freely sell or lease out that quota to other big-vessel owners. He can also sell or lease to hook and line vessel owners, but no-one does as prices are much lower in the hook and line system. Holders of hook and line quotas can now sell or lease their quotas to other hook and liners, but

of share of hook and line fishers and larger vessels the fishery is regulated by a yearly Total Allowable Catch (TAC) and Individual Transferable Quotas (ITQs) as already alluded to.

Assume that the initial allotment of quotas is (at least partly) done by grandfathering the quotas to existing fishing firms. Hence, a typical fishing firm, either a big vessel or hook and line firm, operating under ITQ regulation can be viewed as two separate units. The first unit is the fishing operation unit. That unit rents fishing rights and applies the fishery technique as it best can in order to maximize profits from the operation. The second unit is an ITQ holding unit. That unit rents out the quota holdings of the firm either to its own operation or to other operators.

In a steady state situation the discounted value of the profit of representative big vessel operator can be written as:

$$BO_i = \frac{1}{r}\left[Pq_i - \frac{cq_i^2}{bs^2} - r\Gamma_B q_i - rK \right] \qquad (2)$$

Here, BO_i denotes the expected discounted value of the steady state profits from operation of the big vessel fishing unit. The variable r denotes the discount rate, P is the unit price of output, $r\Gamma_B$ is the rental value of quotas and rK is the rental value of capital utilized by the big vessel fishing unit. The variable c denotes the unit cost of effort. The steady state value of profits in big-vessel quota-holdin unit can be written as

$$BH_i = \Gamma_B A_i = \Gamma_H \alpha_i (\pi \bullet TAC) \qquad (3)$$

Here, A_i is the initial allotment of quotas to the firm, π is the share of Total Allowable Catch (TAC) allotted to big vessels and α_i is the share of big vessel quota allotted to the firm for free. We have that $0 \le \sum_i \alpha_i = \alpha \le 1$. Should the fishery manager auction the ITQs to the highest bidder, then $\alpha = 0$. That parameter would be one if current vessel owners were grandfathered into the system at the outset. Any form of rent-recovery or politically orientated allotment of quotas on behalf of the fishery manager would result in the parameter being somewhere in between the extreme values zero and one.

Similarly, the profit of a typical hook and line operator and quota holder can be written as:

$$HO_i = \frac{1}{r}\left[Pq_i - \frac{cq_i}{b} - r\Gamma_H q_i \right] \qquad (4)$$

and

$$HH_i = \Gamma_H B_i = \Gamma_H \beta_i \left[(1-\pi) \bullet TAC \right] \qquad (5)$$

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not to owners who would utilize the quota against big-vessel catches. Hence, in effect the systems are seperated, except that both fish from the same "pool" and both supply to the same ex-vessel market.

Here, HO_i is the profit of the operator, while HH_i is the profit of the quota holder. B_i is the share of hook and line quotas allotted to firm *i*, β_i is the share that firm *i* is allotted from the total hook and line quota (given as $(1-\pi)TAC$). Γ_H is the market price of hook and line permanent quotas. We have as before that $0 \le \sum_i \beta_i = \beta \le 1$. Should the fishery manager auction the ITQs to the highest bidder, then $\alpha = 0$.

Steady state catch and steady state TAC are given by:

$$TAC = \sum_i q_i = Bb\left(\bar{b} - b\right) \qquad (6)$$

Equation (6) is the equilibrium condition for the fishing stock and is similar to equation (3) in (Grafton 1992). The right hand side of (6) describes (annual) growth of the fishing stock under consideration. The variable b is an index of size of the stock; B is a scalar while $\bar{b}$ is sometimes referred to as a measure of the carrying capacity of the environment. The form of the function implies that growth is fastest for stocks that are neither too small nor too large. Small stocks might not produce enough recruits to sustain the size of the stock while large stocks might endure low fertility due to high use of energy for basic survival. Maximum sustainable yearly catch (TAC) or maximum sustainable yield (MSY) requires that $b = \bar{b}/2$.

Maximizing (2) with respect to q_i yield the individual big vessel operation firm demand for ITQs, here reported in price form:

$$\Gamma_B = \frac{P}{r} - \frac{2c}{rbs^2} q_i \qquad (7)$$

Aggregating individual demands in the usual manner (horizontal addition of individual demand curves) yields:

$$\Gamma_B = \frac{P}{r} - \frac{2c}{rbs^2} \sum_{i=1}^{N} q_i \qquad (8)$$

N is the number of big vessels (and big vessel operating firms). Taking the equilibrium condition (6) and the division of the TAC between big vessels and hook and line vessels into account further yields:

$$\Gamma_B = \frac{P}{r} - \frac{2c}{rs^2 b} \pi TAC \qquad (9)$$

Investment in the big vessel fleet is time- and resource intensive. It may take considerable time for a prospective investor to go from plan to participation in the industry. In the long run, however, firms will invest or be established in the big vessel operation if excess profits are to be earned. Hence, the equilibrium position is that aggregate profits in the big vessel operation are zero, i.e. that $\sum_{i=1}^{N} BO_i = 0$, which, taking (2), (6) and (9) into account and observing that average catch per vessel is given as $1/N \sum_i q_i = \pi TAC/N$ yields:

$$N = \sqrt{\frac{c}{rK}\frac{\pi}{s}\frac{1}{\sqrt{b}}TAC} = \sqrt{\frac{c}{rK}\frac{\pi}{s}B\sqrt{b}\left(\bar{b}-b\right)} \qquad (10)$$

Here N is the total number of big vessels fishing. Number of vessels (firms) increases as big vessel share of total catch increases. Number of vessels decreases if big vessels become more efficient, i.e. if c/s^2decreases. Number of vessels also decreases if investment costs (r and/or K) increases. The relation between stock size and number of vessels depends on the stock size. If the stock is small an increase in the stock size may increase number of vessels. If the stock size is close to $\bar{b}$ then the opposite will happened. Number of firms (vessels) is maximized, cet. par., when the stock is at a third of its maximal level, i.e. considerably less than at its MSY level.

The profit maximation process in the hook and line industry yields the following condition:

$$\Gamma_H = \frac{P}{r} - \frac{c}{rb} \qquad (11)$$

Hence, both short term and long term profits in the hook and line industry are competed away in the quota market. All rent created in that industry will accrue to the holders of hook and line quotas. Remember that $\bar{b}$ is the maximum stock size. Hence, the existence of non-negative hook-and-line quota implies that:

$$P > \frac{c}{\bar{b}} \qquad (12)$$

If this condition is not fulfilled the stock is of no economic value, even in its virgin state.

Problem of a fishery manager

Assume that a fishery manager's objective is to maximize aggregate profit in the industry. The broadest set of instruments applicable is the TAC (or, equivalently, in the long run, the stock size b), the split of quotas between big vessels and hook and line boats (π) and the size of the big vessel fleet. We can write this as:

$$\underset{b,\pi,K}{Max}\, L = PBb\left(\bar{b}-b\right) - cB\left(\bar{b}-b\right)\left(1-\pi\right) - \frac{c}{s^2}\frac{B^2 b\left(\bar{b}-b\right)\pi^2}{N} - \pi rNK \quad s.t.\ 0 \le \pi \le 1 \qquad (13)$$

The first order conditions for solving the fishery managers problem are given as:

$$(i) \quad \frac{\delta L}{\delta \pi} = cB\left(\bar{b}-b\right) - \frac{c}{s^2}\frac{B^2 b\left(\bar{b}-b\right)2\pi}{N} - rNK = 0 \quad or \quad \pi\left(1-\pi\right) = 0$$

$$(ii) \quad \frac{\delta L}{\delta b} = PB\left(\bar{b}-2b\right) + cB\left(1-\pi\right) - \frac{c}{s^2}\frac{B^2\pi^2}{N}\left(\bar{b}-b\right)\left(\bar{b}-3b\right) = 0 \qquad (14)$$

$$(iii) \quad \frac{\delta L}{\delta N} = \frac{c}{s^2}\frac{B^2 b\left(\bar{b}-b\right)^2\pi}{N^2} - rK = 0$$

Equation (14)(*i*)-(*iii*) implies that the optimal division of quotas between the two fleets, optimal size of the stock and optimal number of big vessels depends on both ecological and economic characteristics of the fishery. The first condition reflects that the gain of increasing the share of big vessels, say, should be equal to the loss so incured as share of the hook-and-line boats must be reduced. The second condition takes into account the fact that expansion of the stock size effects both costs and revenue associated with the fishery. Bigger stock will reduce revenue if $b > \frac{1}{2}\bar{b}$. Bigger stock may also reduce cost through the cost-externality of bigger stock in the big vessel cost-function. The third condition reflects the fact that the fleet of big vessels should not be expanded unless the savings in terms of reduced cost more than covers the capital costs associated with the expansion. Taken together the conditions imply that the fishery manager can not reduce the fishery rent by optimally deciding upon the size of the TAC, the number of big vessels taking part in the fishery and the allocation of quotas between big vessels and the hook-and-line fleet. In other words, using some arbitrary method, like historical participation, as the method to fix the TAC, the number of vessels and the split between categories of vessels will most likely reduce the fishery rent as compared to what could be achived.

Now, substitute (14)(iii) into (14)(i) to yield:

$$s^2 N = 3cb\left(\bar{b}-b\right)\pi B \qquad (15)$$

Substitute (15) into (14)(ii) to yield:

$$3b\left[P\left(\bar{b}-2b\right) + c\left(1-\pi\right)\right] - \pi\left(\bar{b}-3b\right) = 0 \qquad (16)$$

We can use (16) to infere optimal stock size for given division of quotas between the two groups of vessels. Should all quotas be allocated to hook and line boats so that $\pi=0$, then

$$b^{op}_{\pi=0} = \frac{\bar{b}}{2} + \frac{c}{2P} \qquad (17)$$

Note that the condition (12) together with (17) implies that $\bar{b}/2 < b^{op}_{\pi=0} < \bar{b}$.

Should all quotas be distributed to big vessels so that π=1, then:

$$b^{op}_{\pi=1} = b_1 > \frac{\bar{b}}{2} \quad \text{or} \quad b^{op}_{\pi=1} = b_2 < \frac{\bar{b}}{3} \qquad (18)$$

As aggregate costs are decreasing in b we can exclude b_2 as a possible solution. It is not possible to decide if $b^{op}_{\pi=1}$ is bigger or smaller than is $b^{op}_{\pi=0}$. But we can show that:

$$\frac{\delta b^{op}_{\pi=0}}{\delta \pi} > 0 \qquad (19)$$

It can also be shown that if $b > \bar{b}/2 + c/2P$ and $P/(1+P) > c$ then $\frac{\delta b^{op}_{\pi=1}}{\delta \pi} > 0$. Thus we know, for the given constellations of external parameters, that the size of the optimal stock is increasing with π when π is small and most likely also when it is large.

Optimal size of stock as seen by hook and line quota holders

The income accruing to hook-and-line quota holder is given as $\Gamma_H Bb(\bar{b} - b)(1-\pi)\beta$ This income will be affected by the size of the stock as chosen by the fishery manager. Assume that $1 \geq \beta > 0$. Then the maximum value of hook-and-line quota holder income is obtained if:

$$b^{op}_{H} = \frac{\bar{b}}{2} + \frac{c}{2P} \qquad (20)$$

We note that $b^{op}_{H} = b^{op}_{\pi=0}$. That implies that if it is optimal to have the hook-and-line fleet fish up all the TAC then the fishery manager and the quota holders will agree on the size of the stock.

Observe also that the importance of opinion regarding the size of the stock reduces as the parameter β is reduced. Hence, the more of the fishery rent that accrues to the public purse the less important is it for the quota holders to fight for a given harvesting policy.

Optimal size of stock as seen by big vessel quota holders

The income accruing to big vessel quota holders is given as $\Gamma_B Bb(\bar{b} - b)\pi\alpha$. Assume as above that $1 \geq \alpha > 0$. The income of big vessel quota holders will, just as the income accuring to hook-and-line quota holders be affected by the size of the stock as chosen by the fishery manager. The first order condition for maximation of big vessel quota holder income is that:

$$\frac{\delta\left[\Gamma_B \pi Bb\left(\bar{b}-b\right)\alpha\right]}{\delta b} = \frac{\alpha B\pi}{r}\left[P\left(\bar{b}-2b\right)-2cB\frac{\pi}{s^2}\left(\bar{b}-b\right)\left(\bar{b}-3b\right)\right]=0 \qquad (21)$$

The optimal stock as seen by the big vessel quota holders, when the parameter π is (hypothetically) sat equal to 0 is given as:

$$b^B_{\pi=0} = \frac{\bar{b}}{2} \qquad (22)$$

Furthermore, it can be seen that the optimal size of the stock as seen by the big vessel owners, b^B, is not equal to the optimal size of the stock as seen by the hook and line quota owners, b^H, unless for specific constellation of the exogenous[3] parameters π, *B*, *P*, *c* and *s*.

Utilizing (21) we find that,

$$\frac{\delta b^B}{\delta \pi} = \frac{\left(\bar{b}-b^B\right)\left(\bar{b}-3b^B\right)}{4\pi\left(\bar{b}-\frac{3}{2}b^B\right)-\frac{P}{{}^{c}\!/_{s^2}\,B}} \qquad (23)$$

Hence, assuming that $b > \bar{b}/3$, we have that:

$$\left.\frac{\delta b^B}{\delta \pi}\right|_{\pi=0} > 0 \qquad (24)$$

Thus, as the big vessel quota holders increase their share of the quota above zero the optimal stock as they see it increases. The constallation of the exogeneous parameters can be such, however, that the stock size they wish for is never as big as the stock size hook and line fishers wish for. Investigating the possible sign of $\left.\frac{\delta b^B}{\delta \pi}\right|_{\pi=1}$ indicates a bit surprisingly that the big vessel quota holders may wish for a smaller stock as their quota holding share increases. For that to be true the ratio of price to cost of fishing a kilo had be very low suggesting that this might coincide with parametric constellations that rendered the resource economically uninteresting.

Observe that, as in the case of the hook-and-line quota holder, the importance of opinion regarding the size of the stock reduces as the parameter α is reduced. Hence, the more of the fishery rent that accrues to the public purse the less important is it for the quota holders to fight for a given harvesting policy.

[3] π is exogeneous from the point of view of the quota holders, not necessarily from the point of view of the fishery manager.

Summary of findings and conclusion

The stock externality that is manifested in the cost function of the vessel operators and rent accruing to holders of quotas is more valuable to hook and line operators than to big vessel owners. Hence, one would expect hook-and-line quota holders to be more eager to keep the stock big than big vessel quota holders. Our model reveals that this may or may not be true if big vessel quota holders do hold most of the quotas as the big vessel quota holders attitute to size of the stock is influenced by their share of the total quota.

Assuming inelastic demand for fishery products it is in the interest of the processor sector that sustainable yield is at its maximum, i.e. that $b = b_{MSY} = \bar{b}/2$. Processor lobbyists would try to persuade the fishery manager to fix the TAC so that b_{MSY} would be the long term stock size. The stock size wished for by fisherman unions organizing fishers working on big vessels depends on the form of remuneration and union objectivs. Union in the big vessel sector that only care about membership would wish the stock to be at the size that maximizes number of vessels. Such a union would try to persuade the fishery manager that the stock should be $\bar{b}/3$. Union organizing members that are remunerated by gross share of revenue would also find their interests best served if stock size was equal to b_{MSY}. Unions organizing members that are remunerated by net share (revenue less operating costs) would lobby for same size of the stock as would the big vessel quota holders. Hook and line quota holders would wish for a stock bigger in size than b_{MSY}, as would big vessel quota holders assuming that their share of the total quota, π, is bigger than zero. The hook and line and the big vessel quota holders would not in general agree on the size of the quota.

Now, as modelled here the Fishery Manager is the only one who has the means to fix the long term stock size. In the real settings some political minister is the ultimate Fishery Manager. Hence, if stakeholders are interested, and can organize politically, they will be able to influence the final decisions regarding stock size. Stakeholders political influence will depend on number of things. Importance of net income generated by the fishery is but one of those things. Hence, other aspects as number of voters affected or distribution of voters by voting districts may play a role.

Empirical evidence supporting the conclusions given above is not in abundance. One must also keep in mind that the political game does not only evolve around the question of size of the stock and of the sustainable TAC. It also evovles around the question of distribution of quotas. Hook and line quota holders argue that they should have more quotas as do the quota holders of big vessel quotas. It may be useful for a group of quotaholders to disguise an attempt to use their political clout to increase their lot in discussion of optimal size of the stock.

Sporadic observers of the Icelandic debate may have noted that seaman's unions and non-quota holding processors usually argue for higher catches (and consequently for lower stocks) than does the federation of Icelandic vessel-owners.[4] The unions usually argue that models of the Fishery Manager (The Ministry of Fishery and the Marine Research Institute) underestimate the size of the quota-regulated stocks. Others (Kristján Pétursson for instance) argue that the basic policy of rebuilding stocks is misplaced as bigger stocks induce higher rate of cannibalism among predators as the cod: Less catch implies higher natural mortality. The quota-holding vessel owners who by and large have accepted the advice offered by the Marine Research Institute do not share those views. Hence, one could argue that the unions some processors

[4] See for instance numerous pieces by Kristján Pétursson on the op-ed pages of the Morgunblaðið last 15-20 years.

have chosen a line of argument that in effect is in their interest according to the model of the present paper. It is an open question if the unions argue as they do as consequence of analysis similar to that presented in the paper or not.

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